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Study on Spider Diversity Associated with an Apple Orchard, Nainital District, Uttarakhand, India

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Abstract: The present study aimed to understand the diversity of spiders in and around the Dev Ban apple orchard from October 2021 to September 2022 in Ramgarh, which lies in the Kumaun region of Nainital district, Uttarakhand, India. This is the first investigation to reveal the presence of 246 spider individuals representing 21 species belonging to 16 genera and 10 families from the study area. The spider sampling was carried out by using visual searching and handpicking, ground hand collection, aerial hand collection, the kerchief method, pitfall traps, beating, and the sweep netting method. The most dominant family of spiders was observed to be the Araneidae (29%), followed by Lycosidae (18%), Salticidae (15%), Pholcidae (10%), Sparassidae (09%), Thomisidae (07%), Linyphiidae (05%), Oxyopidae (04%), Philodromidae (03%), and Theridiidae (1%). The most dominant spider species was *Alopecosa cursor* of family Lycosidae. Also, the Simpson's Diversity Index (SDI) was calculated, which resulted in a value of 0.94, which indicates the presence of high spider species diversity in the study area. This preliminary study gives base line information about the spider's diversity from the unexplored orchard system of the Kumaun region of Uttarakhand.

Keywords: Spider, Apple Orchard, Simpson's Diversity Index, Araneidae, Lycosidae, Salticidae, Pholcidae, Sparassidae, Thomisidae, Linyphiidae

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Introduction

Spiders play an important role in ecology because of their exclusively predatory nature to regulate insect populations. The availability of spiders in any place depends on the occurrence of the number of insects in an area (Wise, 1993). They are omnipresent groups of arthropods with more than 51,260 described species (World Spider Catalog 2023). Spiders have outstanding predation abilities due to their consumption of approximately 600 million tonnes of prey per year by the whole of the spider community on earth (Nyffeler and Birkhofer, 2017). Spiders are also

not particular about their prey choice, which helps in the regulation of pest populations in different terrestrial habitats (Nyffeler and Benz, 1987). Contrastingly, spiders are also food for many animals like birds, frogs, etc. The physical structure of environments has an important influence on the habitat preferences of spider species and ultimately on the composition of spider communities (Uetz, 1991), which also suggests that species-specific responses to variations in habitat structure are important in structuring the overall spider community (Weeks and Holtzer, 2000). Their population's sudden rise or decrease could be a sign of unfavourable or favourable changes in the environment. Spider population decline could be a sign of pollution's direct impact on them or its impact on the spiders' primary food source, as the number of spiders may also decline due to a shortage of food sources or resources.

As per the taxonomical view, spiders benefit from organic farming and shady exposure; from a behavioural perspective, spiders with different foraging strategies show high variations in their responses to different environmental conditions; and from a morphological perspective, body size within guilds is differently conditioned, resulting in the selection of small individuals. These observed differences in taxonomical, behavioural, and morphological responses of spider communities to habitat properties highlight the importance of examining their assemblages from different perspectives when assessing how they respond to changes in management practices and topographic features (Rosas-Ramos, 2020).

In most ecosystems, the regulation of other invertebrate populations is mostly controlled by spiders, a significant but understudied group of arthropods (Russell-Smith, 1999). Spiders have received minimal attention from the conservation community in spite of their well-documented ecological function in many ecosystems, high diversity, and threats (Sebastian *et al*., 2005). Understanding the patterns of variety on such a relevant regional scale is necessary for conservation planning efforts to preserve the diversity of spiders (Uniyal and Shrivastava, 2012). Although spiders are among the most common and diverse groups of organisms in Uttarakhand, little research has been done on them. The present study aimed to divulge the spider diversity associated with the selected apple orchard in Ramgarh, Nainital district, Uttarakhand, India.

Materials and Methods

The present study was conducted at Dev Ban Apple Orchard, Ramgarh, district Nainital, Kumaun region (29°26'32.8"N, 79°36'30.5"E, and 2200 m above mean sea level; Fig.1). The sampling was carried out once a fortnight from October 2021 to September 2022. The spiders were collected by various collection methods, such as visual searching and handpicking, the kerchief method, pitfall traps, beating, and the sweep netting method. Specimens were photographed using a Realme XT camera (12 MP) and then released back into their original environments. Various taxonomic keys for spiders were used to identify the specimens (Tikader, 1987; Murphy and Murphy, 2000; Sebestian and Peters, 2009).

Results and Discussion

This is the first study to reveal the presence of 246 spider individuals representing 21 species, 16 genera and 10 families (Table 1). The most dominant family of spiders was observed to be the Araneidae (29%), followed by Lycosidae (18%), Salticidae (15%), Pholcidae (10%), Sparassidae (09%), Thomisidae (07%), Linyphiidae (5%), Oxyopidae (04%), Philodromidae (3%), and Theridiidae (1%) (Fig. 2). The most dominant spider species was *Alopecosa cursor*, belonging to the family Lycosidae. Some spider species found in this orchard have been shown in Figure 3. The Diversity index was calculated by using Simpson's Diversity Index (SDI) (Simpson, 1949).

$$\text{Simpson's Diversity Index (SDI)} = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

Where, n = Total individual no. of a particular species, N = Total no. of species.

Fig.1: Google map of Dev ban Apple Orchard.

Table 1: Simpson's Diversity Index (SDI) of spider species in the study area

S. No.	Family	Species name	n	n-1	n(n-1)
1.	Araneidae	*Araneus quadratus*	9	8	72
2.	Araneidae	*Argiope anasuja*	10	9	90
3.	Araneidae	*Argiope aurantia*	7	6	42
4.	Araneidae	*Argiope pulchella*	11	10	110
5.	Araneidae	*Cyclosa bifida*	9	8	72
6.	Araneidae	*Cyclosa conica*	11	10	110
7.	Araneidae	*Neoscona nautica*	5	4	20
8.	Araneidae	*Neoscona subfusca*	9	8	72
9.	Sparassidae	*Heteropoda maxima*	8	7	56
10.	Sparassidae	*Hetropoda venatoria*	14	13	182
11.	Linyphiidae	*Linyphia triangularis*	13	12	156
12.	Oxyopidae	*Oxyopes sp.*	9	8	72
13.	Lycosidae	*Alopecosa cursor*	33	32	1056
14.	Lycosidae	*Pardosa minuta*	11	10	110
15.	Philodromidae	*Philodromus*	3	2	6
16.	Philodromidae	*Tibellus sp.*	4	3	12
17.	Pholcidae	*Pholcus phalangioides*	24	23	552
18.	Salticidae	*Plexippus paykulli*	20	19	380
19.	Salticidae	Salticus *sp.*	16	15	240
20.	Thomisidae	*Xysticus cristatus*	17	16	272
21.	Theridiidae	*Achaearanea budana*	3	2	6
Total no. of species (N)= 246					∑n(n-1)= 3688
Simpson's Diversity Index (SDI) = 0.94					

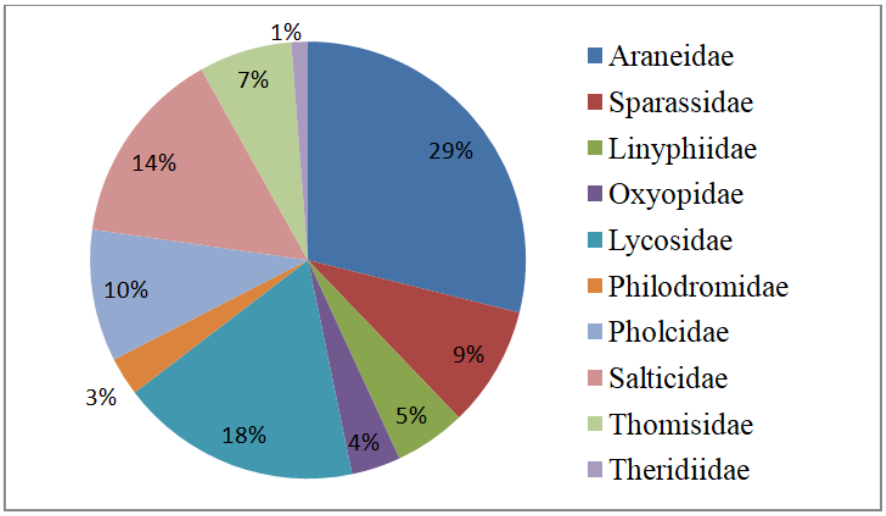

Fig. 2: Per cent distribution of Spider Families in the study area.

Fig. 3: Pictures of some spiders from the study area.

Based on the above calculations, Simpson's Diversity Index (SDI) resulted in 0.94 (very close to 1), which statistically indicates that there is a 94% chance that two individuals selected at random would be from different species and only 6% chance that two individuals selected at random would be from same species. This leads to the conclusion that there is high spider species diversity in the study area. Also, species-specific reactions to differences in habitat structure are crucial in structuring the overall spider community. The physical environment's structure has a significant impact on the habitat choices of spider species and ultimately on the makeup of spider communities. Spiders are beneficial predators and play a significant role in keeping populations of many insect pests under control. Research on spider diversity in orchard systems is precious to observe the effects of these predators on orchard pests. Also, to understand how

profound microhabitat changes affect abundance and species diversity, therefore, there is a great need to do a comprehensive biodiversity study that can add knowledge of the distribution of species and their potential role as biocontrol agents for the spiders of Uttarakhand, India.

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