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A Comparative Study of Soil Mesofauna in Grazed and Non-grazed Grasslands of Dachigam National Park, Kashmir

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ABSTRACT

Cattle Grazing has been known to significantly affect the structure of soil mesofaunal community. The present study was carried out to compare the density and diversity of soil mesofauna in grazed and non-grazed grasslands of Dachigam National Park in order to understand the impact of grazing on the mesofaunal community structure. A total of 27 genera were recorded at the non-grazed site compared to only 18 genera at the grazed site. The average monthly population density was found to be highest at the non-grazed site (3767 individuals/m^2) than at the grazed site (3051 individuals/m^2). Acari was found to be the most abundant group contributing for more than 50% of the mesofauna at both the sites. Collembola was the next most abundant group. Among mesofaunal groups, Diplura and Symphyla exhibited 100% similarity for the two sites, whereas relatively less similarity (72.72%) was shown by Acari. It is concluded that the grazing reduces the density and diversity of soil mesofauna to a certain extent, with Acari and Collembola bearing most of the brunt, and Diplura and Symphyla showing almost no change.

Key Words: Soil, mesofauna, Acari, Collembola, Diplura, Symphyla

INTRODUCTION

Soil is one of the most diverse habitats on earth and contains one of the most diverse assemblages of living organisms (Giller *et al.*, 1997). Nowhere in nature are species so densely packed as in soil communities (Hagvar, 1998). Many modern soil biologists consider the soil fauna to be the last biotic frontier by its sheer numbers, diversity of species, difficult taxonomic compositions and numbers of undescribed species (Andre *et al.*, 1994).

Soil animals have been classified into three categories – microfauna, mesofauna and macrofauna, depending on size (Wallwork, 1970). Soil mesofauna, also called meiofauna, range from 0.1 to 2mm in diameter and includes all microarthropods, as mites (Acari), springtails (Collembola), bristletails (Diplura), symphylans (Symphyla) and Enchytraeids. Among these, mites and springtails often dominate.

Compared to the soil physico-chemical study, soil biology has been least studied, particularly when it comes to soil mesofauna. Considering the density and diversity of mesofauna in soil ecosystem, great emphasis needs to be given to the study of the soil fauna in general, and soil mesofauna in particular. Qualitative and quantitative studies of soil fauna, particularly the micro-arthropods (mesofauna) from Indian soils began from the mid-sixties. However, major contributions have been from the forests, agricultural fields, abandoned fields and tea gardens, and very few from the grasslands, particularly the Himalayan grasslands. The microarthropod studies from various grassland floors of India include those of Mir (1986), Bhat (1987), Sarkar (1990), Alfred *et al.* (1991), Paul (1992), Reddy and Ao (1995), Chakraborti and Bhatacharya (1996), etc.

Grazing by cattle has been known to significantly affect the structure of soil mesofaunal community (Sarkar, 1990; Kay *et al.*, 1998; Chulue and Lee, 2001; Clapperton *et al.*, 2002; Peterson *et al.*, 2004). The present study was carried out to compare the density and diversity of soil mesofauna in grazed and non-grazed grasslands of Dachigam National Park in order to understand the impact of grazing on the mesofaunal community structure.

Study Area and Study Sites

The study was conducted in Dachigam National Park (Fig. 1).

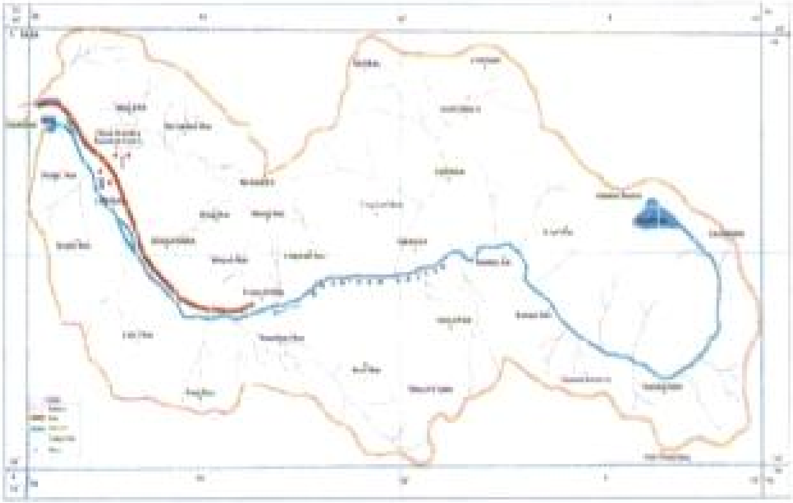


Fig. 1. Map of Dachigam National Park showing the study sites

Dachigam National Park is located about 22 kilometers northeast of Srinagar, the capital city of Jammu and Kashmir, covering an area of 141 km². It is situated between 34°04′ and 34°11′ N latitude and 74°54′ and 75°09′ E longitude.

Since the national park is home to a number of grazed and non-grazed grasslands, it became imperative to choose few sampling locations for each of the grassland type, so as to form a better representative sample for each grassland type.

Site I (Grazed)

Site I consisted of two sample locations representing grazed grassland. The dominant vegetation at this site comprises of *Themeda anathera* and *Poa sp.* Soils are usually sandy and light-brownish in colour.

Site II (Non-grazed)

Site II consisted of two sample locations representing non-grazed grassland. The dominant vegetation at this site comprises of *Themeda anathera, Stipa siberica* and *Poa sp.* Soils are having fine texture, usually sandy and brownish in colour.

MATERIAL AND METHODS

Sampling was carried out on monthly basis for a period of six months from June to November, 2006. Two (10 × 10 × 10) cm soil samples were taken randomly, one at each sampling location for the two sites, for each month with the help of a soil-corer. The results for the two sampling locations of each site were averaged to get the values for the two sites.

Mesofauna was extracted by using modified Berlese-Tullgren funnels (Southwood, 1980). Each undisturbed sample was inserted into the funnels and the fauna got extracted separately through a mesh in the funnel and eventually got collected into glass jars kept beneath the funnels, containing 70% ethyl alcohol. After extraction, the organisms were preserved in freshly prepared 70% ethyl alcohol solution. They were kept in the preservative for at least 2 weeks before examination under a microscope (Christiansen and Bellinger, 1998).

The preserved specimens were sorted out, counted and identified under a stereoscopic binocular microscope. Identification of the specimens was carried mostly up to the generic level using keys and illustrations provided in Baker and Wharton (1952), Balogh and Mahunka (1983), Norton (1990), Balogh and Balogh (1992), Christiansen and Bellinger (1998), as well as comparing them with those identified by Mir (1986) and Bhat (1987) while working on the soil mesofauna of Dachigam National Park. Population density (Eq. 1), relative abundance (Eq. 2) and Sorensen's Quotient of Similarity (Eq. 3) were calculated for the recorded data.

Eq. 1. Population Density

Population density was calculated by the following formulae (Michael, 1984):

$$\text{Density} = \frac{\text{Total no. of individuals of a group}}{\text{Total no. of samples taken}}$$

Eq. 2. Relative Abundance

Relative Abundance was calculated by the following formulae (Michael, 1984):

$$\text{Relative Abundance} = \frac{\text{Total no. of individuals of a group}}{\text{Total no. of individuals of all groups}} \times 100$$

Eq. 3. Sorensen's Quotient of Similarity:

Sorensen's Quotient of Similarity (QS) (Sorensen, 1948) was calculated as:

$$QS = \frac{2C}{I + II} \times 100$$

where C = number of genera common to both the Sites I and II,
I = total number of genera at Site I, and
II = total number of genera at Site II.

RESULTS

1) Faunistic Composition of Soil Mesofauna

A total of 27 genera were recorded at the two sites during the study period, of which 14 genera belonged to Acari, 8 to Collembola, 3 to Diplura and 2 to Symphyla in a decreasing order. There were significant variations in the number of acarine (14 - Site I; 8 - Site II) and collembolan (8 – Site I; 5 – Site II) genera recorded at the two sites, whereas 3 genera of Diplura and 2 genera of Symphyla were recorded at both the sites (Table 1). Overall, all the 27 genera were recorded at the non-grazed site, whereas the number of genera recorded at the grazed site was comparatively lesser, i.e. 18.

Table 1. Site-wise distribution of various mesofaunal genera recorded during the study period

Mesofaunal Group	Site I	Site II
Acari	*Scheloribates*	*Scheloribates*
	Galumna	*Galumna*
	Belba	*Belba*
	Oppia	*Epilohmannia*
	Asca	*Oppia*
	Petrobia	*Asca*
	Smaris	*Gamasipus*
	Gamasina	*Rhagidia*
		Eupodes
		Anystis
		Gamasina
		Petrobia
		Smaris
		Allonothurus
Collembola	*Hypogastrura*	*Hypogastrura*
	Entomobrya	*Entomobrya*
	Onychiurus	*Onychiurus*
	Folsomia	*Folsomia*
	Tomocerus	*Tomocerus*
	TulbergiaIsotoma	
	Friesea	
Diplura	*Anajapyx*	*Anajapyx*
	Heterojapyx	*Heterojapyx*
	Campodea	*Campodea*
Symphyla	*Scutigerella*	*Scutigerella*
	Symphylella	*Symphylella*

(2) Population Density

The complexity and abundance of soil mesofauna was found to be greater in soils with a comparatively thicker litter cover. The population density of mesofauna was found to vary at the two sites from month to month throughout the study period (Table 2). The average monthly population density at the grazed and non-grazed sites was recorded to be 3051 and 3767 individuals/m^2. Acari was the most dominant group at both the sites. Collembola followed it as the second most abundant group, which was followed by Symphyla and Diplura.

The major proportion of the Acari population at Site I was made up by the genera like *Scheloribates*, *Galumna*, *Belba* and *Oppia*, whereas at Site II *Scheloribates*, *Galumna*, *Oppia*, *Rhagidia*, *Eupodes* and *Petrobia* were the major contributors to the Acari population. Among collembolans, the largest contributors to the total population at Site I were *Hypogastrura*, *Entomobrya* and *Onychiurus*, whereas at Site II *Hypogastrura*, *Entomobrya*, *Tulbergia*, *Friesea* and *Onychiurus* were found to be the major contributors. In case of Diplura and Symphyla, all the genera contributed almost equally to the overall population at both the sites.

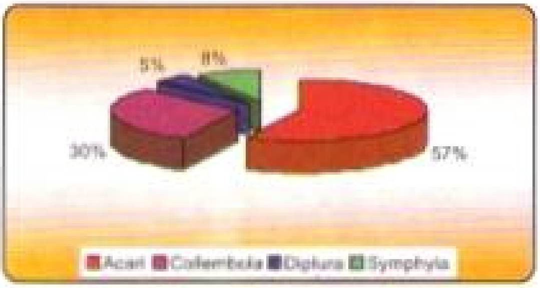
Table 2. Population density of mesofauna (individuals/m^2) at the two sites during the study period

Mesofaunal Group	Site	June	July	Aug	Sep	Oct	Nov
Acari	I	1850	2100	2050	1700	1550	1050
	II	2250	2450	2450	2100	1950	1350
Collembola	I	800	1100	1150	950	900	600
	II	1150	1400	1450	1350	1200	950
Diplura	I	150	150	250	200	150	100
	II	150	200	250	200	100	100
Symphyla	I	200	250	350	350	200	150
	II	200	300	350	400	200	100

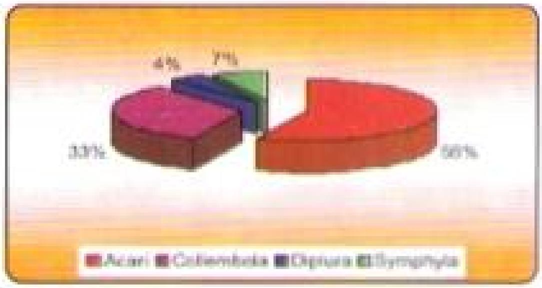
(3) Relative Abundance

The contribution of various mesofaunal groups to the total mesofauna population showed only a little variation for the two sites [Fig. 2(a and b)]. The mean monthly relative abundance (MMRA) of different mesofaunal groups was calculated for the Sites. For Site I, the MMRA for Acari was 57%, followed by Collembola (30%), Symphyla (8%) and Diplura (5%) in a decreasing order, whereas at Site II, the MMRA for Acari, Collembola, Symphyla and Diplura was

56%, 33%, 7% and 4% respectively.



(a)



(b)

Fig. 2(a and b). Mean monthly relative abundance of different mesofaunal groups at Site I and II respectively

4) Sorensen's Quotient of Similarity

This parameter was used to determine the degree of similarity of mesofauna collected at the two sites. On the whole, the mesofaunal community exhibited 80% similarity. Amongst the mesofaunal groups, both Diplura and Symphyla showed 100 similarity, whereas the least similarity (72.72%) was exhibited by Acari (Table 3).

Table 3. Quotient of Similarity (QS) values (%) for different mesofaunal groups

MesofaunalGroup	QS Value
Acari	72.72
Collembola	76.92
Diplura	100
Symphyla	100

DISCUSSION

The mesofaunal groups studied were Acari, Collembola, Diplura and Symphyla. The mesofauna recorded at the sites resembled that of the temperate world. The presence of 27 genera at the non-grazed site compared to only 18 at the grazed site is indicative of the impacts of cattle grazing upon diversity of soil mesofauna. Grazing significantly reduces the diversity of mesofauna, as reported by Chulue and Lee (2001) and Petersen *et al.* (2004). The number of acarine and collembolan genera recorded at the grazed site was significantly lesser that the number recorded at the non-grazed site, whereas the number of dipluran and symphylan genera recorded at two sites was the same. This may be attributed to the fact that Acari and Collembola are more sensitive to above-ground plant cover than Diplura and Symphyla, which is supported by the works of Koehler (1998), Badejo and Ola-Adams (2000) and Clapperton *et al.* (2002). Some genera of the four mesofaunal groups studied were recorded at both the sites. The abundance of these genera may be due to their better adaptability to the diverse kinds of habitat/environmental variables.

Acari and Collembola were the most dominant groups together contributing 87 % of the total mesofauna population at the grazed site and 89% at the non-grazed site, which was supported by the findings of Rusek (1998), Noti *et al.* (2003) and Irmler (2004). The mesofauna of both the sites showed some degree of similarity, as the QS values for all the groups were greater than 50%. Similar findings have been obtained by Heneghan *et al.* (1998), while working on the microarthropod community structure in tropical and temperate sites.

The variations were encountered in the population densities of different mesofaunal groups at the two sites during different months. The highest population density of mesofauna during August at non-grazed site may be attributed to the fact that leaf litter accumulation and consequent humus production during this period is very prominent, thereby making the soil rich in organic matter. Mesofauna are known to be litter feeders, and thus flourish in number with increasing organic matter (Webb, 1994; Heneghan and Bolger, 1998; Irmler, 2000; Reynolds *et al.*, 2003). Comparatively less population density was recorded at the grazed site during the same month. This may be attributed to cattle grazing at this site, as grazing leads to a decline in liter accumulation and humus production. This is supported by the findings of Reddy and Ao (1995), Kay *et al.* (1998) and Clapperton *et al.* (2002). The type of litter was also found to influence the density of mesofauna. A higher faunal abundance in mixed-species litter (non-grazed site) than in those with single-species litter (grazed site) was recorded, which is similar to the observations of Kaneko and Salamanca (1999). Cattle grazing results in a decrease in plant density and diversity which in turn leads to a decline in population density at the grazed site.

The lowest mesofaunal density was recorded at both the sites in November. This can be attributed to the seasonal migration, which mesofauna are known to show in response to the cold temperatures and other changing environmental factors (Hattar *et al.*, 1992; Laakso *et al.*, 1995).

From the present study, it is concluded that grazing probably reduces the density and diversity of soil mesofauna in general, and Acari and Collembola in particular. It disturbs the mesofaunal community structure and thus leads to a decline in mesofaunal biodiversity. The research can be taken forward by studying the response of soil mesofauna to grazing at the generic level.

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