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On variation of diversity of soil oribatids (Acari, Oribatida) in three differently used soil habitats- a waste disposal site, a natural forest and a tea garden in the northern plains of Bengal, India.

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Abstract- Soil samples were collected from three different habitats at monthly intervals. Order Oribatida was the highest numerically abundant group of acrarines followed by order Mesostigmata. ANOVA indicated significant difference ($p<0.05$) in population density of oribatid mites among the sites. Five, eight and ten species of oribatid mites were recorded from the waste disposal site at Panga, Denguajhar tea estate and Bodaganj forest respectively. *Tectocepheus velatus*, *Lamellobates palustris* and the species of genus *Scheloribates* were dominant in all the sites. Species abundance distribution at waste disposal site fitted well to geometric series while log normal model appeared applicable at tea estate and forest site. Population density as well as Shannon's index of diversity (H') was highest at forest site. Right tailed sum diversity ordering showed following order- forest floor > tea estate > waste disposal site. Richness and evenness indices were also highest at Bodaganj forest for the higher number of species and population density. Dominance index was highest at the waste disposal site. Greater similarity was recorded between tea estate and waste disposal site. Beta diversity was a moderately high in the sampling region.

Index Terms- Diversity, Oribatid mite, Soil habitats.

I. Introduction

Order Oribatida is often found to be the single largest group in abundance among soil microarthropods in various types of ecosystems (Wallwork, 1983; Lamoncha and Crossley, 1998). Their role in maintaining physicochemical dynamics of soil is well illustrated which particularly involves their active participation in the decomposition process of organic debris in soil (Sanyal and Bhaduri, 1998; Renker *et al.*, 2005). They are found to occur in a wide range of area from tropics to Antarctic regions and from desert to high mountains (Wallwork, 1967b; Buryn and Usher, 1986; Sanyal *et al*., 2002; Sanyal, 2004; Moitra *et al*., 2006, 2007). Their uses as effective bio-indicator have also been addressed (Franchini and Rockett, 1996; Van Straalen and Herman, 1997). Haq (2007) highlighted their use in increasing fertility of soil. Abundance and diversity of oribatid mites are found to vary depending upon the nature of soil and environment and conspicuous change is observed even in local level. It is therefore necessary to record basic information on them that may be employed in further studies or applications and future assessment of soil condition and the present study was attempted keeping this aspect as major consideration.

II. MATERIALS AND METHODS

Three different sites were selected at Jalpaiguri district ($26^o16''$N to 27^o N and 88^o 4' E to 89^o 53'' E) in the state of West Bengal - a waste disposal site at Panga (Site-I) run under Jalpaiguri Municipal corporation, a tea garden at Denguajhar (Site-II) and a natural forest at Bodaganj (Site-III). Average maximum and minimum temperatures in the region are 30.9^oC in summer and 10.8^oC in winter and average annual rainfall is 3160 mm.

Five samples were collected from each site at 30 days interval from March, 2008 to February, 2009. A total of 180 samples were collected by stainless steel core (Dhillon and Gibson, 1962) and soil fauna was extracted using modified Tullgren funnel apparatus (Macfadyen, 1953). Soil fauna was collected in 90% alcohol and oribatid mites were separated using a fine brush. Prior to identification, oribatids were placed in 1:1 Lactic acid and alcohol and left for an hour to a few days depending upon their pigmentation.

Diversity indices - Shannon's diversity index (Shannon and Weaver, 1963), Richness (Menhinick, 1964), Dominance (Simpson, 1949), Evenness (Pielou, 1966), Simiarity (Sorenson, 1948) and Whittaker's β_w (Whittaker, 1960) were worked out. Right-tailed sum method was applied for the diversity ordering. This method may be considered preferable for practical purposes (Liu *et al*., 2007).

Logarithmic transformations of data were made to meet the requirement of parametric statistical analyses (ANOVA and Tukey test).

III. RESULTS AND DISCUSSION

Relative abundance of oribatid mites (Order Oribatida) was highest among the soil acarines, followed by order Mesostigmata. Other two groups of mites (Prostigmata, Astigmata) were fewer in abundance and of them astigmatid mites were recorded only from Site-III (Fig. 1). Higher abundance of oribatids in soil earlier have been reported by many workers (Bhattacharya and Chakraborti, 1994; Moitra *et. al*., 2007).

Mean density and fluctuation (coefficient of variation) of oribatid mites were highest at Site-III probably because of the presence of natural forest (Table 1, Fig. 2). It is generally found that the oribatids are more numerous in forest floor (Colman *et al*., 1999; Crossley and Coleman, 1999). Population maxima of oribatids were recorded during the post monsoons and the minima was observed during the summer in all the three sites (Fig. 2). Similar observations earlier were made by a few workers (Choudhuri and Banerjee, 1977; Bhattacharya and Raychaudhuri, 1979). One way ANOVA revealed statistically significant difference between the oribatid populations of the sites ($p < 0.05$) and further, Tukey test indicated significant difference between the mean populations of Sites-II and III (Table 2).

A total of fifteen species of oribatid mites were recorded from three sites. Highest number of species (10 species) was collected from Site-III, Site-II was the next (8 species) while the waste disposal site (Site-I) had the least (5 species). *Tectocepheus velatus* was the most abundant species in the sites, having highest abundance at Site-I and also comprised a considerable part of oribatid fauna at other two sites. Other major components included *Scheloribates albialatus*, *Lamellobates palustris*, *Galumna* sp., *Rostrozetes foveolatus* etc (Table 3).
Tectocepheus velatus have a wide range of tolerance to various environmental factors like humus content, pH, mechanical disturbance etc that enable them to dwell at various types of environments (Block, 1966; Hagvar and Amundsen, 1981; Maraun *et al*., 1999). Most of the other species recorded from the sites were also more or less common in the soil of West Bengal (Sanyal and Bhaduri, 1998).

Geometric model fitted well to the species abundance distribution at Site-I and at two other sites, log normal distribution was applicable (Fig. 3). Log normal distribution is relatively common in nature whereas geometric model is generally encountered in the communities under comparatively adverse or stressed environment. Only few species become highly dominant in such condition (Southwood, 1978; Sugihara, 1980; Magurran, 1988). Diversity indices estimated at the sites also substantiate this observation. Dominance index (Simpson, 1949) was highest at Site-I. This index becomes higher as the adversity of the environment rise (Bhattacharya and Chakraborti, 1994). Shannon's diversity index (Shannon and Weaver, 1963) was highest at Site-III, Site-II and Site-I exhibited the least value. Highest richness (Menhenick, 1964) and evenness (Pielou, 1966) were also recorded at Site-III. Beta diversity was moderately high in the region (Table 4) (Table 3). Sites-I and II exhibited highest value of similarity (Sorenson, 1948) and Sites-I and III had the least (Fig. 4). Diversity ordering by right-tailed sum method showed all the sites were comparable to one another and clearly could be ordered as Site-III> Site-II> Site-I in terms of diversity in oribatid communities (Fig. 5). The reasons for the low diversity at Sites-I and II could be attributed to the less complexity in vegetations and polluted condition (Hazra and Choudhuri, 1990; Hansen and Coleman, 1998; Hooper *et. al*., 2000).

Oribatid community in the natural forest floor was more diverse and had higher density in comparison to other two sites probably for higher diversity in vegetation and relatively undisturbed environment. The selected waste disposal site was a dumping ground for both organic and inorganic garbage of a township. Though the lowest diversity and fitting to geometric distribution indicated a stressed condition here, the density of oribatids however was higher than that of tea garden. It may be inferred that the dumping of garbage lowered diversity in oribatid community but did not affect too much the density as did the periodical chemical treatment in the well maintained tea garden.

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Table 1: Shows the abundance, fluctuation and relative abundance of oribatid mites at the sites.

	S-I	S-II	S-III
Mean Abundance (per core ± SE)	7.83 ± 0.87	5.74 ± 0.65	12.23 ± 1.73
Mean density (N/ m2) ± SE	3986.25± 445.21	2922.23 ± 333.57	6226.29 ± 884.3
CV	33.32	32.65	55.55
RA (on total mites)	57.06	60.36	66.43

SE= Standanrd error, N= Number of individuals, CV= Coefficient of variation, RA= Relative abundance.

Table2: Shows the results of ANOVA and Tukey test on abundance of oribatid mites.

One-way ANOVA: S-I, S-II, S-III

Source	DF	SS	MS	F	P
Factor	2	2.021	1.011	5.79	0.007
Error	33	5.756	0.174		
Total	35	7.777			

Tukey test

	S-I	S-II
S-II	-0.1501	
	0.6866	
S-III	-0.7299	-0.9982
	0.1068	-0.1615

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Table3: Shows the species of oribatid mites collected from three sites and their respective relative abundances.

Genera / species	S-I (%)	S-II (%)	S-III (%)	Total (%)
Tectocepheus velatus	66.28	20.04	24.4	36.91
Scheloribates albialatus	23.22	-	28.43	17.22
Lamellobates palustris	0.86	24.25	19.13	14.75
Scheloribates sp.	-	36.47	0.98	12.48
Galumna sp.	7.12	11.04	-	6.05
Rostrozetes foveoloatus	-	-	12.33	4.02
Hoplophorella sp.	-	-	7.8	2.6
Allonothrus russeolus	-	5.35	-	1.78
Setoxylobates foveolatus	-	0.69	3.14	1.28
Xylobates seminudus	-	1.88	-	0.72
Haplochthonius intermedius	2.5	-	-	0.83
Nothrus sp.	-	-	1.68	0.56
Galumna grenata	-	-	1.23	0.41
Rhysotritia sp.	-	-	0.88	0.29
Platynothrus sp.	-	0.28		0.09

Table 4: Shows the diversity indices of oribatid communities at the sites.

	S-I	S-II	S-III
Dominance	0.4990	0.2473	0.1991
Richness	0.0834	0.1195	0.1359
Evenness	0.5358	0.7536	0.7969
Diversity	0.8623	1.5507	1.8070
β- Diversity	3.75		

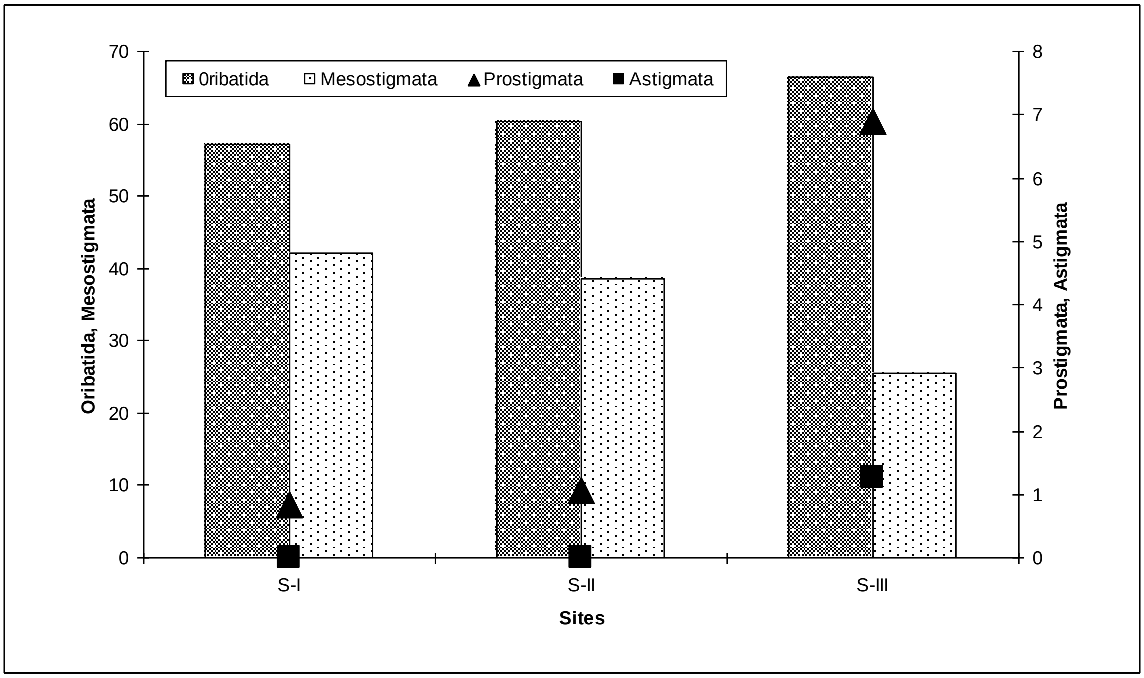


Figure 1: Shows the relative abundances (%) of different orders of soil mites at the sites.

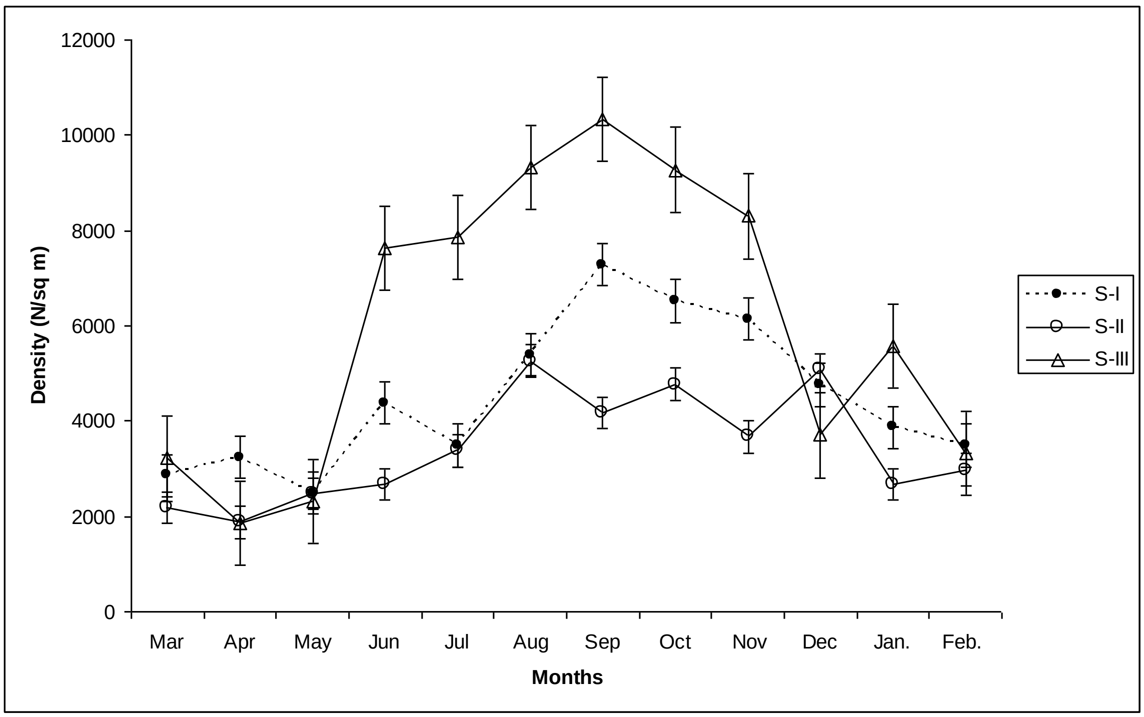


Figure 2: Shows the monthly fluctuation of the density (Individuals/ m^2) oribatid mites at the sites.

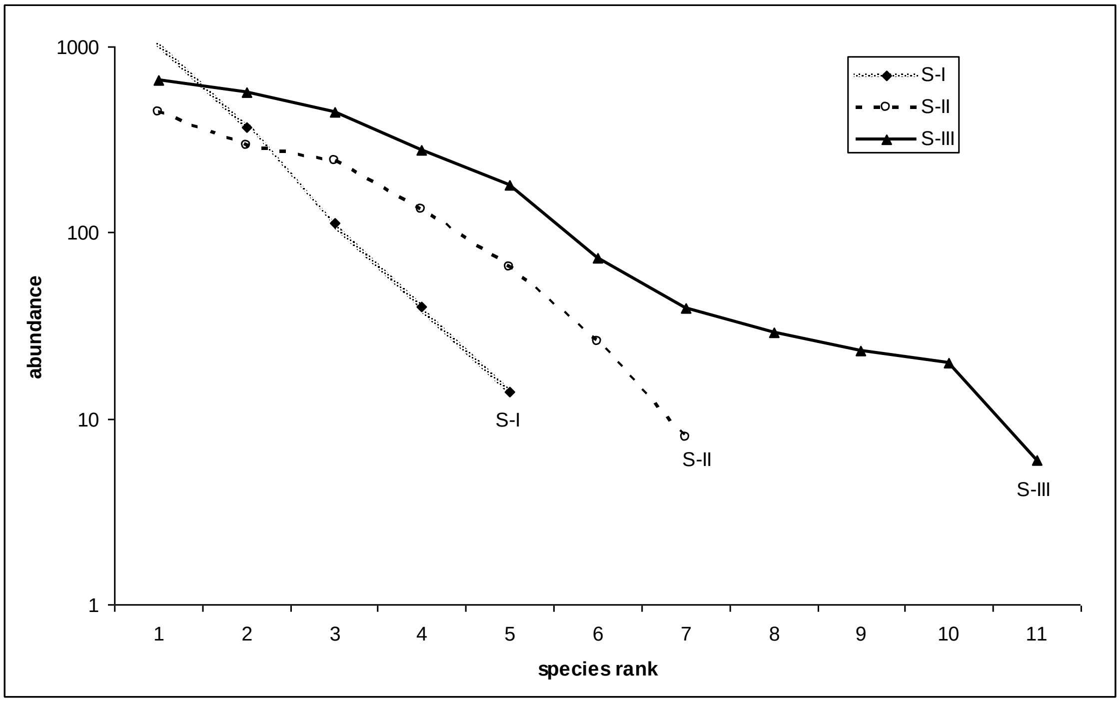


Figure 3: Shows the rank abundance distribution of oribatid species at three sites.

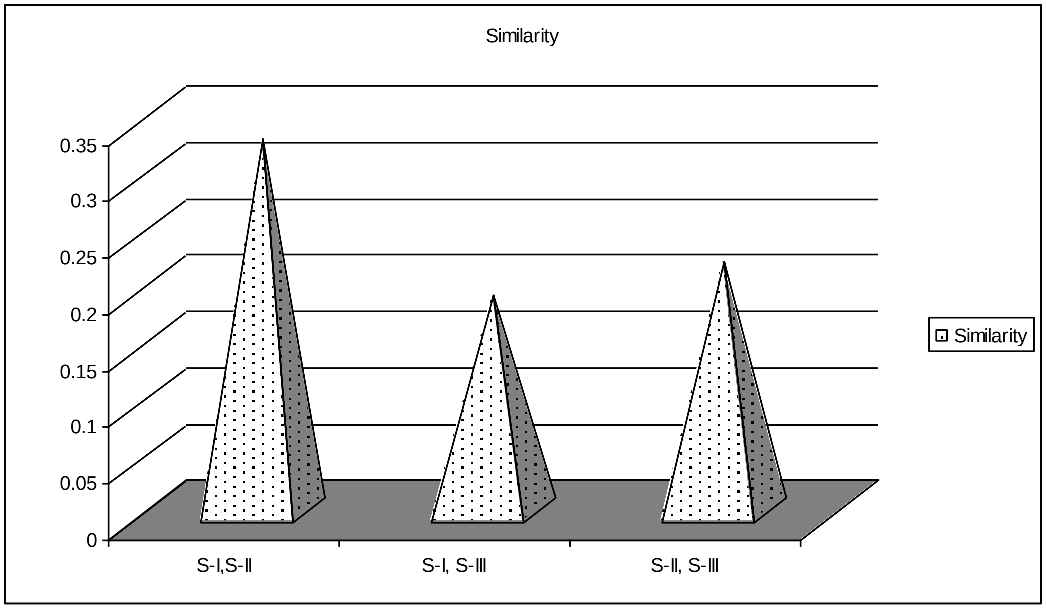


Figure 4: Shows the qualitative similarity (Sorenson, 1948) between the oribatid communities of the sites.

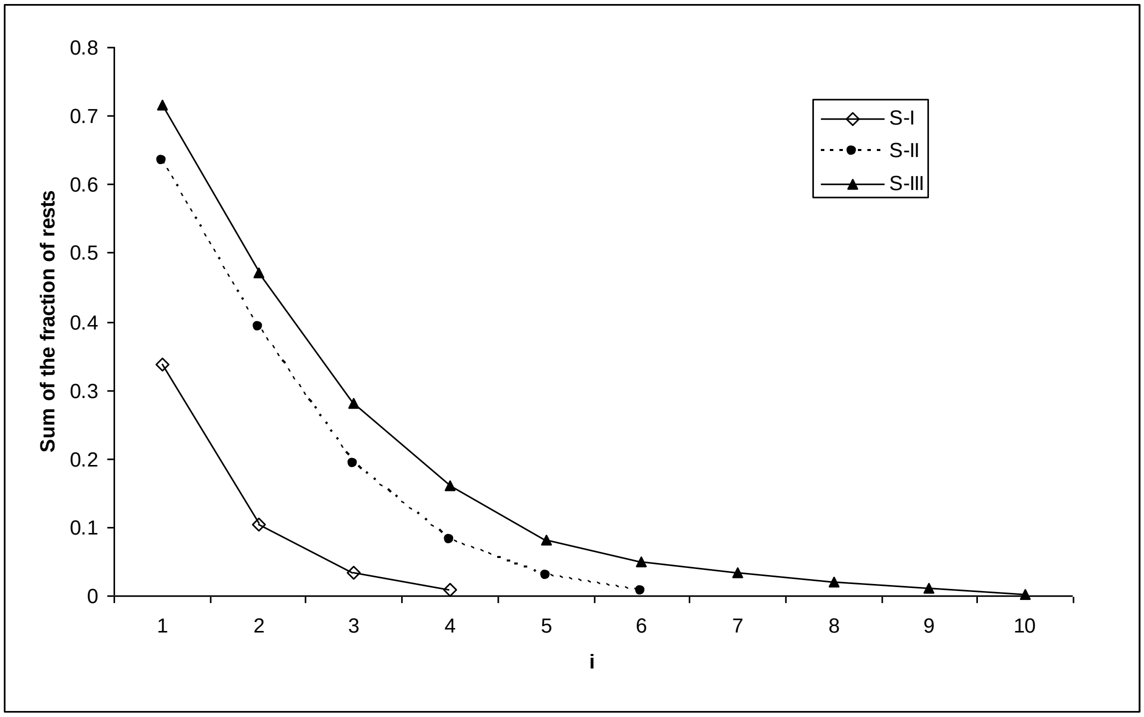
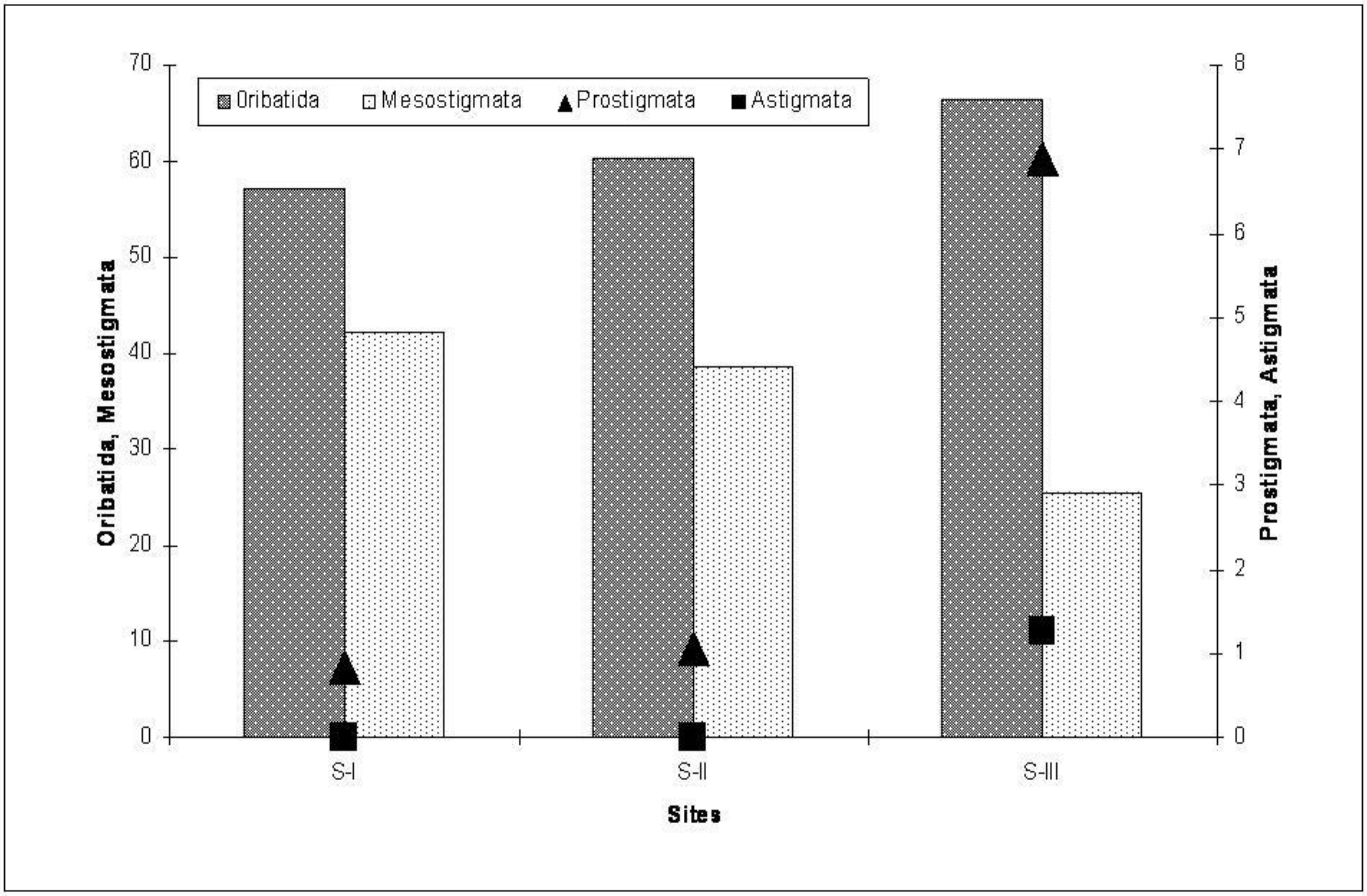


Figure 5: Shows the result of diversity ordering (right-tailed sum method) among the sites. (i = order of species)



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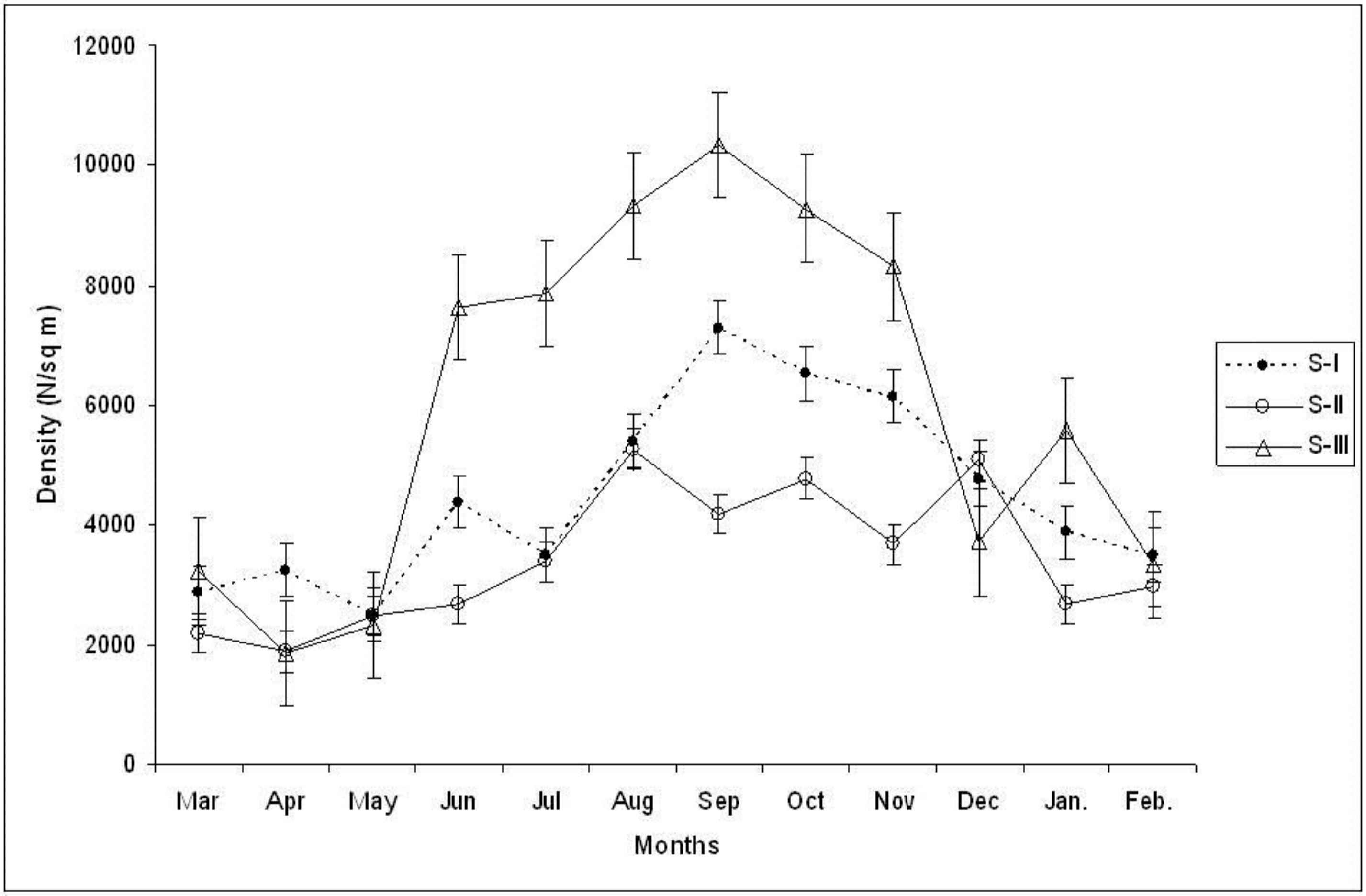

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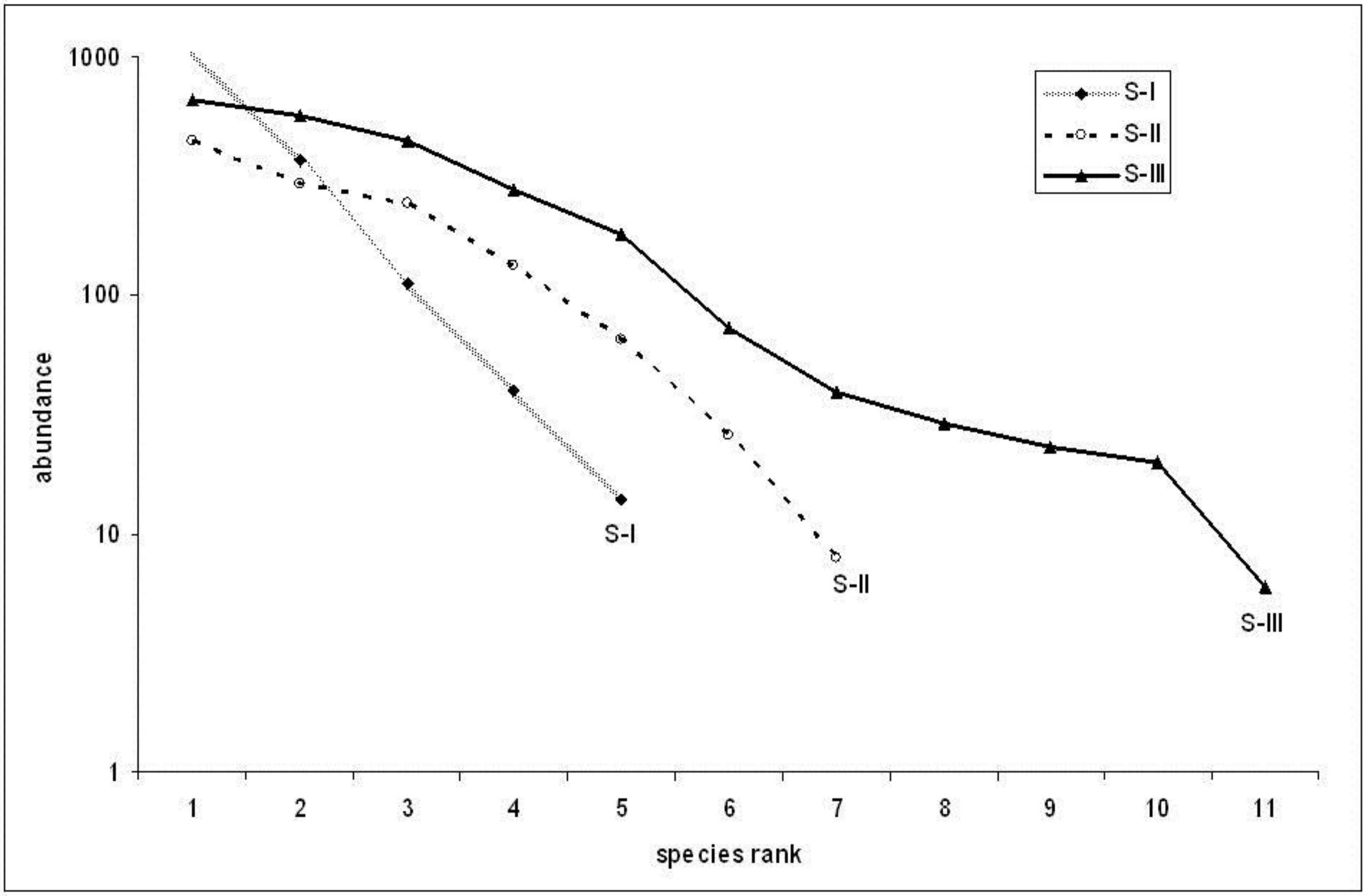

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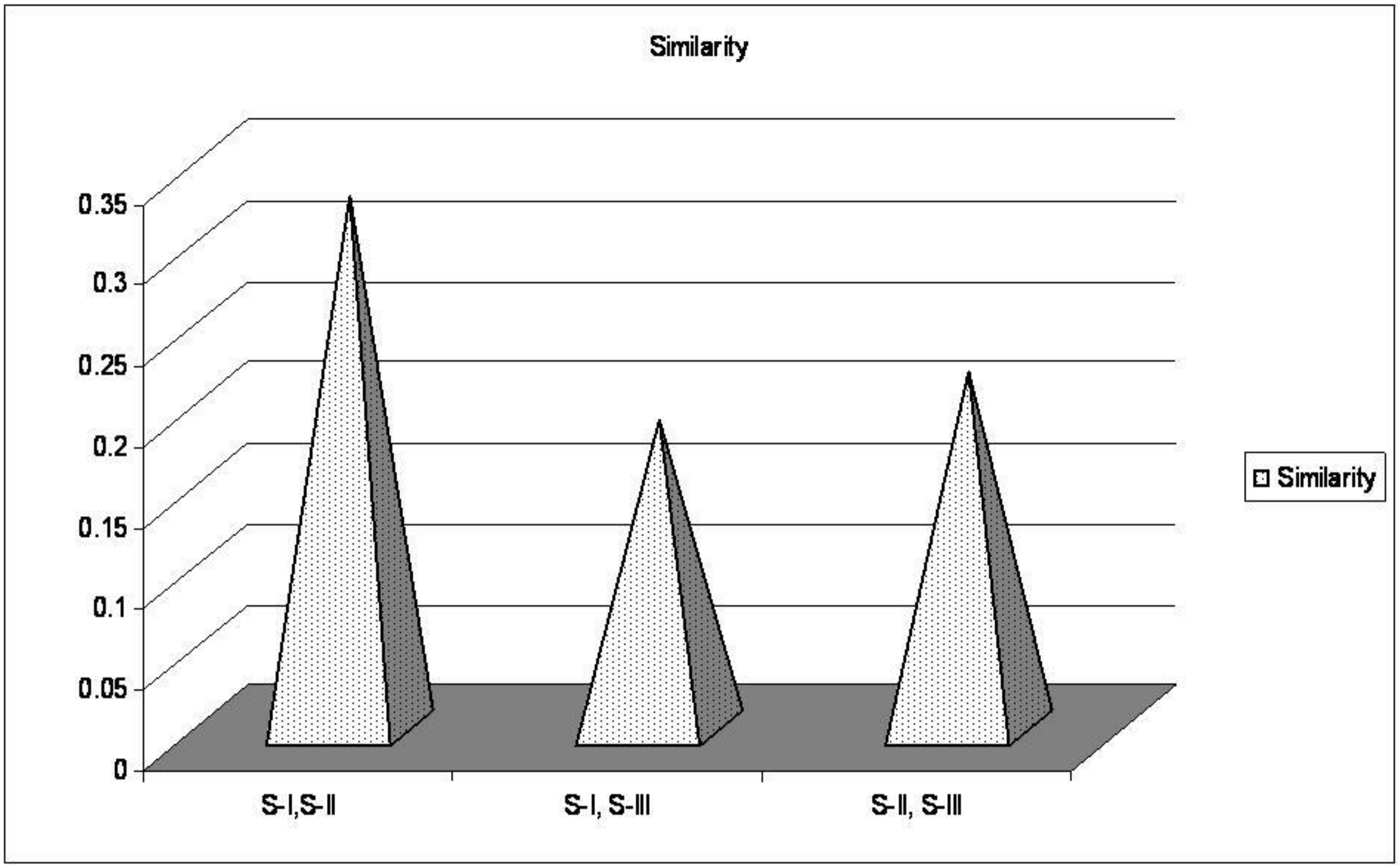

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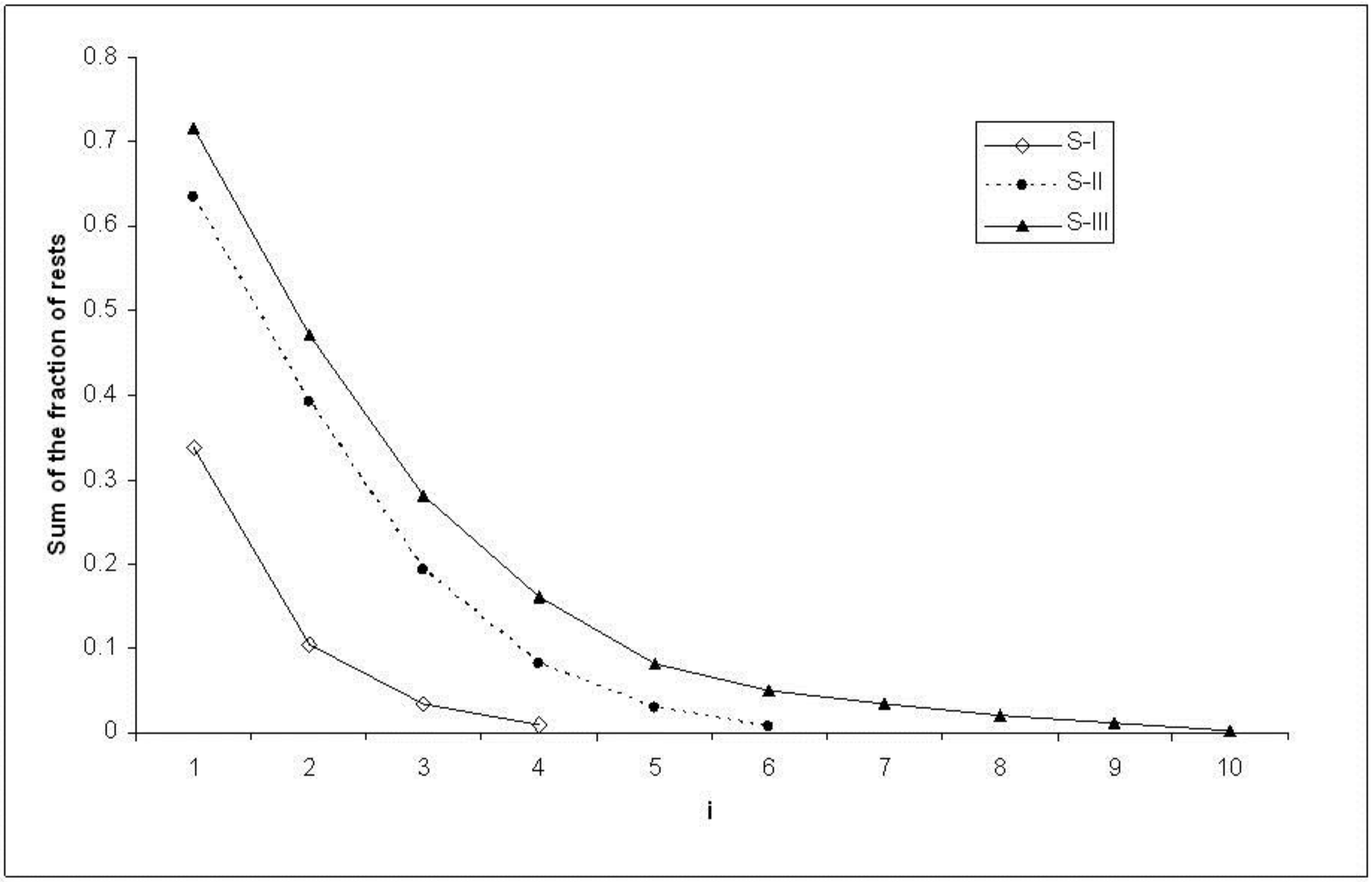

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