IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
August 2017 Vol.:7, Issue:2

Diversity of Soil Microarthropods in the Terine Forest Floors of North Bengal- An RTU Method Assessment

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

M. N. Moitra[1]*, R. Routh[2], N. Sarkar[3], S. Banerjee[4]

1 Deptt. of Zoology, P. D. Women's College, Jalpaiguri

2 Deptt. of Zoology, Sambhunath College, Labpur, Birbhum

3Bhotepatty H.B.L. High School, Jalpaiguri

4Maynaguri Evergreen Public School, Jalpaiguri

Submission: 25 July 2017
Accepted: 3 August 2017
Published: 30 August 2017

HUMAN JOURNALS
www.ijsrm.humanjournals.com

Keywords: Microarthropod, RTU, diversity, terine forest.

ABSTRACT

Diversity in soil microarthropod communities from three different terine forest sites located in the northern parts of Bengal was studied using recognizable taxonomic units (RTUs). The northernmost site supported the highest diversity while the middle one had the lowest value. Three sites were clearly comparable in terms of diversity as the diversity order using Renyie's entropy indicated. Notably, the highest species diversity (Shannon-Weaver index) was recorded at the northern-most site but the species richness (Menhinick's index) was highest at the southern-most plot. As per cluster-observation, the northern-most site was more different than two others located the southern part.

INTRODUCTION

Use of recognizable taxonomic units (RTU) (Rees, 1983; Oliver and Beattie, 1993) (which is suggested rather as Parataxonomic unit (PU) by Krell, 2004), and estimation of group diversity have been suggested and various aspects of the above proposition have been discussed by a few workers to avoid problems of specific identification alongside to have an overview of the diversity scenario with minimum time consumption (Oliver and Beattie, 1993, 1996a, 1996b; Cancela da Fonseca and Sarkar, 1998; Krell, 2004). Use of RTUs in investigating the diversity of soil microarthropods appears reasonable regarding the huge diversity and abundance of the said group. Microarthropods in general, play a very significant role in the physicochemical dynamics in the edaphic microenvironment. They are specifically considered important for degradation of organic debris in the soil. Their ecological role significantly concerns with the fertility of soil by the process of decomposition of organic debris and nutrient cycling (Heneghan *et al.* 1998; Coleman and Crossley, 2004). The present study was taken up to assess the diversity scenario in soil microarthropod communities dwelling terine forest floors of northern parts of Bengal using RTUs.

MATERIALS AND METHODS

Sampling: Sampling was conducted at three different forest floors (site-I, site-II, and site-III) with more or less similar vegetation's, along three 5m strips, adjacent to the motorable road during the four seasons (summer, monsoon, post-monsoon, winter) from March 2014 to February 2015.

Collection of soil and litter together was done with a shovel (Chattopadhyay and Hazra, 2000; Sanyal et al., 2006) and kept in plastic bags for carrying them to college laboratory. Three bags of soil and litter each of about 500cc volume was collected from every site during every collection effort.

Collection site: Site-I ($26^{O}39'11.47''$ N, $88^{O}37'11.96''$ E) was located at Bodaganj forest which is a part of Baikunthapur forest under Gouricone bit situated in Jalpaiguri, a district at the northern part of West Bengal. It is 22 km away from Jalpaiguri town and surrounded by a sparsely populated area. Part of this forest has been affected by deforestation and remains disturbed by anthropogenic activity. Site-II was located at the periphery of Baikunthapur forest adjacent to the canal road while the site-III ($26^{o}48'29.32''$N, $88^{o}20'57.34''$E) was located at southern part of Sukna range under Mahananda Wildlife Sanctuary.

The entire area comes under agroecological sub-region of warm to the hot per humid area. There are three main seasons: Summer, Monsoons, and winter.

Natural vegetation at the sites included *Shorea robusta* and *Tectona grandis* as dominant species of trees. *Tectona grandis*, however, was more numerous in the selected sites. Few mango (*Mangifera indica*) and Jamun trees (*Syzygium cumini*) were among the large trees present at the site. Ground vegetation largely included *Lantana camera*, Ferns (*Dryopteris* sp.) etc. Besides, there were a few wild Champa (*Michelia champaca).*

Extraction: Extraction of soil microarthropods was carried out using *Berlese-Tullgren* funnels (Rohitha, 1992; Lakly & Crossley, 2000). The process was run for 3-4 days for each sample set up depending upon the condition of the soil. Microarthropods extracted was collected and preserved in 80% alcohol (Ghosh, 1986; Gupta, 1986).

Sorting and preservation: Extracts were transferred part by part on a Petri dish and micro arthropods were sorted from the extract using needles and fine camel (No.'00') hair brush under a dissecting microscope (with 32x magnification). Separated micro arthropods were kept in Eppendorf tubes containing 80% alcohol.

Identification of arthropods was done up to order level only, for estimation of diversity, 'recognizable taxonomic unit' (RTU) was used (Rees, 1983; Oliver and Beattie, 1993).

Analysis: Group diversity was calculated using Shannon's Index following Cancela da Fonseca and Sarkar (1998). Distinctly recognizable taxa base upon morphology was used for diversity assessment.

More than one approach appears necessary to assess a community as there is no unanimous view as which diversity index may satisfy all aspects (Magurran, 1988).

Indices used in the present study were -Shannon index of diversity (Shannon and Weaver, 1963), Richness (Menhinick, 1964), Dominance (Simpson, 1949), Evenness (Pielou, 1966), Similarity (Sorenson, 1948), Beta Diversity (Whittaker, 1960).

Besides, diversity ordering based on Renyies' diversity index family (Renyie, 1961) was done using software 'Past'.

RESULTS AND OBSERVATIONS

36 bags of litter and soil were collected from three sites from which 230 soil micro arthropods were extracted. Highest abundance of micro arthropods was recorded at site-III while lowest abundance was observed at site-II (Table 1).

At site-II Diptera larvae were the most abundant group, while oribatid mites constituted the most numerous group at sites-II and III (Table 1, Figure 2).

39 recognizable taxonomic units were recorded from the sits. The highest number of RTUs (28) was collected from site-III, followed by site-I (18) while the lowest number was found at site-II (12) (Table 2).

At site-I, Oribatida was the most abundant order constituting 33.33% of the total collection, followed by Diptera (22.92%). Other mites and collembolans each shared 14.48% of the total population.

At site-II, Diptera constituted 35% of the total collection. Oribatid mites and coleopterans each exhibited 22.22% relative abundance.

At site-III, Oribatida shared 35.77% of total population, followed by Diptera (19.71%). Other mites and collembolans each shared 15.33% of the total collection (Figures 3, 4, 5).

Diversity index (Shannon and Weaver, 1963) was highest at site-III and lowest at site-II. Species richness (Menhinick, 1964) and evenness (Pielou, 1964) were highest at site-II. Dominance index (Simpson, 1949) was recorded to be highest at site-II followed by site-I (Figure 6).

Cluster analysis with single linkage and Euclidian distance (done with software Minitab 13) revealed the greater similarity between sites-I and II (>38%). Site-III had only 7.52% similarity with the cluster of sites-I and II (Figure 7).

Over-all similarity (Sorenson, 1948) among the sites was 0.0469 while the beta diversity (Whittaker, 1960) recorded was 0.9821.

Diversity ordering based on Renyies' diversity index family (Renyie, 1961) showed that all the sites clearly were comparable to one another in terms of diversity (as the curves of sites

did not touch or cross one another) and the order as per diversity was: site-III> site-II> site-I (Figure 8).

DISCUSSION

No conspicuous gradient in terms of diversity and abundance of micro arthropods from north to south was noticed in the study area. The site located at Bodaganj (site-I) exhibited greater abundance and diversity in comparison to the site located in the periphery of Baikunthapur forest (site-II). Site-III located at the Sukna range of Mahananda Wildlife Sanctuary supported highest diversity and abundance in microarthropod communities among the sampling sites. The Greater density of large trees, diverse ground vegetation, relatively less disturbance in this site might have favored microarthropod communities here.

Site-II showed relatively less abundant and diverse microarthropod communities probably due to the poor occurrence of trees at this site. Trees generally provide shadow which supports moist environment even in sunshine; supply thick litter and favors fungal growth. All these collectively create favorable condition for microarthropods.

Greater dominance index at site-II indicates relative harshness of the site in comparison to others.

Species richness was highest at site-I though the diversity index was highest at site-III. It might be due to greater evenness in the community at site-this and I is substantiated by the greater value of evenness index here (Figure 6).

The similarity between sites-II and I was greater in comparison to the similarity between sites-I-III and sites-II-III. It might be due to proximity and likeness of environmental factors. Over-all similarity appeared low and beta diversity was moderate. This observation probably indicates remarkable variation in micro-environmental factors in the area.

It is to be noted that error due to use of RTUs or PUs cannot be ruled out. In a study, the error of estimation of the number of RTU and actual species number was found to vary from 0% to 117% with a median of 22% (Krell, 2004).

CONCLUSION

Anthropogenic activities appeared to have some impact on micro arthropods diversity and abundance in the study area because the site located adjacent to the roadway with vehicular activity at the periphery of Baikunthapur forest supported the least diversity. Any gradient, however, was not established probably due to variation in micro-environmental factors. Further study is required to investigate the actual scenario of the region.

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Table 1: Abundance of different groups of collected soil microarthropods.

	Site-I	Site-II	Site-III
Oribatid adult	10	5	37
Oribatid nymph	6	5	12
Mesostigmata	5	2	18
Prosigmata	2	1	2
Astigmata	0	0	1
Collembola	7	3	21
Protura	0	0	1
Diplura	0	0	2
Simphyla	2	0	0
Coleoptera larva	5	9	14
Diptera larva	11	16	27
Coleoptera adult	0	1	0
Hymenoptera	0	3	1
Araneae	0	0	1
TOTAL	48	45	137

Table 2: Distribution of recognizable taxonomic units (RTU) at different sites.

Site-I			**Site-II**			**Site-III**		
		No.			No.			No.
Oribatid	RTU1	1	Oribatid	RTU8	1	Oribatid	RTU3	10
	RTU2	1		RTU20	2		RTU4	12
	RTU3	2		RTU21	4		RTU20	4
	RTU4	6		RTU22	3		RTU31	5
	RTU5	1	Mesostigmata	RTU9	2		RTU32	1
	RTU6	2	Prostigmata	RTU11	1		RTU7	1
	RTU7	1	Collembola	RTU13	1		RTU34	3
	RTU8	1		RTU26	2		RTU8	1
Mesostigmata	RTU9	2	Coleoptera larva	RTU16	3		RTU36	1
	RTU10	3		RTU28	6		RTU37	1
Prosigmata	RTU11	2	Diptera larva	RTU29	6	Mesostigmata	RTU38	6
Collembola	RTU12	4		RTU17	10		RTU9	8
	RTU13	2					RTU10	3
	RTU14	1					RTU41	1
Simphyla	RTU15	2				Prostigmata	RTU42	2
Coleoptera larva	RTU16	5				Astigmata	RTU43	1
Diptera larva	RTU17	8				Collembola	RTU13	4
	RTU18	3					RTU14	11
							RTU26	2
							RTU47	4
						Protura	RTU48	1
						Diplura	RTU49	2
						Coleoptera larva	RTU16	9
							RTU51	5
						Diptera larva	RTU17	19
							RTU29	8
						Hymenoptera	RTU 38	1
						Araneae	RTU39	1

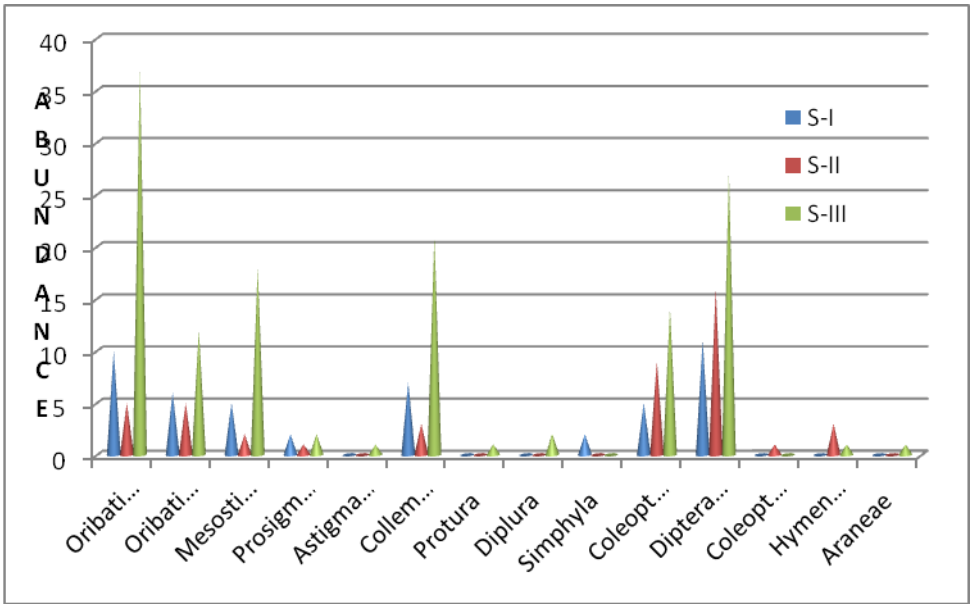
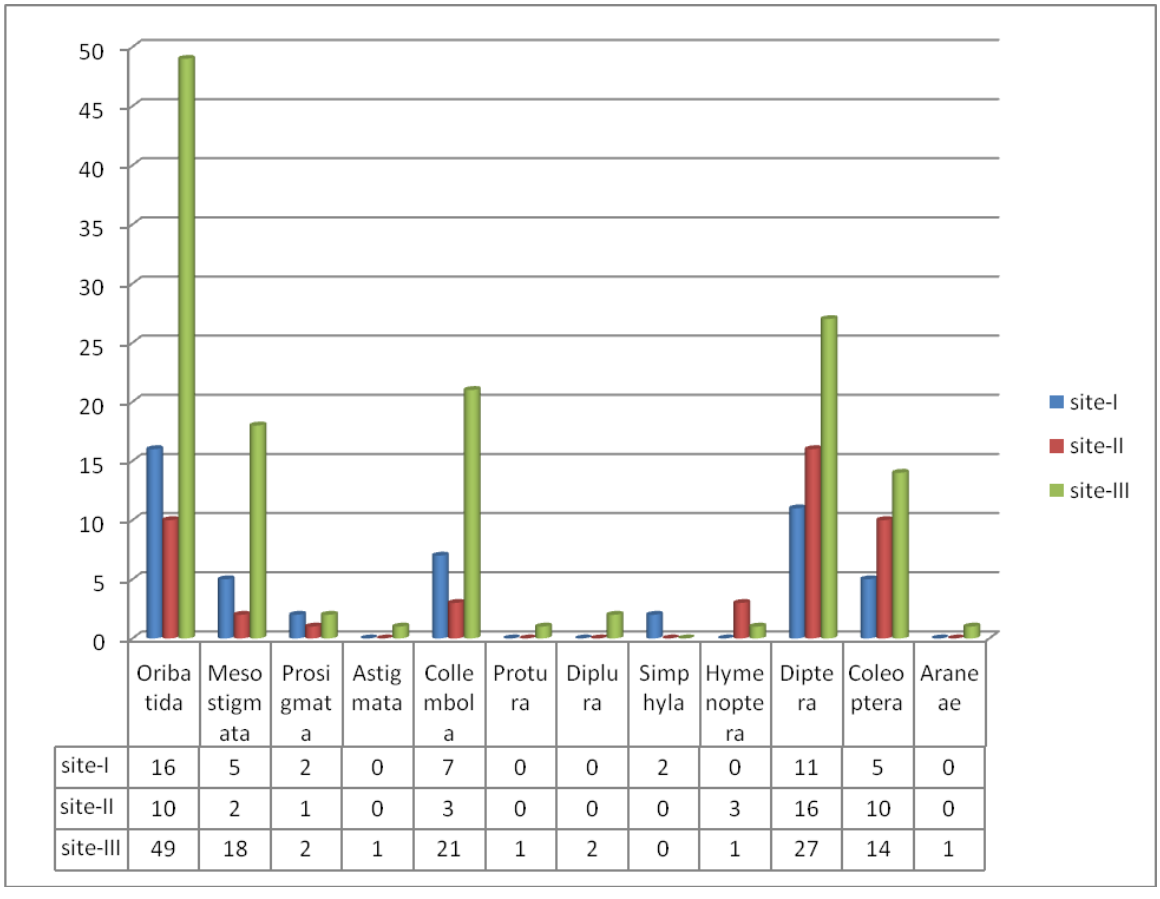


Figure 1: Shows abundance of different microarthropod groups at the collection sites.



	Oribatida	Mesostigmata	Prosigmata	Astigmata	Collembola	Protura	Diplura	Simphyla	Hymenoptera	Diptera	Coleoptera	Araneae
site-I	16	5	2	0	7	0	0	2	0	11	5	0
site-II	10	2	1	0	3	0	0	0	3	16	10	0
site-III	49	18	2	1	21	1	2	0	1	27	14	1

Figure 2: Site-wise distribution of different orders of soil microarthropods.

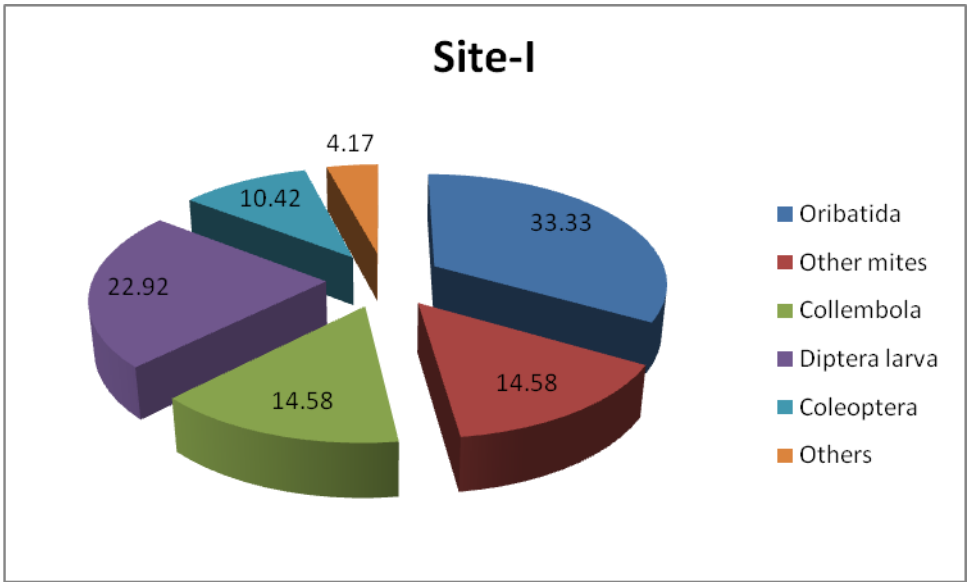


Figure 3: Shows relative abundance (%) of major micro arthropods at site-I.

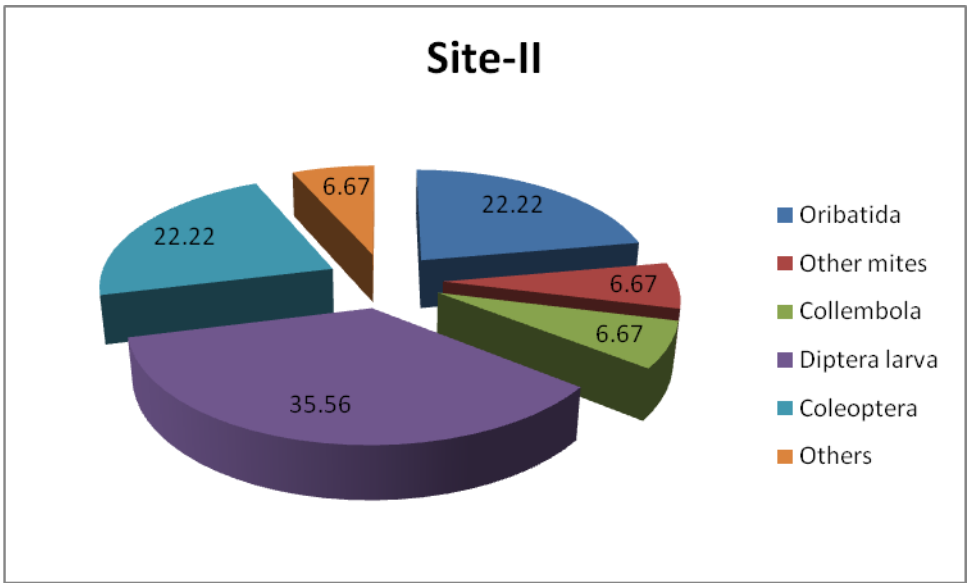


Figure 4: Shows relative abundance (%) of major micro arthropods at site-II.

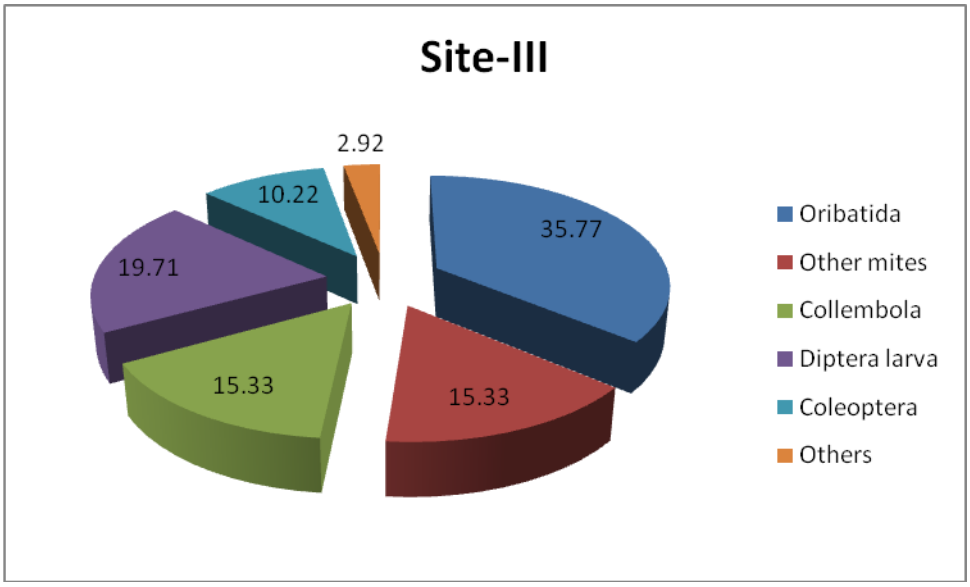
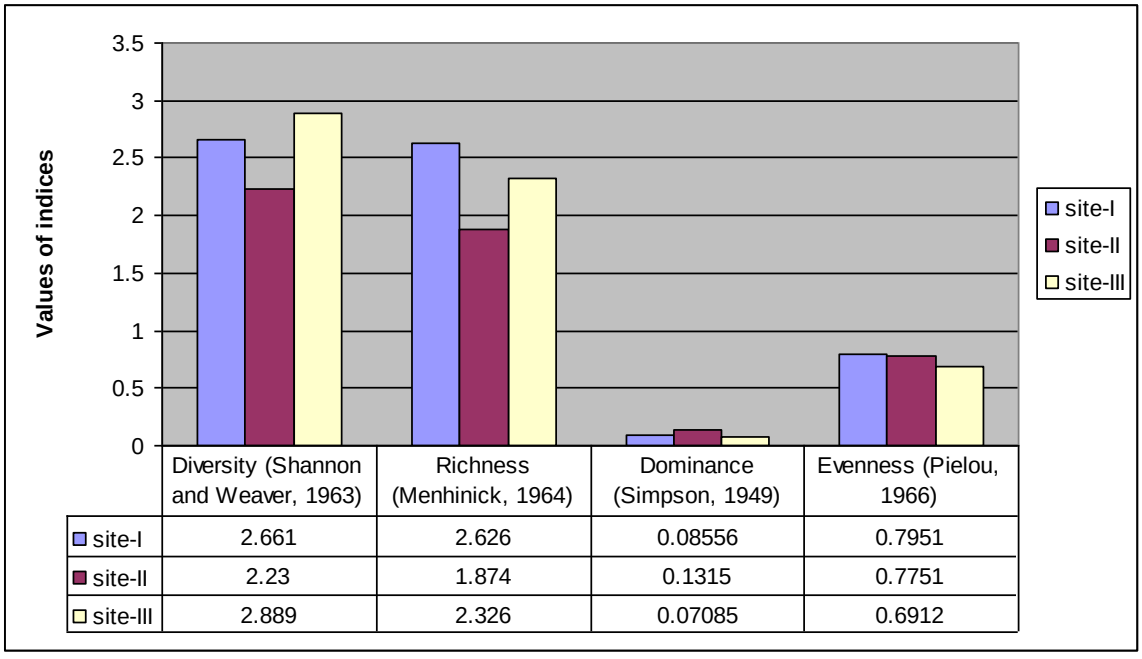


Figure 5: Shows relative abundance (%) of major micro arthropods at site-III.



	Diversity (Shannon and Weaver, 1963)	Richness (Menhinick, 1964)	Dominance (Simpson, 1949)	Evenness (Pielou, 1966)
site-I	2.661	2.626	0.08556	0.7951
site-II	2.23	1.874	0.1315	0.7751
site-III	2.889	2.326	0.07085	0.6912

Figure 6: Shows the diversity indices at different sites.

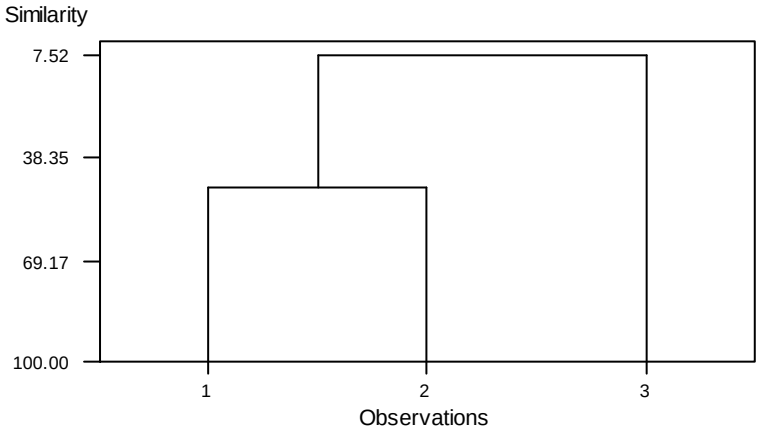


Figure 7: Cluster observation based on similarity. (1= site-I; 2= site-II; 3= site-III)

Table 3: Similarity (Sorenson, 1948) and Beta diversity at the sites.

	S-I	S-II
S-II	0.1224	
S-III	0.1163	0.0964
Overall Similarity (Sorenson, 1948)		
0.0469		
Beta Diversity (Whittaker, 1960)		
0.9821		

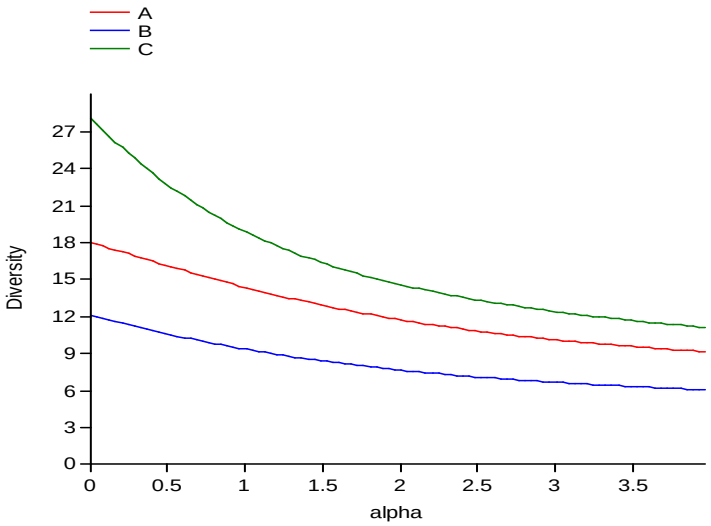


Figure 8: Diversity ordering showing the order of sites as per diversity.

(A= site-I; B= site-II; C= site-III) (alpha = order of species)