BIODIVERSITY COMMUNITIES AND CLIMATE CHANGE

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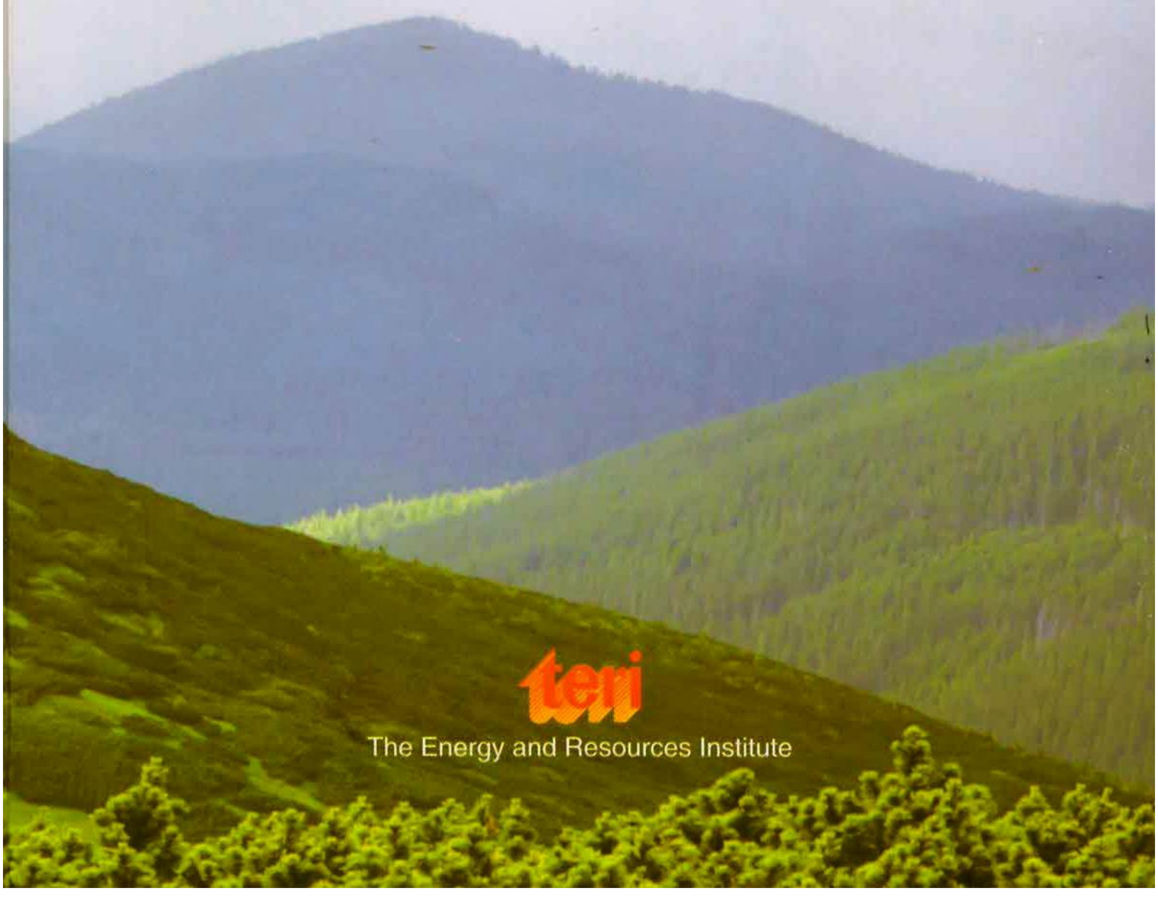

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CHAPTER 2

Spiders (Araneae) in Bhyundar Valley of the Nanda Devi Biosphere Reserve

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INTRODUCTION

Spiders are a special group of invertebrates that exploit a wide variety of niches in virtually all biomes on earth and play a vital role in sustaining the ecosystem. They are a diverse group of animals attaining seventh number in diversity (Benz and Nyffeler 1980). Spiders, which include 42 055 described species under 3821 genera and 110 families globally, comprise a significant portion of terrestrial arthropod diversity (Platnick 2011). Since the early 1980s, a marked number of taxonomic and faunistic reports on arctic, boreal, and temperate spiders, both in the Palaearctic and in the Nearctic regions, have been published. More than 34 000 spider species, of an estimated total of 170 000 extant species, have been described (Coddington and Levi 1991). In the US and Canada alone (Roth 1993) approximately 3500 described species (and an additional estimated 350 undescribed species) exist.

In India, 1442 species of spiders belonging to 361 genera of 59 families have been reported so far. Of these, 21 genera are endemic to India while 13 are endemic to South Asia. Of the 1442 species, 1002 are endemic to the Indian mainland, 71 species are endemic to South Asia, 65 species are endemic to the Andaman and Nicobar Islands, and 1 species is endemic to Lakshadweep (Siliwal, Molur, and Biswas 2005). The Indian spiders checklist prepared by Siliwal, Molur, and Biswas (2005) includes nine subspecies of spiders, of which seven are endemic to the Indian mainland and two to the Andaman and Nicobar Islands. The families represented by the highest number of genera and species in India are *Salticidae* (62 genera and 181 species), followed by *Thomisidae* (37 genera and 154 species).

Spiders are important regulators of insect population (Lockley and Riechert 1984; Bishop and Riechert 1990; Wise 1993) and may prove to be useful indicators of overall species richness and the health of the biotic communities (Colwell, Erwin, Kremen, *et al.* 1993; Coddington and Colwell 1994; Norris 1999). Spider communities are sensitive to a wide range of environmental factors, including habitat structure (Uetz 1991), habitat type (Eyre and Rushton 1992; Rushton 1988), and exposure to wind, moisture, and temperature (Wise 1993).

Although they are a relatively difficult group, taxonomically they have the potential to be ecological indicators (Alderweireldt, Baert, Desender, *et al.* 1989) where suitable taxonomic skills are available and may be effective in assessing and monitoring the ecosystem. The fact that spiders are abundant in nature (Wise 1993), easy to collect, and found in varied habitats make them suitable for biodiversity and bio-monitoring studies (Churchill 1997).

In India, knowledge about diversity and distribution of spiders is sparse in comparison to other regions of the world. Little information is available about them in the Northern part of India, especially in the higher altitudinal zones of the Himalayan region. An urgent need exists to explore the spider fauna in the Himalayan region of the country. Considering their role in the ecosystem, the present study aims to describe the spider diversity in the Bhyundar Valley of the Nanda Devi Biosphere Reserve (NDBR). This study, thus, attempts to make an inventory of the spider species, their density, composition, and richness in different sites of the NDBR with respect to altitudinal gradient.

MATERIALS AND METHODOLOGY

The Bhyundar Valley (30°37' N, 79°33' E) is located in the Nanda Devi Biosphere Reserve in the northern part of the Western Himalayas and comprises parts of Chamoli district in Garhwal, Uttarakhand (Figure 1). The Bhyundar Valley leads into the Valley of Flowers National Park. The topography, climate, and soil of this area support diverse habitats, species, communities, and ecosystems. There is a high percentage of native and unique flora and fauna in this area (Zoological Survey of India 1997).

Sampling

Spider samples were collected from 10 random sampling plots 10 m by 10 m in size along the altitudinal gradient of 1800 m to 2300 m in the Bhyundar Valley (NDBR). In each of the plots, spider sampling was done using pitfall traps and by five other collection methods, such as sweep netting, ground hand collection, aerial hand collection, vegetation beating, and litter sampling. To collect ground-dwelling spiders, nine pitfall traps (cylindrical plastic bottles of 9 cm diameter and 10 cm depth) were arranged within a 10 m × 10 m sampling plot in three horizontal and three vertical rows, each at 5 m distance from the nearest neighbours, thus forming four smaller grids of 5 m × 5 m (Figure 2) within the sampling plot. The traps were filled with liquid preservative (69% water, 30% ethyl acetate, and 1% detergent). Other methods were applied to collect web building, ambush, and ground runner spiders. Sampling was carried out from March to May 2009. The collected specimens were transferred to 70% alcohol for further identification. Voucher specimens were deposited at the Wildlife Institute of India, Dehradun.

Statistical Analysis

The number of individuals belonging to a family collected from each sampling plot was used to estimate the density of each spider family recorded in the study area. The densities of different spider families were then compared for any significant difference using the one-way ANOVA in program *SPSS version 16.0.* The diversity of

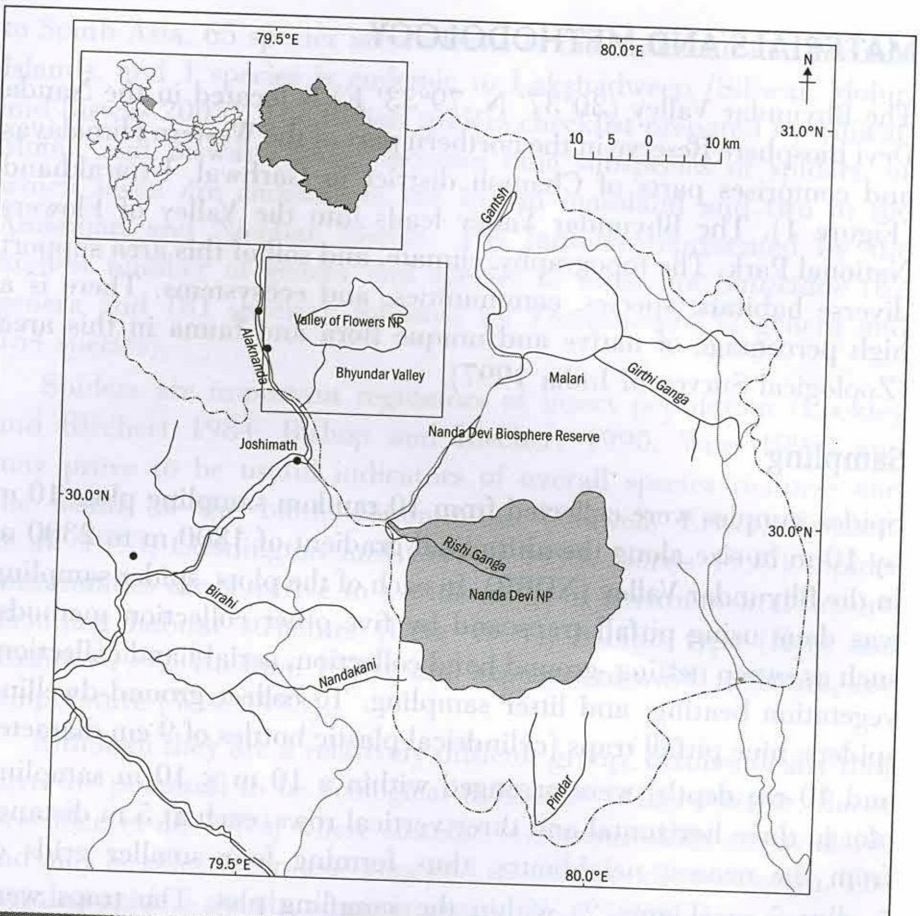

Figure 1 *Location of the study area: Bhyundar Valley*

spider families along the altitudinal gradient was analysed by the Shannon–Wiener index (H′), which is sensitive to changes in the abundance of rare species in a community (Magurran 1988) in program *ESTIMATE S version 8.0* (Colwell 2006). Based on a prior ecological knowledge, it was hypothesized that spider taxa richness would vary along altitude. Consequently, it was tested for normality of data through the Kolmorogov–Smirnov test and investigated for any relationship between family richness (response variable) and altitudinal gradient (predictor variable) using linear regression analysis in program *SPSS version 16.0.*

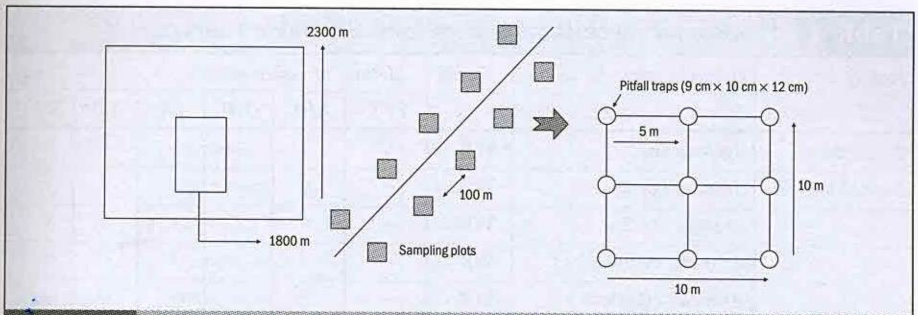

Figure 2 *Route map of the study area with the sampling plots*

RESULTS

Abundance, Richness, and Diversity

A total of 668 individuals (Table 1) belonging to 19 families, 34 genera, and 56 morpho-species/species were recorded. Out of the total 668 individuals, Araneidae was the numerically predominant family, comprising 22.9% of total spider abundance. It was followed by Lycosidae (13.9% of total spider abundance), Theridiidae (9.4%), Thomisidae (9.1%), Tetragnathidae (6.7%), Salticidae (6.1%), Gnaphosidae (5.68%), and Linyphiidae (5.6%). All the other families composed less than 5% of the overall abundance (Figure 3).

Composition of Spider Fauna

Families with the highest number of total species were the orb-web spiders Araneidae with 12 species (22% of all the species), followed by crab spiders Thomisidae (6 species; 11%), comb-footed spiders Theridiidae (5 species; 9%), jumping spiders Salticidae (4 species; 7%), and long-jawed spiders Tetragnathidae (4 species; 7%), while other families composed 24% of the total species richness with 13 species. In the lower altitudinal plots (1800–2100 m), 19 families of spiders were recorded from 10 plots, covering most of the families found in the study area. However, in the higher altitudinal plots (2101–2300 m), the number of families recorded from 10 plots decreased to seven, and mainly comprised Araneidae and Lycosidae (Figure 4).

Table 1 *Provisional checklist of spiders from Bhyundar Valley*

Family	*Genus/species*	*Guild*	*Method of collection*					
			PFT	*AHC*	*GHC*	*LS*	*VB*	*SN*
Agelenidae	*Agelena* sp.	WB	√	–	–	–	–	–
Araneidae	*Araneus* sp. 1	WB	–	√	–	–	√	√
	Araneus sp. 2	WB	–	√	–	–	√	√
	Araneus nympha	WB	–	√	–	–	–	√
	Araneus ellipticus	WB	–	√	–	–	–	√
	Araneus insutus	WB	–	√	–	–	–	√
	Cyclosa confraga	WB	–	√	–	–	–	√
	Cyclosa insigna	WB	–	√	–	–	–	√
	Cyrtophora moluccensis	WB	–	√	–	–	√	√
	Eriophora sp. 1	WB	–	√	–	–	–	√
	Neoscona muhkerjee	WB	–	√	–	–	–	√
	Neoscona theisi	WB	–	√	–	–	–	√
	Zygiella indica	WB	–	√	–	–	√	√
Clubionidae	*Clubiona* sp. 1	GW	√	–	√	–	–	–
	Clubiona sp. 2	GW	√	–	–	–	–	–
Gnaphosidae	*Gnaphosa* sp. 1	GW	√	–	√	√	–	–
	Gnaphosa sp. 2	GW	√	–	√	√	–	–
	Drassodes sp.	GW	√	–	–	–	–	–
Linyphiidae	*Linyphia* sp. 1	WB	–	√	–	–	–	√
	Linyphia sp. 2	WB	–	√	–	–	√	√
	Linyphia sp. 3	WB	–	√	–	–	√	√
Lycosidae	*Hippasa greenalliae*	WB	–	–	√	–	–	–
	Lycosa sp. 1	GW	√	–	√	√	–	–
	Lycosa sp. 2	GW	√	–	√	√	–	–
	Lycosa sp. 3	GW	√	–	√	–	–	–
	Pardosa sp. 1	GW	√	–	√	–	–	–
	Pardosa sp. 2	GW	√	–	√	√	–	–
Miturgidae	*Cheiracanthium* sp. 1	GW	–	–	√	–	–	–
Oxyopidae	*Oxyopes* sp. 1	PW	–	√	–	–	–	–
Philodromidae	*Philodromus* sp. 1	GW	–	–	√	–	–	–
	Philodromus sp. 2	GW	–	–	√	–	–	–
Pholcidae	*Crossopriza* sp. 1	WB	–	√	–	–	–	–
Pisauridae	*Pisaura* sp. 1	GW	√	–	√	–	–	–
	Pisaura sp. 2	GW	√	–	√	√	–	–

Contd...

Table 1 *Contd...*

Family	*Genus/species*	*Guild*	*Method of collection*					
			PFT	*AHC*	*GHC*	*LS*	*VB*	*SN*
Salticidae	*Plexippus* sp. 1	GW	√	–	√	–	–	–
	Myrmarachne sp. 1	GW	–	–	√	–	–	–
	Carrhotus sp. 1	GW	√	–	√	√	–	–
	Carrhotus sp. 2	GW	√	–	√	–	–	–
Selenopidae	*Selenops* sp. 1	GW	–	–	√	–	–	–
Sparassidae	*Heteropoda* sp. 1	GW	–	–	√	–	–	–
	Heteropoda sp. 2	GW	√	–	√	–	–	–
	Heteropoda venetoria	GW	–	–	√	–	–	–
Tetragnathidae	*Leucauge decorata*	WB	–	√	–	–	√	√
	Leucauge sp. 1	WB	–	√	–	–	√	√
	Leucauge sp. 2	WB	–	√	–	–	–	√
	Tetragnatha sp. 1	WB	–	√	–	–	√	√
Theridiidae	*Achaearanea* sp. 1	WB	–	√	–	–		√
	Achaearanea sp. 2	WB	–	√	–	–	√	√
	Theridion sp. 1	WB	–	√	–	–	√	√
	Theridion sp. 2	WB	–	√	–	–	√	√
	Theridion sp. 3	WB	–	–	–	–	√	√
Thomisidae	*Misumena* sp. 1	PW	–	√	–	–	–	√
	Misumena sp. 2	PW	–	√	–	–	–	√
	Runcinia sp. 1	PW	–	√	√	–	–	√
	Xysticus sp. 1	GW	–	√	√	√	–	–
	Diaea sp. 1	PW	–	√	√		√	–
	Diaea decorata	PW	–	√	–	–	–	√
Uloboridae	*Uloborus* sp. 1	WB	–	√	–	–	–	–
Zodariidae	*Lutica* sp. 1	GW	–	–	√	–	–	–

Guild structures: WB - web builders; PW - plant wanderers; GW - ground wanderers

Collection methods: PFT - pitfall traps; GHC - ground hand collection; AHC - aerial hand collection; VB - vegetation beating; LS - litter sampling; SN - sweep netting

Family richness showed a linear declining relationship with increasing altitudinal gradient ($R^2 = -0.9089$, $P < 0.001$; Figure 5).

Pearson's correlation indicated a significant negative correlation between family richness and altitude ($R = -0.95$). The Shannon-Weiner index estimated family diversity at 2.31 ± 0.01. The density of the families Araneidae and Lycosidae

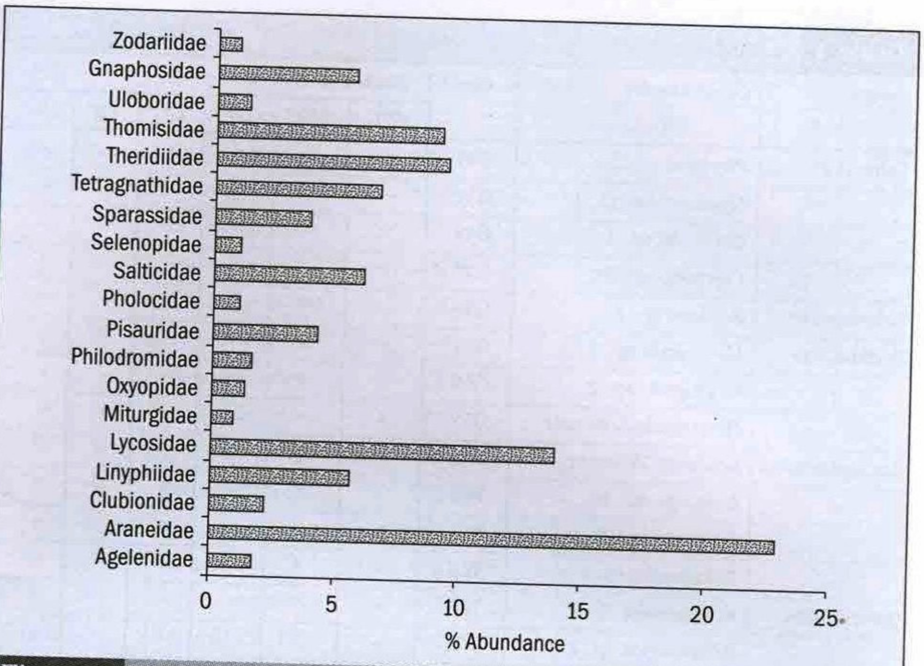

Figure 3 *Relative abundance of the spider families*

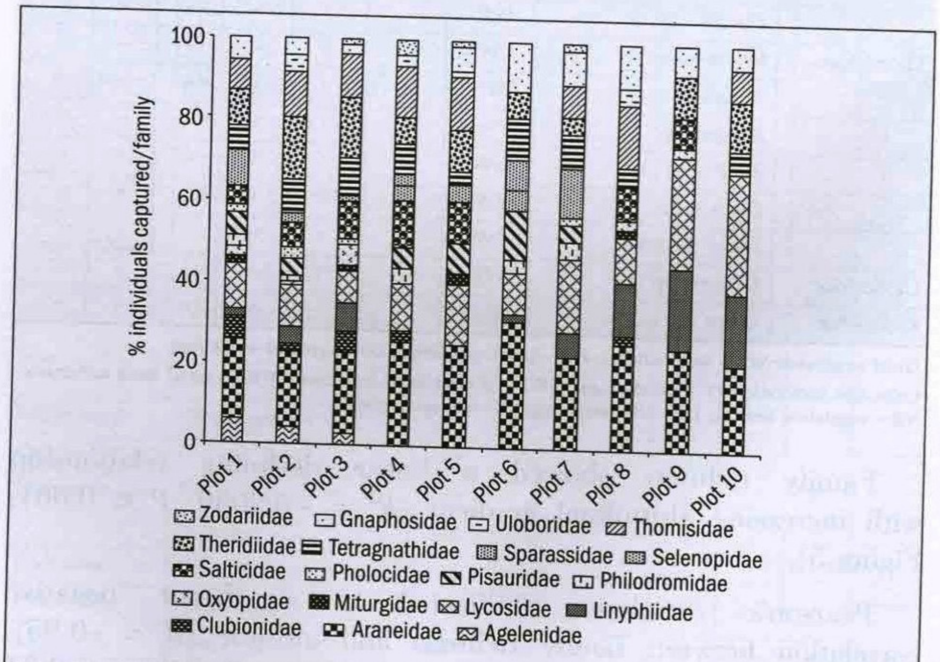

Figure 4 *Family composition of spiders in Bhyundar Valley*

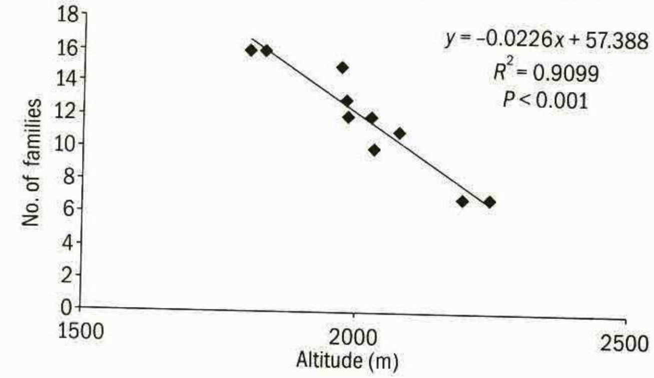

Figure 5 *Relationship between spider family richness and altitudinal gradient in Bhyundar Valley*

Note *Family richness declined linearly with altitude following the equation: $y = -0.0226x + 57.366$, $R^2 = 0.9089$, $P < 0.001$*

(0.15 ± 0.013 and 0.093 ± 0.009) was found to be significantly higher than that of the other families (F-test = 20.74, $P < 0.001$; Figure 6).

DISCUSSION

During the study, 19 families of spiders, which represent 31% of the total families reported from India (Sebastian and Peter 2009),

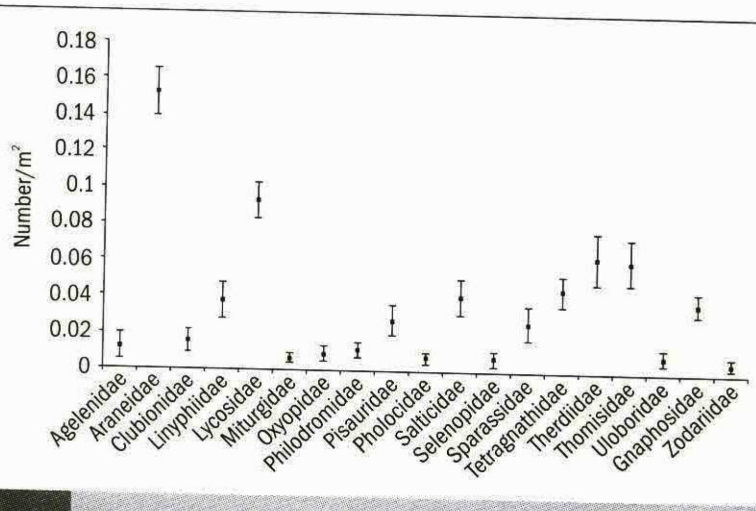

Figure 6 *Density (individuals/m^2) of spider families in Bhyundar Valley*

were recorded. The lower altitudinal areas exhibiting high structural complexities, with a greater availability of niches, recorded highest spider diversity. The density of the families *Araneidae* and *Lycosidae* was found to be significantly more than the rest of the families, which was thought to be due to greater adaptability and resource availability for these families in the study area. However, some families such as *Lycosidae*, which are more tolerant and can overcome harsh conditions, were also collected from relatively higher elevations.

The results showed that the number of families recorded from the sampling plots linearly decreased with increasing altitude and also found that the family richness showed a consistent negative correlation with altitude. However, as only a small altitudinal range was tested in this study, this result may not be true for a larger altitudinal range. In order to test the effect of altitude on spiders, a larger altitudinal range must be taken into consideration. As spiders are sensitive to small changes in the environment, especially vegetation, topography, and climate, these parameters might show interesting effects on the spider diversity. It would be interesting to study the effect of these parameters on the spider fauna.

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