

A STUDY OF
DIVERSITY OF COLLEMBOLA (INSECTA)
FAUNA OF DARJEELING HIMALAYAS,
WEST BENGAL, INDIA



● Dhrubajyoti Pahari ● Gurupada Mandal ● Ashis Kumar Hazra

ZOOLOGICAL SURVEY OF INDIA



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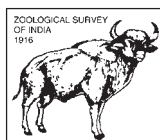
RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA

A Study Of Diversity Of Collembola (Insecta) Fauna of Darjeeling Himalayas, West Bengal, India

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INTRODUCTION

The collembolans, popularly known as “spring-tails”, are small, entognathous, primarily wingless insects having a spring-like forked jumping organ, the furcula underneath the fourth abdominal segment. They are minute in size (less than 6 mm in length) and antennae primarily with 4 segments. The presence of antennae and absence of cerci distinguish them from the other entognathous hexapods.

The collembolans have very diverse distribution occurring in all zoo-geographical regions of the world inhabiting a wide range of ecological niche and climate. It includes a variety of habitats where they feed as scavengers on decaying vegetation and soil fungi even occurring in the vicinity of both south and north poles upto 83° south latitude in Antarctica. The collembolans are major components of terrestrial ecosystems (and particularly significant members of the soil communities), constituting a significant proportion of the animal biomass reaching densities of 200 to 1800 individuals per cm³, densities surpassed by the soil acarine population (Handschin, 1925).

The researchers like Baijal (1955), Yossii (1966a & 1966b) have studied the collembolan communities in different zones of north-western Himalayas, while Salmon (1957a & 1957b), Hazra (1995), Hazra *et al.* (2001 & 2003) have studied the collembolan group in different parts of north-eastern India. However, available reports (Choudhuri and Roy, 1971a, 1971b & 1972; Choudhuri *et al.*, 1978; Hazra, 1978a & 1978b; Hazra and Choudhuri, 1983 & 1990) demonstrated that ecological works on collembolans have been restricted in plains of West Bengal, India. Although some sporadic information on ecology of collembola on a particular altitudinal site of Darjeeling Himalayas has been given by Mukherjee and Banerjee (1993) and Ghosh and Roy (2005), but very little attention has been paid to study the collembolan diversity in respect to altitudinal differences and to assess the effect of different edaphic factors on the distribution and abundance of collembolan population from the Darjeeling Himalaya.

Therefore, the present study has been designed to investigate the diversity, species composition, density, distribution and seasonal population structure of collembolan community inhabiting different altitudes of Darjeeling Himalaya with special reference to edaphic factors and to workout species richness index, species diversity index, group

diversity index, evenness index etc. It is in this context the present investigations were undertaken with the following objectives:

To ascertain the diversity of collembola qualitatively from the different altitudes in relation to physic-chemical parameters of Darjeeling Himalaya, West Bengal, India.

The interrelationship between population of collembola and soil factors has also been discussed statistically.

MATERIALS AND METHODS

Study Sites:

The present investigation involves collection and extraction of collembolan fauna from following eight different altitudinal sites:

Study Sites	Name of Locality	Altitude (m)
I	Sukna	181
II	Chunnabatti	675
III	Gayabari	1173
IV	Tung	1655
V	Darjeeling	2123
VI	Tiger Hill	2557
VII	Kalapakhri	3109
VIII	Sandakphu	3618

Extensive collections of soil samples and data related to physico-chemical parameters of soil were collected from different altitudinal ranges of Darjeeling Himalayas (Fig M1) of West Bengal, India during January, 2006 – December, 2008 study period. The Darjeeling Himalaya is situated between 26°31'N – 27°13'N and 87°59'E- 88°53'E.

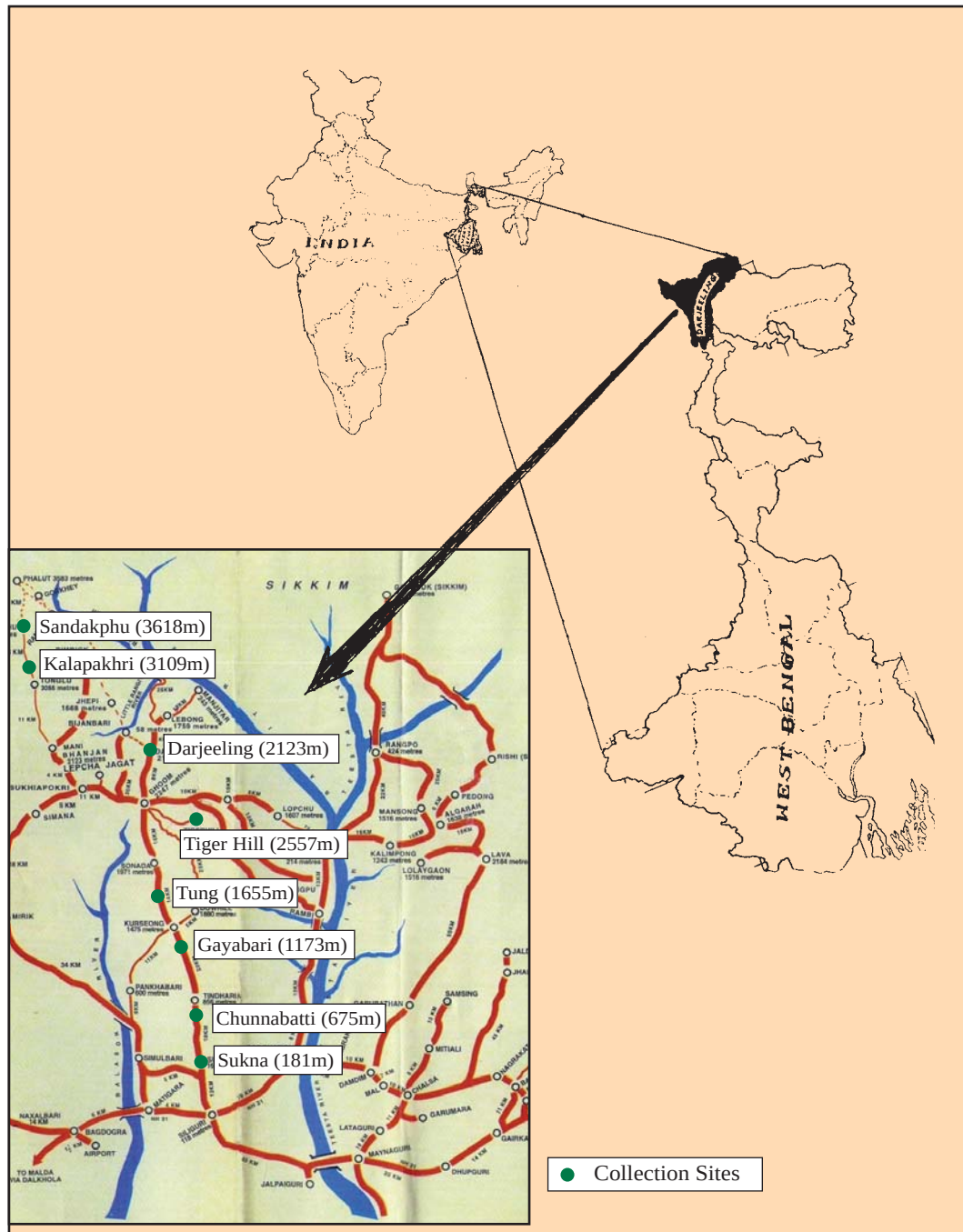


Fig. M1. Showing the location of different collection sites at different altitudes of Darjeeling Himalaya

Collection of Collembolan Fauna:

Soil arthropod fauna including collembola were collected from eight different altitudinal sites of Darjeeling Himalayas, West Bengal, India. Each site was divided into three plots and from each plot (measuring 4 sq. m) three soil samples were drawn with the help of stainless steel corer (8.5 inner cross sectional diameter) from a depth of 5 cm at random per month for three consecutive years. A total of 2,592 (3 x 3 x 8 x 36) soil samples were drawn from January, 2006 to December, 2008. The soil samples just after collection in the field were kept immediately in sterile polythene packet to avoid desiccation. The soil samples, thus, collected were extracted in a high gradient extraction apparatus designed by Macfadyen (1953) with slight modification (Fig. M2a & Fig. M3). An electric bulb (40 watt) above the funnel was used as heat and light source and alcohol as preservative.

Mechanical Analysis of Soil Samples:

It has been measured by Hydrometer method (Piper, 1942). The data obtained in respect of mechanical analysis were mentioned in Table 1:

Table 1. Mechanical analysis of soil samples

Study Sites	Colour	Soil Texture	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)
I	Greyish Black	Silty clay loam	12.6	19.1	45	23.3
II	Greyish Black	Clay loam	12.1	30.2	36.3	21.4
III	Light Grey	Sandy clay loam	8.2	42.2	22.8	26.8
IV	Light Brown	Sandy clay loam	4.5	49.1	25.2	21.2
V	Dark Grey	Sandy clay loam	4.4	55.1	21.3	19.2
VI	Dark Grey	Sandy clay loam	4.2	56.1	21.1	18.6
VII	Light Brown	Sandy loam	5.8	55.3	22.4	16.5
VIII	Dark Brown	Sandy loam	7.4	55.1	22.1	15.4

Analysis Of Physico-chemical Parameters Of Soil:

Phosphate: In the present investigation molybdenum blue test was used for measuring phosphate content in soil (Dowdeswell, 1959).

Nitrate: Nitrate content has been estimated colorometrically from the extracts of soil (Dowdeswell, 1959).

Relative Humidity

Relative humidity of the surface soil has been determined with the help of a dial hygrometer (Bariago, Germany).

Temperature

The temperature of the soil was measured in the field directly by inserting the soil thermometer (made by Zeel, UK) into the soil.

Moisture

Moisture of the soil sample was measured by the 'Oven Dry Method' (Dowdeswell, 1959).

Hydrogen Ion Concentration (pH)

The pH value of soil was examined with the electronic pH meter, "WTW - pH 320".

Organic Carbon

Rapid titration method by Walkley and Black (1934) has been used to determine the organic carbon content of soil.



Fig. M2. Exterior view of the Tullgren Funnel extraction Apparatus.



Fig. M2a. Extraction of soil arthropods by a Tullgren extraction apparatus modified by Macfadyen.

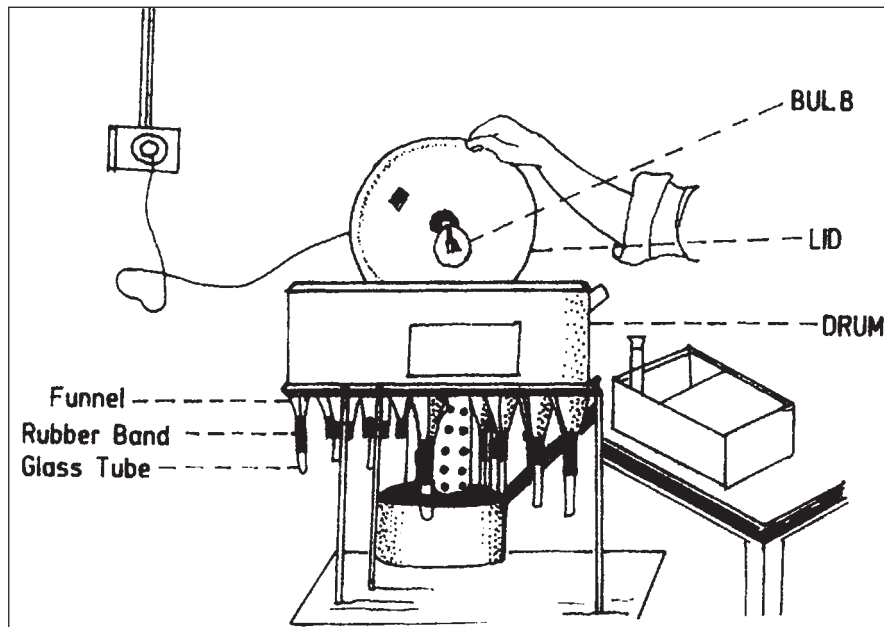


Fig. M3. Field Soil sample extraction apparatus (modified)

OBSERVATIONS

Site I: Sukna (photograph 1.)

Altitude: 181 m.

Characteristics and vegetation of sampling site: This site is situated at the foothill areas of Darjeeling Himalayas with an approximate altitude of 181 m. As stated earlier that the site was divided into three plots each with four square metres area. The plots were undisturbed and forest floor. The site was covered by trees like *Tectona grandis*, *Shorea robusta*, *Saraca indica*, *Bauhinia* sp., *Albizia* sp., *Dalbargia sisoo*. Besides, different kinds of herbs and shrubs (*Anaphalis contorta*, *Acer sikkimensis* etc.) were also present on the forest floor.

Edaphic factors: The soil of the sampling plot was grayish black in colour and silty-clay-loam in texture. Mechanical analysis of soil sample from this site showed maximum percentage of silt (Table M1). The soil temperature was maximum during May (28.8°C in 2006; 29.2°C in 2007; 28.5°C in 2008) and minimum during January (16.9°C in 2006; 17.5°C in 2007; 16.3°C in 2008) in each sampling year. The maximum and minimum moisture were recorded in the month of July (27.42 % in 2006; 29.12 % in 2007; 28.76 % in 2008) and February (14.24 % in 2006; 10.62 % in 2007; 12.35 % in 2008) respectively in each year. The RH (%) was maximum during the month of March (84.2 % in 2006; 82.2 % in 2007; 81.2 % in 2008) and minimum in the month of January (60.8 % in 2006; 60.2 % in 2007; 60.4 % in 2008) in each sampling year. The soil organic carbon and nitrate content of soil showed maximum values in the month of December (4.43% & 3.51 ppm in 2006; 4.39 % & 3.44 ppm in 2007; 4.44 % & 3.28 ppm in 2008 respectively). The minimum organic carbon was recorded in the month of May (2.88 % in 2006; 2.72 % in 2007; 2.94 % in 2008) in each sampling year, while the minimum nitrate content of soil was recorded in the month of July (1.98 ppm in 2006; 1.77 ppm in 2007; 1.91 in 2008) in each sampling year. The maximum and minimum values of phosphate were recorded in the month of January (0.64 ppm in 2006; 0.63 ppm in 2007; 0.57 ppm in 2008) and March (0.34 ppm in 2006, 0.31 ppm in 2007; 0.33 ppm in 2008) respectively in each year (Table 1a).

Collembola fauna: The collembolan fauna obtained from this site belonged to 21 species under 17 genera. The Table 1b revealed the monthly density and relative abundance of each collembolan species in this study site. The species *Entomobrya kali* was the most dominant one contributing 32.46% of the total fauna recorded from this site, followed by *Cyphoderus simulans* (17.85%), *Lepidocyrtus medius* (12.01%), *Lepidocyrtus malayanus* (7.76%), *Isotoma (Desoria) trispinata* (3.76%), *Xenylla obscura* (3.7%), *Lepidocyrtus heterolepis* (3.61%), *Isotomina thermophila* (2.32%), *Tomocerus mitrai* (2.32%), *Lepidocyrtus magnificus* (2.08%), *Isotomurus balteatus* (1.76%),

Lobella kraepelini (1.68%) and *Pseudosinella* sp. (1.68%), *Sinella curviseta* (1.44%) and *Hypogastrura indovaria* (1.36%) of total collembolan population. Other species in this site are numerically very low and highly irregular in occurrence (Table 1b & Fig 1b).

Seasonal changes: The monthly changes in the relative abundance of four dominant species of collembola (*Entomobrya kali*, *Cyphoderus simulans*, *Lepidocyrtus medius* and *Lepidocyrtus malayanus*) as observed in this site have been shown in Table 1b. The species like *Entomobrya kali*, *Lepidocyrtus medius* and *Lepidocyrtus malayanus* showed population peak during the month of December in each sampling year might be due to the maximum concentration of organic carbon and nitrate content of soil (Table 1a). The species *Cyphoderus simulans* showed its peak during March in each sampling year when relative humidity of surface soil was maximum and concentration of soil phosphate was low (Table 1a). The other collembolan species were represented by numerically low in number and showed irregular trends of monthly population fluctuations (Table 1b).

Table 1a. Showing values of edaphic factors in different months from Jan'2006 – Dec'2008 at Site I

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	16.9	19.23	60.8	5.46	3.34	3.23	0.64
	F	18.3	14.24	61.2	5.64	3.23	2.31	0.51
	M	26.4	15.23	84.2	5.55	3.98	2.48	0.34
	A	27.4	18.32	70.3	5.29	3.24	2.35	0.39
	M	28.8	17.22	74.5	5.69	2.88	2.11	0.44
	J	25.5	18.22	71.2	5.2	2.96	2.02	0.51
	J	21.3	27.42	74.8	5.04	3.02	1.98	0.49
	A	23.5	25.27	75.4	5.32	4.22	3.2	0.47
	S	25.6	25.23	79.2	5.16	4.32	2.97	0.4
	O	24.4	21.76	72.6	5.08	4.37	3.23	0.41
	N	22.3	19.18	70.3	5.11	4.24	3.22	0.39
	D	19.5	18.33	61.2	5.32	4.43	3.51	0.47

Table 1a. continued.....

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	17.5	19.16	60.2	5.56	3.31	3.39	0.63
	F	19.2	10.62	60.8	5.6	3.24	2.38	0.53
	M	26.1	14.27	82.2	5.5	3.58	2.47	0.31
	A	28.5	18.94	72.3	5.27	3.44	2.32	0.38
	M	29.2	16.38	71.2	5.61	2.72	2.13	0.46
	J	26.4	17.18	70.8	5.21	3.02	1.89	0.53
	J	21.5	29.12	75.4	5.11	3.14	1.77	0.51
	A	28.7	23.96	78.8	5.34	3.92	2.31	0.4
	S	23.4	22.23	73.8	5.17	4.32	2.33	0.47
	O	25.6	21.94	70.1	5.21	4.35	3.02	0.46
	N	22.5	20.96	72.8	5.19	4.23	3.39	0.45
	D	20.6	18.38	62.5	5.52	4.39	3.44	0.43
2008	J	16.3	19.23	60.4	5.38	3.29	2.33	0.57
	F	19.5	12.35	61.2	5.59	3.24	2.32	0.47
	M	26.8	13.34	81.2	5.52	3.54	2.45	0.33
	A	27.7	17.45	71.4	5.34	3.25	2.29	0.37
	M	28.5	17.56	79.8	5.6	2.94	2.09	0.52
	J	25.4	16.23	72.8	5.24	2.99	1.99	0.55
	J	21.5	28.76	78.5	5.06	3.02	1.91	0.49
	A	22.6	27.96	77.3	5.31	4.32	2.94	0.47
	S	21.4	22.18	75.4	5.18	4.42	3.23	0.46
	O	23.4	21.59	69.8	5.1	4.33	3.27	0.39
	N	22.3	19.43	75.4	5.17	4.21	2.95	0.45
	D	19.2	19.23	59.7	5.28	4.44	3.28	0.49

Table 1b. Showing monthwise density (no. / sq.m.) of collembolan species from Jan'2006 – Dec'2008 at Site I.
(Figures in parenthesis showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
Lepidocyrtus heterolepis	392.15 (0.24)	-	-	-	-	-	-	-	-	-	392.15 (0.24)	-
Lepidocyrtus medius	-	915.03 (0.57)	784.31 (0.48)	915.03 (0.57)	-	-	653.6 (0.4)	392.15 (0.24)	-	-	915.03 (0.57)	1303.18 (0.81)
Entomobrya kali	1568.62 (0.97)	1176.47 (0.73)	1568.62 (0.97)	1699.34 (1.05)	522.87 (0.32)	784.31 (0.48)	915.03 (0.57)	1045.75 (0.65)	1568.62 (0.97)	1437.9 (0.89)	2222.22 (1.37)	2483.66 (1.53)
Lepidocyrtus malayanus	915.03 (0.57)	915.03 (0.57)	-	-	-	-	-	-	392.15 (0.24)	915.03 (0.57)	-	1045.75 (0.65)
Hypogastrura indovaria	-	-	-	-	-	-	-	-	-	-	-	-
Isotomurus balteatus	-	-	-	-	-	-	-	-	-	-	-	-
Isotomina thermophila	-	-	522.87 (0.32)	-	-	-	-	-	-	392.15 (0.24)	522.87 (0.32)	-
Cyphoderus javanus	392.15 (0.24)	-	-	-	-	-	-	-	-	-	-	653.6 (0.4)
Xenylla obscura	-	784.31 (0.48)	1176.47 (0.73)	653.6 (0.4)	-	-	-	-	-	-	-	-
Cyphoderus simulans	1176.47 (0.73)	1307.18 (0.81)	1568.62 (0.97)	522.87 (0.32)	392.15 (0.24)	653.6 (0.4)	653.6 (0.4)	915.03 (0.57)	915.03 (0.57)	1176.47 (0.73)	653.6 (0.4)	392.15 (0.24)

Table 1b. continued.

Table 1b.

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
Tomocerus mitrai	-	-	-	522.87 (0.32)	261.43 (0.16)	-	-	-	-	-	-	-
Lobella kraepelini	-	-	-	-	-	-	-	-	653.6 (0.4)	-	-	-
Neanura corralina	-	-	-	-	-	-	-	-	-	653.6 (0.4)	-	-
Isotoma (Desoria) trispinata	-	-	-	784.31 (0.48)	522.87 (0.32)	653.6 (0.4)	-	-	-	-	-	-
Pseudosinella sp.	-	-	-	-	392.15 (0.24)	261.43 (0.16)	522.87 (0.32)	-	-	-	-	-
Sinella curviseta	-	-	-	-	-	-	522.87 (0.32)	522.87 (0.32)	392.15 (0.24)	-	-	-
Lepidocyrtus magnificus	-	-	-	-	-	-	-	784.31 (0.48)	392.15 (0.24)	-	-	-
Salina bengalensis	261.43 (0.16)	-	-	-	-	-	-	-	-	-	-	-
Salina indica	-	-	-	-	-	-	-	-	-	-	-	-
Willosia sp.	-	-	-	-	-	-	-	-	-	-	522.87 (0.32)	-
Willemia sp.	-	-	-	-	261.43 (0.16)	392.15 (0.24)	-	-	-	-	-	-

Table 1b. continued.....

Table 1b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus heterolepis</i>	784.31 (0.48)	915.03 (0.57)	522.87 (0.32)	-	-	-	-	-	-	-	653.6 (0.4)	-
<i>Lepidocyrtus medius</i>	-	1307.18 (0.81)	1045.75 (0.65)	1045.75 (0.65)	392.15 (0.24)	653.6 (0.4)	-	-	392.15 (0.24)	-	653.6 (0.4)	1568.62 (0.97)
<i>Entomobrya kali</i>	915.03 (0.57)	130.71 (0.81)	2352.94 (1.45)	1568.62 (0.97)	915.03 (0.57)	653.6 (0.4)	522.87 (0.32)	1437.9 (0.89)	1437.9 (0.89)	1699.34 (1.05)	1830.06 (1.13)	3137.25 (1.94)
<i>Lepidocyrtus malayanus</i>	392.15 (0.24)	-	392.15 (0.24)	-	-	-	915.03 (0.57)	522.87 (0.32)	392.15 (0.24)	392.15 (0.24)	-	1045.75 (0.65)
<i>Hypogastrura indovaria</i>	-	-	-	-	-	-	522.87 (0.32)	653.6 (0.4)	-	-	-	-
<i>Isotomurus balteatus</i>	-	261.43 (0.16)	522.87 (0.32)	-	-	-	-	-	392.15 (0.24)	392.15 (0.24)	-	-
<i>Isotomina thermophila</i>	-	-	-	-	-	-	-	-	-	653.6 (0.4)	522.87 (0.32)	-
<i>Cyphoderus javanus</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Xenylla obscura</i>	522.87 (0.32)	522.87 (0.32)	-	-	-	-	-	-	-	-	-	653.6 (0.4)
<i>Cyphoderus simulans</i>	784.31 (0.48)	1045.75 (0.65)	1176.47 (0.89)	1045.75 (0.73)	653.6 (0.4)	653.6 (0.4)	261.43 (0.16)	392.15 (0.24)	653.6 (0.4)	1307.18 (0.57)	1045.75 (0.65)	261.43 (0.16)

Table 1b. continued.

Table 1b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Tomocerus mitrai</i>	-	-	-	-	522.87 (0.32)	-	-	653.6 (0.4)	522.87 (0.32)	-	-	-
<i>Lobella kraepelini</i>	-	-	261.43 (0.16)	653.6 (0.4)	-	-	-	-	-	130.71 (0.08)	-	-
<i>Neanura corralina</i>	-	-	-	-	-	-	-	-	-	522.87 (0.32)	-	-
<i>Isotoma (Desoria) trispinata</i>	-	-	-	-	-	522.87 (0.32)	653.6 (0.4)	261.43 (0.16)	392.15 (0.24)	-	-	-
<i>Pseudosinella sp.</i>	-	-	-	-	-	653.6 (0.4)	-	-	-	-	-	-
<i>Sinella curviseta</i>	392.15 (0.24)	-	-	-	-	-	-	-	-	522.87 (0.32)	-	-
<i>Lepidocyrtus magnificus</i>	-	-	-	-	-	-	784.31 (0.48)	392.15 (0.24)	392.15 (0.24)	-	-	-
<i>Salina bengalensis</i>	-	-	-	-	-	-	-	-	-	-	-	653.6 (0.4)
<i>Salina indica</i>	392.15 (0.24)	-	-	-	-	-	-	-	-	-	-	392.15 (0.24)
<i>Willosia sp.</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Willemia sp.</i>	392.15 (0.24)	-	-	-	-	-	-	-	-	-	-	-

Table 1b. continued.

Table 1b.

SPECIES	2008												
	J	F	M	A	M	J	J	A	S	O	N	D	
<i>Lepidocyrtus heterolepis</i>	784.31 (0.48)	392.15 (0.24)	653.6 (0.4)	-	-	-	-	-	-	-	392.15 (0.24)	-	
<i>Lepidocyrtus medius</i>	-	653.6 (0.4)	522.87 (0.32)	784.31 (0.48)	392.15 (0.24)	784.31 (0.48)	784.31 (0.48)	522.87 (0.32)	392.15 (0.24)	-	784.31 (0.48)	915.03 (0.57)	
<i>Entomobrya kali</i>	1176.47 (0.73)	1960.78 (1.21)	2222.22 (1.37)	1437.9 (0.89)	522.87 (0.32)	784.31 (0.48)	653.6 (0.4)	1176.47 (0.73)	1437.9 (0.89)	1699.34 (1.05)	1699.34 (1.05)	2614.38 (1.61)	
<i>Lepidocyrtus malayanus</i>	784.31 (0.49)	-	-	-	-	-	-	-	522.87 (0.32)	653.6 (0.4)	1045.75 (0.65)	1307.18 (0.81)	
<i>Hypogastrura indovaria</i>	-	-	-	-	-	-	-	-	-	-	392.15 (0.24)	653.6	
<i>Isotomurus balteatus</i>	-	-	-	392.15 (0.24)	-	-	-	392.15 (0.24)	522.87 (0.32)	-	-	-	
<i>Isotomina thermophila</i>	-	784.31 (0.48)	-	-	-	392.15 (0.24)	-	-	-	-	-	-	
<i>Cyphoderus javanus</i>	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Xenylla obscura</i>	392.15 (0.24)	392.15 (0.24)	915.03 (0.57)	-	-	-	-	-	-	-	-	-	
<i>Cyphoderus simulans</i>	1176.47 (0.73)	1045.75 (0.65)	1437.9 (0.89)	653.6 (0.4)	522.87 (0.32)	-	-	915.03 (0.57)	1176.47 (0.73)	784.31 (0.48)	915.03 (0.57)	653.6 (0.4)	

Table 1b. continued.

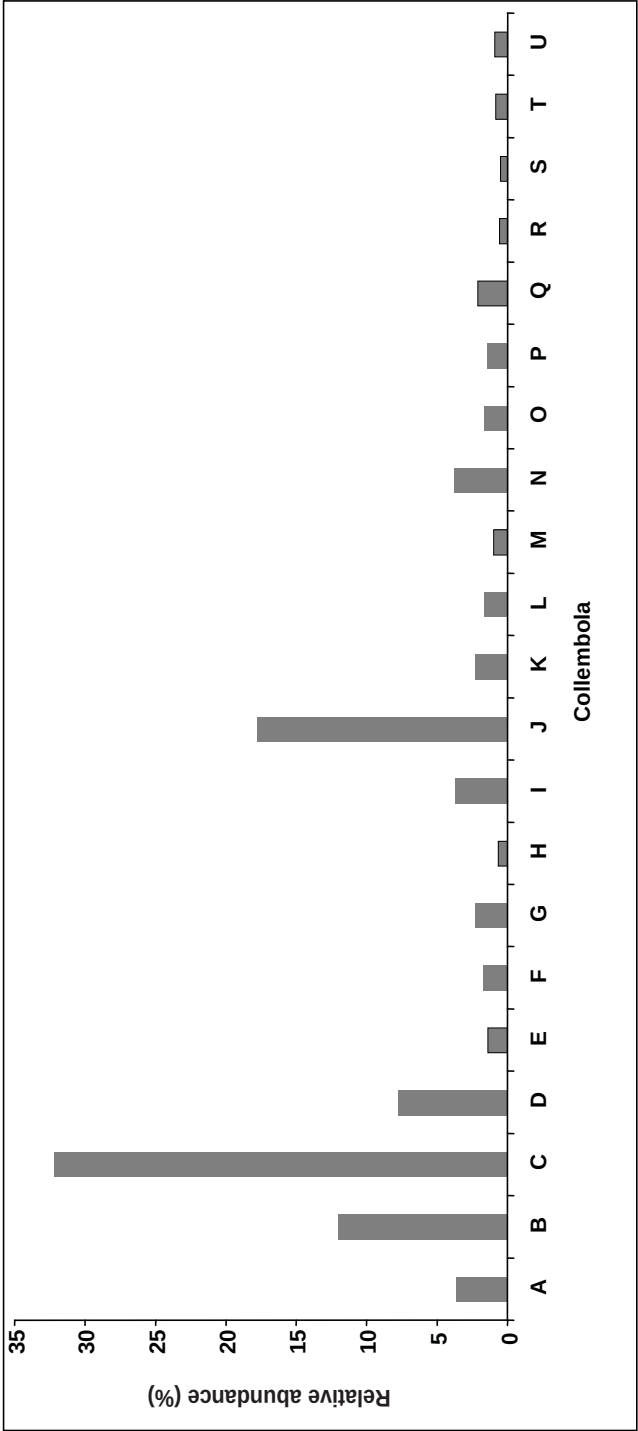


Fig 1b. Showing species composition of collembola at Site I

A = *Lepidocyrtus heterolepis*; B = *Lepidocyrtus medius*; C = *Entomobrya kali*; D = *Lepidocyrtus malayanus*; E = *Hypogastrura indovaria*; F = *Isotomurus balteatus*; G = *Isotomina thermophila*; H = *Cyphoderus javanus*; I = *Xenylla obscura*; J = *Cyphoderus simulans*; K = *Tomocerus mitrai*; L = *Lobella kraepelini*; M = *Neanura coralina*; N = *Isotoma (Desoria) trispinata*; O = *Pseudosinella* sp.; P = *Sinella curviseta*; Q = *Lepidocyrtus magnificus*; R = *Salina bengalensis*; S = *Salina indica*; T = *Willosia* sp.; U = *Willemia* sp.

Site II: Chunnabatti (photograph 2)**Altitude:** 675 m.

Characteristics and vegetation of sapling sites: This site is located in undisturbed hilly areas of Darjeeling District. The site was divided into three plots and each plot was four square metres. The soil of plots was covered by debris of leaves and grasses. This site was covered with *Cryptomaria japonica*, *Betula alnoides*, *Phobea* sp., *Dalbergia* sp., *Machilus edulis* besides herbs and shrubs like *Anaphilis contorta*, *Acer sikkimensis*, *Rubus lasiocarpus* etc.

Edaphic factors: The soil of the sampling plot was grayish-black in colour and clay-loam in texture. Mechanical analysis of soil sample from this site showed high percentage of sand (Table M1). The soil temperature was maximum during June (26.5°C in 2006; 25.5°C in 2007; 26.4°C in 2008) and minimum during January (14.9°C in 2006; 14.5°C in 2007; 14.9°C in 2008) in each sampling year. The maximum moisture was recorded during the month of August in 2006 (20.9 %) and July in 2007 (22.49 %) and 2008 (23.17 %) as well as minimum during February in 2006, 2007 (12.95% and 13.85 % respectively) and January in the year 2008 (14.46 %). The RH (%) was maximum in the month of March in each study year (83.3 % in 2006; 78.5% in 2007; 81% in 2008) and minimum in the month of January during 2006, 2008 (59.2% and 62.6 % respectively) and February (60.4%) in 2007. The soil organic carbon content of soil showed maximum values in the month of March (4.14 % in 2006; 4.22% in 2007; 4.14 % in 2008) and minimum organic carbon was recorded in the month of May (3.01 % in 2006; 2.97 % in 2007; 2.74 % in 2008) when the soil pH was maximum in each sampling year. The maximum nitrate content of soil was recorded in the month of March during 2006 and 2007 (3.12 ppm and 2.99 ppm respectively) and December 2008 (2.79 ppm) as well as minimum in July (1.88 ppm in 2006; 1.86 ppm in 2007; 1.82 ppm in 2008) in each sampling year. The maximum and minimum values of phosphate were recorded in the month of January (0.52 ppm in 2006; 0.58 ppm in 2007; 0.54 ppm in 2008) and March (0.36 ppm in 2006; 0.39 ppm in 2007; 0.37 ppm in 2008) respectively in each year (Table 2a).

Collembola fauna: The collembolan fauna obtained from this site belonged to 18 species under 15 genera. The Table 2b revealed the monthly density and relative abundance of each collembolan species in this study site. The species *Entomobrya kali* was the most dominant species contributing 35.82% of the total fauna recorded from this site followed by *Lepidocyrtus medius* (14.26%), *Cyphoderus simulans* (12.31%), *Isotomurus balteatus* (5.35%), *Xenylla obscura* (3.39%), *Lepidocyrtus malayanus* (3.39%), *Isotoma (Desoria) trispinata* (3.37%), *Sinella curviseta* (3.14%), *Lepidocyrtus heterolepis* (3.9%), *Cryptopygus thermophilus* (3.06%) and *Isotomina thermophila* (2.46%). The remaining collembolan species were represented by numerically low in number and showed highly irregular in occurrence (Table 2a & Fig 2b).

Seasonal changes: The monthly changes in the relative abundance of four dominant species of collembola (*Entomobrya kali*, *Lepidocyrtus medius*, *Cyphoderus simulans* and *Isotomurus balteatus*) as observed in this site have been shown in Table 2b. The most dominant species *Entomobrya kali* attained its peak in the month of March in each sampling year of observation might be due to the maximum concentration of soil organic carbon, higher value of relative humidity of surface soil and concentration of soil phosphate was low (Table 2a). The species *Lepidocyrtus medius*, *Cyphoderus simulans* and *Isotomurus balteatus* showed highest population peak during the month of December in each sampling year when soil nitrate was moderate to maximum, temperature and phosphate were moderate (Table 2a). The rest of the collembolan species were represented by numerically low in number and showed irregular trends of seasonal population fluctuations (Table 2b).

Table 2a. Showing values of edaphic factors in different months from Jan'2006–Dec'2008 at Site II

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	14.9	14.16	59.2	5.23	3.23	2.86	0.52
	F	19.3	12.95	66.9	5.18	3.3	2.14	0.41
	M	23.1	16.14	83.3	5.11	4.14	3.12	0.36
	A	24.8	14.02	77.5	5.18	3.39	2.27	0.41
	M	23.7	16.03	76.2	5.27	3.01	2.01	0.42
	J	26.5	18.49	74.5	5.09	3.13	1.91	0.51
	J	24.8	20.74	70.3	5.04	3.14	1.88	0.45
	A	23.3	20.9	75.4	5.06	4.01	2.81	0.44
	S	24.2	18.45	66.3	5.18	4.12	3.01	0.48
	O	23.4	16.67	68.8	5.17	4.02	3.03	0.46
	N	22.1	18.4	72.4	5.2	4.01	2.82	0.45
	D	18.5	19.2	64	5.11	4.09	2.37	0.47

Table 2a. continued.....

Table 2a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	14.5	15.96	67.4	5.25	3.12	2.14	0.58
	F	20.2	13.85	60.4	5.22	3.24	2.11	0.42
	M	22.4	18.24	78.5	5.21	4.22	2.99	0.39
	A	24.4	17.33	70.8	5.08	3.27	2.26	0.49
	M	23.8	16.43	77.4	5.29	2.97	2.04	0.41
	J	25.5	20.49	73.3	5.08	3.12	1.88	0.55
	J	23.8	22.49	74.6	5.1	3.18	1.86	0.50
	A	24.9	21.23	71.7	5.09	4.05	2.29	0.49
	S	21.1	19.56	74.6	5.15	4.1	2.88	0.48
	O	19.9	19.34	69.5	5.17	3.68	2.91	0.47
	N	19.4	18.25	66.5	5.13	3.78	2.81	0.44
	D	16.5	19.96	68.4	5.11	3.84	2.73	0.43
2008	J	14.9	14.46	62.6	5.2	3.12	2.59	0.54
	F	19.8	15.65	64.4	5.21	3.14	2.23	0.4
	M	24.5	18.96	81	5.14	4.14	2.48	0.37
	A	25.6	18.16	68.4	5.18	3.34	2.25	0.41
	M	23.8	16.34	70.5	5.23	2.74	2.15	0.43
	J	26.4	20.11	71.3	5.12	2.86	1.93	0.52
	J	23.5	23.17	75.4	5.09	3.12	1.82	0.50
	A	25.2	22.24	74.3	5.03	3.99	2.82	0.49
	S	23.2	20.22	70.4	5.08	4.2	2.72	0.48
	O	19.5	17.01	69.5	5.17	4.04	2.69	0.49
	N	21.9	18.24	70.7	5.16	3.7	2.44	0.47
	D	19	15.84	67.4	5.14	3.8	2.79	0.45

Table 2b. Showing monthwise density (no. / sq.m.) of collembolan species from Jan'2006– Dec'2008 at Site II.
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus heterolepis</i>	-	392.15 (0.25)	522.87 (0.34)	-	-	-	-	-	-	392.15 (0.25)	392.15 (0.25)	-
<i>Lepidocyrtus medius</i>	-	-	784.31 (0.51)	915.03 (0.59)	-	-	784.31 (0.51)	784.31 (0.51)	915.03 (0.59)	1176.47 (0.76)	1045.75 (0.68)	1437.9 (0.93)
<i>Entomobrya kali</i>	915.03 (0.59)	1307.18 (0.85)	2745.09 (1.78)	2222.22 (1.44)	1045.75 (0.68)	653.6 (0.42)	522.87 (0.34)	1045.75 (0.68)	1568.34 (1.02)	1437.9 (0.93)	1960.78 (1.27)	2222.22 (1.44)
<i>Isotomurus balteatus</i>	653.6 (0.42)	-	653.6 (0.42)	-	-	-	-	-	-	261.43 (0.17)	-	784.31 (0.51)
<i>Cyphoderus javanus</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cryptopygus thermophilus</i>	392.15 (0.25)	522.87 (0.34)	-	-	-	-	-	-	-	-	-	-
<i>Isotomella minor</i>	-	653.6 (0.42)	-	-	-	-	-	-	-	-	653.6 (0.42)	-
<i>Isotomina thermophila</i>	-	-	-	392.15 (0.25)	-	-	-	-	-	-	522.87 (0.34)	522.87 (0.34)
<i>Xenylla obscura</i>	392.15 (0.25)	784.31 (0.51)	-	392.15 (0.25)	-	-	-	-	-	-	-	-

Table 2b. continued.....

Table 2b.

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus malayanus</i>	653.6	522.87	-	-	-	522.87	-	-	-	-	-	-
	(0.42)	(0.34)				(0.34)						
<i>Cyphoderus simulans</i>	915.03	653.6	1045.75	522.87	522.87	653.6	-	-	522.87	392.15	653.6	522.87
	(0.59)	(0.42)	(0.68)	(0.34)	(0.34)	(0.42)			(0.34)	(0.25)	(0.42)	(0.34)
<i>Tomocerus mitrai</i>	-	-	-	-	-	-	-	-	784.31	653.6	-	-
									(0.51)	(0.42)		
<i>Sinella curviseta</i>	-	-	-	-	-	-	784.31	522.87	-	261.43	-	-
							(0.51)	(0.34)		(0.17)		
<i>Isotoma trispiana</i>	-	-	-	-	653.6	653.6	-	-	-	-	-	-
					(0.42)	(0.42)						
<i>Lobella kraepelini</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Salina bengalensis</i>	392.15	-	-	-	-	-	-	-	-	-	-	653.6
	(0.25)											(0.42)
<i>Willemia</i> sp.	-	392.15	-	-	-	-	-	392.15	-	-	-	-
		(0.25)						(0.25)				
<i>Willisia</i> sp.	-	-	-	-	-	-	522.87	522.87	-	-	-	-
							(0.34)	(0.34)				

Table 2b. continued.....

Table 2b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
Lepidocyrtus heterolepis	-	392.15 (0.25)	-	-	-	-	-	-	-	261.43 (0.17)	1045.75 (0.68)	-
Lepidocyrtus medius	915.03 (0.59)	392.15 (0.25)	653.6 (0.42)	392.15 (0.25)	522.87 (0.34)	392.15 (0.25)	-	1045.75 (0.68)	1045.75 (0.68)	784.31 (0.51)	915.03 (0.59)	1176.47 (0.76)
Entomobrya kali	1176.47 (0.76)	1830.06 (1.19)	3006.53 (1.95)	1960.78 (1.27)	784.31 (0.51)	392.15 (0.25)	392.15 (0.25)	522.87 (0.34)	1960.78 (1.27)	1437.9 (0.93)	2483.66 (1.61)	2352.94 (1.53)
Isotomurus balteatus	784.31 (0.51)	-	-	-	-	-	-	261.43 (0.17)	784.31 (0.51)	522.87 (0.34)	-	915.03 (0.59)
Cyphoderus javanus	-	-	522.87 (0.34)	-	-	-	-	-	-	-	-	522.87 (0.34)
Cryptopygus thermophilus	-	-	-	-	-	392.15 (0.25)	392.15 (0.25)	522.87 (0.34)	-	-	-	-
Isotomella minor	-	392.15 (0.25)	-	-	-	-	522.87 (0.34)	-	-	-	392.15 (0.25)	-
Isotomina thermophila	-	-	-	653.6 (0.42)	-	-	-	-	-	-	653.6 (0.42)	-
Xenylla obscura	522.87 (0.34)	784.31 (0.51)	-	-	-	-	-	-	-	-	-	392.15 (0.25)

Table 2b. continued.....

Table 2b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
Lepidocyrtus malayanus	-	-	392.15 (0.25)	-	-	392.15 (0.25)	392.15 (0.25)	-	-	522.87 (0.34)	-	-
Cyphoderus simulans	1045.75 (0.68)	915.03 (0.59)	1176.47 (0.76)	653.6 (0.42)	522.87 (0.34)	653.6 (0.42)	392.15 (0.25)	-	-	-	-	522.87 (0.34)
Tomocerus mitrai	-	-	-	784.31 (0.51)	-	-	-	-	-	261.43 (0.17)	-	-
Sinella curviseta	-	-	-	392.15 (0.25)	-	-	653.6 (0.42)	522.87 (0.34)	-	-	-	-
Isotoma (Desoria) trispinata	-	-	-	-	522.87 (0.34)	653.6 (0.42)	392.15 (0.25)	522.87 (0.42)	-	-	-	-
Lobella kraepelini	-	-	-	-	-	-	-	-	-	784.31 (0.51)	-	-
Salina bengalensis	261.43 (0.17)	-	-	-	-	-	-	-	-	-	-	261.43 (0.17)
Willemia sp.	-	392.15 (0.25)	-	-	-	-	-	-	-	-	-	261.43 (0.17)
Willotia sp.	-	-	-	-	-	-	-	-	-	-	-	-

Table 2b. continued.....

Table 2b.

SPECIES	2008												
	J	F	M	A	M	J	J	A	S	O	N	D	
<i>Lepidocyrtus heterolepis</i>	-	-	-	-	-	-	-	-	392.15 (0.25)	392.15 (0.25)	653.6 (0.42)	-	
<i>Lepidocyrtus medius</i>	784.31 (0.51)	-	392.15 (0.25)	784.31 (0.51)	-	522.87 (0.34)	261.43 (0.17)	-	653.6 (0.42)	784.31 (0.51)	653.6 (0.51)	915.03 (0.59)	
<i>Entomobrya kali</i>	1437.9 (0.93)	1830.06 (1.19)	2614.37 (1.7)	1699.34 (1.1)	522.87 (0.34)	653.6 (0.42)	653.6 (0.42)	1699.34 (1.1)	1699.34 (1.1)	1960.78 (1.27)	2352.94 (1.53)	2091.5 (1.36)	
<i>Isotomurus balteatus</i>	-	-	-	-	-	-	-	392.15 (0.25)	-	522.87 (0.34)	784.31 (0.51)	915.03 (0.59)	
<i>Cyphoderus javanus</i>	-	392.15 (0.25)	130.71 (0.084)	-	-	-	-	-	-	-	-	261.43 (0.34)	
<i>Cryptopygus thermophilus</i>	653.6 (0.42)	653.6 (0.42)	-	-	-	522.87 (0.34)	-	653.6 (0.42)	-	-	-	-	
<i>Isotomella minor</i>	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Isotomina thermophila</i>	-	-	-	-	-	-	-	-	-	-	392.15 (0.25)	653.6 (0.42)	
<i>Xenylla obscura</i>	-	784.31 (0.51)	653.6 (0.42)	392.15 (0.25)	-	-	-	-	-	-	-	130.71 (0.084)	

Table 2b. continued.....

Table 2b.

SPECIES	2008											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus malayanus</i>	-	-	-	784.31 (0.51)	-	-	392.15 (0.25)	-	-	-	-	653.6 (0.42)
<i>Cyphoderus simulans</i>	392.15 (0.25)	784.31 (0.51)	1045.75 (0.68)	522.87 (0.34)	392.15 (0.25)	522.87 (0.34)	522.87 (0.34)	784.31 (0.51)	653.6 (0.42)	-	392.15 (0.25)	653.6 (0.42)
<i>Tomocerus mitrai</i>	-	392.15 (0.25)	130.71 (0.084)	-	-	-	-	-	-	-	-	-
<i>Sinella curviseta</i>	-	-	392.15 (0.25)	653.6 (0.42)	653.6 (0.42)	-	-	-	-	-	-	-
<i>Isotoma (Desoria) trispinata</i>	-	-	-	-	522.87 (0.34)	522.87 (0.34)	653.6 (0.42)	-	-	-	-	-
<i>Lobella kraepelini</i>	-	-	-	-	-	-	-	-	392.15 (0.25)	522.87 (0.34)	-	-
<i>Salina bengalensis</i>	261.43 (0.17)	-	392.15 (0.25)	-	-	-	-	-	-	-	-	392.15 (0.25)
<i>Willemia</i> sp.	522.87 (0.34)	-	-	-	-	-	392.15 (0.25)	-	-	-	-	261.43 (0.17)
<i>Willisia</i> sp.	-	-	-	-	-	-	-	-	-	-	-	392.15 (0.25)

Table 2b. continued.....

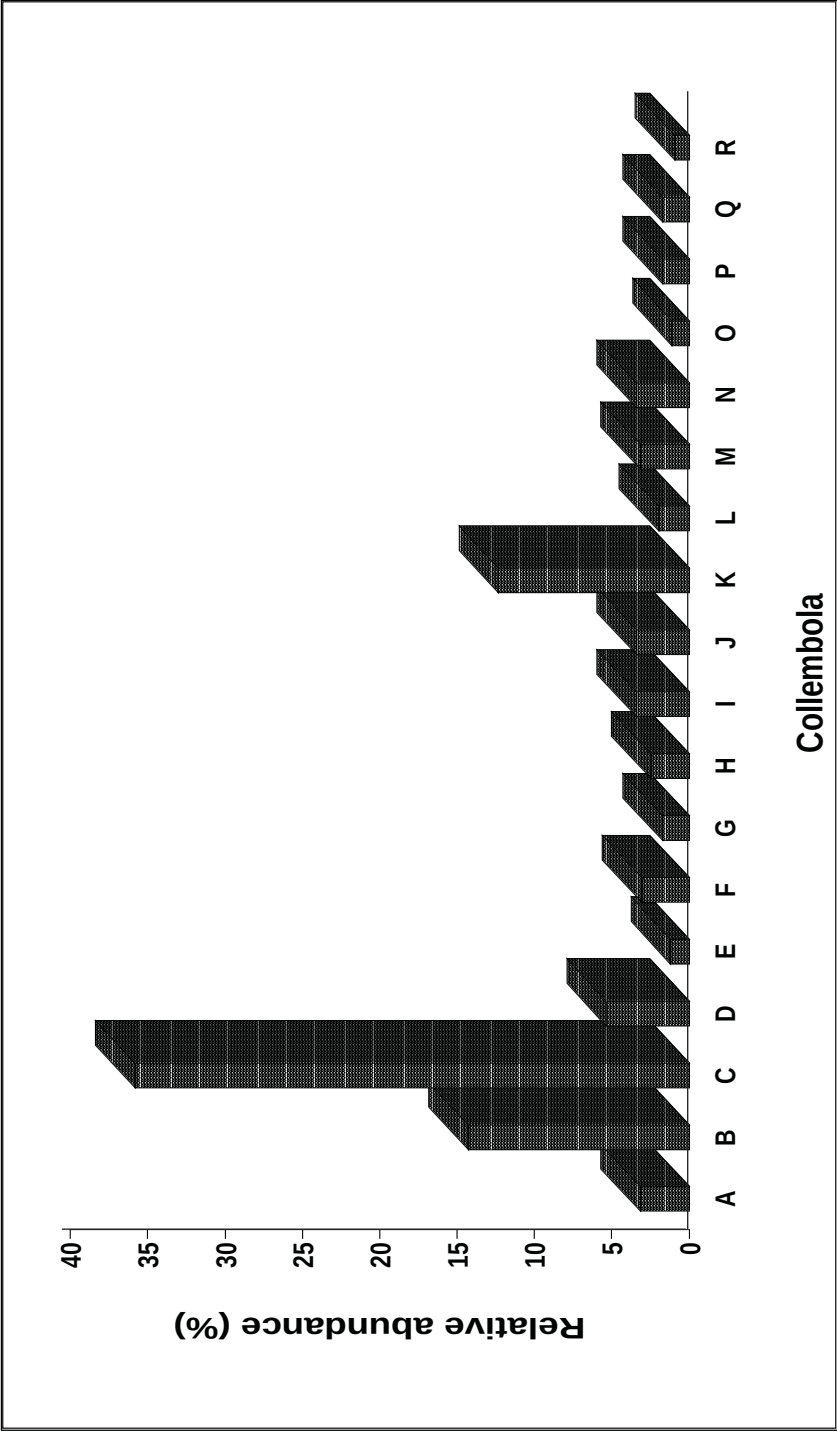


Fig 2b. Showing species composition of collembola at Site II

A = *Lepidocyrtus heterolepis*; B = *Lepidocyrtus medius*; C = *Entomobrya kali*; D = *Isotomurus balteatus*; E = *Cyphoderus javanus*; F = *Cryptopygus thermophilus*; H = *Isotomina thermophila*; G = *Isotomella minor*; I = *Xenylla obscura*; J = *Lepidocyrtus malayanus*; K = *Cyphoderus simulans*; L = *Tomocerus mitrai*; M = *Sinella curviseta*; N = *Isotoma (Desoria) trispinata*; O = *Lobella kraepelini*; P = *Salina bengalensis*; Q = *Willemia* sp.; R = *Willosia* sp.

Site III: Gayabari (photograph 3)**Altitude:** 1173 m.

Characteristics and vegetation of sapling sites: This site is located near the Gayabari railway station. It included three sampling plots, each measured with 4m X 4m. The sampling sites were undisturbed sloppy forest floor areas. The site was covered by trees like *Machilus edulis*, *Dalbergia* sp., *Acacia* sp., *Adina* sp., *Toona* sp., *Cryptomaria japonica*. Besides, different kinds of herbs and shrubs (*Anaphalis contorta*, *Acer sikkimensis* etc) were also present on the forest floor.

Edaphic factors: The soil of the sampling plot was light gray in colour and sandy-clay-loam in texture. Mechanical analysis of soil sample from this site showed high percentage of sand (Table M1). The soil temperature was maximum during the month of May in 2006 and 2008 (25.4°C & 26.4°C respectively) and June in 2007 (26.2°C) and minimum during the month of January (13.5°C in 2006; 13.8°C in 2007; 13.8°C in 2008) in each sampling year. The maximum moisture was recorded in the month of July (30.48% in 2006; 30.58% in 2007; 26.36 % in 2008) as well as minimum during February in each sampling year (13.4% in 2006; 13.33% in 2007; 14.89 % in 2008). The RH (%) was maximum during the month of July in 2006 (84.5%), March in 2007 (84%) and 2008 (85.4%) and minimum in the month of January during each sampling year (60.8% in 2006; 59.6 % in 2007; 59.3 % in 2008). The soil organic carbon content of soil showed maximum values in the month of March (3.97 % in 2006; 3.96 % in 2007; 3.9 % in 2008) and minimum organic carbon was recorded in the month of Jun -July in each sampling year (2.94 % in Jun 2006; 2.98% in June 2007; 2.98 % in June 2008). The maximum pH was recorded during May in 2006 (5.32) and 2007 (5.29) and March in 2008 (5.34). The maximum nitrate content of soil was recorded in the month of December (2.86 ppm in 2006; 2.92 ppm in 2007; 2.82 ppm in 2008) as well as minimum in July in each sampling year (2.12 ppm in 2006; 1.99 ppm in 2007; 1.97 ppm in 2008). The maximum and minimum values of phosphate were recorded in the month of May (0.57 ppm) in 2006, June (0.61 ppm) in 2007, May (0.63 ppm) in 2008 and March respectively in each year (0.32 ppm in 2006; 0.34 ppm in 2007; 0.29 ppm in 2008) as shown in Table 3a.

Collembola fauna: The collembolan fauna obtained from this site belonged to 17 species under 15 genera. The Table 3b revealed the monthly density and relative abundance of each collembolan species in this study site. The species *Entomobrya kali* was the most dominant species contributing 37.49% of the total fauna recorded from this site followed by *Lepidocyrtus medius* (15.11%), *Cyphoderus simulans* (14.60%), *Lepidocyrtus heterolepis* (3.44%), *Lepidocyrtus malayanus* (3.33%), *Isotoma (Desoria) trispinata* (3.84%), *Xenylla obscura* (2.9%), *Isotomella minor* (2.83%), *Onychirus indicus* (2.73%), *Sinella curviseta* (2.39%) and *Yossia dehradunia* (2.13%) of total collembolan population recorded from that site. Other collembolan species in this site were numerically low in number and showed highly irregular in occurrence (Table 3b & Fig 3b).

Seasonal changes: The monthly changes in the relative abundance of four dominant species of collembola (*Entomobrya kali*, *Lepidocyrtus medius*, *Cyphoderus simulans* and *Lepidocyrtus heterolepis*) as observed in this site have been shown in Table 3b. The most dominant species *Entomobrya kali* attained its peak in the month of March in each sampling year of observation might be due to maximum concentration of soil organic carbon and low concentration of soil phosphate (Table 3a), while *Lepidocyrtus medius* showed its peak in the month of March, 2006 and December in 2007 and 2008 when organic carbon was maximum and concentration of phosphate was low in the month of March, 2006 and concentration of soil nitrate was maximum in the month December in 2007 and 2008. *Cyphoderus simulans* showed highest population peak during the month of December in 2006, August and December in 2007 and December in 2008 when concentration of nitrate in soil was maximum. The species *Lepidocyrtus heterolepis* showed highest peak in October in 2006 and September in 2007 and 2008. The remaining collembolan species showed irregular trends of seasonal population fluctuation (Table 3b).

Table 3a. Showing values of edaphic factors in different months from Jan'2006 – Dec'2008 at Site III

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	13.5	16.2	60.8	5.12	3.91	2.85	0.34
	F	16.5	13.4	78.5	5.21	3.83	2.48	0.39
	M	21.8	14.23	83.4	5.11	3.97	2.81	0.32
	A	21.5	19.34	70.4	5.27	3.48	2.43	0.34
	M	25.4	16.36	81.4	5.32	3.02	2.17	0.57
	J	24.2	20.08	82.3	5.19	2.96	2.27	0.55
	J	23.5	30.48	84.5	5.13	2.94	2.12	0.51
	A	21.4	27.43	79.7	5.19	3.67	2.19	0.52
	S	22.4	22.45	70.7	5.13	3.69	2.37	0.42
	O	21.2	19.48	69.8	5.21	3.57	2.29	0.49
	N	21.3	17.87	63.3	5.24	3.35	2.31	0.48
	D	17.2	17.97	71.2	5.21	3.74	2.86	0.51

Table 3a. continued.....

Table 3a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	13.8	19.88	59.6	5.13	3.85	2.86	0.37
	F	15.6	13.33	80.4	5.22	3.67	2.84	0.36
	M	21.3	14.12	84	5.18	3.96	2.79	0.34
	A	20.6	17.28	82.4	5.19	3.44	2.41	0.35
	M	25.3	18.23	74.7	5.29	3.08	2.18	0.61
	J	26.2	22.79	81.5	5.16	2.98	2.13	0.62
	J	22.8	30.58	83.6	5.28	3.04	1.99	0.52
	A	24.1	24.56	80.6	5.19	3.11	2.2	0.49
	S	24.2	21.03	68.5	5.21	3.06	2.27	0.47
	O	21.4	18.18	70.2	5.09	3.29	2.29	0.46
	N	20.9	17.48	61.8	5.12	3.3	2.3	0.51
	D	17.8	17.13	78.5	5.23	3.6	2.92	0.49
2008	J	13.8	19.71	59.3	5.28	3.81	2.59	0.35
	F	15.8	14.89	80.5	5.24	3.74	2.56	0.33
	M	22.2	16.07	85.4	5.34	3.9	2.62	0.29
	A	22.3	17.77	70	5.22	3.41	2.46	0.34
	M	26.4	18.43	79.7	5.31	3.21	2.19	0.63
	J	25.7	20.44	78.6	5.19	2.98	2.11	0.62
	J	24.4	26.36	80.2	5.11	3.11	1.97	0.55
	A	22.2	20.25	75.7	5.33	3.13	2.14	0.59
	S	21.3	21.95	72.8	5.31	3.31	2.2	0.42
	O	20.8	18.54	67.4	5.29	3.35	2.27	0.49
	N	20.5	19.26	64.8	5.22	3.36	2.29	0.45
	D	16.3	16.56	70.4	5.23	3.5	2.82	0.47

Table 3b. Showing monthwise density (no./sq.m) of collembolan species from Jan'2006– Dec' 2008 at Site III
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus heterolepis</i>	130.71	-	130.71	-	-	-	-	392.15	392.15	422.87	261.43	-
	(0.085)		(0.085)					(0.26)	(0.26)	(0.34)	(0.17)	
<i>Entomobrya kali</i>	915.03	1568.34	2483.66	1307.18	522.87	653.6	392.15	1307.18	1830.06	1960.78	2222.22	1307.18
	(0.6)	(1.02)	(1.62)	(0.85)	(0.34)	(0.43)	(0.26)	(0.85)	(1.19)	(1.28)	(1.45)	(0.85)
<i>Cyphoderus simulans</i>	261.43	653.6	1176.47	915.03	261.43	130.71	392.1	915.03	653.6	784.31	1045.75	1307.18
	(0.17)	(0.43)	(0.77)	(0.6)	(0.17)	(0.085)	(0.26)	(0.6)	(0.43)	(0.51)	(0.68)	(0.85)
<i>Xenylla obscura</i>	653.6	-	-	-	-	-	-	-	-	-	522.87	-
	(0.43)										(0.34)	
<i>Onychirus indicus</i>	-	-	-	-	-	392.15	392.15	-	-	-	-	-
						(0.26)	(0.26)					
<i>Lepidocyrtus malayanus</i>	-	392.15	-	653.6	-	-	-	-	-	-	-	522.87
		(0.26)	0	(0.43)							(0.34)	
<i>Isotomella minor</i>	-	-	-	-	-	653.6	-	-	-	-	392.15	392.15
						(0.43)					(0.26)	(0.26)
<i>Isotomina thermophila</i>	-	-	-	-	-	-	522.87	-	-	-	-	522.87
							(0.34)					(0.34)

Table 3b. continued.....

Table 3b.

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomurus balteatus</i>	-	-	-	-	-	-	522.87 (0.34)	-	653.6 (0.43)	-	-	784.31 (0.51)
<i>Lepidocyrtus medius</i>	915.03 (0.6)	784.31 (0.51)	1176.47 (0.77)	392.15 (0.26)	522.87 (0.34)	392.15 (0.26)	522.87 (0.34)	653.6 (0.43)	522.87 (0.34)	653.6 (0.43)	1045.75 (0.68)	915.03 (0.6)
<i>Tomocerus mitrai</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Isotoma (Desoria) trispinata</i>	392.15 (0.26)	-	392.15 (0.26)	-	392.15 (0.26)	-	-	-	-	-	-	-
<i>Sinella curviseta</i>	-	-	-	-	653.6 (0.43)	-	-	-	-	392.15 (0.26)	-	-
<i>Pseudosinella</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-
<i>Yossia dehradunia</i>	-	522.87 (0.34)	-	-	-	392.15 (0.26)	-	392.15 (0.26)	-	-	-	-
<i>Salina bengalensis</i>	130.71 (0.085)	-	-	-	-	-	-	-	-	-	-	392.15 (0.26)
<i>Folsomides purvus</i>	392.15 (0.26)	-	130.71 (0.085)	-	-	-	-	-	-	-	-	-

Table 3b. continued.....

Table 3b.

SPECIES	2007												
	J	F	M	A	M	J	J	A	S	O	N	D	
Lepidocyrtus heterolepis	392.15	-	261.43	-	-	-	-	392.15	392.15	261.43	-	-	
	(0.26)		(0.17)					(0.26)	(0.26)	(0.17)			
Entomobrya kali	1568.34	1960.78	3137.25	1437.9	522.87	392.15	1045.75	1307.18	2091.5	1960.78	2875.81	2352.94	
	(1.02)	(1.28)	(2.05)	(0.94)	(0.34)	(0.26)	(0.68)	(0.85)	(1.37)	(1.28)	(1.88)	(1.54)	
Cyphoderus simulans	784.31	653.6	522.87	392.15	130.71	261.43	522.87	1176.47	915.03	653.6	653.6	1176.47	
	(0.51)	(0.43)	(0.34)	(0.26)	(0.085)	(0.17)	(0.34)	(0.77)	(0.6)	(0.43)	(0.43)	(0.77)	
Xenylla obscura	-	-	-	-	-	-	-	-	653.6	522.87	-	-	
									(0.43)	(0.34)			
Onychirus indicus	-	-	-	392.15	784.31	784.31	653.6	-	-	-	-	-	
				(0.26)	(0.51)	(0.51)	(0.43)						
Lepidocyrtus malayanus	-	-	-	653.6	392.15	653.6	-	-	-	-	-	-	
				(0.43)	(0.26)	(0.43)							
Isotomella minor	-	-	-	784.31	-	-	392.15	-	-	-	-	392.15	
				(0.51)			(0.26)					(0.26)	
Isotomina thermophila	-	-	-	-	-	-	522.87	-	-	-	784.31	261.43	
							(0.34)				(0.51)	(0.17)	

Table 3b. continued.....

Table 3b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
Isotomurus balteatus	-	-	-	-	-	-	-	-	-	-	-	-
Lepidocyrtus medius	653.6 (0.43)	392.15 (0.26)	784.31 (0.51)	-	-	-	-	1176.47 (0.77)	915.03 (0.6)	1045.75 (0.68)	1176.47 (0.77)	1307.18 (0.85)
Tomocerus mitrai	-	-	653.6 (0.43)	-	-	-	-	-	-	392.15 (0.26)	522.87 (0.34)	-
Isotoma (Desoria) trispinata	-	392.15 (0.26)	-	-	-	-	-	-	-	-	-	784.31 (0.51)
Sinella curviseta	-	-	-	-	-	-	-	-	-	522.87 (0.34)	-	-
Pseudosinella sp.	-	-	-	-	-	-	-	-	-	-	-	-
Yossia dehradunia	261.43 (0.17)	-	-	-	-	522.87 (0.34)	-	-	-	-	261.43 (0.17)	-
Salina bengalensis	261.43 (0.17)	-	-	-	-	-	-	-	-	-	-	522.87 (0.34)
Folsomides purvus	-	522.87 (0.34)	-	-	261.43 (0.17)	-	-	522.87 (0.34)	-	-	-	-

Table 3b. continued.....

Table 3b.

SPECIES	2008												
	J	F	M	A	M	J	J	A	S	O	N	D	
<i>Lepidocyrtus heterolepis</i>	-	261.43 (0.17)	392.15 (0.26)	-	-	-	-	-	653.6 (0.43)	-	653.6 (0.43)	653.6 (0.43)	
<i>Entomobrya kali</i>	915.03 (0.6)	1307.18 (0.85)	3921.56 (2.56)	1960.78 (1.28)	261.43 (0.17)	522.87 (0.34)	392.15 (0.26)	1307.18 (0.85)	2222.22 (1.37)	2614.37 (1.71)	2745.09 (1.79)	2091.5 (1.37)	
<i>Cyphoderus simulans</i>	653.6 (0.43)	392.15 (0.26)	1045.75 (0.68)	784.31 (0.51)	392.15 (0.26)	392.15 (0.26)	522.87 (0.34)	915.03 (0.6)	392.15 (0.26)	522.87 (0.34)	-	-	
<i>Xenylla obscura</i>	261.43 (0.17)	1045.75 (0.68)	-	-	-	-	-	-	-	784.31 (0.51)	-	-	
<i>Onychirus indicus</i>	784.31 0.51	-	-	-	-	-	-	-	-	-	-	-	
<i>Lepidocyrtus malayanus</i>	-	-	-	-	522.87 (0.34)	522.87 (0.34)	-	-	-	-	-	784.31 (0.51)	
<i>Isotomella minor</i>	-	-	-	-	-	-	522.87 (0.34)	-	-	-	784.31 (0.51)	-	
<i>Isotomina thermophila</i>	-	-	-	-	-	-	-	-	-	-	-	-	

Table 3b. continued.....

Table 3b.

SPECIES	2008											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomurus balteatus</i>	-	-	-	-	-	-	653.6 (0.43)	522.87 (0.34)	-	392.15 (0.26)	-	-
<i>Lepidocyrtus medius</i>	784.31 (0.34)	653.6 (0.43)	130.71 (0.085)	-	-	-	-	653.6 (0.43)	784.31 (0.51)	1307.18 (0.85)	1307.18 (0.85)	1830.06 (1.19)
<i>Tomocerus mitrai</i>	-	-	-	784.31 (0.51)	-	-	-	-	-	392.15 (0.26)	-	-
<i>Isotoma (Desoria) trispinata</i>	-	-	-	-	-	653.6 (0.43)	392.15 (0.26)	392.15 (0.26)	-	-	-	784.31 (0.51)
<i>Sinella curviseta</i>	-	-	-	-	-	-	522.87 (0.34)	915.03 (0.6)	653.6 (0.43)	-	-	-
<i>Pseudosinella</i> sp.	-	-	-	-	392.15 (0.26)	653.6 (0.43)	-	-	-	-	-	-
<i>Yossia dehradunia</i>	522.87 (0.34)	-	-	-	261.43 (0.17)	-	-	-	-	-	-	130.71 (0.085)
<i>Salina bengalensis</i>	261.43 (0.17)	-	-	-	-	-	-	-	-	261.43 (0.17)	-	392.15 (0.26)
<i>Folsomides purvus</i>	-	392.15 (0.26)	-	-	-	-	-	-	392.15 (0.26)	-	-	-

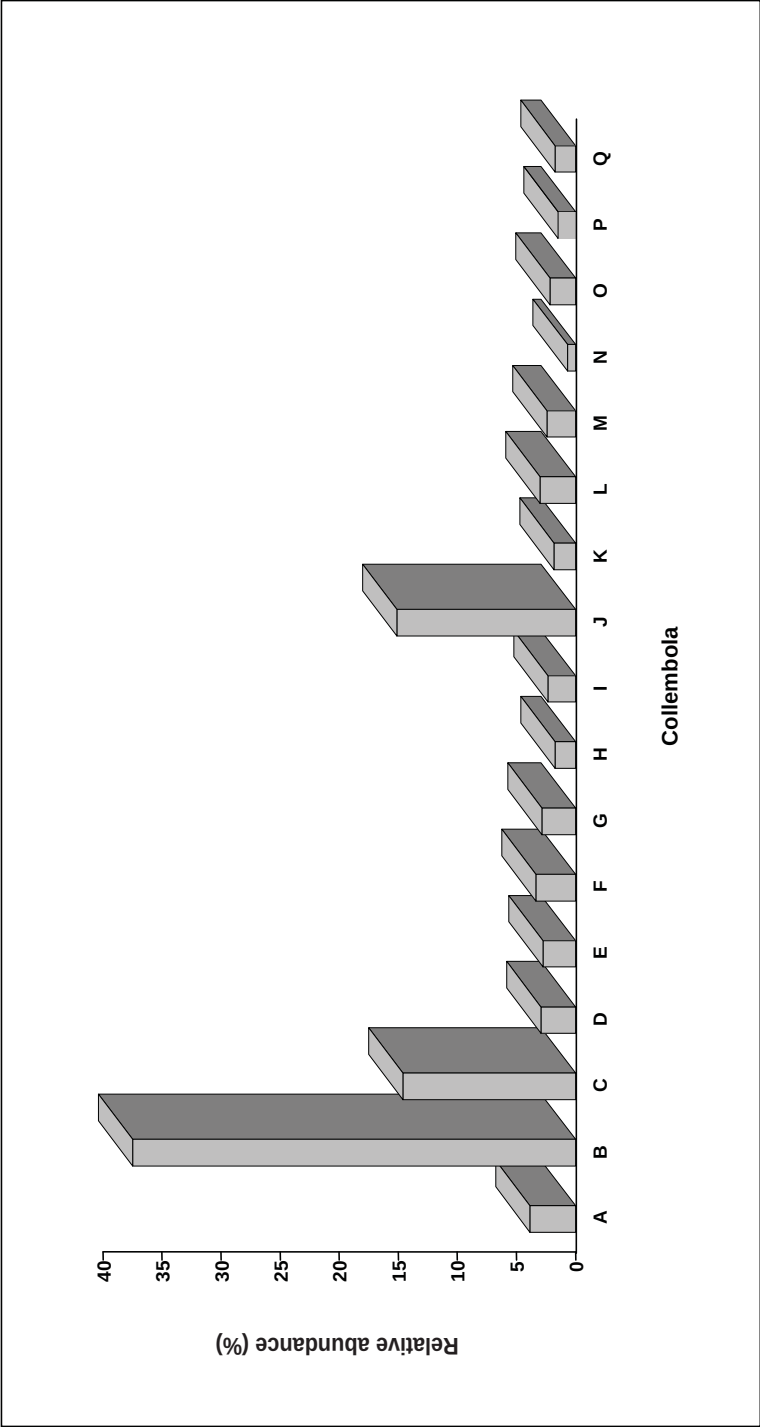


Fig 3b. Showing species composition of collembola at Site III

A = *Lepidocyrtus heterolepis*; B = *Entomobrya kali*; C = *Cyphoderus simulans*; D = *Xenylla obscura*; E = *Onychirus indicus*; F = *Lepidocyrtus malayanus*; G = *Isotomella minor*; H = *Isotomina thermophila*; I = *Isotomurus balteatus*; J = *Lepidocyrtus medius*; K = *Tomocerus mitrai*; L = *Isotoma (Desoria) trispinata*; M = *Sinella curviseta*; N = *Pseudosinella* sp.; O = *Yossia dehradunia*; P = *Salina bengalensis*; Q = *Folsomides purvus*.

Site IV: Tung (photograph 4)**Altitude:** 1655 m.

Characteristics and vegetation of sapling sites: The site under study was a forest floor site and was situated at an area which was nearly two kilometer east of Tung railway station. The site was divided into three plots and three soil samples were taken from each plot. Each plot in measurement was four square metres. The soil of the each plot was covered by litter of the fallen leaves and dried twigs of the trees. The site was covered by varieties of herbs and shrubs (*Rhododendron arboretum*, *Rubus lasiocarpus*, *Acer sikkimense*, *Enonymus echinatus*) and trees like *Quercus lamellose*, *Nyssa sessiliflora*, *Machilus edulis*, *Castanopsis hystrix* etc.

Edaphic factors: The soil of the sampling plot was light brown in colour and sandy-clay-loam in texture. Mechanical analysis of soil sampled from this site showed high percentage of fine sand (Table M1). The soil temperature was maximum during the month of June in 2006 and 2008 (22.4°C & 23.4°C respectively) and May in 2007 (24.4°C in 2006) and minimum during the month of January (11.2°C in 2006; 11.7°C in 2007; 11.7°C in 2008) in each sampling year. The maximum moisture was recorded in the month of August in 2006 (31.47%), 33.24% in July 2007 and also in July (31.12%) 2008 as well as minimum during February in 2006 (19.23%), 2007 (18.32%) and January (18.12 %) in 2008. The RH (%) was maximum during the month of May in 2006 (88%) and 2007 (86.8%) and in March 2008 (82%) and minimum in the month of January during each sampling year (55.5% in 2006; 58.8 % in 2007; 60.3 % in 2008). The soil organic carbon content of soil showed maximum values in the month of March (3.98 % in 2006; 3.96 % in 2007; 3.91 % in 2008) and minimum organic carbon was recorded in the month of July in each sampling year (3.06 % in 2006; 2.98% in 2007; 3.12 % in 2008). The maximum pH was recorded during January in 2006 (5.52) and February in 2007 (5.45) and October in 2008 (5.59). The maximum nitrate content of soil was recorded in the month of March (2.91 ppm in 2006; 2.9 ppm in 2007) and November (2.81 ppm in 2008) as well as minimum in July in each sampling year (1.88 ppm in 2006; 1.89 ppm in 2007; 1.88 ppm in 2008). The maximum and minimum values of phosphate were recorded in the month of July (0.62 ppm in 2006, 0.71 ppm in 2007; 0.63 ppm in 2008) and March respectively in each year (0.33 ppm in 2006; 0.35 ppm in 2007; 0.34 ppm in 2008) as shown in Table 4a.

Collembola fauna: The collembolans fauna obtained from this site belonged to 16 species under 15 genera. The Table 4b revealed the monthly density and relative abundance of each collembolan species in this study site. The species *Lepidocyrtus heterolepis* was the most dominant species contributing 44.15% of the total collembola fauna recorded from this site followed by *Lepidocyrtus medius* (15.72%), *Isotomina thermophila* (8.13%), *Entomobrya kali* (4.57%), *Xenylla obscura* (4.30%), *Isotoma*

(*Desoria trispinata* (3.56%) and *Cryptopygus thermophilus* (3.02%) of total collembolan population recorded from this site during three years of sampling. Other species in this site are numerically low and highly irregular in occurrence (Table 4b & Fig 4b).

Seasonal changes: The monthly variations in relative abundance of four dominant species of collembola (*Lepidocyrtus heterolepis*, *Lepidocyrtus medius*, *Isotomina thermophila* and *Entomobrya kali*) as observed in this site have been shown in Table 4b. The species like *Lepidocyrtus heterolepis* and *Lepidocyrtus medius* showed their population peak in the month of March in each sampling year of observation might be due to the maximum concentration of organic carbon and concentration of phosphate in soil was low (Table 4a). The species *Isotomina thermophila* showed population peak during the month of November in each sampling year. The species *Entomobrya kali* showed population peak in April in 2006 and March in 2007 and 2008. The other collembolan species were represented by numerically low in number and showed irregular trends of monthly population fluctuation (Table 4b).

Table 4a. Showing values of edaphic factors in different months from Jan'2006 – Dec'2008 at Site IV

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	11.2	20.21	55.5	5.52	3.84	2.88	0.53
	F	12.3	19.23	74.6	5.49	3.73	2.89	0.55
	M	16.8	21.08	82.6	5.09	3.98	2.91	0.33
	A	19.3	20.79	75.2	5.17	3.31	2.24	0.49
	M	21.2	20.34	88	5.2	3.29	2.32	0.41
	J	22.4	24.98	85.6	5.19	3.17	2.26	0.52
	J	20.6	30.48	81.5	5.03	3.06	1.88	0.62
	A	21.9	31.47	83.4	5.35	3.52	2.31	0.42
	S	20.8	28.51	78.3	5.93	3.83	2.49	0.4
	O	19.8	27.18	81.3	5.31	3.95	2.32	0.41
	N	15.5	20.65	74.8	5.34	3.52	2.15	0.49
	D	13.3	21.34	61	5.35	3.89	2.39	0.38

Table 4a. continued.....

Table 4a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	11.7	19.12	58.8	5.33	3.83	2.85	0.64
	F	11.8	18.32	81	5.45	3.6	2.49	0.49
	M	18.4	20.35	84.7	5.11	3.96	2.9	0.35
	A	21.5	21.16	78	5.19	3.3	2.23	0.38
	M	24.4	20.23	86.8	5.15	3.22	2.31	0.37
	J	21.3	28.45	84.3	5.26	3.14	2.19	0.43
	J	21.7	33.24	82.4	5.12	2.98	1.89	0.71
	A	23.7	31.69	81	5.56	3.52	2.02	0.43
	S	20.6	27.47	78.5	5.36	3.71	2.18	0.41
	O	19.6	22.23	82	5.27	3.28	2.29	0.49
	N	16.7	19.68	71.3	5.31	3.5	2.21	0.48
	D	12.5	21.34	60	5.37	3.43	2.35	0.49
2008	J	11.7	18.12	60.3	5.49	3.74	2.51	0.61
	F	13.2	19.82	75.5	5.34	3.75	2.78	0.47
	M	18.8	21.67	82	5.08	3.91	2.42	0.34
	A	20.1	21.47	72.3	5.18	3.21	2.28	0.39
	M	22.2	20.21	80	5.1	3.28	2.42	0.37
	J	23.4	23.65	81.6	5.26	3.25	2.13	0.41
	J	21.8	31.12	82	5.13	3.12	1.88	0.63
	A	23.3	30.22	82.4	5.49	3.8	2.04	0.39
	S	20.4	28.33	79.6	5.51	3.85	2.29	0.34
	O	19.8	26.22	84	5.59	3.41	2.08	0.43
	N	18.8	20.67	70.7	5.33	3.46	2.81	0.59
	D	12.5	19.91	60.4	5.3	3.48	2.35	0.46

Table 4b. Showing monthwise density (no./sq.m) of collembolan species from Jan'2006 – Dec' 2008 at Site IV.
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus medius</i>	653.6 (0.46)	392.15 (0.27)	1176.47 (0.82)	915.03 (0.64)	522.87 (0.36)	-	-	522.87 (0.36)	915.03 (0.64)	653.6 (0.46)	653.6 (0.46)	392.15 (0.27)
<i>Lepidocyrtus heterolepis</i>	1568.34 (1.1)	1830.06 (1.28)	2614.37 (1.83)	1699.34 (1.19)	1176.47 (0.82)	392.15 (0.27)	261.43 (0.18)	1437.9 (1)	1960.78 (1.37)	2352.94 (1.64)	2483.66 (1.74)	2222.22 (1.55)
<i>Isotomina thermophila</i>	392.15 (0.27)	784.31 (0.55)	784.31 (0.55)	-	-	-	-	-	-	522.87 (0.36)	1437.9 (1)	392.15 (0.27)
<i>Xenylla obscura</i>	392.15 (0.27)	392.15 (0.27)	392.15 (0.27)	-	-	-	-	-	-	522.87 (0.36)	-	-
<i>Cryptopygus thermophilus</i>	-	522.87 (0.36)	-	522.87 (0.36)	392.15 (0.27)	-	-	-	-	-	-	-
<i>Entomobrya kali</i>	-	-	-	784.31 (0.55)	522.87 (0.36)	522.87 (0.36)	-	-	-	-	-	-
<i>Cyphoderus javanus</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Onychirus indicus</i>	-	-	-	-	-	392.15 (0.27)	522.87 (0.36)	-	-	-	-	-

Table 4b. continued.

Table 4b.

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomella minor</i>	-	-	522.87 (0.36)	-	-	-	-	-	784.31 (0.55)	-	-	-
<i>Tomocerus mitrai</i>	-	-	-	522.87 (0.36)	-	-	-	-	-	-	-	-
<i>Lobella kraepelini</i>	-	-	392.15 (0.27)	-	-	-	-	-	-	-	-	784.31 (0.55)
<i>Isotoma (Desoria) trispinata</i>	-	-	-	392.15 (0.27)	-	392.15 (0.27)	392.15 (0.27)	522.87 (0.36)	-	-	-	-
<i>Sinella curviseta</i>	-	-	-	-	-	-	522.87 (0.36)	392.15 (0.27)	-	-	-	-
<i>Yossia dehradunia</i>	-	-	261.43 (0.18)	-	-	261.43 (0.18)	-	-	-	-	-	-
<i>Salina bengalensis</i>	392.15 (0.27)	-	-	-	-	-	-	392.15 (0.27)	-	-	-	-
<i>Alloscopus tetracantha</i>	261.43 (0.18)	-	-	-	-	-	-	-	-	-	130.71 (0.091)	261.43 (0.18)

Table 4b. continued.....

Table 4b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus medius</i>	522.87	653.6	1307.18	653.6	392.15	522.87	-	653.6	392.15	653.6	915.03	261.43
	(0.36)	(0.46)	(0.91)	(0.46)	(0.18)	(0.36)		(0.46)	(0.27)	(0.46)	(0.64)	(0.18)
<i>Lepidocyrtus heterolepis</i>	1830.06	1960.78	3398.69	1830.06	522.87	784.31	653.6	2091.5	2745.09	2483.66	2614.37	1960.78
	(1.28)	(1.37)	(2.38)	(1.28)	(0.36)	(0.55)	(0.46)	(1.46)	(1.92)	(1.74)	(1.83)	(1.37)
<i>Isotomina thermophila</i>	-	392.15	-	-	-	-	-	-	784.31	915.03	1045.75	653.6
		(0.27)							(0.55)	(0.64)	(0.73)	(0.46)
<i>Xenylla obscura</i>	522.87	-	-	-	-	-	784.31	-	-	-	-	653.6
	(0.36)						(0.55)					(0.46)
<i>Cryptopygus thermophilus</i>	-	-	-	392.15	-	-	-	-	-	-	-	784.31
				(0.27)								(0.55)
<i>Entomobrya kali</i>	-	-	915.03	653.6	784.31	-	-	-	-	-	-	-
			(0.64)	(0.46)	(0.55)							
<i>Cyphoderus javanus</i>	-	-	261.43	392.15	-	-	-	-	-	-	-	-
			(0.18)	(0.27)								
<i>Onychirus indicus</i>	-	-	-	-	653.6	784.31	-	-	-	-	-	-
					(0.46)	(0.55)						

Table 4b. continued.....

Table 4b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomella minor</i>	-	-	-	-	-	-	-	392.15 (0.27)	-	-	653.6 (0.46)	-
<i>Tomocerus mitrai</i>	-	-	-	-	-	392.15 (0.27)	-	653.6 (0.46)	-	-	-	-
<i>Lobella kraepelini</i>	-	-	-	-	392.15 (0.27)	-	-	-	-	784.31 (0.55)	-	-
<i>Isotoma (Desoria) trispinata</i>	-	784.31 (0.55)	522.87 (0.36)	392.15 (0.27)	-	-	-	-	-	-	-	-
<i>Sinella curviseta</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Yossia dehradunia</i>	261.43 (0.18)	392.15 (0.27)	-	-	-	-	392.15 (0.27)	-	-	-	-	-
<i>Salina bengalensis</i>	392.15 (0.27)	-	-	-	-	-	-	-	-	-	522.87 (0.36)	-
<i>Alloscopus tetracantha</i>	-	-	-	-	-	-	-	-	--	-	-	522.87 (0.36)

Table 4b. continued.....

Table 4b.

SPECIES	2008											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus medius</i>	1045.75	1176.47	1437.9	784.31	784.31	-	-	261.43	522.87	1307.18	653.6	784.31
	(0.73)	(0.82)	(1)	(0.55)	(0.55)			(0.18)	(0.36)	(0.91)	(0.46)	(0.55)
<i>Lepidocyrtus heterolepis</i>	1830.06	1307.18	3267.97	1307.18	653.6	915.03	784.31	1307.18	1568.34	2352.94	2745.09	2222.22
	(1.28)	(0.91)	(2.28)	(0.91)	(0.46)	(0.64)	(0.55)	(0.91)	(1.1)	(1.64)	(1.92)	(1.55)
<i>Isotomina thermophila</i>	-	653.6	-	-	-	-	-	-	-	784.31	1176.47	915.03
		(0.460)								(0.55)	(0.82)	(0.64)
<i>Xenylla obscura</i>	-	-	522.87	653.6	-	-	-	-	-	-	784.31	522.87
			(0.36)	(0.46)							(0.55)	(0.36)
<i>Cryptopygus thermophilus</i>	-	-	-	784.31	-	-	-	-	-	-	261.43	653.6
				(0.55)							(0.18)	0.46
<i>Entomobrya kali</i>	-	-	-	522.87	784.31	522.87	522.87	-	-	-	-	-
				(0.36)	(0.55)	(0.36)	(0.36)					
<i>Cyphoderus javanus</i>	-	-	-	784.31	-	392.15	-	-	-	-	522.87	-
				(0.55)		(0.27)					(0.36)	
<i>Onychirus indicus</i>	-	-	-	-	-	-	-	-	-	-	-	-

Table 4b. continued.....

Table 4b.

[illegible]

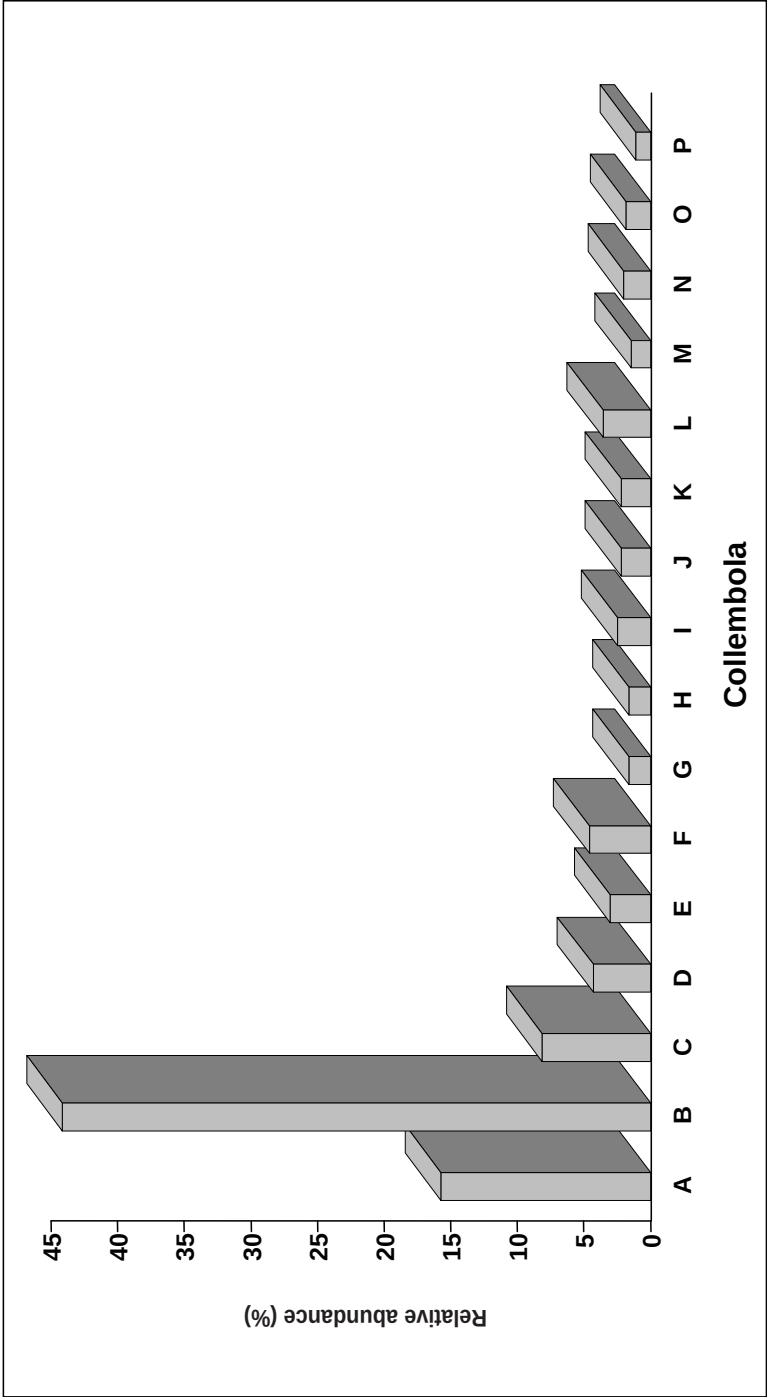


Fig 4b. Showing species composition of collembola at Site IV

A = *Lepidocyrtus medius*; B = *Lepidocyrtus heterolepis*; C = *Isotomina thermophila*; D = *Xenylla obscura*; E = *Cryptopugus thermophilus*; F = *Entomobrya kali*; G = *Cyphoderus javanus*; H = *Onychirus indicus*; I = *Isotomella minor*; J = *Tomocerus mitrai*; K = *Lobella krepalini*; L = *Isotoma (Desoria) trispinata*; M = *Sinella curviseta*; N = *Yossia dehradunia*; O = *Salina bengalensis*; P = *Alloccopus tetracantha*.

Site V: Darjeeling (photograph 5)**Altitude:** 2123 m.

Characteristics and vegetation of sapling sites: This site was a natural forest, located nine km away from Darjeeling railways station. As stated earlier this site also divided into three plots. Each plot was measured into 4m X 4m. The sampling site was covered with litter of the fallen leaves. The site was covered by varieties of mosses, ferns, grasses, herbs and shrubs like *Rhododendron arborium*, *Rubia cordifolia*, *Panicum palmifolium*, *Berberis insignis*, *Polygonum runcinatum*, *Acer sp.* *Enonymus echinatus* and trees like *Quercus lamellosa*, *Nyssa sessiliflora*, *Machilus edulis*, *Castanopsis hystrix*, *Cryptomaria japonica* etc.

Edaphic factors: The soil of the sampling plot was dark grey in colour and sandy-clay-loam in texture. Mechanical analysis of soil sample from this site showed high percentage of fine sand (Table M1). The soil temperature was maximum during the month of June in 2006 and 2008 (19.6°C & 18.4°C respectively) and May in 2007 (19.8°C) and minimum during the month of January (9.3°C in 2006; 9.7°C in 2007; 9.2°C in 2008) in each sampling year. The maximum moisture was recorded in the month of July in 2006 (34.12%), 34.46% in August 2007 and also in August (33.77%) 2008 as well as minimum during April in 2006 (17.19%), 2007 (18.88%) and May (17.12 %) in 2008. The RH (%) was maximum during the month of July in 2006 (87.3%) and June in 2007 (85.3%) and 2008 (86.4%) and minimum in the month of December in 2006 (71.8%), January in 2007 (71.4%) and 2008 (72%) in. The soil organic carbon content of soil showed maximum values in the month of March (4.02 % in 2006; 4.12 % in 2007; 4.11 % in 2008) and minimum organic carbon was recorded in the month of July in each sampling year (2.92 % in 2006; 2.88% in 2007; 3.02 % in 2008). The maximum pH was recorded during January in 2006 (5.63), 2007 (5.66) and 2008 (5.74). The maximum nitrate content of soil was recorded in the month of March (2.9 ppm in 2006; 2.8 ppm in 2007; 2.78 ppm in 2008) as well as minimum in July in each sampling year (1.75 ppm in 2006; 1.91 ppm in 2007; 1.68 ppm in 2008). The maximum and minimum values of phosphate were recorded in the month of July (0.66 ppm in 2006, 0.69 ppm in 2007; 0.61 ppm in 2008) and March-April respectively in each year (0.37 ppm in March, 2006; 0.36 ppm in March, 2007; 0.33 ppm in March-April, 2008) as shown in Table 5a.

Collembola fauna: The collembolans fauna obtained from this site belonged to 14 species under 13 genera. The Table 5b revealed the monthly density and relative abundance of each collembolan species in this study site. The species *Lepidocyrtus heterolepis* was the most dominant species contributing 51.13% of the total fauna recorded from this site followed by *Xenylla obscura* (12.31%), *Lepidocyrtus medius* (6.34%), *Isotomodes dagamae* (6.06%), *Isotomina thermophila* (3.88%), *Allocopus tetracantha* (3.22 %), *Cyphoderus javanus* (2.84%), *Entomobrya kali* (2.84%), *Isotomurus balteatus*

(2.75%) and *Onychirus indicus* (2.27%) of total collembolan population. Other species in this site were represented by numerically low in number and showed highly irregular in occurrence (Table 5b & Fig 5b).

Seasonal changes: The monthly changes in population structure of four predominant species of collembola (*Lepidocyrtus heterolepis*, *Xenylla obscura*, *Lepidocyrtus medius* and *Isotomedes dagamae*) as observed in this site have been shown in Table 5b. The most dominant species *Lepidocyrtus heterolepis* attained its peak in the month of March in each sampling year of observation might be due to the maximum concentration of soil organic carbon and nitrate and concentration of phosphate in soil was low (Table 5a). The species *Xenylla obscura* showed its peak population in the month of November in 2006, March in 2007 and September in 2008. The species *Lepidocyrtus medius* showed peak population during the month of March in 2006 and November - December in remaining two years. The species *Isotomedes dagamae* showed peak population in December in 2006, March in 2007 and November in 2008. The other collembolan species were represented by numerically low in number and showed irregular trends of seasonal population fluctuation (Table 5b).

Table 5a. Showing values of edaphic factors in different months from Jan'2006 – Dec'2008 at Site V

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	9.3	23.86	73.4	5.63	3.97	2.79	0.54
	F	10.2	21.23	77.4	5.39	3.98	2.88	0.63
	M	15.7	21.34	82.2	5.19	4.02	2.9	0.37
	A	16.7	17.19	80.4	5.17	4.01	2.35	0.38
	M	17.2	17.25	83.7	5.34	3.49	2.13	0.44
	J	19.6	30.54	81.2	5.29	3.12	1.86	0.58
	J	17.8	34.12	87.3	5.02	2.92	1.75	0.66
	A	17.4	33.06	86.6	5.21	3.12	1.98	0.48
	S	18.5	31.17	81.3	5.56	3.43	2.01	0.42
	O	15.8	28.04	77.4	5.27	3.41	2.18	0.43
	N	12.5	24.18	73	5.21	3.95	2.21	0.49
	D	10.8	23.29	71.8	5.12	3.83	2.14	0.51

Table 5a. continued.....

Table 5a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	9.7	23.38	71.4	5.66	3.96	2.65	0.62
	F	10.8	20.88	75.6	5.43	4.03	2.71	0.64
	M	17.3	21.28	80.2	5.11	4.12	2.8	0.36
	A	19.4	18.88	78	5.09	3.98	2.34	0.38
	M	19.8	20.54	81.6	5.15	3.69	2.29	0.39
	J	18.5	30.74	85.3	5.06	3.32	1.98	0.53
	J	18.2	31.64	81.8	5.04	2.88	1.91	0.69
	A	18.2	34.46	84.4	5.12	3.01	1.98	0.46
	S	18.7	32.85	78.4	5.3	3.03	2.04	0.52
	O	15.5	30.21	81.3	5.2	3.18	2.05	0.55
	N	12.8	23.17	79.2	5.31	3.42	2.11	0.57
	D	11.2	25.63	79	5.22	3.32	2.17	0.59
2008	J	9.2	25.12	72	5.74	3.89	2.54	0.52
	F	10.4	22.67	75.4	5.54	3.89	2.61	0.55
	M	15.2	23.32	80.6	5.22	4.11	2.76	0.33
	A	15.7	19.63	83	5.28	3.42	2.33	0.33
	M	17.2	17.12	82.7	5.32	3.44	2.16	0.35
	J	18.4	31.19	86.4	5.08	3.13	2.02	0.55
	J	17.8	32.45	85.6	5.01	3.02	1.68	0.61
	A	17.4	33.77	84.9	5.49	3.98	1.98	0.43
	S	17.8	31.23	82.5	5.31	4.02	2.08	0.41
	O	14.7	26.98	84	5.29	3.19	2.1	0.54
	N	13.9	20.25	80.5	5.13	3.34	2.12	0.55
	D	12.6	25.41	75.8	5.15	3.94	2.14	0.58

Table 5b. Showing monthwise density (no./sq.m) of collembolan species from Jan'2006 – Dec' 2008 at Site V.
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus heterolepis</i>	1045.75 (0.76)	1699.34 (1.23)	3398.69 (2.46)	2745.09 (1.99)	1176.47 (0.85)	522.87 (0.38)	392.15 (0.28)	1830.06 (1.32)	2745.09 (1.99)	2091.50 (1.51)	2614.37 (1.89)	2222.22 (1.61)
<i>Lepidocyrtus medius</i>	-	-	784.316 (0.57)	-	-	-	130.71 (0.095)	522.87 (0.38)	-	522.87 (0.38)	-	-
<i>Xenylla obscura</i>	915.03 (0.66)	1045.75 (0.76)	261.43 (0.19)	-	-	-	-	1176.47 (0.85)	915.03 (0.66)	784.31 (0.57)	1307.18 (0.95)	522.87 (0.38)
<i>Isotomedes dagamae</i>	522.87 (0.38)	392.15 (0.28)	-	-	-	-	-	-	-	-	-	915.73 (0.66)
<i>Isotomina thermophila</i>	392.15 (0.28)	-	653.6 (0.47)	261.43 (0.19)	-	522.87 (0.38)	-	-	-	392.15 (0.28)	392.15 (0.28)	-
<i>Cyphoderus javanus</i>	-	-	130.17 (0.095)	-	-	-	-	-	-	522.87 (0.38)	-	-
<i>Entomobrya kali</i>	653.6 (0.47)	-	-	-	784.31 (0.57)	-	-	-	-	-	-	-
<i>Isotomurus balteatus</i>	-	-	-	-	392.15 (0.28)	522.87 (0.38)	653.6 (0.47)	-	-	-	-	-
<i>Onychirus indicus</i>	-	-	-	-	392.15 (0.28)	784.31 (0.57)	522.87 (0.38)	-	-	-	-	-
<i>Alloscopus tetracantha</i>	-	784.31 (0.57)	915.03 (0.77)	522.87 (0.38)	-	-	-	--	-	-	-	-
<i>Sinella curviseta</i>	-	-	-	653.6 (0.47)	-	-	-	392.15 (0.28)	392.15 (0.28)	-	-	-
<i>Hypogastrura indica</i>	-	-	-	-	-	-	-	-	-	261.43 (0.19)	392.15 (0.28)	261.43 (0.19)
<i>Salina indica</i>	392.15 (0.28)	-	-	-	-	-	-	-	-	-	-	392.15 (0.28)
<i>Callyntrura zaheri</i>	-	-	-	-	-	-	-	-	-	-	-	-

Table 5b. continued.....

Table 5b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus heterolepis</i>	1307.18 (0.95)	2222.22 (1.61)	3267.97 (2.37)	2745.09 (1.99)	1176.47 (0.85)	653.6 (0.47)	522.87 (0.38)	1960.78 (1.42)	2352.94 (1.70)	2614.37 (1.89)	2875.81 (2.08)	2091.50 (1.51)
<i>Lepidocyrtus medius</i>	522.87 (0.38)	-	261.43 (0.19)	653.6 (0.47)	-	-	-	-	-	-	1176.47 (0.85)	915.03 (0.66)
<i>Xenylla obscura</i>	261.43 (0.19)	522.87 (0.38)	1307.18 (0.950)	-	-	-	-	-	-	1045.75 (0.76)	1176.47 (0.85)	784.31 (0.57)
<i>Isotomedes dagamae</i>	522.87 (0.38)	522.87 (0.38)	653.6 (0.57)	-	522.87 (0.38)	-	-	-	-	-	130.71 (0.095)	392.15 (0.28)
<i>Isotomina thermophila</i>	-	-	-	261.43 (0.19)	261.43 (0.19)	-	-	392.15 (0.28)	-	-	-	-
<i>Cyphoderus javanus</i>	-	-	522.87 (0.38)	392.15 (0.28)	261.43 (0.19)	-	-	-	653.6 (0.47)	392.15 (0.28)	-	-
<i>Entomobrya kali</i>	392.15 (0.28)	-	392.15 (0.28)	-	392.15 (0.28)	-	-	-	261.43 (0.19)	-	-	-
<i>Isotomurus balteatus</i>	-	-	-	-	-	-	392.15 (0.28)	522.87 (0.38)	-	-	-	-
<i>Onychirus indicus</i>	-	392.15 (0.28)	-	-	-	392.15 (0.28)	-	-	653.6 (0.47)	-	-	-
<i>Alloscopus tetracantha</i>	-	-	-	-	-	522.87 (0.38)	653.6 (0.47)	-	-	-	-	-
<i>Sinella curviseta</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hypogastrura indica</i>	-	-	-	-	-	392.15 (0.28)	-	392.15 (0.28)	-	-	-	-
<i>Salina indica</i>	261.43 (0.19)	261.43 (0.19)	-	-	-	-	-	-	-	-	-	392.15 (0.28)
<i>Callyntrura zaheri</i>	130.71 (0.095)	-	-	-	-	-	-	261.43 (0.19)	-	-	-	392.15 (0.28)

Table 4b. continued.....

Table 5b.

SPECIES	2008												
	J	F	M	A	M	J	J	A	S	O	N	D	
<i>Lepidocyrtus heterolepis</i>	1307.18 (0.95)	2222.22 (1.61)	3921.56 (2.84)	2614.37 (1.89)	1307.18 (0.95)	784.31 (0.57)	261.43 (0.19)	1437.90 (1.04)	2091.50 (1.51)	2875.81 (2.08)	3267.97 (2.37)	2222.22 (1.61)	
<i>Lepidocyrtus medius</i>	-	-	784.31 (0.57)	261.43 (0.19)	-	392.15 (0.28)	261.43 (0.19)	392.15 (0.28)	-	-	261.43 (0.19)	915.03 (0.66)	
<i>Xenylla obscura</i>	-	-	915.03 (0.66)	-	-	-	-	522.87 (0.38)	1045.75 (0.76)	915.03 (0.66)	653.6 (0.47)	915.03 (0.85)	
<i>Isotomedes dagamae</i>	392.15 (0.28)	522.87 (0.38)	784.31 (0.57)	653.6 (0.47)	-	-	392.15 (0.28)	-	-	-	1045.75 (0.76)	-	
<i>Isotomina thermophila</i>	-	-	-	-	522.87 (0.38)	-	-	-	-	392.15 (0.28)	522.87 (0.38)	392.15 (0.28)	
<i>Cyphoderus javanus</i>	261.43 (0.19)	-	-	-	-	-	-	-	-	392.15 (0.28)	392.15 (0.28)	-	
<i>Entomobrya kali</i>	392.15 (0.28)	261.43 (0.19)	-	130.71 (0.095)	-	261.43 (0.19)	-	-	-	-	-	-	
<i>Isotomurus balteatus</i>	392.15 (0.28)	-	-	261.43 (0.19)	653.6 (0.47)	-	-	-	-	-	-	-	
<i>Onychirus indicus</i>	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Alloscopus tetracantha</i>	-	-	-	-	-	-	392.15 (0.28)	-	653.6 (0.47)	-	-	-	
<i>Sinella curviseta</i>	-	-	-	-	-	-	-	522.87 (0.38)	-	-	-	392.15 (0.28)	
<i>Hypogastrura indica</i>	-	-	-	-	-	392.15 (0.28)	392.15 (0.28)	-	-	-	-	-	
<i>Salina indica</i>	522.87 (0.38)	-	-	-	-	-	-	-	-	261.43 (0.19)	-	-	
<i>Callyntrura zaheri</i>	-	392.15 (0.28)	-	-	-	261.43 (0.19)	-	-	-	-	-	-	

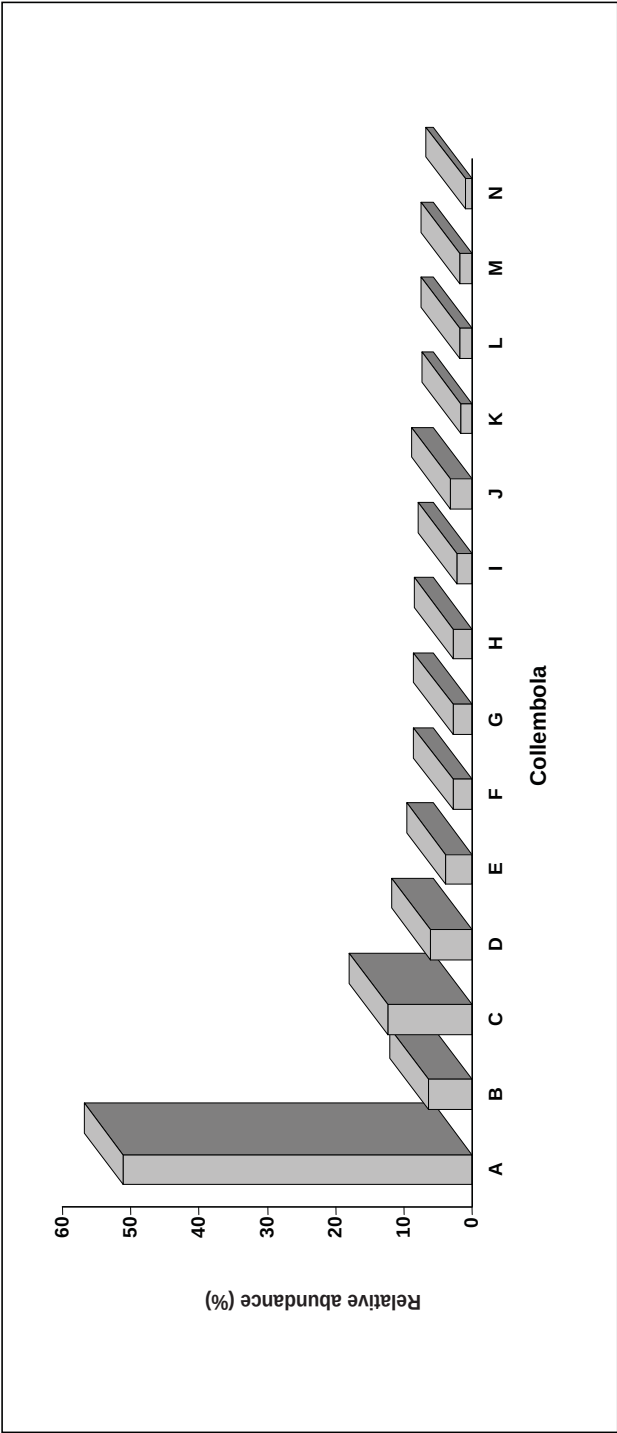


Fig 5b. Showing species composition of collembola at Site V

A = *Lepidocyrtus heterolepis*; B = *Lepidocyrtus medius*; C = *Xenylla obscura*; D = *Isotomodes dagamae*; I = *Onychirus indicus*; H = *Isotomurus balteatus*; E = *Isotomina thermophila*; G = *Entomobrya kali*; K = *Sinella curviseta*; F = *Cyphoderus javanus*; J = *Allocopus tetracantha*; L = *Hypogastrura indica*; M = *Salina indica*; N = *Callyntrura zaheeri*.

Site VI: Tiger Hill (photograph 6)**Altitude:** 2557 m.

Characteristics and vegetation of sampling sites: This sampling site was situated at a distance of approximately 10 km from the Railway station of Ghum. This site was divided into three plots and each plot was four square metres in measurement. The sampling plots were covered with litter of fallen leaves and dried twigs of the trees. The site was covered by different kinds of herbs and shrubs like *Pteris quadriaurita*, *Euphorbia* sp., *Rhododendron lepidotum*, *Anaphilis* sp., *Rubus lineatus*, *Acer* sp. *Enonymus echinatus* and trees like *Pinus longifolia*, *Quercus lamellose*, *Cryptomaria japonica* etc.

Edaphic factors: The soil of the sampling plot was dark grey in colour and sandy-clay-loam in texture. Mechanical analysis of soil sample from this site showed high percentage of fine sand than silt (Table M1). The soil temperature was maximum during the month of June in 2006 and 2008 (15.8°C and 15.8°C respectively) and 15.6°C during 2007 and minimum during the month of January in 2007 (6.5°C) and December in 2006 (6.8°C) and 2008 (6.2°C). The maximum moisture was recorded in the month of August in 2006 (36.27%), 33.6% in 2007 and July (35.41%) in 2008 as well as minimum during April in 2006 (20.45%), October in 2007 (24.87%) and April in 2008 (21.03%). The RH (%) was maximum during the month of August in 2006 (88%), June in 2007 (87.9%) and July 2008 (87.3%) and minimum in the month of December in 2006 (69.5%), 2007 (68.8%) and January in 2008 (69.5%). The soil organic carbon content of soil showed maximum values in the month of March (3.49 % in 2006; 3.98 % in 2007; 3.84 % in 2008) and minimum organic carbon was recorded in the month of July in 2006, 2007 and 2008 (2.96 % , 3.04 % and 3.12 % respectively). The maximum pH was recorded during November in 2006 (5.23), September in 2007 (5.21) and October in 2008 (5.15). The maximum nitrate content of soil was recorded in the month of March (2.71 ppm in 2006; 2.81 ppm in 2007; 2.92 ppm in 2008) as well as minimum in July in each sampling year (1.89 ppm in 2006; 1.87 ppm in 2007; 1.92 ppm in 2008). The maximum and minimum values of phosphate were recorded in the month of July (0.63 ppm in 2006; 0.66 ppm in 2007; 0.62 ppm in 2008) and March respectively in each year (0.32 ppm in 2006; 0.31 ppm 2007; 0.41 ppm in 2008) as shown in Table 6a.

Collembola fauna: The collembolan fauna obtained from this site belonged to 13 species under 11 genera. The Table 6b revealed the monthly density and relative abundance of individual collembolan species in this study site. The species *Xenylla obscura* was the most dominant one contributing 50.48% of the total fauna recorded from this site followed by *Folsomia octoculata* (12.04%), *Hypogastrura indovaria* (9.73%), *Cyphoderus javanus* (4.24%), *Isotomedes dagamae* (3.95%), *Entomobrya kali* (3.85%), *Onychirus indicus* (3.18%), *Sinella cueviseta* (3.08%), *Salina indica* (2.5 %), *Hypogatrura indica* (2.41%) and *Lepidocyrtus heterolepis* (2.02%) of total collembolan population. Other collembolan species in this site were represented by numerically low in number and showed highly irregular in distribution pattern (Table 6b & Fig 6b).

Seasonal changes: The monthly changes in the relative abundance of predominant species of collembola (*Xenylla obscura*, *Folsomia octoculata*, *Hypogastrura indovaria*, and *Cyphoderus javanus*) as observed in this site have been shown in Table 6b. The most dominant species *Xenylla obscura* showed its peak population in the month of March in each sampling year of observation when the concentration of soil organic carbon and nitrate were maximum and concentration of phosphate was low (Table 6a). The species *Folsomia octoculata* showed its peak population in the month of November in each sampling year of study. *Hypogastrura indovaria* showed peak population during the month of March in 2006 and 2008 and September in 2007. The species *Cyphoderus javanus* showed peak population during February in 2006, November in 2007 and 2008. The other collembolan species were represented by numerically low in number and showed irregular trends of seasonal population fluctuation (Table 6b).

Table 6a. Showing values of edaphic factors in different months from Jan'2006 – Dec'2008 at Site VI

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	7.9	33.25	70.2	4.98	3.47	2.52	0.61
	F	10.1	30.86	78.2	5.09	3.21	2.58	0.59
	M	12.4	21.67	80.1	4.97	3.49	2.71	0.32
	A	13.4	20.45	79.3	4.82	3.27	2.24	0.34
	M	12.5	22.43	85	4.95	3.25	2.41	0.37
	J	15.8	32.2	85.3	4.98	3.29	2.11	0.48
	J	12.6	33.4	84.1	4.87	3.09	1.89	0.63
	A	13.3	36.27	88	5.12	2.96	1.94	0.62
	S	12.4	27.49	83.4	5.21	3.05	2.01	0.38
	O	12.6	25.7	80.2	5.12	3.21	2.39	0.36
	N	10.2	27.12	74	5.23	3.46	2.34	0.53
	D	6.8	30.12	69.5	5.2	3.14	2.15	0.54

Table 6a. *continued*....

Table 6a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	6.5	32.33	75.3	5.05	3.34	2.56	0.58
	F	10.6	30.65	86	5.12	3.8	2.61	0.64
	M	13.6	27.23	78.3	4.68	3.98	2.81	0.31
	A	12.8	26.2	81.7	4.4	3.35	2.34	0.33
	M	13.5	23.3	84.7	4.91	3.29	2.41	0.38
	J	14.8	31.22	87.9	4.97	3.08	2.22	0.45
	J	12.3	33.6	76	4.76	3.04	1.87	0.66
	A	15.6	30.74	75.7	4.58	3.22	2.2	0.39
	S	12.7	27.34	78	5.21	3.22	2.01	0.36
	O	11.5	24.87	82.6	5.12	3.27	2.05	0.33
	N	9.6	29.23	73.6	4.97	3.41	2.1	0.36
	D	6.5	32.97	68.8	4.98	3.35	2.15	0.59
2008	J	6.8	33.88	69.5	5.08	3.14	2.38	0.61
	F	9.5	34.31	84.4	4.99	3.22	2.44	0.59
	M	11.3	26.9	81.5	4.91	3.84	2.78	0.38
	A	11.5	21.03	80	5.07	3.41	2.33	0.51
	M	12.8	23.4	79.7	4.94	3.24	2.27	0.41
	J	15.8	34.4	82.7	4.97	3.28	2.13	0.43
	J	11.3	35.41	87.3	4.96	3.12	1.92	0.62
	A	12.8	33.21	85.7	5.02	3.65	2.92	0.59
	S	10.3	28.01	86.8	5.12	3.76	2.75	0.58
	O	11.5	23.88	86	5.15	3.79	2.43	0.61
	N	8.7	30.22	76.4	4.72	3.48	2.61	0.54
	D	6.2	34.27	71.2	4.63	3.25	2.34	0.61

Table 6b. Showing monthwise density (no./sq.m) of collembolan species from Jan'2006 – Dec' 2008 at Site VI
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Xenylla obscura</i>	1437.9 (1.06)	2091.5 (1.54)	3006.53 (2.21)	2483.66 (1.83)	1960.78 (1.44)	392.15 (0.29)	522.87 (0.38)	1568.34 (1.16)	1699.34 (1.25)	1830.06 (1.35)	2614.37 (1.93)	2352.94 (1.73)
<i>Folsomia octoculata</i>	-	-	261.43 (0.19)	784.31 (0.58)	-	-	522.87 (0.38)	915.03 (0.67)	522.87 (0.38)	784.31 (0.58)	1176.47 (0.96)	915.03 (0.67)
<i>Hypogastrura indovaria</i>	522.87 (0.38)	653.6 (0.48)	915.03 (0.67)	653.6 (0.48)	-	-	-	522.87 (0.38)	653.6 (0.48)	522.87 (0.38)	392.15 (0.29)	-
<i>Isotomodes dagamae</i>	-	261.43 (0.19)	261.43 (0.19)	392.15 (0.29)	-	-	-	392.15 (0.29)	-	392.15 (0.29)	522.87 (0.38)	-
<i>Lepidocyrtus heterolepis</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cyphoderus javanus</i>	-	522.87 (0.38)	-	-	-	-	261.43 (0.19)	261.43 (0.19)	522.87 (0.38)	261.43 (0.19)	-	-
<i>Entomobrya kali</i>	392.15 (0.29)	261.43 (0.19)	522.87 (0.38)	-	392.15 (0.29)	392.15 (0.29)	-	-	261.43 (0.19)	-	-	-
<i>Salina tricolour sikkimensis</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Onychirus indicus</i>	392.15 (0.29)	-	130.71 (0.096)	-	-	261.43 (0.19)	-	-	-	-	392.15 (0.29)	653.6 (0.48)
<i>Sinella curviseta</i>	-	-	-	-	392.15 (0.29)	784.31 (0.58)	-	-	-	-	-	261.43 (0.19)
<i>Lobella kraepelini</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hypogastrura indica</i>	261.43 (0.19)	-	130.71 (0.096)	-	-	392.15 (0.29)	392.15	-	-	261.43 (0.19)	-	-
<i>Salina indica</i>	392.15 (0.29)	392.15 (0.29)	-	-	-	-	-	-	261.43 (0.19)	-	-	-

Table 6b. continued.....

Table 6b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Xenylla obscura</i>	1699.34 (1.25)	2483.66 (1.83)	3921.56 (2.89)	2614.37 (1.93)	1307.18 (0.96)	522.87 (0.38)	653.6 (0.48)	1307.18 (0.96)	1568.34 (1.16)	2352.94 (1.73)	2875.81 (2.02)	2091.5 (1.54)
<i>Folsomia octoculata</i>	-	392.15 (0.29)	130.71 (0.096)	653.6 (0.48)	392.15 (0.29)	392.15 (0.29)	-	522.87 (0.38)	653.6 (0.48)	653.6 (0.48)	915.03 (0.67)	522.87 (0.38)
<i>Hypogastrura indovaria</i>	522.87 (0.38)	392.15 (0.29)	653.6 (0.48)	522.87 (0.38)	-	-	-	-	784.31 (0.58)	392.15 (0.29)	261.43 (0.19)	261.43 (0.19)
<i>Isotomodes dagamae</i>	-	-	261.43 (0.19)	522.87 (0.38)	-	-	-	-	653.6 (0.48)	261.43 (0.19)	392.15 (0.29)	-
<i>Lepidocyrtus heterolepis</i>	261.43 (0.19)	-	392.15 (0.29)	-	-	-	-	-	-	-	-	392.15 (0.29)
<i>Cyphoderus javanus</i>	-	-	-	-	-	-	392.15 (0.29)	392.15 (0.29)	-	261.43 (0.19)	522.87 (0.38)	-
<i>Entomobrya kali</i>	-	-	-	-	392.15 (0.29)	522.87 (0.38)	-	522.87 (0.38)	-	-	-	-
<i>Salina tricolour sikkimensis</i>	-	-	130.71 (0.096)	261.43 (0.19)	522.87 (0.38)	261.43 (0.19)	-	-	-	-	-	-
<i>Onychirus indicus</i>	522.87 (0.38)	-	-	-	-	-	-	-	-	-	130.71 (0.096)	653.6 (0.48)
<i>Sinella curviseta</i>	-	-	-	-	-	-	522.87 (0.38)	392.15 (0.29)	-	392.15 (0.29)	-	-
<i>Lobella kraepelini</i>	-	-	-	-	-	-	-	522.87 (0.38)	392.15 (0.29)	-	-	-
<i>Hypogastrura indica</i>	392.15 (0.29)	-	-	-	-	261.43 (0.19)	-	-	-	392.15 (0.29)	-	-
<i>Salina indica</i>	522.87 (0.38)	392.15 (0.29)	-	-	-	-	-	-	-	-	-	261.43 (0.19)

Table 6b. continued.

Table 6b.

[illegible]

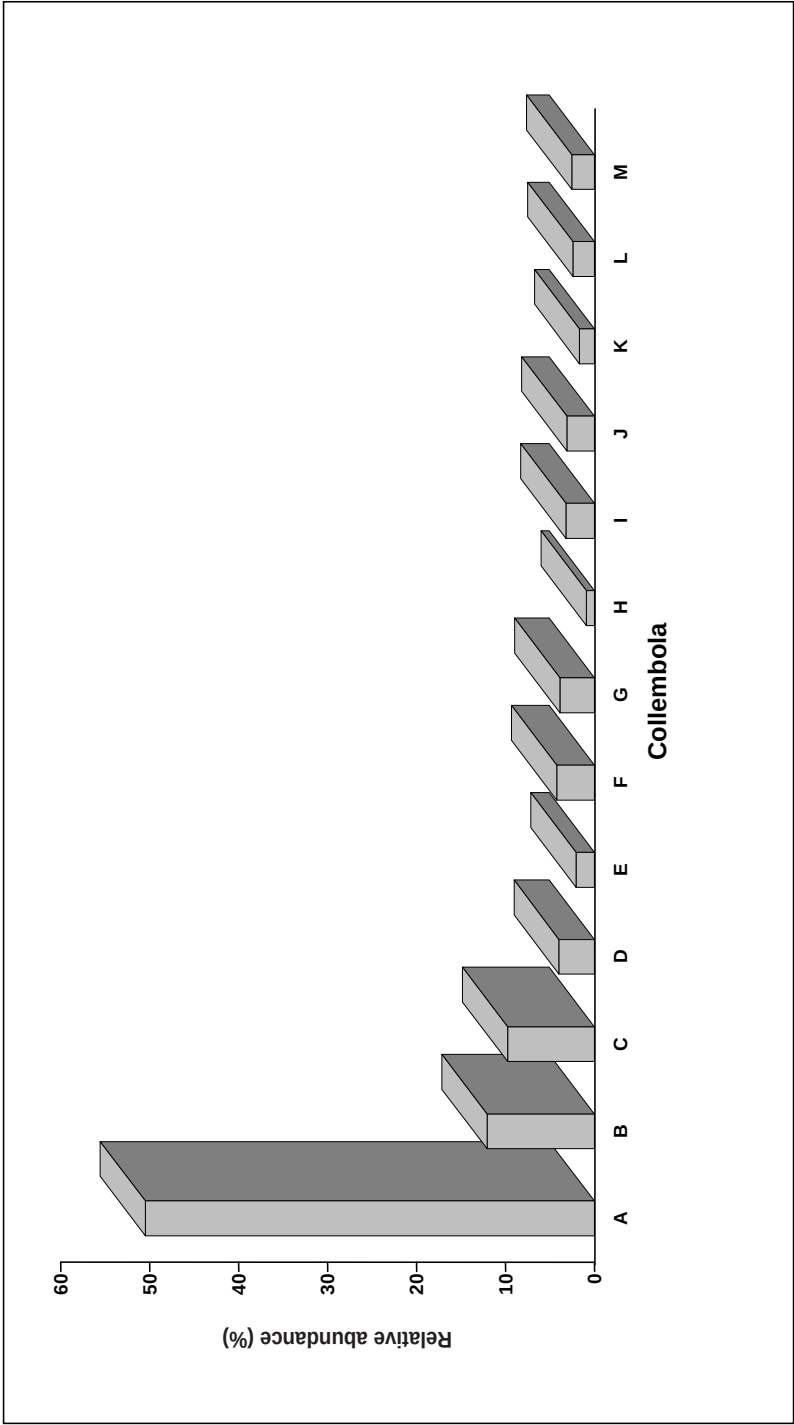


Fig 6b. Showing species composition of collembola at Site VI

A = *Xenylla obscura*; B = *Folsomia octoculata*; C = *Hypogastrura indovaria*; D = *Isotomedes dagamae*; E = *Lepidocyrtus heterolepis*; F = *Cyphoderus javanus*; G = *Entomobrya kali*; H = *Salina tricolour sikkimensis*; I = *Onychirus indicus*; J = *Sinella curviseta*; K = *Lobella krepalini*; L = *Hypogastrura indica*; M = *Salina indica*.

Site VII: Kalapakhri (photograph 7)**Altitude:** 3109 m.

Characteristics and vegetation of sapling sites: This site was located in the Singalila National Park near the Nepal border. The site was divided into three plots and each sampling plot was four square metres in measurement. The sampling site was covered with litter of the fallen leaves of trees. Fog, mystic condition and snow fall were very common phenomenon here. The site was covered by different types of mosses, ferns, grasses, herbs and shrubs like *Panicum palmifolium*, *Berberis insignis*, *Rubus lasiocarpus*, *Rhododendron lepidotum*, *Arundinaria* sp., *Acer* sp. etc and trees like *Quercus lamellose*, *Q. pachyphlla*, *Castanopsis hystrix*, *Machilus edulis* etc.

Edaphic factors: The soil of the sampling plot was light brown in colour and sandy-loam in texture. Mechanical analysis of soil sample from this site showed high percentage of fine sand (Table M1). The soil temperature was maximum during the month of May in 2006, 2007 and 2008 (12.5°C, 13.8°C and 13.3°C respectively) and minimum during the month of January in 2006 (3.7°C), 2007 (3.9°C), and 2008 (3.5°C). The maximum moisture was recorded in the month of July in 2006 (35.24%), 2007 (38.12%) and 2008 (37.12%) as well as minimum during May in 2006 (24.54%) and 2007 (25.36%) and March in 2008 (25.65%). The RH (%) was maximum during the month of July in 2006 (86.2%) and in 2008 (89.6%) and June in 2007 (87.9%) and minimum in the month of December in 2006 (72.2%), 2007 (75.3%) and 2008 (73.2%). The soil organic carbon content of soil showed maximum values in the month of March (4.24 % in 2006; 4.09 % in 2007; 4.15 % in 2008) and minimum organic carbon was recorded in the month of July in 2006, 2007 and 2008 (3.11% and 3.01 % and 2.96% respectively). The maximum pH was recorded during October in 2006 (5.21), November (5.11) in 2007 and December in 2008 (5.09). The maximum nitrate content of soil was recorded in the month of March (2.56 ppm in 2006; 2.66 ppm in 2007; 2.49 ppm in 2008) as well as minimum in July in each sampling year (1.93 ppm in 2006; 1.97 ppm in 2007; 1.94 ppm in 2008). The maximum and minimum values of phosphate were recorded in the month of July (0.73 ppm in 2006, 0.71 ppm in 2007; 0.79 ppm in 2008) and March respectively in each year (0.27 ppm in 2006; 0.29 ppm 2007; 0.28 ppm in 2008) as shown in Table 7a.

Collembola fauna: The collembolan fauna obtained from this site belonged to 11 species under 10 genera. The Table 7b revealed the monthly density and relative humidity of each collembolan species in this study site. The species *Xenylla obscura* was the most dominant one, contributing 47.91% of the total fauna recorded from this site followed by *Hypogastrura indovaria* (25.9%), *Isotomurus balteatus* (5.38%), *Folsomia occtoculata* (4.28%), *Isotomedes dagamae* (4.28%), *Salina tricolour sikkimensis* (3.09%), *Entomobrya kali* (2.59%) and *Hypogatrura indica* (1.99%) of total collembolan population. Other species in this site were represented by numerically low in number and showed highly irregular in occurrence (Table 7b & Fig 7b).

Seasonal changes: The monthly changes in relative abundance of three predominant species of collembola (*Xenylla obscura*, *Hypogastrura indovaria* and *Isotomurus balteatus*) as observed in this site have been shown in Table 7b. The most dominant species *Xenylla obscura* showed its peak population in the month of March in each sampling year of observation when the concentration of soil organic carbon and nitrate were maximum and concentration of phosphate was low (Table 7a). The species *Hypogastrura indovaria* showed its peak population in the month of November in each sampling year of study. *Isotomurus balteatus* showed peak population during the month of March and November in 2006 and November in 2007 and 2008. The other collembolan species were represented by numerically low in number and showed irregular trends of population fluctuation (Table 7b).

Table 7a. Showing values of edaphic factors in different months from Jan'2006– Dec'2008 at Site VII

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	3.7	35.14	74.2	5.01	3.13	2.38	0.71
	F	4.2	33.64	84.3	4.98	3.19	2.47	0.51
	M	11.2	27.12	79.2	4.68	4.24	2.56	0.27
	A	12.2	25.11	76.7	4.95	3.41	2.17	0.33
	M	12.5	24.54	80	4.93	3.19	2.18	0.34
	J	12.3	35.24	84.5	4.76	3.14	2.11	0.49
	J	11.3	33.64	86.2	4.88	3.11	1.93	0.73
	A	12.2	35.12	83.2	4.91	4.2	2.29	0.51
	S	11.2	34.54	79.2	5.12	4.17	2.24	0.62
	O	12.3	30.24	80.2	5.21	3.28	2.2	0.68
	N	6.5	37.29	81.4	5.07	3.38	2.23	0.53
	D	4.8	36.24	72.2	4.94	3.31	2.18	0.68

Table 7a. continued....

Table 7a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	3.9	37.24	76.3	5.09	3.15	2.47	0.7
	F	4.3	30.26	82.6	5.08	3.27	2.56	0.53
	M	9.2	26.24	80.2	4.91	4.09	2.66	0.29
	A	11	25.44	75.2	4.94	3.43	2.21	0.32
	M	13.8	25.36	67.2	5.02	3.44	2.23	0.35
	J	12.5	37.54	87.4	4.75	3.33	2.12	0.43
	J	11.5	38.12	84.5	4.89	3.01	1.97	0.71
	A	11.9	36.24	81.5	4.87	3.28	2.4	0.58
	S	12.5	37.37	78	4.95	3.27	2.45	0.64
	O	11.5	32.76	80	4.98	3.2	2.28	0.53
	N	8.2	33.87	79.8	5.11	3.31	2.15	0.44
	D	5.5	36.43	75.3	5.09	3.32	2.19	0.65
2008	J	3.5	38.24	78.3	5.07	3.13	2.1	0.57
	F	3.9	31.26	81.2	5.05	3.21	2.05	0.48
	M	8.5	25.65	82.2	4.77	4.15	2.49	0.28
	A	10.6	26.61	79.8	4.95	3.37	2.04	0.3
	M	13.3	29.23	71.3	4.76	3.29	2.18	0.34
	J	12.1	32.42	81.1	4.72	3.25	2.12	0.43
	J	10.2	37.12	89.6	4.98	2.96	1.94	0.79
	A	11.2	33.32	86.6	5.34	4.03	2.26	0.48
	S	12.5	29.54	78	4.87	4.11	2.11	0.65
	O	7.7	30.21	80.5	4.87	3.38	2.19	0.69
	N	6.3	34.62	78.5	5.01	3.34	2.21	0.51
	D	3.7	36.24	73.2	5.09	3.31	2.22	0.67

Table 7b. Showing monthwise density (no./ sq.m) of collembolan species from Jan'2006 – Dec' 2008 at Site VII.
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
Xenylla obscura	1437.9 (1.09)	1307.18 (1)	2745.09 (2.09)	1830.06 (1.39)	1307.18 (1)	784.31 (0.6)	784.31 (0.6)	1437.9 (1.09)	1960.78 (1.49)	2222.22 (1.69)	2614.37 (1.99)	1960.78 (1.49)
Hypogastrura indovaria	784.31 (0.6)	653.6 (0.5)	1307.18 (1)	1176.47 (0.9)	653.6 (0.5)	653.6 (0.5)	522.87 (0.4)	653.6 (0.5)	915.03 (0.7)	1307.18 (1)	1437.9 (1.09)	1176.47 (0.9)
Folsomia octoculata	392.15 (0.3)	392.15 (0.3)	522.87 (0.4)	-	-	-	-	-	-	392.15 (0.3)	-	-
Isotomurus balteatus	-	-	-	522.87 (0.4)	522.87 (0.4)	392.15 (0.3)	-	-	-	-	522.87 (0.4)	-
Salina tricolour sikkimensis	392.15 (0.3)	522.87 (0.4)	-	-	-	-	-	-	-	-	-	392.15 (0.3)
Entomobrya kali	392.15 (0.3)	130.71 (0.099)	-	-	-	-	-	392.15 (0.3)	392.15 (0.3)	-	-	-
Isotomedes dagamae	-	-	522.87 (0.4)	392.15 (0.3)	392.15 (0.3)	-	-	-	-	522.87 (0.4)	-	-
Lobella kraepelini	-	-	-	-	-	392.15 (0.3)	522.87 (0.4)	-	-	-	-	-
Lepidocyrtus heterolepis	-	-	-	-	-	-	-	-	-	-	-	-
Hypogastrura indica	-	-	-	-	-	-	-	-	-	-	-	-
Callyntrura zaheeri	-	261.43 (0.2)	-	-	-	-	-	-	-	-	-	522.87 (0.4)

Table 7b. continued.

Table 7b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Xenylla obscura</i>	1699.34 (1.290)	2091.5 (1.59)	3267.97 (2.49)	2483.66 (1.89)	1568.34 (1.19)	522.87 (0.4)	522.87 (0.4)	1437.9 (1.09)	2222.22 (1.69)	1830.06 (1.39)	2091.5 (1.59)	1960.78 (1.49)
<i>Hypogastrura indovaria</i>	784.31 (0.6)	915.03 (0.7)	784.31 (0.6)	915.03 (0.7)	392.15 (0.3)	915.03 (0.7)	653.6 (0.5)	784.31 (0.6)	522.87 (0.4)	1176.47 (0.9)	1307.18 (1)	1568.34 (1.19)
<i>Folsomia octoculata</i>	-	261.43 (0.2)	392.15 (0.3)	-	-	-	-	-	653.6 (0.5)	261.43 (0.2)	-	-
<i>Isotomurus balteatus</i>	-	-	392.15 (0.3)	-	-	-	392.15 (0.3)	392.15 (0.3)	522.87 (0.4)	653.6 (0.5)	784.31 (0.6)	-
<i>Salina tricolour sikkimensis</i>	653.6 (0.5)	-	-	-	-	-	-	-	-	-	392.15 (0.3)	-
<i>Entomobrya kali</i>	-	-	392.15 (0.3)	-	-	-	-	653.6 (0.5)	-	-	-	-
<i>Isotomedes dagamae</i>	-	-	-	-	522.87 (0.4)	-	-	-	392.15 (0.3)	522.87 (0.4)	522.87 (0.4)	-
<i>Lobella kraepelini</i>	-	-	-	261.43 (0.2)	261.43 (0.2)	915.03 (0.7)	-	-	-	-	-	-
<i>Lepidocyrtus heterolepis</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hypogastrura indica</i>	261.43 (0.2)	392.15 (0.3)	-	261.43 (0.2)	-	-	-	-	-	-	-	392.15 (0.3)
<i>Callyntrura zaheri</i>	261.43 (0.2)	261.43 (0.2)	-	-	-	-	-	-	-	-	-	261.43 (0.2)

Table 7b. continued.....

Table 7b.

SPECIES	2008													
	J	F	M	A	M	J	J	A	S	O	N	D		
<i>Xenylla obscura</i>	1568.34 (1.19)	1699.34 (1.29)	4052.28 (3.09)	2091.5 (1.59)	1568.34 (1.19)	522.87 (0.4)	653.6 (0.5)	784.31 (0.6)	1568.34 (1.19)	2091.5 (1.59)	2483.66 (1.89)	1699.34 (1.29)		
<i>Hypogastrura indovarica</i>	784.31 (0.6)	1437.9 (1.09)	784.31 (0.6)	653.6 (0.5)	1176.47 (0.9)	522.87 (0.4)	522.87 (0.4)	1045.75 (0.8)	1045.75 (0.8)	1307.18 (1)	1307.18 (1)	1437.9 (1.09)		
<i>Folsomia octoculata</i>	522.87 (0.4)	392.15 (0.3)	653.6 (0.5)	-	-	-	-	-	261.43 (0.2)	-	522.87 (0.4)	-		
<i>Isotomurus balteatus</i>	-	-	-	-	-	522.87 (0.4)	-	653.6 (0.5)	-	-	784.31 (0.6)	-		
<i>Salina tricolour sikkimensis</i>	522.87 (0.4)	392.15 (0.3)	-	-	-	-	-	-	-	-	-	784.31 (0.6)		
<i>Entomobrya kali</i>	-	-	-	653.6 (0.5)	-	-	-	-	392.15 (0.3)	-	-	-		
<i>Isotomodes dagamae</i>	-	-	-	-	392.15 (0.3)	653.6 (0.5)	392.15 (0.3)	392.15 (0.3)	-	-	-	-		
<i>Lobella kraepelini</i>	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Lepidocyrtus heterolepis</i>	-	-	-	653.6 (0.5)	-	-	-	-	522.87 (0.4)	130.71 (0.099)	-	-		
<i>Hypogastrura indica</i>	-	-	392.15 (0.3)	522.87 (0.4)	-	-	-	-	-	392.15 (0.3)	-	-		
<i>Callyntrura zaheri</i>	392.15 (0.3)	-	-	-	-	-	-	-	-	392.15 (0.3)	-	-		

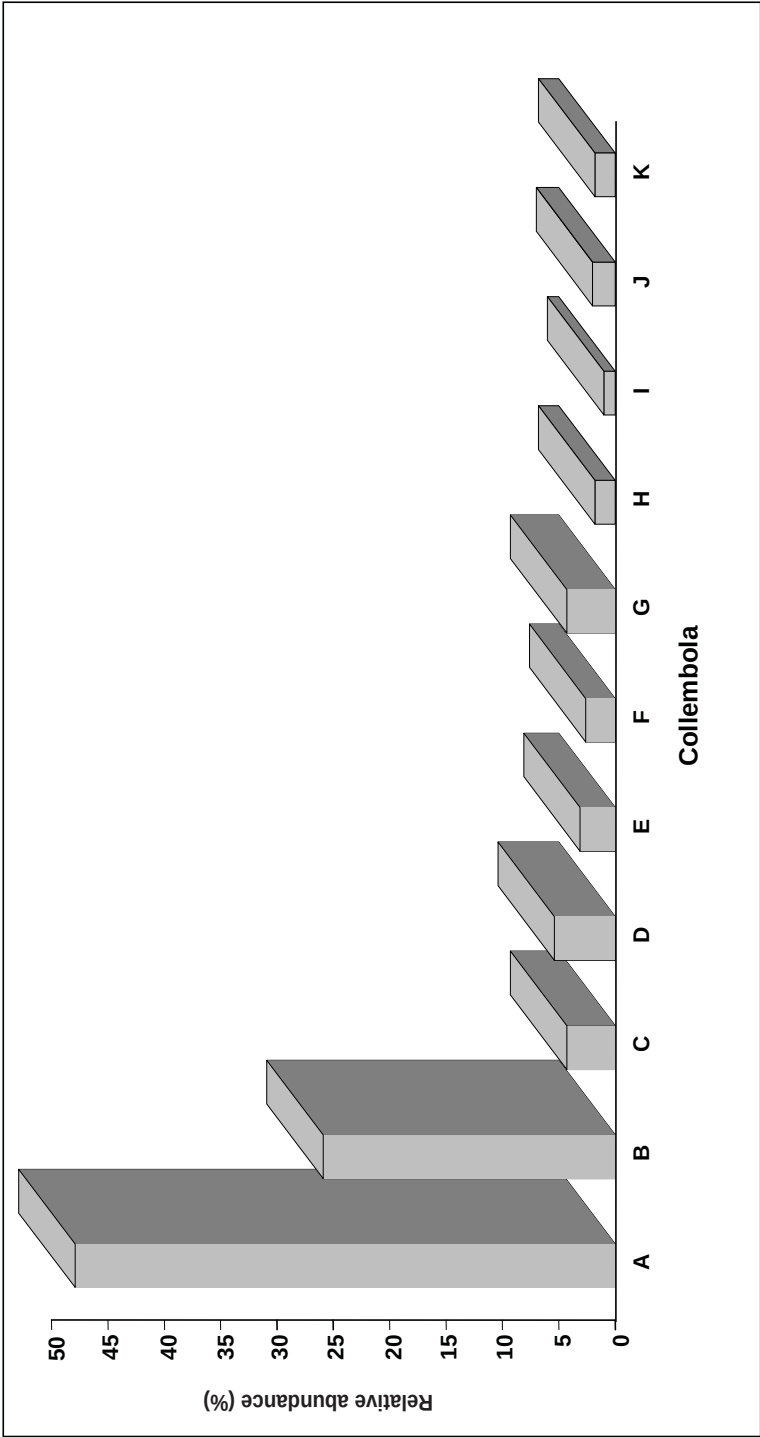


Fig 7b. Showing species composition of collembola at Site VII

A = *Xenylla obscura*; B = *Hypogastrura indovaria*; C = *Folsomia octoculata*; D = *Isotomurus balteatus*; E = *Salina tricolour sikkimensis*; F = *Entomobrya kali*; G = *Isotomodes dagamae*; H = *Lobella krepalini*; I = *Lepidocyrtus heterolepis*; J = *Hypogastrura indica*; K = *Callyntrura zaheri*.

Site VIII: Sandakphu (photograph 8)**Altitude:** 3618 m.

Characteristics and vegetation of sapling sites: This site is located in the Singalila range of the Darjeeling Himalayas near the Nepal border. The site is also divided into three plots and each plot was four square metres in measurement. Air temperature was quite low in winter, often falls below 0°C. Fog, mystic condition and snowfall are common phenomenon here. This site was covered with trees like *Quercus lamellose*, *Q. pachyphlla*, *Nyssa sessiliflora*, *Machilis edulis*, *Castanopsis hystrix*, besides under growth like mosses, ferns, herbs and shrubs such as *Engelhardia gardneri*, *Acer camllii*, *Pteris quadriaurita*, *Euphorbia* sp., *Rhododendron lepidotum*, *Rhododendron arboretum* etc. were also found on the surface.

Edaphic factors: The soil of the sampling plot was dark-brown in colour and sandy-loam in texture. Mechanical analysis of soil sample from this site showed high percentage of sand (Table M1). The soil temperature was maximum during May in 2006 (13.4°C), 2007 (14.3 °C) and 2008 (13.5 °C) and minimum during January in each sampling year (1.5 °C in 2006; 1.2 °C in 2007 and 1.3 °C in 2008). The maximum moisture was recorded in the month of July in 2006 (37.28 %) and January in 2007 (40.45 %) and 2008 (40.26 %). The RH (%) was maximum during the month of June in 2006 (87.5 %), August in 2007 (84.6 %) and 2008 (85.8 %) and minimum in the month of December during 2006 (66.4%), 2007 (71.4%) and January and April in 2008 (69.7%). The soil organic carbon content of soil showed maximum values in the month of March (4.17 % in 2006; 4.14 % in 2007; 4.11 % in 2008) and minimum organic carbon was recorded in the month of July (3.23 % in 2006; 3.37 % in 2007; 3.27 % in 2008). The soil pH was maximum in the month of March in 2006 (4.95), May in 2007 (4.98) and April in 2008 (4.97) in each sampling year. The maximum nitrate content of soil was recorded in the month of March during 2006 (2.48 ppm), 2007 (2.51 ppm) and 2008 (2.52 ppm) as well as minimum in July in each sampling year (1.95 ppm in 2006; 1.88 ppm in 2007; 1.94 ppm in 2008). The maximum and minimum values of phosphate were recorded in the month of July (0.69 ppm in 2006; 0.57 ppm in 2007; 0.68 ppm in 2008) and March (0.28 ppm in 2006; 0.29 ppm in 2007; 0.36 ppm in 2008) respectively in each year (Table 8a).

Collembola fauna: The collembolan fauna obtained from this site belonged to 11 species under 11 genera. The Table 8b revealed the monthly density and relative abundance of collembolan species in this study site. The species *Xenylla obscura* was the most dominant species contributing 48.8% of the total fauna recorded from this site followed by *Hypogastrura indovaria* (25.18%), *Isotomedes dagamae* (5.85%), *Isotomurus balteatus* (4.07%), *Folsomia occtoculata* (4.07%), *Entomobrya kali* (3.03%), *Salina indica* (2.92%) and *Callyntrura zaheri* (2.92%) of total collembolan population. The remaining of the species in this site was represented by numerically low in number and highly irregular in distribution pattern (Table 8b & Fig 8b).

Seasonal changes: The monthly changes in the relative abundance of four predominant species of collembola (*Xenylla obscura*, *Hypogastrura indovaria*, *Isotomedes dagamae* and *Isotomurus balteatus*) recorded from this site have been shown in Table 8b. The most dominant species *Xenylla obscura* showed its peak population in the month of March in each sampling year of observation when the concentration of soil organic carbon and nitrate were maximum and concentration of phosphate in soil was low (Table 8a). The next dominant species *Hypogastrura indovaria* showed peak population in the month of March during 2007 and 2008 and September in 2006. *Isotomedes dagamae* showed its peak population in the month of November during the 2006 and 2008 and February in the year of 2007, while the *Isotomurus balteatus* showed peak population during March, January and July in three consecutive years. The other collembolan species were represented by numerically low in number and showed irregular trends of population fluctuation in their abundance. It is apparent from this study that the predominant forms of collembola encountered in this site exhibited maximum population during March and November. The population peak is minimum between Jun-July.

Table 8a. Showing values of edaphic factors in different months from Jan'2006 – Dec'2008 at Site VIII

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2006	J	1.5	34.8	70.4	4.89	3.66	2.21	0.56
	F	2.9	30.78	80.5	4.91	3.45	2.39	0.59
	M	11.8	23.23	72.4	4.95	4.17	2.48	0.28
	A	12.1	22.32	70.4	4.71	3.84	2.27	0.39
	M	13.4	28.34	77.3	4.27	3.54	2.36	0.33
	J	12.4	36.57	87.5	4.78	3.28	2.02	0.47
	J	10.1	37.28	84.6	4.91	3.23	1.95	0.69
	A	10.2	36.14	81.3	4.31	4.05	2.18	0.39
	S	9.2	30.92	78.4	4.28	4.01	2.15	0.47
	O	7.4	26.12	70.2	4.29	4.03	2.29	0.45
	N	3.5	34.51	79.8	4.42	4.01	2.43	0.38
	D	2.7	36.73	66.4	4.79	3.56	2.38	0.4

Table 8a. *continued*....

Table 8a.

Years	Months	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
2007	J	1.2	40.45	74.1	4.98	3.91	2.19	0.51
	F	2.3	39.14	77.4	4.87	3.62	2.17	0.42
	M	11.8	23.25	80.2	4.88	4.14	2.51	0.29
	A	13.7	24.1	73.2	4.87	3.87	2.36	0.38
	M	14.3	26.22	80.4	4.98	3.68	2.12	0.33
	J	12.5	31.38	83.6	4.73	3.57	1.98	0.4
	J	10.5	36.33	84.5	4.71	3.37	1.88	0.57
	A	11.6	31.12	84.6	4.94	4.03	2.43	0.39
	S	10.3	21.58	81.5	4.87	4.06	2.13	0.37
	O	12.2	19.28	73.7	4.41	3.89	2.15	0.42
	N	4.4	23.41	83	4.49	4.07	2.18	0.39
	D	2.4	35.83	71.4	4.43	3.39	2.17	0.49
2008	J	1.3	40.26	69.7	4.56	3.45	2.15	0.57
	F	3.2	35.12	81.7	4.68	3.49	2.03	0.54
	M	10.1	23.56	77.2	4.82	4.11	2.52	0.36
	A	13.2	18.98	69.7	4.97	3.24	2.25	0.39
	M	13.5	23.18	76.5	4.92	3.51	2.42	0.38
	J	12.3	30.5	82.1	4.67	3.34	2.28	0.41
	J	11.5	30.12	83.8	4.71	3.27	1.94	0.68
	A	10.5	30.12	85.8	4.77	3.61	2.46	0.34
	S	9.4	22.45	73.3	4.74	4.01	2.39	0.39
	O	8.4	25.24	75.3	4.75	3.51	2.24	0.49
	N	5.7	30.44	81.4	4.48	3.73	2.23	0.44
	D	3.2	30.35	70.4	4.37	3.63	2.48	0.51

Table 8b. Showing monthwise density (no./sq.m) of collembolan species from Jan'2006 – Dec' 2008 at Site VIII.
(Figure in parentheses showing %)

SPECIES	2006											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Folsomia octoculata</i>	-	-	-	-	-	-	-	-	130.71 (0.104)	261.43 (0.21)	392.15 (0.42)	653.6 (0.52)
<i>Xenylla obscura</i>	915.03 (0.73)	1568.34 (1.25)	3006.53 (2.4)	2222.22 (1.78)	1307.18 (1.04)	915.03 (0.73)	130.71 (0.104)	1045.75 (0.83)	1699.34 (1.36)	1960.78 (1.57)	1690.78 (1.57)	1699.34 (1.36)
<i>Hypogastrura indovaria</i>	1045.75 (0.83)	1176.47 (0.94)	1437.9 (1.15)	1176.47 (0.94)	653.6 (0.52)	522.87 (0.42)	-	522.87 (0.42)	1307.18 (1.04)	915.03 (0.73)	915.03 (0.73)	653.6 (0.52)
<i>Isotomodes dagamae</i>	-	-	-	392.15 (0.31)	653.6 (0.52)	-	-	-	522.87 (0.42)	-	784.31 (0.63)	-
<i>Lobella kraepelini</i>	-	-	-	-	-	-	653.6 (0.52)	-	-	-	-	-
<i>Isotomurus balteatus</i>	261.43 (0.21)	392.15 (0.31)	522.87 (0.42)	-	-	-	-	-	261.43 (0.21)	392.15 (0.31)	-	-
<i>Entomobrya kali</i>	130.71 (0.104)	261.43 (0.21)	-	653.6 (0.52)	-	261.43 (0.21)	-	-	-	-	-	-
<i>Salina indica</i>	653.6 (0.52)	-	-	-	-	-	-	-	-	-	-	653.6 (0.52)
<i>Callyntrura zaheri</i>	261.43 (0.21)	-	-	-	-	261.43 (0.21)	392.15 (0.31)	-	-	-	-	261.43 (0.21)
<i>Lepidocyrtus heterolepis</i>	-	-	-	-	-	-	-	-	-	261.43 (0.21)	261.43 (0.21)	-
<i>Willowsia</i> sp.	-	-	-	-	-	130.71 (0.104)	130.71 (0.104)	-	-	261.43 (0.21)	-	-

Table 8b. continued.....

Table 8b.

SPECIES	2007											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Folsomia octoculata</i>	-	261.43 (0.21)	-	392.15 (0.31)	392.15 (0.31)	-	392.15 (0.31)	-	-	653.6 (0.52)	-	-
<i>Xenylla obscura</i>	1437.9 (1.15)	1568.34 (1.25)	2745.09 (2.19)	1699.34 (1.36)	1437.9 (1.15)	1307.18 (1.04)	653.6 (0.52)	1960.78 (1.57)	2091.5 (1.67)	2222.22 (1.78)	2483.66 (1.98)	1960.78 (1.57)
<i>Hypogastrura indovaria</i>	1045.75 (0.83)	915.03 (0.73)	1307.18 (1.04)	1045.75 (0.83)	1045.75 (0.83)	653.6 (0.52)	653.6 (0.52)	915.03 (0.73)	1307.18 (1.04)	653.6 (0.52)	1176.47 (0.94)	1045.75 (0.83)
<i>Isotomodes dagamae</i>	-	653.6 (0.52)	261.43 (0.21)	522.87 (0.42)	-	392.15 (0.31)	261.43 (0.21)	-	-	-	522.87 (0.42)	-
<i>Lobella kraepelini</i>	-	-	522.87 (0.42)	392.15 (0.31)	-	-	-	-	-	-	-	-
<i>Isotomurus balteatus</i>	261.43 (0.21)	392.15 (0.31)	-	-	-	-	-	-	-	-	522.87 (0.42)	522.87 (0.42)
<i>Entomobrya kali</i>	261.43 (0.21)	130.71 (0.104)	-	-	-	-	-	-	653.6 (0.52)	-	-	-
<i>Salina indica</i>	653.6 (0.52)	-	-	-	-	-	-	-	-	-	-	653.6 (0.52)
<i>Callyntrura zaheri</i>	-	-	-	-	-	-	261.43 (0.21)	261.43 (0.21)	-	653.6 (0.52)	-	130.71 (0.104)
<i>Lepidocyrtus heterolepis</i>	-	-	-	-	-	-	-	-	-	-	-	-
<i>Willowsia</i> sp.	-	-	-	-	-	-	261.43 (0.21)	130.71 (0.104)	-	-	-	-

Table 7b. continued.

Table 8b.

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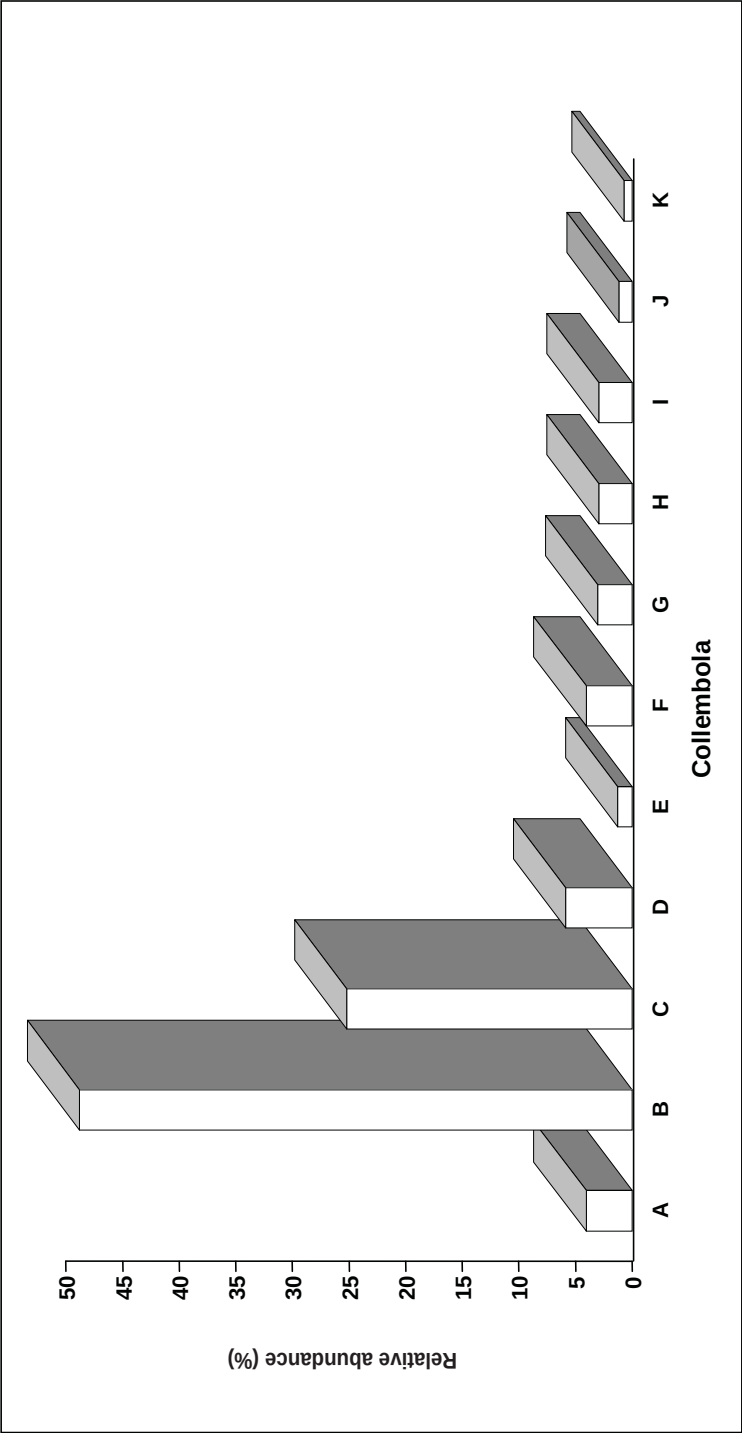


Fig 8b. Showing species composition of collembola at Site VIII

A = *Folsomia octoculata*; B = *Xenylla obscura*; C = *Hypogastrura indovaria*; D = *Isotomodes dagamae*; E = *Lobella krepalini*; F = *Isotomurus balteatus*; G = *Entomobrya kali*; H = *Salina indica*; I = *Callyntrura zaheri*; J = *Lepidocyrtus heterolepis*; K = *Willowsia* sp.

STATISTICAL ANALYSIS OF DATA

The statistical analysis of the complex soil faunal communities has been conducted to show the relationship between the soil factors and Collembola as well as interrelationship between the soil factors and different groups of soil arthropods. The application of LINEAR CORRELATION, ANCOVA and STEP-WISE REGRESSION were undertaken in the present study involving the data of soil factors, different orders of soil arthropods as well as different species of collembolan population densities of soil separately for each site. All the analysis has been carried out by using BMDP statistical software.

Linear Correlation

The correlation coefficients ('r' value) of each variable (i.e. total population of collembola fauna and seven edaphic factors such as temperature, moisture, RH, pH, organic carbon, nitrate and phosphate) on each other in individual site were shown in Table 9a-h. The correlation coefficient data mentioned in the above table broadly indicated that the edaphic factors like moisture, temperature and phosphate with the biotic variable (collembola population) showed strong negative correlation in almost all altitudinal sites (Table 9i). The correlation coefficient ('r' value) in respect of other variables like organic carbon and nitrate with the biotic variable (collembola population) was found to be positively significant correlated in all the altitudinal sites (Table 9i). The RH showed significant negative correlation with the collembola population in all the sites except at sites II, IV and V. The pH did not show any significant correlation with the collembolan population in these study sites (Table 9i).

Table 9 a-i. Showing correlations between different variables in the different altitudinal sampling sites of Darjeeling Himalayas, India.

Table 9a. Site I: Sukna (181 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.340*	1						
S2	-0.356*	-0.060	1					
S3	-0.344*	0.690***	0.3184	1				
S4	0.101	0.042	-0.714***	-0.2172	1			
S5	0.522***	-0.174	0.2793	0.0337	-0.408*	1		
S6	0.521**	-0.395*	0.0875	-0.310	-0.157	0.800***	1	
S7	-0.335*	-0.596***	0.0869	-0.570***	0.132	-0.340*	-0.039	1

Table 9b. Site II : Chunnabatti (675 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.495**	1						
S2	-0.298	0.451**	1					
S3	-0.223	0.621***	0.361*	1				
S4	0.045	-0.384*	-0.709***	-0.219	1			
S5	0.521**	-0.032	0.249	0.190	-0.299	1		
S6	0.517**	-0.304	-0.089	-0.033	0.010	0.786***	1	
S7	-0.339*	-0.197	0.261	-0.349*	-0.198	-0.244	-0.203	1

Table 9c. Site III : Gayabari (1173 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.417*	1						
S2	-0.336*	0.407*	1					
S3	-0.330*	0.470**	0.147	1				
S4	-0.073	0.111	-0.121	0.108	1			
S5	0.421*	-0.732***	-0.542***	-0.201	-0.122	1		
S6	0.497**	-0.759***	-0.651***	-0.203	-0.142	-0.142	1	
S7	-0.330*	0.617***	0.440**	0.156	0.109	-0.773***	-0.650**	1

Table 9d. Site IV : Tung (1655 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.339*	1						
S2	-0.469*	0.627***	1					
S3	-0.236	0.775***	0.455**	1				
S4	0.056	-0.233	0.117	-0.270	1			
S5	0.512***	-0.472**	-0.246	-0.302	0.419	1		
S6	0.447**	-0.601***	-0.650***	-0.378**	0.134	0.629***	1	
S7	-0.363*	-0.296	0.091	-0.326	-0.035	-0.356*	-0.088	1

Table 9e. Site V : Darjeeling (2123 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.339*	1						
S2	-0.395*	0.364*	1					
S3	-0.325	0.767**	0.413*	1				
S4	0.040	-0.554***	-0.154	-0.516**	1			
S5	0.463**	-0.464**	-0.585***	-0.576***	0.402*	1		
S6	0.522**	-0.563***	-0.634***	-0.545***	0.442**	0.771***	1	
S7	-0.354*	-0.366*	0.357*	-0.163	0.021	-0.360*	-0.230	1

Table 9f. Site VI : Tiger Hill (2557 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.342*	1						
S2	-0.384*	-0.254	1					
S3	-0.353*	0.648**	-0.125	1				
S4	0.043	-0.175	-0.042	0.119	1			
S5	0.522**	-0.065	-0.285	0.069	-0.045	1		
S6	0.511**	-0.185	-0.228	0.014	-0.064	0.769***	1	
S7	-0.331*	-0.493**	0.668***	-0.084	0.205	-0.080	-0.040	1

Table 9g. Site VII: Kalapakhri (3109 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.331*	1						
S2	-0.332*	-0.342*	1					
S3	-0.332*	0.142	0.262	1				
S4	0.133	-0.386*	0.215	-0.080	1			
S5	0.345*	0.250	-0.368*	0.0003	-0.082	1		
S6	0.516**	-0.210	0.721***	-0.165	-0.005	0.425**	1	
S7	-0.332*	-0.318	0.721***	0.137	0.337*	-0.388*	-0.278	1

Table 9h. Site VIII: Sandakhphu (3618 m)

	TC	S1	S2	S3	S4	S5	S6	S7
TC	1							
S1	-0.331*	1						
S2	-0.331*	-0.586***	1					
S3	-0.490*	0.315	0.163	1				
S4	-0.065	0.172	-0.086	0.088	1			
S5	0.522**	0.027	-0.374*	-0.119	-0.140	1		
S6	0.422*	-0.004	-0.381*	-0.359*	0.051	0.478**	1	
S7	-0.335*	-0.416**	0.531***	0.091	-0.029	-0.581***	-0.592***	1

Table 9i. The 'r' values of collembolan fauna with different edaphic factors at different altitudinal sites (I-VIII)

	I	II	III	IV	V	VI	VII	VIII
S1	-0.340*	-0.495**	-0.417*	-0.339*	-0.342*	-0.342*	-0.331*	-0.331*
S2	-0.356*	-0.298	-0.336*	-0.469*	-0.395*	-0.384*	-0.332*	-0.331*
S3	-0.344*	-0.223	-0.330*	-0.236	-0.326	-0.353*	-0.332*	-0.490*
S4	0.101	0.045	-0.073	0.056	0.041	0.044	0.133	-0.065
S5	0.522***	0.521**	0.421*	0.512***	0.463**	0.522**	0.345*	0.522**
S6	0.521**	0.517**	0.497**	0.447**	0.522**	0.511**	0.516**	0.422*
S7	-0.335*	-0.339*	-0.330*	-0.363*	-0.354*	-0.331*	-0.332*	-0.335*

[* = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$; TC = total collembolan population, S1 = temperature, S2 = moisture, S3 = relative humidity; S4 = pH, S5 = organic carbon, S6 = nitrate, S7 = phosphate]

Analysis Of Covariance (ANCOVA)

Analysis of covariance with months as fixed factors and altitude as covariates has been carried out for each species of Collembola and of each arthropod order to find out whether any significant monthly and altitudinal fluctuation exist or not in the population of individual species of Collembola as well as different groups of soil arthropod orders. The results of analysis are presented in tables from 10a to 10c. The Table 10a showed the result of analysis of covariance which has been carried out for each species of collembola with respect to altitude and month. From the Table 10a it is evident that 23 species out of 32 species showed significant altitudinal variation, while 13 species showed significant monthly population fluctuation. All the soil arthropod orders were significantly varied with the altitude and six orders namely, Collembola, Hymenoptera, Acari, Isopoda, Diplopoda and Chilopoda showed significant monthly population fluctuation (Table 10b). The Table 10c reveals that all the seven edaphic factors showed significant monthly fluctuation and except two soil factors such as organic carbon and phosphate all the soil factors showed significant altitudinal fluctuation.

Table 10a. Showing ANCOVA for individual collembolan species collected from Darjeeling Himalayas, India during Jan' 2006 – Dec' 2008 with respect to altitude and month.

Dependent Variable	Source	Sum of Squares	DF	Mean Square	F	*Sig.
<i>Hypogastrura indovaria</i>	Altitude	1668.355	1	1668.355	311.75	0
	Month	136.538	11	12.413	2.319	0.01
<i>Hypogastrura indica</i>	Altitude	5.826	1	5.826	10.22	0.002
	Month	5.194	11	0.472	0.828	0.612
<i>Xenylla obscura</i>	Altitude	5064.908	1	5064.908	298.244	0
	Month	1093.903	11	99.446	5.856	0
<i>Lobella kraeplini</i>	Altitude	2.55E-02	1	2.55E-02	0.017	0.896
	Month	21.927	11	1.993	1.341	0.201
<i>Neanura coralina</i>	Altitude	1.183	1	1.183	7.216	0.008
	Month	3.25	11	0.295	1.803	0.053
<i>Onychiurus indicus</i>	Altitude	3.69E-03	1	3.69E-03	0.003	0.96
	Month	34.288	11	3.117	2.17	0.016
<i>Isotomurus balteatus</i>	Altitude	0.142	1	0.142	0.048	0.827
	Month	24.958	11	2.269	0.768	0.672
<i>Isotoma (Desoria) tripsinata</i>	Altitude	73.882	1	73.882	40.253	0
	Month	38.372	11	3.488	1.901	0.039
<i>Isotoma thermophila</i>	Altitude	33.729	1	33.729	12.138	0.001
	Month	131.861	11	11.987	4.314	0
<i>Isotomella minor</i>	Altitude	8.074	1	8.074	7.013	0.009
	Month	17.111	11	1.556	1.351	0.196
<i>Cryptopygus thermophilus</i>	Altitude	7.263	1	7.263	7.52	0.007
	Month	11.594	11	1.054	1.091	0.368
<i>Folsomia octoculata</i>	Altitude	633.061	1	633.061	23.671	0
	Month	255.208	11	23.201	0.868	0.573
<i>Folsomides purvus</i>	Altitude	0.563	1	0.563	2.591	0.109
	Month	2.278	11	0.207	0.953	0.49
<i>Isotomedes dagamae</i>	Altitude	103.066	1	103.066	49.12	0
	Month	33.417	11	3.038	1.448	0.151
<i>Lepidocyrtus magnificus</i>	Altitude	5.551	1	5.551	15.814	0
	Month	7.569	11	0.688	1.96	0.032
<i>Lepidocyrtus medius</i>	Altitude	1290.191	1	1290.191	60.26	0
	Month	695.417	11	63.22	2.953	0.001

Table 10a. continued.....

Dependent Variable	Source	Sum of Squares	DF	Mean Square	F	*Sig.
<i>Lepidocyrtus malayanus</i>	Altitude	161.515	1	161.515	67.253	0
	Month	44.705	11	4.064	1.692	0.075
<i>Lepidocyrtus heterolepis</i>	Altitude	1.361	1	1.361	0.044	0.833
	Month	585.288	11	53.208	1.738	0.065
<i>Entomobrya kali</i>	Altitude	5471.463	1	5471.463	277.586	0
	Month	902.955	11	82.087	4.165	0
<i>Sinella curviseta</i>	Altitude	14.906	1	14.906	8.193	0.005
	Month	56.705	11	5.155	2.834	0.002
<i>Cyphoderus javanus</i>	Altitude	1.31E-02	1	1.31E-02	0.01	0.919
	Month	10.125	11	0.92	0.722	0.717
<i>Cyphoderus simulans</i>	Altitude	1266.071	1	1266.071	300.943	0
	Month	101.444	11	9.222	2.192	0.015
<i>Tomocerus mitrai</i>	Altitude	26.765	1	26.765	21.936	0
	Month	22.038	11	2.003	1.642	0.087
<i>Allocopus tetracantha</i>	Altitude	7.41E-02	1	7.41E-02	0.103	0.749
	Month	3.819	11	0.347	0.48	0.915
<i>Salina indica</i>	Altitude	10.192	1	10.192	15.463	0
	Month	69.872	11	6.352	9.637	0
<i>Salina bengalensis</i>	Altitude	7.783	1	7.783	14.344	0
	Month	36.778	11	3.343	6.162	0
<i>Salina tricolor sikimensis</i>	Altitude	5.332	1	5.332	10.796	0.001
	Month	7.278	11	0.662	1.339	0.202
<i>Calyntrua zaheri</i>	Altitude	14.872	1	14.872	33.846	0
	Month	8.01	11	0.728	1.657	0.083
<i>Yossia dehradunia</i>	Altitude	1.457	1	1.457	3.141	0.077
	Month	6.288	11	0.572	1.232	0.265
<i>Pseudosinella</i> sp.	Altitude	4.854	1	4.854	14.286	0
	Month	11.788	11	1.072	3.154	0
<i>Willowsia</i> sp.	Altitude	0.93	1	0.93	3.161	0.077
	Month	3.444	11	0.313	1.064	0.39
<i>Willemia</i> sp.	Altitude	5.152	1	5.152	18.113	0
	Month	4.288	11	0.39	1.371	0.186

* < 0.05 significant

Table 10b. Showing ANCOVA for order collembola collected from Darjeeling Himalayas, India during Jan' 2006– Dec' 2008 with respect to altitude and month with respect to altitude and month.

Dependent Variable	Source	Sum of Squares	DF	Mean Square	F	*Sig.
Collembola	Altitude	1779.619	1	1779.619	105.684	0
	Month	21309.955	11	1937.269	115.046	0

* < 0.05 significant

Table 11. Showing ANCOVA for soil factors collected from Darjeeling Himalayas, India during Jan' 2006 – Dec' 2008 with respect to altitude and month.

Dependent Variable	Source	Sum of Squares	DF	Mean Square	F	*Sig.
Temperature	Altitude	8535.591	1	8535.591	2733.341	.000
	Month	3078.054	11	279.823	89.607	.000
Moisture	Altitude	6398.597	1	6398.597	451.393	.000
	Month	3182.965	11	289.360	20.413	.000
Relative humidity	Altitude	2399.838	1	2399.838	104.061	.000
	Month	6215.634	11	565.058	24.502	.000
pH	Altitude	8.364	1	8.364	219.037	.000
	Month	1.307	11	0.119	3.111	.001
Organic carbon	Altitude	6.578E-02	1	6.578E-02	0.663	.416
	Month	18.998	11	1.727	17.410	.000
Nitrate	Altitude	3.523	1	3.523	51.483	.000
	Month	12.593	11	1.145	16.732	.000
Phosphate	Altitude	1.651E-02	1	1.651E-02	2.753	.098
	Month	1.451	11	0.132	22.004	.000

* < 0.05 significant

Step-Wise Regression Analysis Of Collembolan Species

Our goal is to determine / estimate species density of collembola as well as soil arthropod order density based altitude, soil temperature, soil moisture, relative humidity of surface soil, soil pH, soil organic carbon, nitrate and phosphate content of soil. The simplest technique to do so is to use multiple linear regression estimation technique. However, the factors here are inter-related, as deduced from product moment correlation coefficients. Hence, this technique is not applicable. So, we use the next best technique available i.e., stepwise linear regression technique for each species of collembola as well as each order of soil arthropod consisting of altitude and soil parameters as factors and obtain the relative importance of the factors, decide and drop the unimportant factors and also obtain the equation for estimation. The Table 11 and Table 12 show the effects of these in decreasing order of importance. The R^2 statistic can be interpreted as proportion of variability explained by the factors. Based on this R^2 and changes in R^2 as new variates are introduced for estimation of species / order density the following conclusion may be done.

Table 12. Summary Table of Step Regression Analysis of Collembolan Species

Variable used = Altitude, S1, S2, S3, S4, S5, S6, S7,

C01, C02, C03, C04, C05, C06, C07, C08, C09, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32.

Independent variables = Altitude, S1 to S7

Dependent variable = C01 (= *Hypogastrura indovaria*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R^2	ADJUST R^2	F RATIO	DF
		R	R^2				
1	Altitude	0.7136	0.5092	0.5092	0.5075	296.69	1,286
2	S4	0.7273	0.5290	0.0198	0.5257	160.04	2,285
3	S1	0.7405	0.5483	0.0193	0.5435	114.91	3,284
4	S5	0.7468	0.5578	0.0095	0.5515	89.23	4,283
5	S3	0.7486	0.5605	0.0027	0.5527	71.92	5,282
6	S7	0.7501	0.5626	0.0022	0.5533	60.24	6,281
7	S2	0.7521	0.5657	0.0030	0.5548	52.10	7,280
8	S6	0.7522	0.5659	0.0002	0.5534	45.46	8,279

Dependent variable = C02 (= *Hypogastrura indica*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S2	0.2364	0.0559	0.0559	0.0526	16.93	1,286
2	S3	0.2525	0.0638	0.0079	0.0572	9.71	2,285
3	S1	0.2729	0.0745	0.0107	0.0647	7.62	3,284
4	Altitude	0.2908	0.0846	0.0101	0.0716	6.53	4,283
5	S5	0.3066	0.0940	0.0095	0.0780	5.85	5,282
6	S7	0.3110	0.0967	0.0027	0.0774	5.01	6,281
7	S6	0.3124	0.0976	0.0009	0.0751	4.33	7,280
8	S4	0.3130	0.0980	0.0004	0.0721	3.79	8,279

Dependent variable = C03 (= *Xenylla obscura*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.6839	0.4677	0.4677	0.4659	251.31	1,286
2	S3	0.7129	0.5083	0.0406	0.5048	147.30	2,285
3	S7	0.7279	0.5298	0.0215	0.5249	106.67	3,284
4	S5	0.7337	0.5383	0.0085	0.5318	82.49	4,283
5	S1	0.7362	0.5420	0.0037	0.5339	66.75	5,282
6	S6	0.7406	0.5485	0.0064	0.5388	56.89	6,281
7	S4	0.7417	0.5501	0.0017	0.5389	48.92	7,280
8	S2	0.7429	0.5519	0.0017	0.5390	42.95	8,279

Dependent variable = C04 (= *Lobella kraeplini*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.6839	0.4677	0.4677	0.4659	251.31	1,286
2	S3	0.7129	0.5083	0.0406	0.5048	147.30	2,285
3	S7	0.7279	0.5298	0.0215	0.5249	106.67	3,284
4	S5	0.7337	0.5383	0.0085	0.5318	82.49	4,283
5	S1	0.7362	0.5420	0.0037	0.5339	66.75	5,282
6	S6	0.7406	0.5485	0.0064	0.5388	56.89	6,281
7	S4	0.7417	0.5501	0.0017	0.5389	48.92	7,280
8	S2	0.7429	0.5519	0.0017	0.5390	42.95	8,279

Dependent variable = C05 (= *Neanura coralina*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.1546	0.0239	0.0239	0.0205	7.00	1,286
2	S5	0.1920	0.0369	0.0130	0.0301	5.46	2,285
3	S2	0.2132	0.0454	0.0086	0.0354	4.51	3,284
4	S1	0.2224	0.0495	0.0040	0.0360	3.68	4,283
5	S6	0.2363	0.0559	0.0064	0.0391	3.34	5,282
6	S4	0.2398	0.0575	0.0017	0.0374	2.86	6,281
7	S7	0.2411	0.0582	0.0006	0.0346	2.47	7,280
8	S3	0.2415	0.0583	0.0002	0.0313	2.16	8,279

Dependent variable = C06 (= *Onychiurus indicus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S5	0.2109	0.0445	0.0445	0.0411	13.31	1,286
2	S7	0.2234	0.0499	0.0054	0.0432	7.48	2,285
3	S3	0.2306	0.0532	0.0033	0.0432	5.32	3,284
4	S4	0.2403	0.0578	0.0046	0.0444	4.34	4,283
5	S2	0.2448	0.0599	0.0022	0.0433	3.60	5,282
6	S1	0.2492	0.0621	0.0021	0.0421	3.10	6,281
7	S6	0.2522	0.0636	0.0015	0.0402	2.72	7,280
8	Altitude	0.2564	0.0658	0.0022	0.0390	2.45	8,279

Dependent variable = C07 (= *Isotomurus balteatus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S4	0.0942	0.0089	0.0089	0.0054	2.56	1,286
2	Altitude	0.1129	0.0127	0.0039	0.0058	1.84	2,285
3	S1	0.1520	0.0231	0.0104	0.0128	2.24	3,284
4	S2	0.1627	0.0265	0.0033	0.0127	1.92	4,283
5	S5	0.1710	0.0292	0.0028	0.0120	1.70	5,282
6	S6	0.1759	0.0309	0.0017	0.0103	1.50	6,281
7	S7	0.1779	0.0317	0.0007	0.0075	1.31	7,280
8	S3	0.1780	0.0317	0.0000	0.0039	1.14	8,279

Dependent variable = C08 [= *Isotoma (Desoria) trispinata*]

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.3637	0.1323	0.1323	0.1292	43.59	1,286
2	S6	0.3771	0.1422	0.0099	0.1362	23.62	2,285
3	Altitude	0.4041	0.1633	0.0211	0.1545	18.48	3,284
4	S4	0.4128	0.1704	0.0071	0.1587	14.54	4,283
5	S3	0.4152	0.1724	0.0020	0.1577	11.75	5,282
6	S2	0.4167	0.1737	0.0012	0.1560	9.84	6,281
7	S7	0.4173	0.1741	0.0005	0.1535	8.43	7,280
8	S5	0.4175	0.1743	0.0002	0.1507	7.36	8,279

Dependent variable = C09 (= *Isotomina thermophila*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S4	0.2533	0.0642	0.0642	0.0609	19.61	1,286
2	S2	0.2764	0.0764	0.0123	0.0699	11.79	2,285
3	S5	0.2888	0.0834	0.0070	0.0737	8.61	3,284
4	S1	0.2930	0.0859	0.0025	0.0729	6.64	4,283
5	S7	0.2952	0.0871	0.0013	0.0709	5.38	5,282
6	S6	0.2966	0.0880	0.0009	0.0685	4.52	6,281
7	S3	0.2974	0.0884	0.0005	0.0657	3.88	7,280
8	Altitude	0.2974	0.0885	0.0000	0.0623	3.38	8,279

Dependent variable = C10 (= *Isotomella minor*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.1828	0.0334	0.0334	0.0300	9.89	1,286
2	S4	0.2071	0.0429	0.0095	0.0362	6.39	2,285
3	S7	0.2160	0.0466	0.0037	0.0366	4.63	3,284
4	S6	0.2239	0.0501	0.0035	0.0367	3.73	4,283
5	S3	0.2256	0.0509	0.0008	0.0341	3.03	5,282
6	S2	0.2295	0.0527	0.0018	0.0324	2.60	6,281
7	Altitude	0.2312	0.0534	0.0008	0.0298	2.26	7,280
8	S5	0.2215	0.0536	0.0001	0.0264	1.97	8,279

Dependent variable = C11 (= *Cryptopygus thermophilus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S3	0.2270	0.0515	0.0515	0.0482	15.54	1,286
2	S5	0.2588	0.0670	0.0154	0.0604	10.23	2,285
3	S2	0.2843	0.0808	0.0138	0.0711	8.32	3,284
4	S6	0.2860	0.0818	0.0010	0.0688	6.30	4,283
5	S4	0.2869	0.0823	0.0005	0.0660	5.06	5,282
6	S1	0.2875	0.0826	0.0003	0.0631	4.22	6,281
7	S7	0.2876	0.0827	0.0001	0.0598	3.61	7,280
8	Altitude	0.2876	0.0827	0.0001	0.0564	3.15	8,279

Dependent variable = C12 (= *Folsomia octoculata*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.3283	0.1078	0.1078	0.1047	34.55	1,286
2	S3	0.3499	0.1224	0.0146	0.1162	19.87	2,285
3	S6	0.3625	0.1314	0.0090	0.1222	14.32	3,284
4	S5	0.4181	0.1748	0.0434	0.1631	14.99	4,283
5	S7	0.4413	0.1948	0.0200	0.1805	13.64	5,282
6	S4	0.4516	0.2040	0.0092	0.1870	12.00	6,281
7	Altitude	0.4589	0.2105	0.0066	0.1908	10.67	7,280
8	S2	0.4594	0.2120	0.0005	0.1884	9.33	8,279

Dependent variable = C13 (= *Folsomides purvus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S2	0.1453	0.0211	0.0211	0.0177	6.17	1,286
2	S3	0.1585	0.0251	0.0040	0.0183	3.67	2,285
3	S1	0.1640	0.0269	0.0018	0.0166	2.62	3,284
4	Altitude	0.1736	0.0301	0.0032	0.0164	2.20	4,283
5	S5	0.1788	0.0320	0.0018	0.0148	1.86	5,282
6	S7	0.1895	0.0359	0.0039	0.0153	1.74	6,281
7	S6	0.1922	0.0370	0.0011	0.0129	1.53	7,280
8	S4	0.1929	0.0372	0.0003	0.0096	1.35	8,279

Dependent variable = C14 (= *Isotomedes dagamae*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.3801	0.1445	0.1445	0.1415	48.29	1,286
2	S2	0.4035	0.1629	0.0184	0.1570	27.72	2,285
3	S1	0.4087	0.1670	0.0042	0.1582	18.98	3,284
4	S7	0.4133	0.1708	0.0038	0.1591	14.58	4,283
5	S5	0.4136	0.1711	0.0002	0.1564	11.64	5,282
6	S6	0.4147	0.1720	0.0009	0.1543	9.73	6,281
7	S3	0.4150	0.1722	0.0002	0.1515	8.32	7,280
8	S4	0.4150	0.1722	0.0000	0.1485	7.26	8,279

Dependent variable = C15 (= *Lepidocyrtus magnificus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.2250	0.0506	0.0506	0.0473	15.25	1,286
2	S2	0.3429	0.1176	0.0669	0.1114	18.98	2,285
3	S5	0.3781	0.1429	0.0254	0.1339	15.79	3,284
4	S4	0.3911	0.1529	0.0100	0.1410	12.77	4,283
5	S6	0.4024	0.1619	0.0090	0.1470	10.90	5,282
6	S7	0.4057	0.1646	0.0027	0.1467	9.23	6,281
7	S1	0.4105	0.1685	0.0039	0.1477	8.11	7,280
8	S3	0.4155	0.1726	0.0041	0.1489	7.28	8,279

Dependent Variable = C16 (= *Lepidocyrtus medius*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S4	0.4314	0.1861	0.1861	0.1833	65.40	1,286
2	S2	0.4796	0.2300	0.0439	0.2246	42.56	2,285
3	S5	0.4992	0.2492	0.0192	0.2413	31.43	3,284
4	S1	0.5034	0.2534	0.0042	0.2429	24.02	4,283
5	S3	0.5099	0.2600	0.0066	0.2469	19.82	5,282
6	S7	0.5123	0.2624	0.0025	0.2467	16.66	6,281
7	S6	0.2625	0.0001	0.0001	0.2441	14.24	7,280
8	Altitude	0.5123	0.2625	0.0000	0.2414	12.41	8,279

Dependent Variable = C17 (= *Lepidocyrtus malayanus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.4317	0.1864	0.1864	0.1835	65.51	1,286
2	S6	0.4768	0.2273	0.0410	0.2219	41.93	2,285
3	S4	0.4903	0.2404	0.0130	0.2323	29.95	3,284
4	S7	0.5022	0.2522	0.0118	0.2416	23.86	4,283
5	S3	0.5086	0.2587	0.0065	0.2455	19.68	5,282
6	S2	0.5117	0.2618	0.0032	0.2461	16.61	6,281
7	S5	0.5124	0.2626	0.0008	0.2442	14.24	7,280
8	S1	0.5124	0.2626	0.0000	0.2414	12.42	8,279

Dependent Variable = C18 (= *Lepidocyrtus heterolepis*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S4	0.2974	0.0884	0.0884	0.0853	27.75	1,286
2	Altitude	0.3786	0.1433	0.0549	0.1373	23.84	2,285
3	S5	0.4162	0.1732	0.0299	0.1645	19.83	3,284
4	S6	0.4302	0.1851	0.0119	0.1736	16.07	4,283
5	S3	0.4387	0.1925	0.0074	0.1781	13.44	5,282
6	S2	0.4507	0.2032	0.0107	0.1861	11.94	6,281
7	S1	0.4592	0.2108	0.0077	0.1911	10.69	7,280
8	S7	0.4598	0.2115	0.0006	0.1888	9.35	8,279

Dependent Variable = C19 (= *Entomobrya kali*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.6811	0.4639	0.4639	0.4620	247.47	1,286
2	S6	0.7262	0.5274	0.0635	0.5241	159.03	2,285
3	S4	0.7486	0.5603	0.0329	0.5557	120.65	3,284
4	S2	0.7643	0.5842	0.0239	0.5783	99.40	4,283
5	S7	0.7661	0.5870	0.0028	0.5796	80.15	5,282
6	S3	0.7665	0.5875	0.0005	0.5787	66.70	6,281
7	S1	0.7673	0.5888	0.0013	0.5785	57.27	7,280
8	S5	0.7676	0.5892	0.0004	0.5774	50.02	8,279

Dependent Variable = C20 (= *Sinella curviseta*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.2066	0.0427	0.0427	0.0393	12.75	1,286
2	S2	0.2611	0.0682	0.0255	0.0616	10.43	2,285
3	S3	0.2702	0.0730	0.0048	0.0632	7.46	3,284
4	S6	0.2781	0.0773	0.0043	0.0643	5.93	4,283
5	Altitude	0.2829	0.0800	0.0027	0.0637	4.91	5,282
6	S4	0.2854	0.0815	0.0014	0.0619	4.15	6,281
7	S7	0.2859	0.0817	0.0003	0.0588	3.56	7,280
8	S5	0.2863	0.0820	0.0003	0.0556	3.11	8,279

Dependent Variable = C21 (= *Cyphoderus javanus*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S6	0.0748	0.0056	0.0056	0.0021	1.61	1,286
2	S5	0.1399	0.0196	0.0140	0.0127	2.84	2,285
3	S2	0.1570	0.0246	0.0051	0.0143	2.39	3,284
4	S7	0.1650	0.0272	0.0026	0.0135	1.98	4,283
5	S4	0.1696	0.0288	0.0015	0.0116	1.67	5,282
6	Altitude	0.1728	0.0299	0.0011	0.0091	0.0091	6,281
7	S3	0.1740	0.0303	0.0004	0.0060	0.0060	7,280
8	S1	0.1742	0.0304	0.0001	0.0026	1.09	8,279

Dependent Variable = C22 (= *Cyphoderus simulans*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	Altitude	0.7082	0.5015	0.5015	0.4998	287.75	1,286
2	S4	0.7241	0.5242	0.0227	0.5209	157.03	2,285
3	S6	0.7324	0.5364	0.0122	0.5315	109.55	3,284
4	S2	0.7363	0.5421	0.0057	0.5356	66.93	4,283
5	S1	0.7367	0.5427	0.0006	0.5346	55.73	5,282
6	S7	0.7371	0.5434	0.0007	0.5336	55.73	6,281
7	S3	0.7372	0.5434	0.0001	0.5320	47.61	7,280
8	S5	0.7372	0.5435	0.0000	0.5304	41.52	8,279

Dependent Variable = C23 (= *Tomocerus mitrai*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.3188	0.1017	0.1017	0.0985	32.36	1,286
2	S3	0.3358	0.1128	0.0111	0.1066	18.11	2,285
3	Altitude	0.3451	0.1191	0.0063	0.1098	12.80	3,284
4	S7	0.3493	0.1220	0.0029	0.1096	9.83	4,283
5	S5	0.3523	0.1241	0.0021	0.1086	7.99	5,282
6	S6	0.3533	0.1248	0.0007	0.1061	6.68	6,281
7	S2	0.3546	0.1257	0.0009	0.1039	5.75	7,280
8	S4	0.3553	0.1263	0.0006	0.1012	5.04	8,279

Dependent Variable = C24 (= *Allocopus tetracantha*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S4	0.0963	0.0093	0.0093	0.0058	2.68	1,286
2	Altitude	0.1432	0.0205	0.0112	0.0136	2.98	2,285
3	S5	0.1632	0.0266	0.0061	0.0164	2.59	3,284
4	S7	0.1804	0.0326	0.0059	0.0189	2.38	4,283
5	S6	0.1875	0.0352	0.0026	0.0180	2.05	5,282
6	S2	0.1955	0.0382	0.0031	0.0177	1.86	6,281
7	S3	0.1956	0.0383	0.0000	0.0142	1.59	7,280
8	S1	0.1956	0.0383	0.0000	0.0107	1.39	8,279

Dependent Variable = C25 (= *Salina indica*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.3803	0.1446	0.1446	0.1416	48.35	1,286
2	Altitude	0.4337	0.1881	0.0434	0.1824	33.00	2,285
3	S2	0.4555	0.2075	0.0194	0.1991	24.78	3,284
4	S3	0.4716	0.2224	0.0149	0.2114	20.24	4,283
5	S4	0.4755	0.2261	0.0037	0.2124	16.48	5,282
6	S6	0.4777	0.2282	0.0021	0.2117	13.85	6,281
7	S5	0.4778	0.2283	0.0001	0.2090	11.83	7,280
8	S7	0.4778	0.2283	0.0000	0.2062	0.2062	8,279

Dependent Variable = C26 (= *Salina bengalensis*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S3	0.3214	0.1033	0.1033	0.1001	32.94	1,286
2	S6	0.3490	0.1218	0.0186	0.1157	19.77	2,285
3	S4	0.3650	0.1332	0.0114	0.1240	14.55	3,284
4	S1	0.3686	0.1359	0.0027	0.1236	11.12	4,283
5	Altitude	0.3715	0.1380	0.0022	0.1227	9.03	5,282
6	S2	0.3736	0.1396	0.0016	0.1212	7.60	6,281
7	S7	0.3748	0.1405	0.0009	0.1190	6.54	7,280
8	S5	0.3752	0.1408	0.0003	0.1162	5.72	8,279

Dependent Variable = C27 (= *Salina tricolour sikkimensis*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.2864	0.0821	0.0821	0.0788	25.56	1,286
2	S5	0.3252	0.1057	0.0237	0.0995	16.85	2,285
3	S6	0.3451	0.1191	0.0133	0.1098	12.80	3,284
4	S2	0.3597	0.1294	0.0103	0.1171	10.52	4,283
5	Altitude	0.3712	0.1378	0.0084	0.1225	9.01	5,282
6	S3	0.3782	0.1431	0.0053	0.1248	7.82	6,281
7	S7	0.3803	0.1446	0.0016	0.1232	6.76	7,280
8	S4	0.3806	0.1448	0.0002	0.1203	5.91	8,279

Dependent Variable = C28 (= *Calytrura zaheri*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.3510	0.1232	0.1232	0.1202	40.19	1,286
2	S7	0.3711	0.1377	0.0145	0.1317	22.76	2,285
3	S4	0.3806	0.1449	0.0071	0.1358	16.04	3,284
4	S6	0.3836	0.1471	0.0023	0.1351	12.20	4,283
5	S5	0.3853	0.1484	0.0013	0.1333	9.83	5,282
6	S2	0.3858	0.1489	0.0005	0.1307	8.19	6,281
7	Altitude	0.3861	0.1491	0.0002	0.1278	7.01	7,280
8	S3	0.3862	0.1492	0.0001	0.1248	6.11	8,279

Dependent Variable = C29 (= *Yossia derhadunia*)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S2	0.1087	0.0118	0.0118	0.0084	3.42	1,286
2	S7	0.1258	0.0158	0.0040	0.0089	2.29	2,285
3	S3	0.1412	0.0199	0.0041	0.0096	1.93	3,284
4	S4	0.1472	0.0217	0.0017	0.0078	1.57	4,283
5	S5	0.1489	0.0222	0.0005	0.0048	1.28	5,282
6	S1	0.1497	0.0224	0.0002	0.0015	1.07	6,281
7	S6	0.1502	0.0225	0.0001	-0.0019	0.92	7,280
8	Altitude	0.1502	0.0226	0.0000	-0.0055	0.80	8,279

Dependent Variable = C30 (= *Pseudosinella* sp.)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S1	0.2393	0.0573	0.0573	0.0540	17.38	1,286
2	S5	0.3119	0.0973	0.0400	0.0909	15.36	2,285
3	S7	0.3239	0.1049	0.0076	0.0954	11.09	3,284
4	S2	0.3299	0.1088	0.0039	0.0962	8.64	4,283
5	S6	0.3396	0.1153	0.0065	0.0997	7.35	5,282
6	Altitude	0.3412	0.1164	0.0011	0.0975	6.17	6,281
7	S4	0.3424	0.1172	0.0008	0.0951	5.31	7,280
8	S3	0.3426	0.1174	0.0002	0.0921	4.64	8,279

Dependent Variable = C31 (= *Willowsia* sp.)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S5	0.1237	0.0153	0.0153	0.0119	4.44	1,286
2	Altitude	0.1590	0.0253	0.0100	0.0184	3.69	2,285
3	S4	0.2246	0.0505	0.0252	0.0404	5.03	3,284
4	S3	0.2308	0.0533	0.0028	0.0399	3.98	4,283
5	S2	0.2370	0.0562	0.0029	0.0394	3.36	5,282
6	S1	0.2423	0.0587	0.0025	0.0386	2.92	6,281
7	S7	0.2436	0.0593	0.0006	0.0358	2.52	7,280
8	S6	0.2445	0.0598	0.0005	0.0328	2.22	8,279

Dependent Variable = C32 (= *Willemia* sp.)

STEP NO	VARIABLE ENTERED	MULTIPLE		CHANGE IN R ²	ADJUST R ²	F RATIO	DF
		R	R ²				
1	S3	0.2507	0.0628	0.0628	0.0596	19.18	1,286
2	Altitude	0.2947	0.0869	0.0240	0.0805	13.55	2,285
3	S5	0.3215	0.1034	0.0165	0.0939	10.92	3,284
4	S1	0.3333	0.1111	0.0077	0.0985	8.84	4,283
5	S4	0.3437	0.1181	0.0071	0.1025	7.56	5,282
6	S2	0.3496	0.1222	0.0041	0.1035	6.52	6,281
7	S6	0.3509	0.1232	0.0010	0.1012	5.62	7,280
8	S7	0.3510	0.1232	0.0000	0.0980	4.90	8,279

Abbreviation:C01 = *Hypogastrura indovaria*,C02 = *Hypogastrura indica*,C03 = *Xenylla obscura*,C04 = *Lobella kraeplini*,C05 = *Neanura coralina*,C06 = *Onychiurus indicus*,C07 = *Isotomurus balteatus*,C08 = *Isotoma(Desoria)trispinata*,C09 = *Isotomina thermophila*,C10 = *Isotomella minor*,C11 = *Cryptopygus thermophilus*,C12 = *Folsomia octoculata*,C13 = *Folsomides purvus*,C14 = *Isotomedes dagamae*,C15 = *Lepidocyrtus magnificus*,C16 = *Lepidocyrtus medius*,C17 = *Lepidocyrtus malayanus*,C18 = *Lepidocyrtus heterolepis*,C19 = *Entomobrya kali*,C20 = *Sinella curviseta*,C21 = *Cyphoderus javanus*,C22 = *Cyphoderus simulans*,C23 = *Tomocerus mitrai*,C24 = *Allocoptes tetracantha*,C25 = *Salina indica*,C26 = *Salina bengalensis*,C27 = *Salina tricolour sikkimensis*,C28 = *Calytrura zaheri*,C29 = *Yossia derhadunia*,C30 = *Pseudosinella* sp.,C31 = *Willowsia* sp.,C32 = *Willemia* sp.

S1 = soil temperature,

S2 = soil moisture,

S3 = relative humidity of surface soil,

S4 = soil pH,

S5 = organic carbon of soil,

S6 = nitrate content of the soil,

S7 = phosphate content of the soil.

COMPARATIVE ANALYSIS OF DATA IN DIFFERENT STUDY SITES

Table 13. Showing abundance of collembolan genera (expressed in % of total population) obtained from all sampling sites of Darjeeling Himalayas, India

GENERA	SITES (ALTITUDE)								TOTAL
	I (181m)	II (675m)	III (1173m)	IV (1655m)	V (2123m)	VI (2557m)	VII (3109)	VIII (3618m)	
<i>Hypogastrura</i> sp.	0.19	0	0	0	0.22	1.45	3.20	2.76	7.82
<i>Xenylla</i> sp.	0.53	0.46	0.39	0.54	1.49	6.0	5.5	5.34	20.25
<i>Lobella</i> sp.	0.24	0.15	0	0.27	0	0.19	0.21	0.14	1.2
<i>Neanura</i> sp.	0.14	0	0	0	0	0	0	0	0.14
<i>Onychiurus</i> sp.	0	0	0.37	0.21	0.27	0.38	0	0	1.23
<i>Isotomurus</i> sp.	0.25	0.72	0.31	0	0.33	0	0.62	0.45	2.68
<i>Isotoma</i> sp.	0.54	0.46	0.4	0.45	0	0	0	0	1.85
<i>Isotomina</i> sp.	0.33	0.33	0.23	1.02	0.47	0	0	0	2.38
<i>Isotomella</i> sp.	0	0.23	0.38	0.31	0	0	0	0	0.92
<i>Cryptopygus</i> sp.	0	0.41	0	0.38	0	0	0	0	0.79
<i>Folsomia</i> sp.	0	0	0	0	0	1.43	0.49	0.45	2.37
<i>Folsomides</i> sp.	0	0	0.23	0	0	0	0	0	0.23
<i>Isotomedes</i> sp.	0	0	0	0	0.73	0.47	0.49	0.64	2.33
<i>Lepidocyrtus</i> sp.	3.61	2.8	2.98	7.3	6.95	0.24	0.11	0.12	24.31
<i>Entomobrya</i> sp.	4.57	4.83	5.02	0.57	0.34	0.46	0.3	0.33	16.42
<i>Sinella</i> sp.	0.21	0.42	0.32	0.18	0.21	0.37	0	0	1.71
<i>Cyphoderus</i> sp.	2.61	1.82	1.96	0.21	0.34	0.5	0	0	7.44
<i>Tomocerus</i> sp.	0.33	0.26	0.24	0.27	0	0	0	0	1.1
<i>Allocopus</i> sp.	0	0	0	0.14	0.39	0	0	0	0.53
<i>Salina</i> sp.	0.15	0.23	0.19	0.23	0.22	0.4	0.35	0.32	2.09
<i>Calytrura</i> sp.	0	0	0	0	0.12	0	0.21	0.32	0.65
<i>Yossia</i> sp.	0	0	0.29	0.25	0	0	0	0	0.54
<i>Pseudosinella</i> sp.	0.24	0	0.09	0	0	0	0	0	0.33
<i>Willowsia</i> sp.	0.11	0.12	0	0	0	0	0	0.08	0.31
<i>Willemia</i> sp.	0.12	0.23	0	0	0	0	0	0	0.35
TOTAL	14.17	13.47	13.4	12.53	12.08	11.89	11.48	10.95	100

Table 14. Showing abundance of collembolan species (expressed in % of total population) obtained from all the sites of Darjeeling Himalayas, India

SPECIES / GENUS	SITES (ALTITUDE)								TOTAL
	I (181 m)	II (675 m)	III (1173 m)	IV (1655 m)	V (2123 m)	VI (2557 m)	VII (3109 m)	VIII (3618 m)	
<i>Hypogastrura indovaria</i>	0.19	0	0	0	0	1.16	2.97	2.76	7.08
<i>Hypogastrura indica</i>	0	0	0	0	0.22	0.29	0.23	0	0.74
<i>Xenylla obscura</i>	0.53	0.46	0.39	0.54	1.49	6.0	5.5	5.34	20.25
<i>Lobella kraepelini</i>	0.24	0.15	0	0.27	0	0.19	0.21	0.14	1.2
<i>Neanura coralina</i>	0.14	0	0	0	0	0	0	0	0.14
<i>Onychiurus indicus</i>	0	0	0.37	0.21	0.27	0.38	0	0	1.23
<i>Isotomurus balteatus</i>	0.25	0.72	0.31	0	0.33	0	0.62	0.45	2.68
<i>Isotoma(Desoria)trispinata</i>	0.54	0.46	0.4	0.45	0	0	0	0	1.85
<i>Isotomina thermophila</i>	0.33	0.33	0.23	1.02	0.47	0	0	0	2.38
<i>Isotomella minor</i>	0	0.23	0.38	0.31	0	0	0	0	0.92
<i>Cryptopygus thermophilus</i>	0	0.41	0	0.38	0	0	0	0	0.79
<i>Folsomia octoculata</i>	0	0	0	0	0	1.43	0.49	0.45	2.37
<i>Folsomides purvus</i>	0	0	0.23	0	0	0	0	0	0.23
<i>Isotomides dagamae</i>	0	0	0	0	0.73	0.47	0.49	0.64	2.33
<i>Lepidocyrtus magnificus</i>	0.3	0	0	0	0	0	0	0	0.3
<i>Lepidocyrtus medius</i>	1.7	1.92	2.02	1.97	0.77	0	0	0	8.38
<i>Lepidocyrtus malayanus</i>	1.1	0.46	0.45	0	0	0	0	0	2.01
<i>Lepidocyrtus heterolepis</i>	0.51	0.42	0.51	5.53	6.18	0.24	0.11	0.12	13.62
<i>Entomobrya kali</i>	4.57	4.83	5.02	0.57	0.34	0.46	0.3	0.33	16.42
<i>Sinella curviseta</i>	0.21	0.42	0.32	0.18	0.21	0.37	0	0	1.71
<i>Cyphoderus javanus</i>	0.09	0.16	0	0.21	0.34	0.5	0	0	1.3
<i>Cyphoderus simulans</i>	2.52	1.66	1.96	0	0	0	0	0	6.14
<i>Tomocerus mitrai</i>	0.33	0.26	0.24	0.27	0	0	0	0	1.1
<i>Alloporus tetracantha</i>	0	0	0	0.14	0.39	0	0	0	0.53
<i>Salina indica</i>	0.07	0	0	0	0.22	0.3	0	0.32	0.91
<i>Salina bengalensis</i>	0.08	0.23	0.19	0.23	0	0	0	0	0.73
<i>Salina tricolour sikkimensis</i>	0	0	0	0	0	0.1	0.35	0	0.45
<i>Calyntrura zaheri</i>	0	0	0	0	0.12	0	0.21	0.32	0.65
<i>Yossia derhadunia</i>	0	0	0.29	0.25	0	0	0	0	0.54
<i>Pseudosinella sp.</i>	0.24	0	0.09	0	0	0	0	0	0.33
<i>Willowsia sp.</i>	0.11	0.12	0	0	0	0	0	0.08	0.31
<i>Willemia sp.</i>	0.12	0.23	0	0	0	0	0	0	0.35
TOTAL	14.17	13.47	13.4	12.53	12.08	11.89	11.48	10.95	99.97

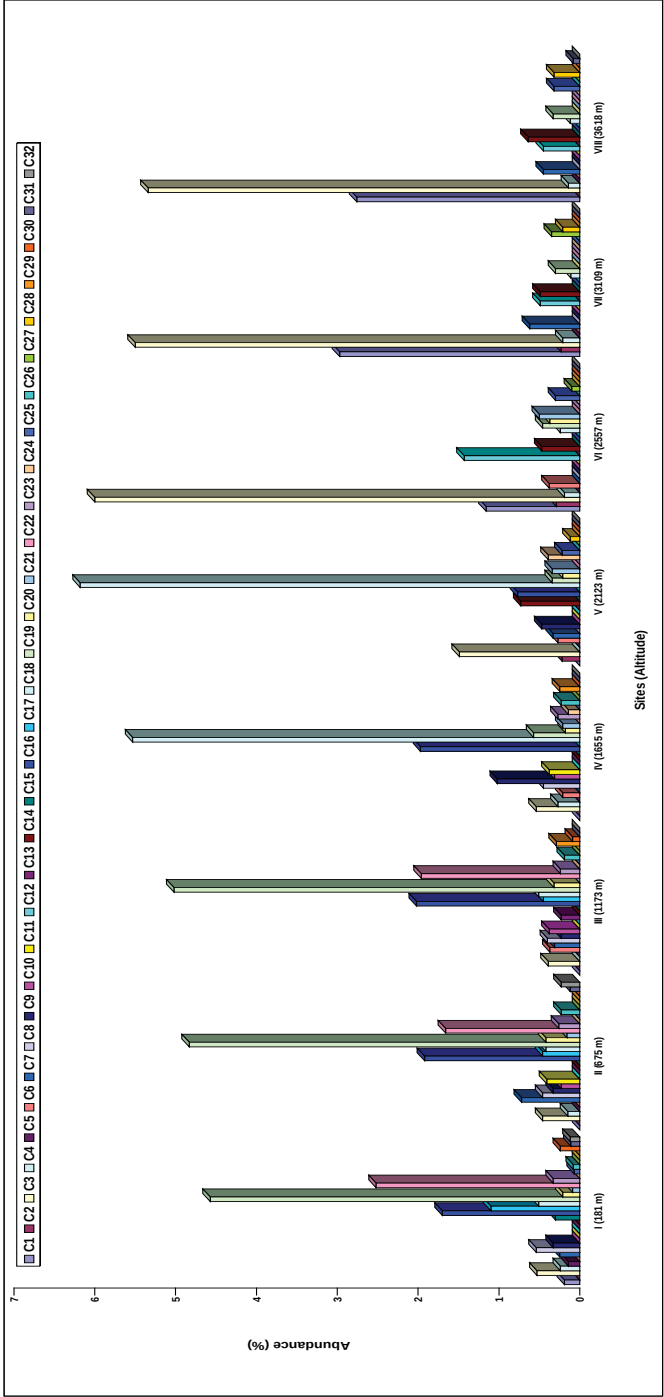


Fig D1. Showing abundance (%) of collembolan species in different altitudinal sites

C01. *Hypogastrura indovaria*; C02. *Hypogastrura indica*; C03. *Xenylla obscura*; C04. *Lobella kreplini*; C05. *Neanura coralina*. C06. *Onychirus indicus*; C07. *Isotomurus balteatus*; C08. *Isotoma (Desoria) trispinata*; C09. *Isotomina thomopila*; C010. *Isotomella minor*; C11. *Cryptopygus thermophilus*; C12. *Folsomia octoculata*; C13. *Folsomides purvus*; C14. *Isotomodes dagamae*; C15. *Lepidocyrtus magnificus*; C16. *Lepidocyrtus medius*; C17. *Lepidocyrtus malayanus*; C18. *Lepidocyrtus heterolepis*; C19. *Entomobrya kali*; C20. *Sinella curviseta*; C21. *Cyphoderus javanus*; C22. *Cyphoderus simulans*; C23. *Tomocerus mitrai*; C24. *Alloopus tetracantha*; C25. *salina indica*; C26. *Salina bengalensis*. C27. *Salina tricolor sikkimensis*; C28. *calyntrura zaheri*; C29. *Yossia derhadunia*; C30. *Pseudosinella sp.* C31. *Willowsia sp.*; C32. *Willemia sp.*

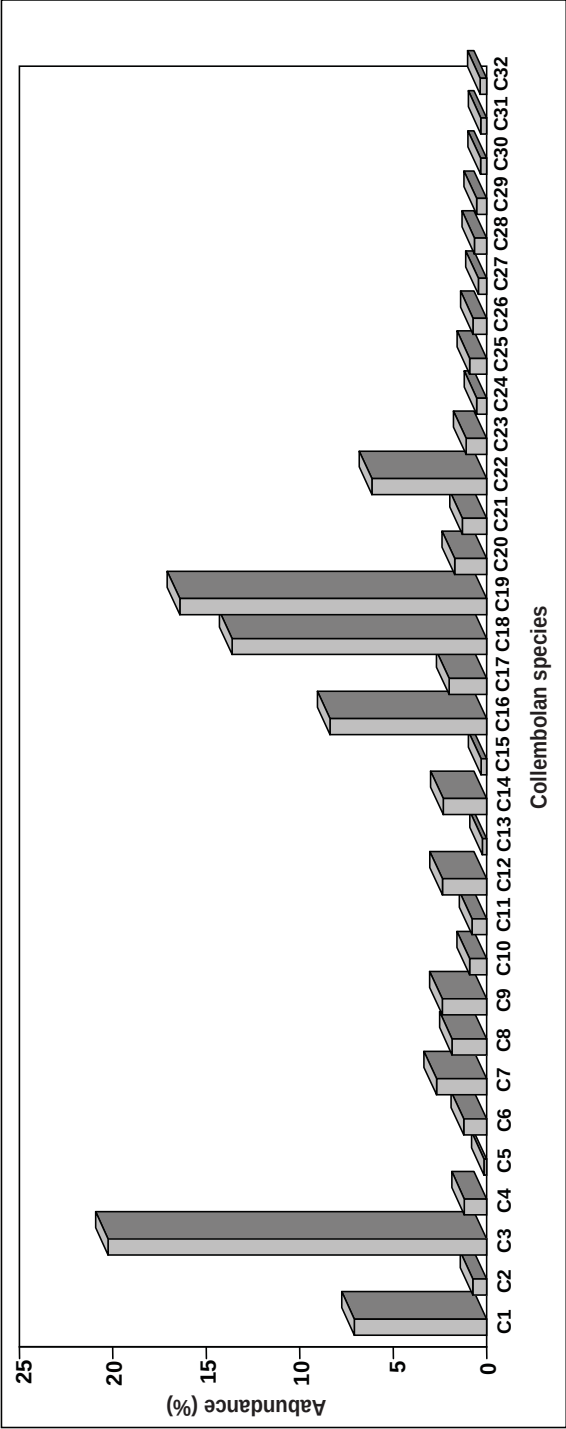


Fig D2. Showing abundance of collembolan species obtained from the study sites.

C01. *Hypogastrura indovaria*; C02. *Hypogastrura indica*; C03. *Xenylla obscura*; C04. *Lobella kreplini*; C05. *Neanura coralina*. C06. *Onychirus indicus*; C07. *Isotomurus balteatus*; C08. *Isotoma (Desoria) trispirata*; C09. *Isotomina thomopila*; C10. *Isotomella minor*; C11. *Cryptopygus thermophilus*; C12. *Folsomia octoculata*; C13. *Folsomides purvus*; C14. *Isotomodes dagamae*; C15. *Lepidocyrtus magnificus*; C16. *Lepidocyrtus medius*; C17. *Lepidocyrtus malayanus*; C18. *Lepidocyrtus heterolepis*; C19. *Entomobrya kali*; C20. *Sinella curviseta*; C21. *Cyphoderus javanus*; C22. *Cyphoderus simulans*; C23. *Tomocerus mitrai*; C24. *Alloopus tetracantha*; C25. *salina indica*; C26. *Salina bengalensis*. C27. *Salina tricolor sikkimensis*; C28. *calyntrura zaheri*; C29. *Yossia derhadunia*; C30. *Pseudosinella* sp. C31. *Willowsia* sp.; C32. *Willemia* sp.

Table 15. Showing monthly variation of total population of different collembola genera obtained from the various altitudinal sites of Darjeeling Himalayas, India (percentage of total population of collembola are given in each parenthesis)

GENERA	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Hypogastrura</i> sp.	56	62	81	64	33	38	23	59	64	67	67	69
	(0.64)	(0.71)	(0.93)	(0.73)	(0.38)	(0.43)	(0.26)	(0.67)	(0.73)	(0.77)	(0.77)	(0.79)
<i>Xenylla</i> sp.	103	140	199	128	72	45	35	84	116	147	168	133
	(1.18)	(1.60)	(2.28)	(1.46)	(0.82)	(0.51)	(0.40)	(0.96)	(1.33)	(1.68)	(1.92)	(1.52)
<i>Lobella</i> sp.	-	-	9	14	5	10	9	9	20	21	2	6
			(0.10)	(0.16)	(0.06)	(0.11)	(0.10)	(0.10)	(0.23)	(0.24)	(0.02)	(0.07)
<i>Neanura</i> sp.	-	-	-	-	3	-	-	-	-	9	-	-
					(0.03)					(0.10)		
<i>Onychiurus</i> sp.	17	3	3	6	14	29	16	-	5	-	4	10
	(0.19)	(0.03)	(0.03)	(0.07)	(0.16)	(0.33)	(0.18)		(0.06)		(0.04)	(0.11)
<i>Isotomurus</i> sp.	23	11	16	9	12	11	24	24	24	21	29	30
	(0.260)	(0.12)	(0.18)	(0.10)	(0.14)	(0.12)	(0.27)	(0.27)	(0.27)	(0.24)	(0.33)	(0.34)
<i>Isotoma</i> sp.	3	9	11	17	20	31	23	19	7	5	-	16
	(0.03)	(0.10)	(0.12)	(0.19)	(0.23)	(0.35)	(0.26)	(0.22)	(0.08)	(0.06)		(0.18)
<i>Isotomina</i> sp.	6	20	15	12	6	7	8	3	6	31	61	33
	(0.07)	(0.23)	(0.17)	(0.14)	(0.07)	(0.08)	(0.09)	(0.03)	(0.07)	(0.35)	(0.70)	(0.38)

Table 15. continued.

Table 15.

GENERA	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomella</i> sp.	-	8	4	6	-	5	11	9	9	-	22	6
		(0.09)	(0.04)	(0.07)		(0.06)	(0.12)	(0.10)	(0.10)		(0.25)	(0.07)
<i>Cryptopygus</i> sp.	8	13	-	13	3	7	3	9	-	-	2	11
	(0.09)	(0.15)		(0.15)	(0.03)	(0.08)	(0.03)	(0.10)			(0.02)	(0.12)
<i>Folsomia</i> sp.	43	60	96	64	43	11	17	33	47	68	69	55
	(0.49)	(0.69)	(1.10)	(0.73)	(0.49)	(0.12)	(0.19)	(0.38)	(0.54)	(0.78)	(0.79)	(0.63)
<i>Folsomides</i> sp.	3	7	1	-	2	-	-	4	3	-	-	-
	(0.03)	(0.08)	(0.01)		(0.02)			(0.04)	(0.03)			
<i>Isotomedes</i> sp.	15	20	22	26	19	8	8	6	12	18	36	14
	(0.17)	(0.23)	(0.25)	(0.30)	(0.22)	(0.09)	(0.09)	(0.07)	(0.14)	(0.21)	(0.41)	(0.16)
<i>Lepidocyrtus</i> sp.	160	174	272	185	80	78	77	156	196	217	266	265
	(1.83)	(1.99)	(3.11)	(2.12)	(0.91)	(0.89)	(0.88)	(1.78)	(2.24)	(2.48)	(3.04)	(3.03)
<i>Entomobrya</i> sp.	101	120	203	149	82	65	46	95	136	124	156	158
	(1.16)	(1.37)	(2.32)	(1.70)	(0.94)	(0.74)	(0.53)	(1.09)	(1.56)	(1.42)	(1.78)	(1.81)
<i>Sinella</i> sp.	9	5	3	13	13	6	32	36	11	16	-	5
	(0.10)	(0.06)	(0.03)	(0.15)	(0.15)	(0.07)	(0.37)	(0.41)	(0.12)	(0.18)		(0.06)

Table 15. continued.....

Table 15.

GENERA	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Cyphoderus</i> sp.	63	64	92	59	31	35	30	51	58	57	57	53
	(0.72)	(0.73)	(1.05)	(0.67)	(0.35)	(0.40)	(0.34)	(0.58)	(0.66)	(0.65)	(0.65)	(0.61)
<i>Tomocerus</i> sp.	3	3	10	26	11	7	-	10	10	10	7	-
	(0.03)	(0.03)	(0.11)	(0.30)	(0.12)	(0.08)		(0.11)	(0.11)	(0.11)	(0.08)	
<i>Allocopus</i> sp.	5	6	7	4	-	4	8	0	5	-	1	6
	(0.06)	(0.07)	(0.08)	(0.04)		(0.04)	(0.09)		(0.06)		(0.01)	(0.07)
<i>Salina</i> sp.	63	15	6	2	4	2	-	3	2	8	8	60
	(0.72)	(0.17)	(0.07)	(0.02)	(0.04)	(0.02)		(0.03)	(0.02)	(0.09)	(0.09)	(0.67)
<i>Calytrura</i> sp.	11	8	2	-	-	4	5	4	-	8	3	12
	(0.12)	(0.09)	(0.02)			(0.04)	(0.06)	(0.04)		(0.09)	(0.03)	(0.14)
<i>Yossia</i> sp.	8	10	6	-	2	9	3	6	-	-	2	1
	(0.09)	(0.11)	(0.07)		(0.02)	(0.10)	(0.03)	(0.07)			(0.02)	(0.01)
<i>Pseudosinella</i> sp.	-	-	-	-	9	16	4	-	-	-	-	-
					(0.10)	(0.18)	(0.04)					
<i>Willowsia</i> sp.	-	-	-	2	-	1	7	5	-	2	4	7
				(0.02)		(0.01)	(0.08)	(0.06)		(0.02)	(0.04)	(0.08)
<i>Willemia</i> sp.	10	6	-	-	2	3	3	3	-	-	-	4
	(0.11)	(0.07)			(0.02)	(0.03)	(0.03)	(0.03)				(0.04)

Table 16 . Showing monthly variations of total population of different collembolan species obtained from the eight altitudinal sites of Darjeeling Himalayas, India (expressed in percentage of total collembola)

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Hypogastrura indovaria</i>	I	–	–	–	–	–	–	0.04	0.06	–	–	0.03	0.06
	II	–	–	–	–	–	–	–	–	–	–	–	–
	III	–	–	–	–	–	–	–	–	–	–	–	–
	IV	–	–	–	–	–	–	–	–	–	–	–	–
	V	–	–	–	–	–	–	–	–	–	–	–	–
	VI	0.09	.12	0.24	0.17	–	–	–	0.09	0.19	0.11	0.08	0.04
	VII	0.21	0.26	0.25	0.24	0.19	0.18	0.15	0.22	0.22	0.33	0.35	0.37
	VIII	0.26	0.24	0.39	0.25	0.18	0.12	0.01	0.24	0.32	0.21	0.26	0.26
<i>Hypogastrura indica</i>	I	–	–	–	–	–	–	–	–	–	–	–	–
	II	–	–	–	–	–	–	–	–	–	–	–	–
	III	–	–	–	–	–	–	–	–	–	–	–	–
	IV	–	–	–	–	–	–	–	–	–	–	–	–
	V	–	–	–	–	–	0.07	0.03	0.03	–	0.02	0.03	0.02
	VI	0.06	0.04	0.01	–	–	0.06	0.02	0.03	–	0.06	–	–
	VII	0.02	0.03	0.03	0.07	–	–	–	–	–	0.03	–	0.03
	VIII	–	–	–	–	–	–	–	–	–	–	–	–
<i>Xenylla obscura</i>	I	0.08	0.15	0.18	0.06	–	–	–	–	–	–	–	0.06
	II	0.08	0.21	0.06	0.07	–	–	–	–	–	–	–	0.04
	III	0.08	0.09	–	–	–	–	–	–	0.06	0.11	0.04	–
	IV	0.08	0.03	0.08	0.06	–	–	0.07	–	–	0.04	0.07	0.10
	V	0.10	0.14	0.22	–	–	–	–	0.15	0.17	0.24	0.27	0.19
	VI	–	0.03	0.06	0.19	0.08	0.10	0.07	0.17	0.12	0.18	0.26	0.15
	VII	0.41	0.45	0.88	0.56	0.39	0.16	0.17	0.32	0.50	0.54	0.63	0.49
	VIII	0.34	0.50	0.80	0.53	0.35	0.25	0.09	0.32	0.47	0.56	0.64	0.48

Table 16. continued.....

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Lobella kraeplini</i>	I	-	-	0.02	0.09	-	-	-	-	0.05	0.05	-	-
	II	-	-	-	-	-	-	-	-	0.03	0.11	-	-
	III	-	-	-	-	-	-	-	-	0	-	-	-
	IV	-	-	0.03	-	0.03	-	-	-	0.07	0.07	-	0.07
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	0.10	0.07	-	0.02	-
	VII	-	-	-	0.02	0.02	0.11	0.04	-	-	-	-	-
	VIII	-	-	0.04	0.03	-	-	0.06	-	-	-	-	-
<i>Neanura coralina</i>	I	-	-	-	-	0.03	-	-	-	-	0.10	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Onychiurus indicus</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	0.07	-	-	0.03	0.07	0.10	0.09	-	-	-	-	-
	IV	-	-	-	-	0.06	0.10	0.04	-	-	-	-	-
	V	-	0.03	-	-	0.03	0.10	0.04	-	0.05	-	-	-
	VI	0.12	-	0.03	0.03	-	0.02	-	-	-	-	0.04	0.11
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomurus balteatus</i>	I	–	0.02	0.04	0.03	–	–	–	0.03	0.08	0.03	–	–
	II	0.12	–	0.06	–	–	–	–	0.06	0.07	0.11	0.07	0.23
	III	–	–	–	–	–	–	0.10	0.04	0.05	–	0.03	0.07
	IV	–	–	–	–	–	–	–	–	–	–	–	–
	V	0.03	–	–	0.02	0.09	0.04	0.09	0.04	–	–	–	–
	VI	–	–	–	–	–	–	–	–	–	–	–	–
	VII	–	–	0.03	0.04	0.04	0.08	0.03	0.09	0.04	0.06	0.18	–
	VIII	0.10	0.10	0.04	–	–	–	0.04	–	0.02	0.03	0.04	0.04
<i>Isotoma (Desoria) trispinata</i>	I	–	–	–	0.12	0.04	0.10	0.10	0.02	0.03	0.06	–	0.04
	II	–	–	–	–	0.15	0.16	0.09	0.06	–	–	–	–
	III	0.03	0.03	0.03	–	0.03	0.06	0.03	0.03	–	–	–	0.14
	IV	–	0.07	0.09	0.07	–	0.03	0.03	0.10	0.04	–	–	–
	V	–	–	–	–	–	–	–	–	–	–	–	–
	VI	–	–	–	–	–	–	–	–	–	–	–	–
	VII	–	–	–	–	–	–	–	–	–	–	–	–
	VIII	–	–	–	–	–	–	–	–	–	–	–	–
<i>Isotomina thermophila</i>	I	–	0.06	0.04	–	–	0.03	–	–	–	0.09	0.09	–
	II	–	–	–	0.09	–	–	–	–	–	–	0.14	0.10
	III	–	–	–	–	–	–	0.09	–	–	–	0.07	0.07
	IV	0.03	0.16	0.07	–	–	–	–	–	0.07	0.19	0.32	0.17
	V	0.03	–	0.06	0.04	0.07	0.04	–	0.03	–	0.07	0.08	0.03
	VI	–	–	–	–	–	–	–	–	–	–	–	–
	VII	–	–	–	–	–	–	–	–	–	–	–	–
	VIII	–	–	–	–	–	–	–	–	–	–	–	–

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Isotomella minor</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	0.09	-	-	-	-	0.04	-	-	-	0.09	-
	III	-	-	-	0.07	-	0.06	0.08	-	-	-	0.10	0.07
	IV	-	-	0.04	-	-	-	-	0.10	0.10	-	0.06	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cryptopygus thermophilus</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	0.09	0.10	-	-	-	0.08	0.03	0.10	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	0.04	-	0.15	0.03	-	-	-	-	-	0.02	0.12
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Folsomia octoculata</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	0.41	0.57	0.96	0.67	0.41	0.12	0.16	0.38	0.43	0.58	0.71	0.57
	VII	0.08	0.09	0.14	-	-	-	-	-	0.08	0.06	0.04	-
	VIII	-	0.02	-	0.06	0.08	-	0.03	-	0.02	0.14	0.03	0.06

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Folsomides purvus</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	0.03	0.08	0.01	-	0.02	-	-	0.04	0.03	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Isotomedes dagamae</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	0.12	0.12	0.12	0.06	0.04	-	0.03	-	-	-	0.10	0.11
	VI	0.04	0.02	0.04	0.08	-	-	-	0.03	0.06	0.06	0.08	0.04
	VII	-	-	0.04	0.03	0.11	0.06	0.03	0.03	0.03	0.09	0.04	-
	VIII	-	0.08	0.03	0.12	0.06	0.03	0.02	-	0.04	0.06	0.18	-
<i>Lepidocyrtus magnificus</i>	I	-	-	-	-	-	-	0.10	0.12	0.07	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Lepidocyrtus medius</i>	I	—	0.25	0.21	0.24	0.07	0.12	0.12	0.08	0.07	—	0.21	0.33
	II	0.15	0.03	0.16	0.18	0.04	0.08	0.09	0.16	0.23	0.24	0.24	0.31
	III	0.18	0.16	0.18	0.03	0.04	0.03	0.04	0.22	0.19	0.26	0.31	0.35
	IV	0.46	0.45	0.81	0.42	0.21	0.18	0.15	0.42	0.55	0.63	0.69	0.56
	V	0.04	—	0.16	0.08	—	0.03	0.03	0.08	—	0.04	0.12	0.16
	VI	—	—	—	—	—	—	—	—	—	—	—	—
	VII	—	—	—	—	—	—	—	—	—	—	—	—
	VIII	—	—	—	—	—	—	—	—	—	—	—	—
<i>Lepidocyrtus malayanus</i>	I	0.18	0.08	0.03	—	—	—	0.08	0.04	0.11	0.17	0.09	0.30
	II	0.06	0.04	0.03	0.07	—	0.08	0.07	—	—	0.04	—	0.05
	III	—	0.03	—	0.11	0.08	0.10	—	—	—	—	—	0.11
	IV	—	—	—	—	—	—	—	—	—	—	—	—
	V	—	—	—	—	—	—	—	—	—	—	—	—
	VI	—	—	—	—	—	—	—	—	—	—	—	—
	VII	—	—	—	—	—	—	—	—	—	—	—	—
	VIII	—	—	—	—	—	—	—	—	—	—	—	—
<i>Lepidocyrtus heterolepis</i>	I	0.17	0.11	0.10	—	—	—	—	—	—	—	0.12	—
	II	—	0.07	0.04	—	—	—	—	—	0.03	0.09	0.18	—
	III	0.04	0.02	0.07	—	—	—	—	0.07	0.11	0.07	0.07	0.06
	IV	0.19	0.19	0.34	0.21	0.15	0.04	—	0.12	0.16	0.23	0.19	0.12
	V	0.32	0.54	0.93	0.71	0.32	0.17	0.10	0.46	0.63	0.66	0.77	0.57
	VI	0.02	—	0.03	—	—	0.03	0.02	—	0.03	—	0.02	0.07
	VII	—	—	—	0.06	—	—	—	—	0.04	0.01	—	—
	VIII	—	—	—	—	—	—	0.06	—	—	0.02	0.02	0.02

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Entomobrya kali</i>	I	0.32	0.39	0.54	0.41	0.17	0.19	0.18	0.32	0.39	0.42	0.50	0.72
	II	0.31	0.43	0.73	0.51	0.21	0.15	0.14	0.29	0.46	0.42	0.59	0.58
	III	0.30	0.42	0.83	0.41	0.11	0.14	0.16	0.34	0.54	0.57	0.69	0.50
	IV	–	–	0.08	0.17	0.18	0.09	0.04	–	–	–	–	–
	V	0.12	0.02	0.03	0.01	0.10	0.02	–	–	0.02	–	–	–
	VI	0.03	0.06	0.07	0.03	0.11	0.08	–	0.04	0.02	–	–	–
	VII	0.03	0.01	0.03	0.05	–	–	–	0.09	0.07	–	–	–
	VIII	0.03	0.03	–	0.09	0.04	0.07	–	–	0.06	–	–	–
<i>Sinella cueviseta</i>	I	0.03	–	–	–	–	–	0.04	0.04	0.03	0.04	–	–
	II	–	–	0.03	0.09	0.06	–	0.12	0.09	–	0.02	–	–
	III	–	–	–	–	0.06	–	0.04	0.08	0.06	0.08	–	–
	IV	–	–	–	–	–	–	0.10	0.08	–	–	–	–
	V	–	–	–	0.06	–	–	–	0.08	0.03	–	–	0.04
	VI	0.07	0.06	–	–	0.03	0.07	0.04	0.03	–	0.03	–	0.02
	VII	–	–	–	–	–	–	–	–	–	–	–	–
	VIII	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cyphoderus javanus</i>	I	0.03	–	–	–	–	–	–	–	–	–	–	0.06
	II	–	0.03	0.06	–	–	–	–	–	–	–	–	0.07
	III	–	–	–	–	–	–	–	–	–	–	–	–
	IV	–	–	0.02	0.10	–	0.03	–	–	–	–	0.04	–
	V	0.02	–	0.06	0.03	0.02	–	–	–	0.06	0.11	0.03	–
	VI	0.03	0.04	–	–	–	0.03	0.06	0.06	0.09	0.08	0.10	–
	VII	–	–	–	–	–	–	–	–	–	–	–	–
	VIII	–	–	–	–	–	–	–	–	–	–	–	–

Table 16. continued.....

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Cyphoderus similans</i>	I	0.27	0.30	0.39	0.21	0.14	0.10	0.08	0.19	0.24	0.25	0.23	0.11
	II	0.21	0.21	0.29	0.15	0.12	0.16	0.08	0.07	0.10	0.03	0.09	0.15
	III	0.15	0.15	0.24	0.18	0.07	0.07	0.12	0.26	0.17	0.17	0.15	0.22
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tomocerus mitrai</i>	I	0.03	-	0.04	0.08	0.07	-	-	0.06	0.04	-	-	-
	II	-	0.03	0.01	0.07	-	-	-	-	0.07	0.08	-	-
	III	-	-	0.06	0.07	-	-	-	-	-	0.03	0.08	-
	IV	-	-	-	0.08	0.06	0.08	-	0.06	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Allocopus tetracantha</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	0.06	-	-	-	-	-	-	-	-	-	0.01	0.07
	V	-	0.07	0.08	0.04	-	0.04	0.09	-	0.06	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Salina indica</i>	I	0.03	-	-	-	-	-	-	-	-	-	-	0.03
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	0.10	0.02	-	-	-	-	-	-	-	0.02	-	0.07
	VI	0.12	0.07	0.02	-	-	-	-	-	0.02	-	-	0.06
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	0.17	-	-	-	-	-	-	-	-	-	0.01	0.14
<i>Salina bengalensis</i>	I	0.02	-	-	-	-	-	-	-	-	-	-	0.06
	II	0.08	-	0.03	-	-	-	-	-	-	-	-	0.11
	III	0.06	-	-	-	-	-	-	-	-	0.02	-	0.11
	IV	0.10	-	-	-	-	-	-	0.03	-	0.04	0.04	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Salina tricolour sikkimensis</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	0.01	0.02	0.04	0.02	-	-	-	-	-	-
	VII	0.14	0.08	-	-	-	-	-	-	-	-	0.03	0.10
	VIII	-	-	-	-	-	-	-	-	-	-	-	-

Table 16. continued.

Table 16.

GENERA	SITES	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Callyntrura zaheri</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	0.01	0.03	-	-	-	0.02	-	0.02	-	-	-	0.03
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	0.06	0.04	-	-	-	-	-	-	-	0.03	-	0.07
	VIII	0.06	0.01	0.02	-	-	0.02	0.06	0.02	-	0.06	0.03	0.03
<i>Yossia derhadunia</i>	I	-	-	-	-	-	-	-	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	0.07	0.04	-	-	0.02	0.08	-	0.03	-	-	0.02	0.01
	IV	0.02	0.07	0.07	-	-	0.02	0.03	0.03	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pseudosinella sp.</i>	I	-	-	-	-	0.07	0.12	0.04	-	-	-	-	-
	II	-	-	-	-	-	-	-	-	-	-	-	-
	III	-	-	-	-	0.03	0.06	-	-	-	-	-	-
	IV	-	-	-	-	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-	-	-	-	-
	VI	-	-	-	-	-	-	-	-	-	-	-	-
	VII	-	-	-	-	-	-	-	-	-	-	-	-
	VIII	-	-	-	-	-	-	-	-	-	-	-	-

Table 16. continued.

Table 17. Showing the relative abundance of collembolan species in eight altitudinal sites of Darjeeling Himalayas, India

Species / Genus	Site I (181m)	Site II (675m)	Site III (1173m)	Site IV (1655m)	Site V (2123m)	Site VI (2557m)	Site VII (3109m)	Site VIII (3618m)
<i>Hypogastrura indovaria</i>	1.37	0	0	0	0	9.73	25.9	25.18
<i>Hypogastrura indica</i>	0	0	0	0	1.8	2.41	1.99	0
<i>Xenylla obscura</i>	3.71	3.39	2.9	4.3	12.31	50.48	47.91	48.8
<i>Lobella kraepelini</i>	1.69	1.1	0	2.19	0	1.64	1.79	1.25
<i>eanura coralina</i>	0.97	0	0	0	0	0	0	0
<i>Onychiurus indicus</i>	0	0	2.73	1.64	2.27	3.18	0	0
<i>Isotomurus balteatus</i>	1.77	5.35	2.3	0	2.75	0	5.38	4.07
<i>Isotoma (Desoria) trispinata</i>	3.79	3.39	2.99	3.56	0	0	0	0
<i>Isotomina thermophila</i>	2.34	2.46	1.71	8.13	3.88	0	0	0
<i>Isotomella minor</i>	0	1.7	2.82	2.47	0	0	0	0
<i>Cryptopygus thermophilus</i>	0	3.06	0	3.02	0	0	0	0
<i>Folsomia octocolata</i>	0	0	0	0	0	12.04	4.28	4.07
<i>Folsomides purvus</i>	0	0	1.71	0	0	0	0	0
<i>Isotomedes dagamae</i>	0	0	0	0	6.06	3.95	4.28	5.85
<i>Lepidocyrtus magnificus</i>	2.1	0	0	0	0	0	0	0
<i>Lepidocyrtus medius</i>	12.05	14.26	15.11	15.72	6.34	0	0	0
<i>Lepidocyrtus malayanus</i>	7.75	3.39	3.33	0	0	0	0	0
<i>Lepidocyrtus heterolepis</i>	3.63	3.14	3.84	44.15	51.13	2.02	1	1.15
<i>Entomobrya kali</i>	32.2	35.82	37.49	4.57	2.84	3.85	2.59	3.03
<i>Sinella curviseta</i>	1.45	3.14	2.39	1.46	1.7	3.08	0	0

Table 17. continued.

Species / Genus	Site I (181m)	Site II (675m)	Site III (1173m)	Site IV (1655m)	Site V (2123m)	Site VI (2557m)	Site VII (3109m)	Site VIII (3618m)
<i>Cyphoderus javanus</i>	0.64	1.19	0	1.64	2.84	4.24	0	0
<i>Cyphoderus simulans</i>	17.76	12.31	14.6	0	0	0	0	0
<i>Tomocerus mitrai</i>	2.34	1.95	1.79	2.19	0	0	0	0
<i>Alloopus tetracantha</i>	0	0	0	1.1	3.22	0	0	0
<i>Salina indica</i>	0.48	0	0	0	1.8	2.5	0	2.92
<i>Salina bengalensis</i>	0.56	1.7	1.45	1.83	0	0	0	0
<i>Salina tricolour sikkimensis</i>	0	0	0	0	0	0.87	3.09	0
<i>Callyntrura zaheri</i>	0	0	0	0	1.04	0	1.79	2.92
<i>Yossia derhadunia</i>	0	0	2.13	2.01	0	0	0	0
<i>Pseudosinella</i> sp.	1.69	0	0.68	0	0	0	0	0
<i>Willowsia</i> sp.	0.81	0.93	0	0	0	0	0	0.73
<i>Willemia</i> sp.	0.89	1.7	0	0	0	0	0	0

Table 18. Showing 'ubiquitous' and 'stenoecious' species of collembola in the study sites of Darjeeling Himalayas, India

SiteI	' Stenoecious species' (Restricted to)							' Ubiquitous species'	
	SiteII	SiteIII	SiteIV	SiteV	SiteVI	SiteVII	SiteVIII	Present in all sites	
1. <i>Neamra corralina</i>								1. <i>Lepidocyrtus heterolepis</i> 2. <i>Xenylla obscura</i> 3. <i>Entomobrya kali</i>	
2. <i>Lepidocyrtus magnificus</i>									

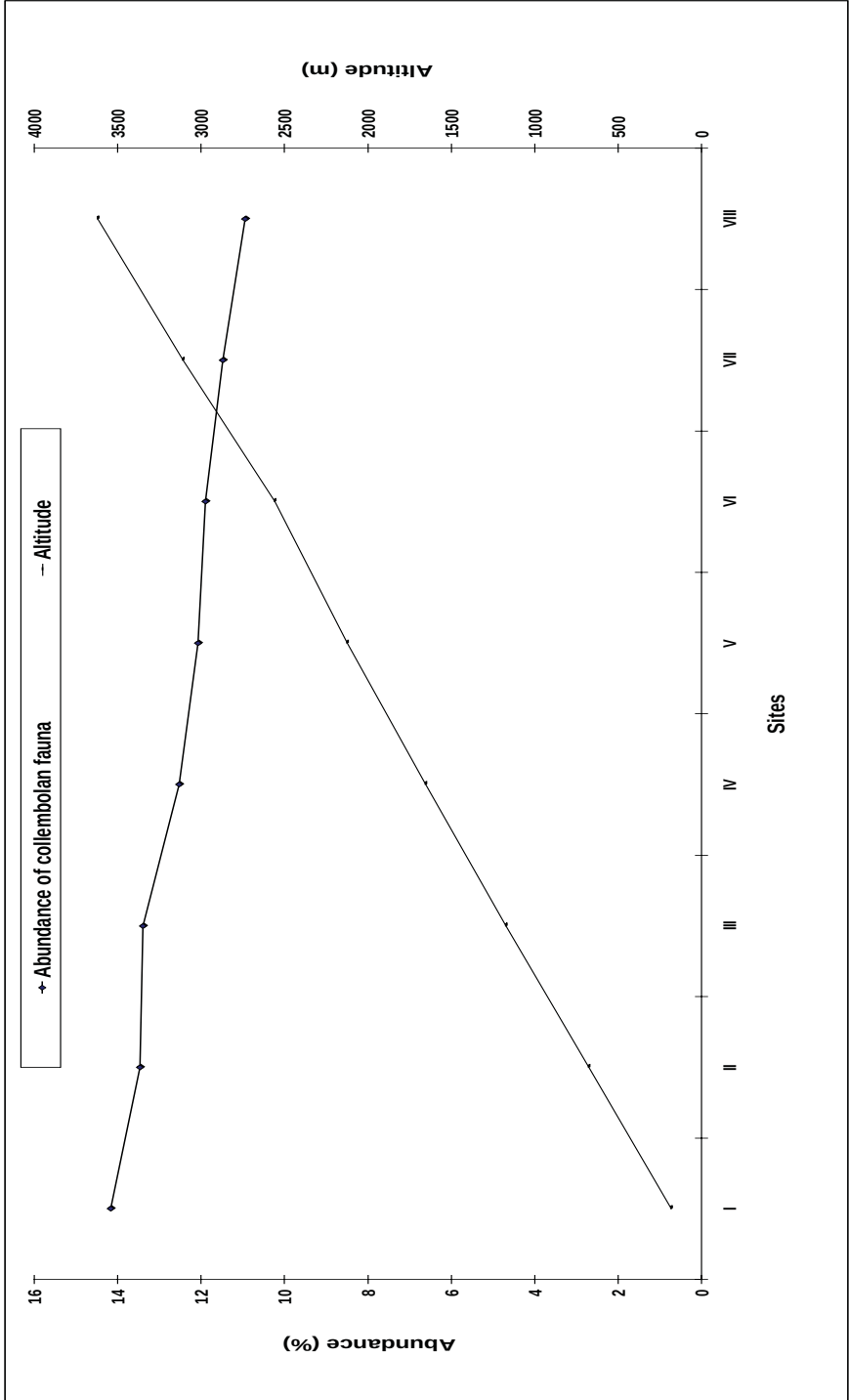


Fig D3. Showing the abundance (%) of collembolan fauna and total soil arthropod fauna in relation to altitude in different studied sites

Table 19 . Showing mean values of edaphic factors in the different study sites of Darjeeling Himalayas, India

Sites	Mean value of						
	Temperature (°C)	Moisture (%)	RH (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)
I	23.44	19.67	71.37	5.34	3.66	2.62	0.46
II	22.01	18.05	70.94	5.15	3.56	2.44	0.46
III	20.99	19.45	74.63	5.21	3.42	2.40	0.46
IV	18.47	23.64	76.70	5.31	3.52	2.36	0.46
V	15.33	25.78	80.15	5.27	3.57	2.24	0.50
VI	11.35	29.15	79.92	4.97	3.34	2.33	0.49
VII	9.27	32.48	79.71	4.96	3.43	2.24	0.52
VIII	8.52	29.73	77.60	4.70	3.70	2.24	0.44

Table 20. Showing the mean values of soil factors in the months when maximum and minimum population of collembola fauna extracted in eight different altitudinal sites of Darjeeling Himalayas, India.

Sites	Mean value of							Months of maximum and minimum population of Collembola Fauna
	Temperature (°C)	Moisture (%)	Relative Humidity (%)	pH	Organic Carbon (%)	Nitrate (ppm)	Phosphate (ppm)	
Site I	19.76	18.64	61.13	5.37	4.42	3.41	0.46	December
	28.83	17.05	75.16	5.63	2.84	2.11	0.47	May
Site II	18	18.33	66.6	5.12	3.91	2.63	0.45	December
	23.76	16.26	74.7	5.26	2.90	2.06	0.42	May
Site III	17.1	17.22	73.36	5.22	3.61	2.86	0.49	December
	25.7	17.63	78.6	5.30	3.10	2.18	0.60	May
Site IV	18	21.03	83.1	5.09	3.95	2.74	0.34	March
	21.8	31.61	81.96	5.09	3.05	1.88	0.65	July
Site V	16.06	21.98	81	5.17	4.08	2.82	0.35	March
	17.93	32.73	84.9	5.02	2.94	1.78	0.65	July
Site VI	12.43	25.26	79.96	4.85	3.77	2.76	0.33	March
	12.06	34.13	82.46	4.86	3.08	1.89	0.63	July
Site VII	9.63	26.33	80.53	4.78	4.16	2.57	0.28	March
	11	36.29	86.76	4.91	3.02	1.94	0.79	July
Site VIII	11.23	23.34	76.6	4.88	4.14	2.5	0.31	March
	10.7	34.57	84.3	4.77	3.29	1.92	0.64	July

Table 21. Showing density (no. / m²) of collembola population in different altitudinal sites of Darjeeling Himalayas, India

SITES	ALTITUDE	COLLEMBOLA
I	181 m	4498.91
II	675 m	4277.41
III	1175 m	4251.99
IV	1655 m	3972.4
V	2123 m	3834.42
VI	2557 m	3769.06
VII	3109 m	3645.6
VIII	3618 m	3474.94

Table 22. Showing species diversity and relative abundance (RA) of eight different altitudinal sites of Darjeeling Himalayas, India**Site : I, Altitude : 181m.**

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Lepidocyrtus heterolepis</i>	45		03.63
<i>Lepidocyrtus medius</i>	149		12.05
<i>Entomobrya kali</i>	399		32.20
<i>Lepidocyrtus malayanus</i>	96		07.75
<i>Hypogastrura indovaria</i>	17		01.37
<i>Isotomurus balteatus</i>	22		01.77
<i>Isotomina thermophila</i>	29		02.34
<i>Cyphoderus javanus</i>	8		00.64
<i>Xenylla obscura</i>	46		03.71
<i>Cyphoderus simulans</i>	220		17.76
<i>Tomocerus mitrai</i>	29		02.34
<i>Lobella kraepelini</i>	21		01.69

Table 22. *continued....*

Table 22.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Neanura corralina</i>	12		00.97
<i>Isotoma (Desoria) trispinata</i>	47		03.79
<i>Pseudosinella</i> sp.	21		01.69
<i>Sinella curviseta</i>	18		01.45
<i>Lepidocyrtus magnificus</i>	26		02.10
<i>Salina bengalensis</i>	7		00.56
<i>Salina indica</i>	6		00.48
<i>Willosia</i> sp.	10		00.81
<i>Willemia</i> sp.	11		00.89
	N = 1239	2.291841765	

Site : II, Altitude : 675m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Lepidocyrtus heterolepis</i>	37		03.14
<i>Lepidocyrtus medius</i>	168		14.26
<i>Entomobrya kali</i>	422		35.82
<i>Isotomurus balteatus</i>	63		05.35
<i>Cyphoderus javanus</i>	14		01.19

Table 22. continued.....

Table 22.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Cryptopygus thermophilus</i>	36		03.06
<i>Isotomella minor</i>	20		01.70
<i>Isotomina thermophila</i>	29		02.46
<i>Xenylla obscura</i>	40		03.39
<i>Lepidocyrtus malayanus</i>	40		03.39
<i>Cyphoderus simulans</i>	145		12.31
<i>Tomocerus mitrai</i>	23		01.95
<i>Sinella curviseta</i>	37		03.14
<i>Isotoma (Desoria) trispinata</i>	40		03.39
<i>Lobella kraepelini</i>	13		01.10
<i>Salina bengalensis</i>	20		01.70
<i>Willemia</i> sp.	20		01.70
<i>Willosia</i> sp.	11		00.93
	N = 1178	2.250247313	

Site : III, Altitude : 1173m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Lepidocyrtus heterolepis</i>	45		03.84

Table 22. *continued....*

Table 22.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Entomobrya kali</i>	439		37.49
<i>Cyphoderus simulans</i>	171		14.60
<i>Xenylla obscura</i>	34		02.90
<i>Onychirus indicus</i>	32		02.73
<i>Lepidocyrtus malayanus</i>	39		03.33
<i>Isotomella minor</i>	33		02.82
<i>Isotomina thermophila</i>	20		01.71
<i>Isotomurus balteatus</i>	27		02.30
<i>Lepidocyrtus medius</i>	177		15.11
<i>Tomocerus mitrai</i>	21		01.79
<i>Isotoma (Desoria) trispinata</i>	35		02.99
<i>Sinella curviseta</i>	28		02.39
<i>Pseudosinella sp.</i>	8		00.68
<i>Yossia dehradunia</i>	25		02.13
<i>Salina bengalensis</i>	17		01.45
<i>Folsomides purvus</i>	20		01.71
	N = 1171	2.144499524	

Table 22. continued.....

Table 22.

Site : IV, Altitude : 1655m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Lepidocyrtus medius</i>	172		15.72
<i>Lepidocyrtus heterolepis</i>	483		44.15
<i>Isotomina thermophila</i>	89		08.13
<i>Xenylla obscura</i>	47		04.30
<i>Cryptopygus thermophilus</i>	33		03.02
<i>Entomobrya kali</i>	50		04.57
<i>Cyphoderus javanus</i>	18		01.64
<i>Onychirus indicus</i>	18		01.64
<i>Isotomella minor</i>	27		02.47
<i>Tomocerus mitrai</i>	24		02.19
<i>Lobella kraepelini</i>	24		02.19
<i>Isotoma (Desoria) trispinata</i>	39		03.56
<i>Sinella curviseta</i>	16		01.46
<i>Yossia dehradunia</i>	22		02.01
<i>Salina bengalensis</i>	20		01.83
<i>Allocopus tetracantha</i>	12		01.10
	N = 1094	2.013763338	

Table 22. continued.....

Table 22.

Site : V, Altitude : 2123m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Lepidocyrtus heterolepis</i>	540		51.13
<i>Lepidocyrtus medius</i>	67		06.34
<i>Xenylla obscura</i>	130		12.31
<i>Isotomedes dagamae</i>	64		06.06
<i>Isotomina thermophila</i>	41		03.88
<i>Cyphoderus javanus</i>	30		02.84
<i>Entomobrya kali</i>	30		02.84
<i>Isotomurus balteatus</i>	29		02.75
<i>Onychirus indicus</i>	24		02.27
<i>Allocopus tetracantha</i>	34		03.22
<i>Sinella curviseta</i>	18		01.70
<i>Hypogastrura indica</i>	19		01.80
<i>Salina indica</i>	19		01.80
<i>Callyntrura zaheri</i>	11		01.04
	N = 1056	1.831039502	

Table 22. continued.....

Table 22.

Site : VI, Altitude : 2557m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Xenylla obscura</i>	524		50.48
<i>Folsomia octoculata</i>	125		12.04
<i>Hypogastrura indovaria</i>	101		09.73
<i>Isotomedes dagamae</i>	41		03.95
<i>Lepidocyrtus heterolepis</i>	21		02.02
<i>Cyphoderus javanus</i>	44		04.24
<i>Entomobrya kali</i>	40		03.85
<i>Salina tricolour sikkimensis</i>	9		00.87
<i>Onychirus indicus</i>	33		03.18
<i>Sinella curviseta</i>	32		03.08
<i>Lobella kraepelini</i>	17		01.64
<i>Hypogastrura indica</i>	25		02.41
<i>Salina indica</i>	26		02.50
	N = 1038	1.80020585	

Table 22. continued.....

Table 22.

Site : VII, Altitude : 3109m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Xenylla obscura</i>	481		47.91
<i>Hypogastrura indovaria</i>	260		25.90
<i>Folsomia octocolata</i>	43		04.28
<i>Isotomurus balteatus</i>	54		05.38
<i>Salina tricolour sikkimensis</i>	31		03.09
<i>Entomobrya kali</i>	26		02.59
<i>Isotomedes dagamae</i>	43		04.28
<i>Lobella kraepelini</i>	18		01.79
<i>Lepidocyrtus heterolepis</i>	10		01.00
<i>Hypogastruran indica</i>	20		01.99
<i>Callyntrura zaheri</i>	18		01.79
	N = 1004	1. 599600166	

Site : I, Altitude : 181m.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Folsomia octocolata</i>	39		04.07
<i>Xenylla obscura</i>	467		48.80

Table 22. continued....

Table 22.

Taxa / Specimens	Abundance	Shannon – Wiener index (H') [(H') = - $\sum P_i \ln P_i$]	RA (%)
<i>Hypogastrura indovaria</i>	241		25.18
<i>Isotomedes dagamae</i>	56		05.85
<i>Lobella kraepelini</i>	12		01.25
<i>Isotomurus balteatus</i>	39		04.07
<i>Entomobrya kali</i>	29		03.03
<i>Salina indica</i>	28		02.92
<i>Callyntrura zaheri</i>	28		02.92
<i>Lepidocyrtus heterolepis</i>	11		01.15
<i>Willowsia</i> sp.	7		00.73
	N = 957	1. 579141471	

Table 23. Sorensons's coefficient of similarity of collembolan species diversity between different altitudinal sites of Darjeeling Himalaya, India

Sites	II	III	IV	V	VI	VII	VIII
I	82.05	68.42	59.45	45.71	35.29	31.25	43.75
II		74.28	76.47	50	38.7	34.48	41.37
III			72.72	48.48	38.7	28.57	28.57
IV				60	48.27	29.62	29.62
V					66.66	56	56
VI						75	58.33
VII							81.81

Table 24. Species richness index of collembola in different altitudinal sites of Darjeeling Himalaya, India.

Sites	Altitude (m)	Menhinicks index [$d=S / \sqrt{N}$]
I	181	0.596
II	675	0.524
III	1173	0.496
IV	1655	0.483
V	2123	0.430
VI	2557	0.403
VII	3109	0.347
VIII	3618	0.355

Table 25. Evenness index of collembola in different altitudinal sites of Darjeeling Himalaya, India

Sites	Altitude (m)	Evenness index [$e = H' / \log S$]
I	181	0.752775456
II	675	0.778532141
III	1173	0.75691424
IV	1655	0.726311595
V	2123	0.693823314
VI	2557	0.701848496
VII	3109	0.667085083
VIII	3618	0.658553144

DISCUSSION

The study deals with the results of an ecological study involving the the diversity of collembolan in relation to altitude includine soil parameters from eight hilly habitats with an approximate altitudinal gap of 500 metre of Darjeeling Himalayas, West Bengal, India. The results presented here were based on a sample survey of 72 plots from eight different altitudinal habitats of Darjeeling Himalayas, West Bengal, India. A total of

2,592 soil samples were drawn from various plots at monthly interval over a period of 36 months (January, 2006 to December, 2008). All the plots under study were forest floor, uncultivated and undisturbed hilly habitats. Geographically the location of the studied sites varies from typical tropical climate to temperate Himalayan climate at Kalapahri (3109 m) and Sandakphu (3618 m). The general texture of soil was mostly sandy.

In this investigation 32 species under 25 genera of collembolan fauna were obtained throughout the study periods belonging to 4 families such as Hypogastridae, Onychuridae, Isotommidae and Entomobryidae. Some forms differed in their abundance from one altitudinal site to another and from season to season. Moreover, it was observed that the number of genera occurring in different altitudinal sites also varied, maximum number of species was obtained from lowest altitudinal site at site I (181 m) having 21 species under 17 genera, followed by site II (673 m), site III (1173 m), site IV (1655 m), site V (2123 m), site VI (2557 m) and minimum was recorded from site VII (3109 m) having 11 species under 10 genera and site VIII (3618 m) having also 11 species under 11 genera. The number of species gradually decreases with the increase of altitude. Species composition of collembola of eight different altitudinal sites differed considerably and only 3 species of collembola out of 32 species were found to occur in all the altitudinal sites (*Xenylla obscura*, *Lepidocyrtus heterolepis* and *Entomobrya kali*) i.e., they may be termed as ubiquitous species. Of the 25 genera, the predominant ones were *Lepidocyrtus* (4 species), *Xenylla* (1 species), *Entomobrya* (1 species), *Hypogastrura* (2 species) and *Cyphoderus* (2 species) mentioned in order of dominance.

The genus *Lepidocyrtus* was represented by four species viz., *Lepidocyrtus magnificus*, *Lepidocyrtus medius*, *Lepidocyrtus malayanus* and *Lepidocyrtus heterolepis*. They were comprised about 24.31 % of the total population of collembola and being numerically dominant over other forms (Table 13). The species *Lepidocyrtus heterolepis* was the most dominant taxon under this genus and occupied the third position in order of dominance in respect to the total number of collembola (comprising 13.62 %). It was widely distributed being found in all sampling site with the maximum number from the site V (6.18 % of total collembola) which suggested that the capability of this species to exist varying ecological conditions (Table 14 and Fig D1). The species *Lepidocyrtus medius* was the second most dominant taxon under this genus and occupied the fourth position in order of dominance in respect of the total number of collembola (comprising 8.38 %), but it was extracted only from five altitudinal sites (Site I, II, III, IV & V) with the maximum from the site III (2.02 % of total collembola). The population maxima of this species also varied from site to site in most cases, maximum in November in lower altitudinal sites (I, II, III) and the peak was shifted to March in higher altitudinal sites (Table 16). The species *Lepidocyrtus malayanus* was extracted only from three lower altitudinal sites (site I, II & III) with the maximum from site I (1.1 % of total collembola). While, the species,

Lepidocyrtus magnificus was recorded only from the site I (0.3 % of total collembola) and showed a low tolerance for various altitudinal habitats. The total population of this genus (irrespective of sites) was maxima in March (3.11 %) which is shown in Table 15.

The second predominant genus *Xenylla* was represented by single species, *Xenylla obscura* which was widely distributed in all the altitudinal sites, comprising of 20.25 % of total population of collembola and being numerically dominant over the other forms and occupied the first position in order of dominance in respect to the total number of collembola (Table 13 and Table 14). The individuals of the species were obtained maximum from the sample of site VI (6.0 % of total collembola). Its abundance was higher in the last three higher altitudinal sites viz., site VI (6.0 % of total collembola), site VII (5.5 % of total collembola) and site VIII (5.34 % of total collembola) than the remaining five lower altitudinal sites (Table 14). The wide distribution range and numerical dominance suggested that the capacity of this species to exists in varying ecological conditions. This genus exhibited its population peak (irrespective of sites) in the month of March (2.28 %) which is shown in Table 15. When sitewise monthly abundance was considered it was found that the population maxima and minima of the species, *Xenylla obscura*, also varied from one altitudinal site to another in most cases, maximum observed during either February – March or November – December in most of the sites except site III where the peak was shifted to October, but the population minima changed from month to month depending upon the characters of altitudinal sites (Table 16).

The next numerical dominant genus *Entomobrya* was represented also by single species, *Entomobrya kali*. The genus, *Entomobrya* was widely distributed being extracted from eight altitudinal sampling sites and comprised 16.42 % of the total collembola population (Table 13). The species, *Entomobrya kali* was the only dominant taxon under this genus and occupied the second position in order of dominance in respect to the total number of collembola (comprising 16.42 %) which is shown in Table 15. The species, *Entomobrya kali* showed quite high tolerance for lower altitudinal habitats than the higher altitudinal habitats as it was extracted from the maximum number from three lower altitudinal sites viz., site I, II & III which constituted about 86 % of the total *Entomobrya kali* population. Though the species was extracted from all the altitudinal habitats, but the maximum number of individuals of this species (5.02 % of the total collembola) was obtained from site III (Table 14). The total population of this genus (irrespective of sites) was maximum in March (2.32%) which was shown in Table 21. The monthly abundance of maximum and minimum population of this species also varied from site to site in most of the cases and being maximum in the month of December in site I, March in site II, May in site IV, V and VI, August in site VII and April in site VIII (Table 16).

The other important collembolan genera obtained were *Hypogastrura*, *Cyphoderus*, *Isotomurus*, *Isotomina*, *Folsomia*, *Istomedes*, *Isotoma* and *Sinella* constituting 7.82%,

7.44%, 2.68 %, 2.38 %, 2.37 %, 2.33 %, 2.01 %, 1.85 % and 1.71 % of the total population of collembola respectively (Table 13). The forms belonging to the genera / species *Onychiurus indicus* (1.23 %), *Lobella kraepelini* (1.2 %), *Tomocerus mitrai* (1.1 %), *Isotomella minor* (0.92 %), *Cryptopygus thermophilus* (0.79 %), *Callyntrura zaheri* (0.65 %), *Yossia derhadunia* (0.54 %), *Allocopus tetracantha* (0.53 %), *Willemia* sp. (0.35 %), *Pseudosinella* sp. (0.33 %), *Willowsia* sp. (0.31 %), *Folsomides purvus* (0.23 %) and *Neanura coralina* (0.14 %) occupied individually very minor position in relation to total collembolan community and were more or less localized forms restricted to only one, two or three altitudinal sites (Table 14 and Fig D2).

The dominance was calculated on the basis of relative abundance which is expressed as $RA = n_i / N \times 100$, where RA = relative abundance, n_i = number of individuals of i^{th} group, N = total number of individuals of all the groups. The Table 17 showed the relative abundance of collembolan species in each altitudinal site. From the Table 17 it was clear that *Entomobrya kali* occupied first position in order of dominance in site I (32.2 %), II (35.82 %) and III (37.49 %). In site I, the species *Cyphoderus simulans* occupied second position in order of dominance (17.76 %) and *Lepidocyrtus medius* also occupied second position in site II (14.26 %) and III (15.11 %). The third position in order of dominance in site I was represented by *Lepidocyrtus medius* (12.05 %) and in site II and III was represented by *Cyphoderus simulans* of 12.31 % and 14.6 % respectively. In site IV the first, second and third position in order of dominance were occupied by *Lepidocyrtus heterolepis* (44.15 %), *Lepidocyrtus medius* (15.72 %) and *Isotomina thermophila* (8.13 %) respectively. In site V *Lepidocyrtus heterolepis* (44.15 %) occupied the first position in order of dominance, followed by *Xenylla obscura* (12.31 %) and *Lepidocyrtus medius* (6.34 %). The species *Xenylla obscura* occupied the first position in order of dominance in site VI (50.48 %), VII (47.91 %) and VIII (48.8 %). The second position in site VI was occupied by *Folsomia octoculata* (12.04 %) and *Hypogastrura indovaria* occupied the second position both in site VII (25.9 %) and VIII (25.18 %). The third position in order of dominance in in site VI, VII and VIII was represented by *Hypogastrura indovaria* (9.73 %), *Isotomurus balteatus* (5.38 %), and *Isotomedes dagamae* (5.85 %) respectively.

The variations in the faunal make up might be due to the differences in altitudinal and ecological conditions. Some species were wide spread occurring regularly in different altitudinal sampling sites, they could tolerate wide variety of altitudinal habitats and were called 'ubiquists' or 'ecological generalists groups'. On the other hand some forms were localized i.e., restricted to a particular habitat and they were accordingly termed as 'stenoecious' or 'ecological specialists' group. The three species of collembola viz., *Lepidocyrtus heterolepis*, *Xenylla obscura* and *Entomobrya kali* seemed to have wider tolerance for various altitudinal habitats in the present study. Therefore, they were 'ubiquists'. While two species of collembola namely, *Neanura corralina* and *Lepidocyrtus magnificus* were restricted to site I and *Folsomides purvus* was restricted to site III and as such they were 'stenoecious' (Table 18)

Population density of collembolan species varied considerably from one month to another month, and also from one season to another season in different altitudinal sites. The population peak in lower altitudinal sites were also varied from higher altitudinal sites. The three lower altitudinal sites (site I, II & III) showed peak population of collembola in December and a second population peak during March, while the remaining five higher altitudinal sites population peak was observed during March and a second peak during the month of November.

The study indicates that sites I, II, III, IV, V, VI, VII and VIII of Darjeeling Himalaya represented by 14.18%, 13.48%, 13.40%, 12.52%, 12.08%, 11.88%, 11.49% and 10.95% individuals of total collembolan community respectively and gradually their abundance (%) decreases with the increase of altitude (Fig D3).

Different soil factors like temperature, moisture, relative humidity, pH, organic carbon, nitrate and phosphate content of soil in the study sites exhibited fairly wide range of variation during different months of the study period. Of the edaphic factors studied, soil temperature showed a wide range of variation with the change of season ranging between 1.2°C and 28.8°C. In the lower altitudinal sites (I, II and III) during months May the samples yielded low population of collembola when the temperature was significantly high and moisture was appreciably minimum and maximum population was recorded during the month of December when soil temperature was low. While in the remaining five higher altitudinal sites (IV-VII) the collembolan population was minimum in the month of July and maximum in the month of March when soil temperature was moderate (Table 20). In this study as the sampling sites belonged to typical tropical climate to temperate climate the mean variation of the temperature in these altitudinal changes showed a decline of soil temperature with the increase of altitude (Table 19). The statistical analysis for finding out correlation between the collembola and the edaphic factors in different altitudinal sites indicate that temperature showed a significant negative correlation with collembolan species in all the altitudinal sites. It was also found to be negatively correlated with total soil arthropod population in all the altitudinal sites. This result also coincided with the earlier result of Hazra and Choudhuri (1983), Ghosh and Roy (2005) and Pahari *et al.* (2007). The negative correlations shown by temperature in this study might be explained explained in terms of the fact that the rise of temperature was expected to cause greater evaporation from the soil making it dry and the minimum population during May –July in lower altitudinal sites was generally attributed to both the lesser water content and to the physical instability of humus layer due to high rain fall in this type of climate in Darjeeling Himalayas. But the actual influence of temperature on soil organisms could not be evaluated unless it was considered in conjunction with effect of moisture.

The mean moisture content of soil in each site showed wide range of variation and exhibited a higher value with altitude (Table 19). As altitude increases, the requirement of moisture from the soil of these arthropods is reduced due to cold climatic condition. In the plain areas moisture played a positive correlation with the collembolan as reported by earlier workers like Hazra and Choudhuri (1983) and Hazra and Bhattacharyya (2003). But in this present investigation of the study soil moisture showed a negative correlation with the collembolans. Such a negative correlation was earlier witnessed by Dhillon and Gibson (1962), Mukherjee and Banerjee (1993), Ghosh and Roy (2005) and Pahari *et al.* (2007). The negative correlations showed by moisture in these altitudinal sites might be due to the fact that the sampling plots were subjected to maximum rain fall which might be led to surface erosion to some extent in sloppy areas leading to a decline in surface dwelling soil fauna and also shifted the population peaks from monsoon (July-August in site I – III and June – August in site IV - VIII) to other months. Similar results were also obtained by Oatman and Voth (1972) while studying the effects of flooding on the soil fauna. Mitra *et al.* (1977 and 1983) studied the impact of rain water drainage of Calcutta.

The relative humidity of surface soil showed wide variation from 59 % in a sample collected from site I to 88 % in a sample collected from site VIII. The average value of relative humidity in each study site was increased with the increase of altitude except in site II. It was found that the surface soil RH showed negative correlation with collembola in all the altitudinal sites but it was not significant in site II, IV and V.

The value of pH of the soil samples varied between 4.27 and 5.93. The collembolan population in the lower altitudinal sites (I, II and III) were attained peak in the month of December when mean values of pH read at 5.25 and in May – Jun when population was minimum in these sites the mean value of pH was recorded as 5.39. While in the remaining five higher altitudinal sites (IV – VIII), in March when collembolan population attained its peak the mean value of pH read at 4.95 and in July when collembolan population were recorded minimum the mean value of pH was 4.93. Therefore, in the present study it appears that the soil pH possibly did not have a significant impact on the population fluctuation. The statistical analysis showed that the pH in all the sites did not exhibit any significant correlation with collembolan population.

The content of organic carbon varied between 2.72 % and 4.44 % and exhibited strong positive correlation with the population of collembola (Table 19). It is also seemed likely that some instances such as dryness as such influenced the soil fauna indirectly rather than directly since this factor largely determined the type and density of the vegetation which in turn contributed towards the augmentation of soil organic matter. The latter not only served as a source of food but also influenced the amount of living space available for soil animals. The increased population of collembola with the increased content of organic matter in soil as met with in this study was reported by Haarlov (1960), Choudhuri and

Roy (1972), Kaczmarek (1975), Choudhuri and Banerjee (1975), Hazra (1978), Hazra and Choudhuri (1983), Mukherjee and Banerjee (1993), Hazra and Bhattacharyya (2003), Ghosh and Roy (2005), Pahari *et al.* (2006) and in case of soil arthropods Choudhuri and Hazra (1983), Pahari *et al.* (2007).

Another important driving variable affecting the population fluctuation of soil biota was the nitrate content of soil. It was measured minimum 1.68 ppm at site V (2123 m) and maximum 3.51 ppm at site I (181 m). A strong positive significant correlation between the nitrate and collembola has also been observed by Kühnelt (1950), Choudhuri and Roy (1972), Hazra and Choudhuri (1990), Pal *et al.* (1992), Mukherjee and Banerjee (1993), Hazra and Bhattacharya (2003).

In the present investigation, the phosphate content of the soil measured maximum 0.73 ppm and minimum 0.27 ppm at site VII (3109 m). The mean value of phosphate was high in site VII (0.52 ppm) in comparison to other sites, 0.50 ppm at site V, 0.49 ppm at site VI, 0.46 at site I, II, III and IV and 0.44 ppm at site VIII (Table 25). the analysis of correlation coefficient showed negative with the population of collembola and soil arthropod fauna considered. Choudhuri and Roy (1972) observed either positive (strong or weak) or negative correlation between collembolan population and phosphate contents. However, Hazra *et al.* (1976) and Mukherjee and Banerjee (1993) found either weak or negative correlation with the collembolan population. Thus the present study suggested that the highly significant negative correlation was existed between the soil phosphate and collembolan population. This is perhaps due to the fact that all the phosphate in soil was not available to the living system.

Analysis of covariance has been carried out for each collembolan species with altitude and month / season as factors. From Table 10a, it was found that 23 species out of 32 species, like *Hypogastrura indovaria*, *Hypogastrura indica*, *Xenylla obscura*, *Neanura coralina*, *Isotoma (Desoria) tripsinata*, *Isotoma thermophila*, *Isotomella minor*, *Cryptopygus thermophilus*, *Folsomia octoculata*, *Isotomedes dagamae*, *Lepidocyrtus magnificus*, *Lepidocyrtus medius*, *Lepidocyrtus malayanus*, *Entomobrya kali*, *Sinella curviseta*, *Cyphoderus simulans*, *Tomocerus mitrai*, *Salina indica*, *Salina bengalensis*, *Salina tricolor sikimensis*, *Calyntrua zaheri*, *Pseudosinella* sp. and *Willemia* sp. were showed significant variation with altitude. The Table 10a also showed that only 13 species out of 32 species i.e., *Hypogastrura indovaria*, *Xenylla obscura*, *Onychiurus indicus*, *Isotoma (Desoria) tripsinata*, *Isotoma thermophila*, *Lepidocyrtus magnificus*, *Lepidocyrtus medius*, *Entomobrya kali*, *Sinella curviseta*, *Cyphoderus simulans*, *Salina indica*, *Salina bengalensis* and *Pseudosinella* sp. were significantly varied with month. From the Table 10b, it was found that order collembola showed significant altitudinal population fluctuation and significant monthly variation. Among the soil factors, except the organic carbon and phosphate all the soil factors showed significant altitudinal

population fluctuation and significant monthly variation was observed in all the soil factors (Table 11).

The step-wise regression analysis has been carried out to determine / estimate species density of collembola consisting of altitude and soil parameters as factors. From the Table 12 it was found that for the density of collembolan species like *Hypogastrura indovaria*, *Xenylla obscura*, *Isotomedes dagamae*, *Lepidocyrtus magnificus*, *Lepidocyrtus malayanus*, *Entomobrya kali* and *Cyphoderus simulans* altitude played a maximum effect besides the other factors and for the density of collembolan species like *Hypogastrura indica*, *Folsomides purvus* and *Yossia derhadunia* soil moisture played a predominant role besides the other factors. For the density of collembolan species, *Lobella kraepelini* soil phosphate played major importance among all the factors. The organic carbon contribute major role besides the other factors for the density of collembolan species like *Onychiurus indicus* and *Willowsia* sp. Among the factors soil pH contributes major effect in the density of collembolan species like *Isotomurus balteatus*, *Isotomina thermophila*, *Lepidocyrtus medius*, *Lepidocyrtus heterolepis* and *Allocopus tetracantha*. For the density of collembolan species like *Isotoma (Desoria) trispinata*, *Isotomella minor*, *Folsomia octoculata*, *Sinella curviseta*, *Tomocerus mitrai*, *Salina indica*, *Salina tricolour sikkimensis*, *Calytrura zaheri* and *Pseudosinella* sp. soil temperature exert major effect among all the factors under consideration. The soil surface relative humidity played a predominant effect among the factors for the density of species like *Cryptopygus thermophilus*, *Salina bengalensis* and *Willemia* sp. For the density of *Cyphoderus javanus* the soil nitrate exerts major effect. The Table 21 showed the density of collembola population gradually decreases with the increase of altitude in Darjeeling Himalayas.

It is evident from the Table 22 that the species diversity evaluated by Shannon-Weinner index showed a higher diversity index value at site I [(H') = 2.291] and minimum at site VIII [(H') = 1.579] and index value gradually decreases with the increase of altitude. An attempt was made to compare objectively the collembolan communities associated with the different altitudinal habitats (β -diversity). The Sorensen coefficient of similarity was calculated for comparisons of the fauna by $C_s = 2a / (2a + b + c)$, where C_s is Sorensen coefficient, 'a' is the number of species common to both sites, 'b' is the number of species in site second site but not in the first site, 'c' is the number of species in the first site but not in the second site. From the Table 23, it would be evident that β -diversity between the altitudinal pair of sites (I and II) namely Sukna (181 m) and chunnabatti site (675 m) showed the highest similarity index (82.05 %) in respect to collembolan species, followed by site VII and VII (81.81 %). The site III and VII / VIII showed minimum similarity (28.57 % in each site), followed by site IV and VII / VIII (29.62 % each). This might be due to changes in micro climatic conditions in altitudinal sites. The species richness index was measured by Menhinick's index shows that species richness increases from the

lower altitudes to higher altitudes. Thus lower altitudinal site had higher value of species richness index being maximum in site I (0.596) than the higher altitudinal sites (Table 24). The evenness index of Pielou (e) shows the uniformity of distribution of species in different altitudinal sites, it was observed that evenness was maximum in site II (0.778) and minimum in site VIII (0.658) and did not show uniform distribution in relation to altitude (Table 25).

The results of this investigation mostly corroborated those of other workers while in certain aspects they showed striking differences from those reported earlier. This might be due to the prevalence of local environmental factors which were likely to exert profound influences in the pattern of population structure (Wallwork, 1970). It could be inferred from this investigation that some species of collembola might have played an important role in building up of the primary soil fauna in the improvised soil of different altitude of the great Himalaya. Lastly, it could be concluded that the biotic and abiotic components evaluated here in conjunction with other biotic and abiotic components not considered in this study, collectively contributed to the building of collembola and soil fauna and their distribution and fluctuations in this part of Himalaya.

SUMMARY

The collembolan fauna encountered during this study belonged to 32 genera of the families Hypogastridae, Onychuridae, Isotommidae and Entomobryidae. It was observed that the number of genera occurring in different altitudinal sites varied, maximum number of species was obtained from the lowest altitudinal site at Sukna (21 species under 17 genera) and minimum was recorded from site VII (11 species under 10 genera) and site VIII (11 species under 11 genera). The number of species gradually decreases with the increase of altitude. Species composition of collembola of eight different altitudinal sites differed considerably and only 3 species of collembola out of 32 species were found to occur in all the altitudinal sites (*Xenylla obscura*, *Lepidocyrtus heterolepis* and *Entomobrya kali*) i.e., they may be termed as ubiquitous. Species richness increases from the lower altitudes to higher altitudes. The species diversity evaluated by Shannon-Weinner index showed a higher diversity index value at site I and minimum at site VIII and index value gradually decreases with the increase of altitude. Of the seven soil factors viz. moisture, temperature and phosphate showed negative correlation and nitrate and organic carbon showed positive correlation with collembolan population in all the altitudinal sites. The collembolan population density was highest in lowest altitudinal site (site I) and gradually decreases with the increase of altitude. Among the altitudinal sites, the relative abundance of collembola was more in site VII. The local variation in edaphic characteristics and altitudinal variation produced differences in density and relative abundance of collembola fauna.

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Appendix

Taxonomic status and distribution of the collembolan species in different altitudinal studied sites of Darjeeling Himalayas, India

Sl No.	Name of Species	Study sites							
		I	II	III	IV	V	VI	VII	VIII
Order- COLLEMBOLA									
Sub order- ARTHROPEONA Borner, 1901									
Family- HYPOGASTRURIDAE Borner, 1913									
Subfamily- Hypogastruinae , Borner 1901									
1	<i>Hypogastrura indovaria</i> Salmon,1970	+	-	-	-	-	+	+	+
2	<i>Hypogastrura indica</i> Salmon , 1956	-	-	-	-	+	+	+	-
3	<i>Xenylla obscura</i> Imms , 1912	+	+	+	+	+	+	+	+
4	<i>Willemia</i> sp.	+	+	-	-	-	-	-	-
Subfamily- Neanurinae Borner, 1901									
5	<i>Lobella kraepelini</i> Borner, 1912	+	+	-	+	-	+	+	+
6	<i>Neanura coralina</i> Imms , 1912	+	-	-	-	-	-	-	-
Family : ONYCHIURIDAE Gervais, 1841									
Subfamily - Onychiurinae									
7	<i>Onychiurus indicus</i> Choudhuri & Roy, 1965	-	-	+	+	+	+	-	-
Family: ISOTOMIDAE Borner, 1913									
Subfamily- Isotominae Schaeffer, 1896									
8	<i>Isotomurus balteatus</i> (Reuter,1876)	+	+	+	-	+	-	+	+
9	<i>Isotoma (Desoria) trispinata</i> Mac Gillivany,1896	+	+	+	+	-	-	-	-
10	<i>Isotomina thermophila</i> (Axelson,1900)	+	+	+	+	+	-	-	-
11	<i>Isotomiella minor</i> (Schaeffer,1898)	-	+	+	+	-	-	-	-
12	<i>Isotomdes dagamae</i> Prabhoo, 1971	-	-	-	-	+	+	+	+

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Sl No.	Name of Species	Study sites							
		I	II	III	IV	V	VI	VII	VIII
13	<i>Cryptopygus thermophilus</i> (Axelson,1900)	-	+	-	+	-	-	-	-
14	<i>Folsomides purvus</i> Folsom, 1932	-	-	+	-	-	-	-	-
15	<i>Folsomia octoculata</i> Hadschin, 1925	-	-	-	-	-	+	+	+
Family: ENTOMOBRYIDAE Tomosvary,1882									
Subfamily: Entomobryinae Schaeffer, 1896									
16	<i>Lepidocyrtus</i> (S.Str) <i>magnificus</i> Carpenter,1924	+	-	-	-	-	-	-	-
17	<i>Lepidocyrtus</i> (S.Str) <i>medius</i> Schaeffer,1898	+	+	+	+	+	-	-	-
18	<i>Lepidocyrtus</i> (<i>Acrocyrtus</i>) <i>malayanus</i> Yosii,1959	+	+	+	-	-	-	-	-
19	<i>Lepidocyrtus</i> (A) <i>heterolepis</i> Yosii, 1959	+	+	+	+	+	+	+	+
20	<i>Entomobrya kali</i> Imms,1912	+	+	+	+	+	+	+	+
21	<i>Sinella curviseta</i> Brook,1882	+	+	+	+	+	+	-	-
22	<i>Pseudosinella</i> sp.	+	-	+	-	-	-	-	-
23	<i>Willowsia</i> sp.	+	+	-	-	-	-	-	+
Subfamily: Cyphoderinae Borner, 1913									
24	<i>Cyphoderus javanus</i> Borner,1906	+	+	-	+	+	+	-	-
25	<i>Cyphoderus simulans</i> Imms, 1912	+	+	+	-	-	-	-	-
Subfamily: Tomocerinae									
26	<i>Tomocerus mitrai</i> Prabhoo, 1980	+	+	+	+	-	-	-	-
Subfamily: Paronellinae Borner, 1913									
27	<i>Alloscopus tetracantha</i> Borner,1906	-	-	-	+	+	-	-	-
28	<i>Salina indica</i> (Imms,1912)	+	-	-	-	+	+	-	+
29	<i>Salina bengalensis</i> Mitra ,1973	+	+	+	+	-	-	-	-
30	<i>Salina tricolor sikkimensis</i> Mitra,1973	-	-	-	-	-	+	+	-
31	<i>Callyntrura</i> (<i>Callyntrura</i>) <i>zaheri</i> Mitra ,1974	-	-	-	-	+	-	+	+
32	<i>Yosiia dehradunia</i> Mitra,1967	-	-	+	+	-	-	-	-



Photograph 1. Sampling site at Site I



Photograph 2. Sampling site at Site II



Photograph 3. Sampling site at Site III



Photograph 4. Sampling site at Site IV



Photograph 5. Sampling site at Site V



Photograph 6. Sampling site at Site VI



Photograph 7. Sampling site at Site VII



Photograph 8. Sampling site at Site VIII

