A Study of Ecological Distribution and Community Diversity of Spiders in Gulmarg Wildlife Sanctuary of Kashmir Himalaya

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ABSTRACT

The state of Jammu and Kashmir has been a tourist paradise from times because of its pleasant climate, typical flora and fauna and the beauty of its natural landscape. Gulmarg – a majestic hill station in the district Baramulla of Jammu and Kashmir nestled with stunning peaks in the Himalayan ranges offers tremendous opportunities for research. Keeping in view the importance and usefulness of Gulmarg Wildlife Sanctuary, it was thought necessary to conduct preliminary studies on the spider community of the Gulmarg wildlife sanctuary in order to assess the diversity and distribution of spiders at four sites during the months of May, June, July, October & December 2012. The spider community was found to be represented by 18 taxa. Araneidae was dominant family followed by Lycosidae, Linyphiidae, Pholcidae, Salticidae, Sparassidae and Clubionidae. Differences in vegetation cover or human use showed variation in diversity and composition of spiders between different sites. Forest sites showed relatively higher diversity as compared to meadow sites.

Introduction

Arachnids are an important albeit poorly studied group of arthropods that play a significant role in the regulation of other invertebrate populations in most ecosystems (Russell-Smith, 1999). Spiders, which globally include about 42,055 described species (Platnick, 2011), are estimated to be around 60,000-170,000 species (Coddington and Levi, 1991). They include a significant portion of the terrestrial arthropod diversity, being one of the dominant macro invertebrate predator groups in terrestrial environments (35 – 95%) (Specht and Dondale, 1960; Van Hook, 1971; Moulder and Reichle, 1972; Edwards *et al.*, 1976).

Spiders are copious in both natural and cultivated environments, in which their average annual abundance ranges from 50 to 150 individuals per square meter but can periodically reach maximal densities of more than 1000 individuals per square meter (Pearse, 1946; Duffey, 1962). They occupy a wide range of spatial and temporal niches, exhibit taxon and guild responses to environmental change, extreme sensitivity to small changes in habitat structure, primarily vegetation complexity and microclimate characteristics (Uetz, 1991). Furthermore, strong associations exist between plant architecture and species that capture prey without webs (Duffey, 1962; Uetz, 1991). Spiders respond distinctly to altered litter depth, and structural complexity and nutrient content of litter (Uetz, 1991; Bultman and Uetz, 1982). They employ a remarkable variety of predation strategies. As they are generalist predators, they are of immense economic importance to man because of their ability to suppress pest abundance in agro ecosystems. The population densities and species abundance of spider communities in agricultural fields can be as high as that in natural ecosystems (Riechert, 1981). In spite of this, they have not been treated as an important biological control agent since very little is known of the ecological role of spiders in pest control (Riechert and Lockley,

1984). Spiders regulate decomposer populations (Clarke and Grant, 1968) and by doing so, they influence ecosystem functioning (Lawrence and Wise, 2000, 2004). Their high biomass also makes them a critical resource for larger forest predators such as salamanders, small mammals and birds. 6 Spiders can be used as successful biological indicators to assess the 'health' of an ecosystem because they can be easily identified and are differentially responsive to natural and anthropogenic disturbances (Pearce and Venier, 2006). For a species to be identified as an effective ecological indicator, it must meet the primary criteria of being feasible and cost effective to sample, easily and reliably identified, functionally significant, and ability to respond to disturbance in a consistent manner. Spiders readily meet the first three criteria. Their high relative abundance, ease of collection, and diversity in habitat preferences and foraging strategies allow for effective monitoring of site differences (Yen, 1995). Many studies have widely recommended the potential of spiders as bioindicators (Duchesne and McAlpine, 1993; Niemelä *et al.*, 1993; Beaudry *et al.*, 1997; Atlegrim *et al.*, 1997; Churchill, 1997; Duchesne *et al.*, 1999; Bromham *et al.*, 1999; Werner and Raffa, 2000; Heyborne *et al.*, 2003). This paper intends to study the diversity of spiders at different vegetation types.

Material and methods

Study area

The study was conducted at Gulmarg (Fig. 1), Gulmarg literally means 'meadow of flowers'. Gulmarg is a town, a hill station and Kashmir's premier ski resort. It is located 56 km south west of Srinagar. Gulmarg's legendary beauty, prime location and proximity to Srinagar naturally make it one of the premier charming luxury hill resorts in the country. The study sites selected had relatively different vegetation and anthropogenic impacts.

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Site-1 represented Drang forest with geographical coordinates of N 34° 02′ 04.0″ and E 74° 24′ 25″ and an elevation of about 2328m. The site was having dominant tree cover of *Pinus wallichiana* and, *Picea smithiana*, while *Taxus baccata* was less prominent. The prominent shrubs were *Viburnum grandiflora* and *Geranum wallicianum*. Site-2 Drang Meadow (N 34° 03′ 35.7″ and E 74° 25′ 31.7″; Elevation 2328m). It was dominated by herbaceous vegetation but witnessed grazing and anthropogenic activities. Site-3 Gulmarg Forest (N 34° 02′ 41.6″ and E 74° 23′ 09.3″; Elevation 2684m). This site had a mixed type of vegetation dominated by *Populous migra*, *Rolinia pseudacacia*, and dotted with *Pinus wallichiana* trees also. Site-4 Gulmarg meadow (N 34° 02′ 51.6″ and E 74° 23′ 09.3″; Elevation 2687 m). It was located about 60m away from the main market of Gulmarg and taxi stand.
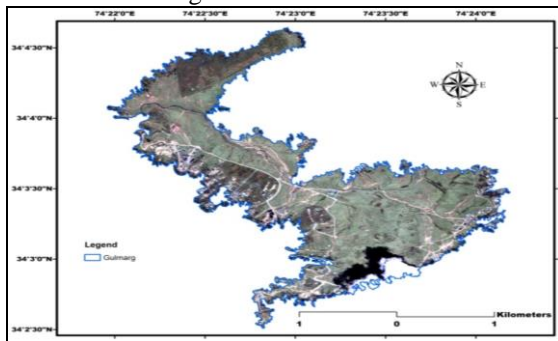

Fig. 1. Satelliteimage of the study a*rea – Gulmarg*

Materials and Methods

Established sampling protocols for spider collection (Sorensen et al., 2002) were adopted in different sampling plots. At each site exercise was conducted for 30 minutes. Hand picking method or by forceps using (1m²) quadrant. Vegetation Beating: The method is employed to collect spiders living in the shrub, high herb vegetation, bushes, and small trees and branches (Coddington et al., 1991, 1996). Spiders were collected by beating the vegetation with a stick and collecting the samples on a cloth (1 m²). The Spiders were preserved in different vials filled with ethyl alcohol (75-80%) and marked using a piece of paper with the sample number.

Data analysis

No single index encompasses all characteristics of an ideal index, i.e., high discriminate ability, low sensitivity to a sample size, and ease in calculation (Marguran, 1988). Therefore an observation of the different indices reflecting species evenness, dominance and diversity heterogeneity provide some valid viewpoints. Shannon's index of diversity (Price, 1997) reflects both evenness and richness (Colwell & Huston, 1991) and is commonly used in diversity studies (Krebs, 1989). It is calculated as $H = -\sum (ni/N)Ln(ni/N)$; i =1–n; where n is the number of species and Pi is the proportion of the ith species in the total. Index of dominance is calculated as $= \sum (ni/N)^2$ where ni is the number of individuals of a species and N is the total number of individuals of all species. Evenness indicates the degree of homogeneity in abundance between species and is based on the Shannon index of diversity. Shannon evenness [E = H/H_{max} = H/lnS; where H is the Shannon diversity index and S the number of species in the community] ranges from 0 to 1.

Results and Discussion

Taxonomical diversity

The spider community (order Araneae) was found to be represented by 18 taxa. Araneidae was dominant family followed by Lycosidae, Linyphiidae, Pholcidae, Salticidae, Sparassidae and Clubionidae. Among the four sites selected, site

I (Drang forest) showed the maximum number of taxa followed by Site III (Gulmarg Forest), site II (Drang meadow) and site IV (Gulmarg meadow). At Site I (Drang Forest) *Araneus* sp. was found to be dominant taxa throughout the study period. *Araneus* sp. recorded its maximum density (4 individual/m²) in the month of July 2012 and lowered to (2 individual/m²) in the month of December 2012. While as the *Lepthyphantes* sp. was least dominant at Site I having a maximum density (1 individual/m²) in the month of July and was not recorded in the month of December (Table 1). At Site II (Drang Meadow) *Lycosa* sp. and *Padosa* sp. were two dominant taxa throughout the sampling. In the month of June *Lycosa* sp. showed the highest dominance (10 individuals/m²) and was totally absent in the month of July. While as *Salticus* sp. and *Thomisius* sp. were present only in the month of December (Table 2). At Site III (Gulmarg Forest) *Lycosa* sp. was found to be dominant taxa throughout the study period. In the month of June *Lycosa* sp. showed the highest dominance (4 individual/m²) and lowest (1 individual/m²) in the month of December. While as *Clubiona* sp. was least dominant at site 3 having a maximum density (2 individuals/m²) in the month of July and lowered to (0 individual/m²) in the month of December (Table 3). At Site IV (Gulmarg Meadow) only *Lycosa* sp. and *Pardosa* sp. were observed, out of which *Lycosa* sp. was found to be more dominant. In the month of May *Lycosa* sp. showed the highest dominance (15 individual/m²) but no individuals were recorded during December. *Pardosa* sp. was dominant in the month of July (6 individual/m²) while no individuals were encountered in the month of December (Table 4).

Spider community of study area was found to be represented by 18 genera belonging to order Araneae. Araneidae was dominant family followed by Lycosidae, Linyphiidae, Pholcidae ,Salticidae ,Sparassidae, and Clubionidae. Among arthropods, spiders are the most abundant predators in many terrestrial ecosystems, playing an important role in ecosystem functioning throughout habitats (Van Hook, 1971). While spiders in forest ecosystems contribute to the maintenance of insect community equilibrium, the distribution of species and the composition of assemblages are significantly influenced by environmental conditions (Ziesche and Roth, 2008). Spiders seem well suited to discriminate habitat type and quality, since play important role as diverse and abundant invertebrate predators in terrestrial ecosystems. Despite their ecological role in many ecosystems, high diversity, documented threats and the known imperilment of some species, spiders have received little attention from the conservation community (Skerl, 1999). While this lack of attention may be related to negative public attitudes towards spiders (Kellert, 1986), a paucity of compiled information on spider conservation status and distribution may be a more important issue. However, it is important that imperiled and vulnerable spiders and other invertebrates are not left out of conservation planning efforts, as they may have unique ecological requirements or require particular site selection and management activities.

The diversity of spiders in the two forest sites was noted to be higher as compared to the two meadow sites. This may be due to the increased anthropogenic stress in the meadow areas which lead to the decrease in biodiversity and also the less availability of food in the meadow. Meadows are open areas in which there are high chances of predation. There are several other environmental factors that may also affect spider species diversity such as, spatial heterogeneity, competition, predation, habitat type, environmental stability and productivity (Rosenzweig, 1995).

Table 1. Monthly Variation in Spider Community Density (Ind./m^2) at Site I from May 2012-December 2012.

S. No	Taxa	May	June	July	October	December	Mean (n$_i$)
	Site I (Drang Forest)						
1	Lycosa sp.	6	4	0	0	1	2.2
2	Araneus sp.	2	4	4	3	2	3
3	Obscuriphantes sp.	0	2	0	0	0	0.4
4	Stegodyphus sp.	0	1	0	3	0	0.8
5	Sparassus sp.	0	0	2	4	0	1.2
6	Lepthyphantes sp.	0	0	1	0	0	0.2
7	Pholcus sp.	2	1	2	0	0	1
8	Microlinphia sp.	0	0	0	6	0	1.2
9	Pardosa sp.	0	0	0	2	1	0.6
	Total	10	12	9	18	4	10.6

Table 2. Monthly Variation in Spider Community Density (Ind. /m^2) at Site II from May 2012-December 2012

S. No	Taxa	May	June	July	October	December	Mean (n$_i$)
	Site II (Drang Meadow)						
1	*Lycosa* sp.	4	10	0	2	4	4
2	*Pardosa* sp.	4	6	0	4	0	2.8
3	*Microlinphia* sp.	0	0	3	4	0	1.4
4	*Salticus* sp.	0	0	0	4	0	0.8
5	*Thomisius* sp	0	0	0	6	0	1.2
	Total	8	16	3	20	4	10.2

Table 3. Monthly Variation in Spider Community Density (Ind./m^2) at Site III from May 2012-December 2012.

S. No	*Taxa*	May	June	July	October	December	Mean (n$_i$)
	Site III (Gulmarg Forest)						
1	Lycosa sp.	3	4	2	1	1	2.2
2	Araneus sp.	2	2	4	2	1	2.2
3	Clubiona sp.	1	0	2	0	0	0.6
4	Dictyna sp.	2	0	2	0	0	0.8
5	Microlinyphia sp.	0	0	2	0	0	0.4
6	Salticus sp.	0	0	4	0	0	0.8
7	Loxosceles sp.	0	0	4	0	0	0.8
8	Pholcus sp.	1	2	3	1	0	1.4
	Total	9	8	23	4	2	9.2

Table 4. Monthly Variation in Spider Community Density (Ind./m^2) at Site IV from May 2012-December 2012.

S. No	Taxa	May	June	July	October	December	Mean (n$_i$)
	Site IV (Gulmarg Meadow)						
1	Lycosa sp.	15	2	2	1	0	4
2	Pardosa sp.	4	4	6	2	0	3.2
	Total	19	6	8	3	0	7.2

Table 5. Diversity, Dominance and Evenness index for the four sits during the study for spider community.

Selected sites	Shannon Diversity Index	Simpson's Index	Shannon Evenness	Dominance Index
Site I (Drang Forest)	1.96	0.83	0.79	0.08
Site II (Drang Meadow)	1.45	0.73	0.85	0.27
Site III (Gulmarg Forest)	1.92	0.83	0.85	0.50
Site IV (Gulmarg Meadow)	0.69	0.49	0.99	0.51

Table 6. Species common in Drang and Gulmarg

S. No.	Species
1	Lycosa sp.
2	Araneus sp.
3	Pholcus sp.
4	Microlinphia sp.
5	Pardosa sp.
6	Salticus sp.

On the other hand forests have large number of microhabitats which help spiders to escape there predators .Availability of food also effects diversity. In forests food is available in abundance which is another reason that forests show high diversity as compared to meadow.

At Site I (Drang Forest) *Araneus* sp. was found to be dominant taxa throughout the study period. *Araneus* sp. recorded its maximum density (4 individual/m^2) in the month of July 2012 and lowered to (2 individual/m^2) in the month of December 2012. While as the *Lepthyphantes* sp. was least dominant at Site I having a maximum density (1 individual/m^2) in the month of July and was not recorded in the month of December.

At Site II (Drang Meadow) *Lycosa* sp. and *Padosa* sp. were two dominant taxa throughout the sampling. In the month of June *Lycosa* sp. showed the highest dominance (10 individual/m^2) and was totally absent lowest in the month of July. While as *Salticus* sp. and *Thomisius sp.* were present only in the month of December.

At Site III (Gulmarg Forest) *Lycosa* sp. was found to be dominant taxa throughout the study period. In the month of June *Lycosa* sp. showed the highest dominance (4 individual/m^2) and lowest (1individual/m^2) in the month of December. While as *Clubiona* sp. was least dominant at site3 having a maximum density (2 individual/m^2) in the month of July and was absent in the month of June, October and December.

At Site IV (Gulmarg Meadow) only *Lycosa* sp. and *Pardosa* sp. were observed, out of which *Lycosa* sp. was found to be more dominant. In the month of May *Lycosa* sp. showed the highest dominance (15 individual/m^2) and lowered to (0 individual/m^2) in the month of December. While *Pardosa* sp. was dominant in the month of July (6 individual/m^2) and lowered to (0 individual/m^2) in the month of October and December.

Araneus sp. and *Lycosa* sp. were two dominant taxa throughout the study period; they are cosmopolitan in distribution and have high species diversity. However the families like Lycosidae and Araneidae are more tolerant and overcome harsh climatic conditions and can survive in low temperature.

Also the site I (Drang forest) has high diversity than site III (Gulmarg forest), this may be due to the fact that the site I is away from the dwelling areas and its natural conditions while the Site III which is a tourist spot is in a relatively more stress.

Also the site II (Drang meadow) showed high diversity than site IV (Gulmarg meadow) the reason may be that in the site IV there is high anthropogenic and more biotic interferences are taking place.

Also the results showed that the number of individuals recorded from the sampling sites linearly decreased with the increasing altitude and also found that the family diversity showed a constant negative value with altitude. As spiders are sensitive to even small changes in the environment especially vegetation topography and climatic changes, patterns of linear decline may also be probably related to more severe climatic conditions terrain and landscape of study site. Similar results of spider abundance and declining linearly with elevation were observed in the studies of Otto and Swenson (1982) and Mc Coy (1990). Diversity is supposed to peak at mid elevation via primary productivity, which is considered to peak at mid elevations.

Conclusions

The study enhanced my knowledge about spider community in different ecosystems   and the effects of both biotic and a

biotic factors, as well as anthropogenic impacts on diversity and distribution of these spiders. Different sites with differences in either vegetation cover or human use   showed variation in diversity and composition of spiders. The number of individuals recorded from the sampling sites linearly decreased with the increasing altitude and also found that the family diversity showed a constant negative value with altitude. As, was observed from the results of the study, that altitude, habitat type and temperature play an important role in distribution and composition of spiders. Forests showed highest diversity as compared to meadow.

Gulmarg Wild Life sanctuary is interestingly diverse in spider fauna. During study it was found that there have been less attention towards spiders in the state and therefore similar research in other parts of the Kashmir valley will surely supplement Information in this direction. It is also important to note that spider fauna is Ubiquitous in nature and their diversity cannot be explained by quantifying one aspect of the environment. It does depend on many other factors or a combination of factors, apart from altitudinal variation and habitat structure. Looking into these factors would surely bring in more interesting results which can be relevant for maintenance and management of spider diversity of this region.

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