

## Faunal Population in Some Forest Soils of Chittagong University Campus

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**Abstract:** Faunal population in soils under six-forest tree species viz. *Lagerstroemia speciosa*, *Acacia auriculiformis*, *Acacia mangium*, *Dipterocarpus turbinatus*, *Tectona grandis* and *Eucalyptus camaldulensis* were assessed in the present study from the temporary sample plots located at various plantation sites in Chittagong University campus of Bangladesh. These plantations were raised by the Institute of Forestry and Environmental Sciences of the University of Chittagong and managed according to standard silvicultural procedures. Among the faunal population, Earthworm was the most represented, followed by Oribatid mites. Soil fauna are found significantly related with the total nitrogen content of the soil. The influence of pH was also significant.

**Key words:** Fauna · Forest soils · Tree plantation · Chittagong University Campus

### INTRODUCTION

Bangladesh has 1.43 million ha reserve forests and 0.73 million ha state forests corresponding to 10 and 6.7 percent respectively of its total land area. The actual area under forest cover is much less, possibly less than 6 percent of the total land area [1]. Considering the economic and environmental aspects, efforts have been taken to combat the situation by afforestation and reforestation.

Macrofauna are organisms that are more than 10 mm in size and manipulate the soil by making biogenic structures and galleries that sometimes persist longer than the organisms themselves. Earthworms, ants and termites are the dominant macrofauna in the forest-ecosystem. Soil plays an important role in forest growth and management and also in the abundance of soil fauna. Again, through their activities, macrofauna influence the physical, chemical and biological status of the soil. They also communitate organic resources and determine diversity and abundance of other organisms through availability of nutrients [2, 3].

Vegetation may affect earthworm populations directly through inputs of litter and leachates and indirectly through alteration of soil properties. Earthworm densities in the O horizon and in the upper 20 cm of mineral soil ranged from 0 to 20 and from 0 to 80 individuals/m<sup>2</sup>, respectively. In mixed-species forests, abundance and

species composition of earthworm assemblages are spatially variable in correspondence with patterns of soil properties and of the occurrence of tree and understory plant species [4]. They are of major importance in soil development and agricultural production as they enhance soil fertility and productivity through increasing availability of mineral nutrients to plants and integrating undecomposed surface residues, into the soil, hence reducing loss of nutrients, increasing O.M. content and improving soil structure [5].

Oribatids normally exceed most other soil microarthropods in abundance and diversity. They do not act as true "decomposers" in the way that fungi and bacteria do in forest ecosystems. They capture only an insignificant proportion of the total energy available in leaf-fall and they are much less efficient than the microflora in chemically degrading recalcitrant substrates, particularly those that are highly lignified. Their direct effects on the decomposition of plant material are then minimal. However, their indirect effects, through the stimulation of microfloral growth and activity and by unlocking nutrient pools present in these microfloras may be more substantial [6, 7].

Most of soil animals extracted by a Berlese funnel are so-called microarthropods, arthropods with a body size of 0.1-5.0 mm. These animals are unable to dig their own way in soil; they inhabit soil crevices, pores and hollows created by larger animals. Both fire frequency and

landscape position have significant effects on microarthropod abundance. Through interactions with fungal and bacterial microflora, these animals regulate decomposition rate, affect nutrient cycling and play an important part in soil fertility [8].

Chittagong University is situated in the hilly area of Chittagong. The present work is to study the faunal population such as Earthworms, micro arthropods and Oribatid mites in some forest soils of Chittagong University Campus. The studied forest plantation are *Lagerstroemia speciosa*, *Acacia auriculiformis*, *Dipterocarpus turbinatus*, *Tectona grandis*, *Acacia mangium* and *Eucalyptus camaldulensis*.

### METHODOLOGY

**Site Condition:** There were appreciable variations within the same plantation area in either growth or soil or slope or all in some localities. Due care was taken to identify location. Conditions of the studied sites and associated tree species are shown in Table 1.

**Collection of Soil Samples:** Soil samples at 0-6cm depth were collected with an auger. To represent the site, several soil samples were collected from a particular depth in a sample plot. Then soils of a particular slope of a site were mixed in equal proportion to have a composite sample. The samples were taken in polythene bags and brought into laboratory.

### Laboratory Analysis

**Soil Sample Processing:** Soil samples were air dried and passed through a 2 mm sieve. These samples were preserved in polythene pots. Samples for microbial study were kept in refrigerator until it used for the experiments.

**Determination of Soil Properties:** The physico-chemical properties of soils in the six plantations are shown in Table 2. Soil pH was determined in 1:2 soil: 0.01M CaCl<sub>2</sub> suspension with an electronic digital pH meter (TOA, Japan). Mechanical composition was determined according to Bouyoucos Hydrometer method [9] and the textural class names were those of USDA [10].

Table 1: Conditions of the study sites of different plantations.

Site No.	Species	Study Area in Chittagong University Campus	Site Characteristics
1	<i>Acacia auriculiformis</i>	East side of Godown	Very steep slope, medium hill
2	<i>Eucalyptus camaldulensis</i>	Beside University play ground	Steep sloping, medium hill
3	<i>Lagerstroemia speciosa</i>	Pump house	Steep sloping, medium hill
4	<i>Tectona grandis</i>	East of Science Cafeteria	Flat top of very steep slope, high hill
5	<i>Acacia mangium</i>	West side of Institute of Forestry and Environmental Sciences	Gently sloping, low hill
6	<i>Dipterocarpus turbinatus</i>	South side of Shahjalal Hall	Steeply sloping, medium hill

Table 2: Physico-chemical properties of soils in the six plantations.

Site No.	Slope	Texture	pH	EC $\mu$ s/cm	OC%	OM%	C/Nratio	CECmeq/100g	BSP	TEBmeq/100g	N%	P <sub>av</sub> ,mg/100g
1	Level	CL*	5.60	0.82	0.77	1.32	11.00	3.90	33	1.29	0.07	0.25
	Middle	SCL	5.68	1.23	1.14	1.96	14.25	5.60	38	2.13	0.08	0.79
	Top	SL	5.60	1.23	1.10	1.89	15.71	4.58	36	1.63	0.07	0.75
2	Level	SL	5.60	1.26	0.97	1.67	12.13	5.15	41	2.11	0.08	1.7
	Middle	CL	5.70	1.27	1.07	1.84	9.73	6.25	43	2.69	0.11	1.8
	Top	SCL	5.70	1.27	1.16	1.99	9.67	5.45	41	2.13	0.12	1.8
3	Level	CL	5.60	0.49	0.82	1.41	10.25	5.5	36	1.98	0.08	1.67
	Middle	SC	5.61	1.24	0.94	1.62	10.44	7.5	37	2.78	0.09	1.65
	Top	SCL	5.62	0.42	0.84	1.44	9.33	7.0	36	2.52	0.09	1.52
4	Level	SL	5.62	1.25	1.09	1.87	13.63	5.50	36	1.98	0.08	0.32
	Middle	C	5.70	1.70	1.32	2.27	13.20	5.50	38	1.86	0.10	1.95
	Top	C	5.68	0.64	0.90	1.55	10	4.90	36	1.98	0.09	1.08
5	Level	CL	5.69	0.56	0.78	1.34	9.75	3.00	31	0.93	0.08	0.07
	Middle	CL	5.90	1.24	0.80	1.38	7.27	4.80	37	1.78	0.11	0.11
	Top	L	5.80	1.26	0.96	1.65	9.6	2.95	34	0.66	0.10	0.08
6	Level	L	5.60	0.57	0.75	1.29	10.71	1.95	34	0.66	0.07	0.09
	Middle	CL	5.90	0.60	1.19	2.05	11.9	6.10	43	2.62	0.10	1.20
	Top	CL	5.90	0.60	1.19	2.05	11.9	6.10	42	2.62	0.10	1.30

\* CL= Clay loam, SCL = Sandy clay loam, SL= Silt loam, C = Clay, L = Loam

Soil organic carbon was determined according to the wet oxidation method of Walkley and Black as modified by Jackson [11]. CEC was determined by 1N  $\text{NH}_4\text{OAc}$  saturation followed by 10% KCl displacement. Available phosphorus was determined from field moist samples. Bray and Kurtz No. 1 extractant (0.03N  $\text{NH}_4\text{F}$  in 0.025N HCl) was used for the extraction of available phosphorus. Phosphorus was determined spectrophotometrically according to the  $\text{SnCl}_2$  reduced molybdophosphoric blue colour method [11].

**Estimation of Macro and Microfauna:** Macrofauna includes organisms that measures 4 to 80 mm height, visible with the naked eyes. Soil macrofaunal characterization and identification were based on the body size as described by Blair *et al.* [12].

Information regarding earthworm density and population structure was obtained by extensive digging of large quadrants to obtain individual specimens. Sampling was done randomly by extraction of cubes of size 30cm×30cm×30cm to quantify the macro faunal groups. The cubes were placed at randomly selected points within the sampling plots. The soil from the cubes was removed by hand and was placed into different plastic buckets. The soil was later placed on plastic trays of size 20cm×30cm and gently sorted out to locate the animals. The organisms were hand sorted and the samples were taken into the laboratory for identification. The method was preferred because it was easy to handle and did not depend on macrofaunal behaviour or presence of substrate.

Berlese-Tullgren apparatus is used in estimating micro arthropods which a great tool for separating microscopic animals from the litter and soil they inhabit. Free of soil debris, they can be counted and identified. A soil sample is placed on the sieve at the top of a funnel. A small lamp with a low-power light bulb heats and dries the soil from above, which stimulates the soil animals to move downward (positive geotaxis in response to dryness). This downward movement eventually causes the soil animals to fall through the sieve into a container with preservative. This method gives a biased sample of soil fauna, because it is based on specific avoidance behavior triggered by dryness and thus best captures animals that are mobile and do not desiccate easily. Immobile larvae, endophagous nymphs and soft-bodied invertebrates such as nematodes are not extracted by a Berlese funnel.

## RESULTS AND DISCUSSION

The forests varied significantly in abundance and diversity of faunal population. The diversity was low compared to that of the natural ecosystem. The abundance of soil fauna under the six forest species in different slopes is presented in the Table 3. The macrofauna earthworm was most represented, followed by oribatid mites. The results of Correlation between the soil fauna and soil properties are shown in Table 4.

Earthworms were found in all sampled sites. The analyzed sample resulted in identification of 1112 individuals. Estimated earthworm population numbers were higher under *A. auriculiformis* and *T. grandis* forest plantations having 141 and 139 individuals per  $\text{m}^2$  respectively, high density was found in the top of the *A. auriculiformis* as its moisture content was relatively high. Earthworm population densities were much lower with maximum counts at 7 individuals per  $\text{m}^2$  in *E. camaldulensis*. Correlations between physico-chemical properties and Earthworm population densities were weak. No significant correlations were found between microbiological indicator loads at earthworm habitat soils and earthworm population densities. It is noted that the amount of total soil nitrogen, but not the content of total soil carbon, was positively correlated with earthworm numbers which is similar with the results of Mäder *et al.* and Paoletti [13, 14].

Large differences in the abundance of macrofauna were observed in relation to planted species [4, 15]. However Diversity did not differ in different hills within the forest-ecosystems. Acacia was most favourable to soil macrofauna. The total numbers were highest under the *A. auriculiformis* and more or less the same in *D. turbinatus*, *T. grandis* and *E. camaldunensis*. Total macrofauna frequency was significantly correlated with the percentage of total nitrogen in all the six forest soils. There was no positive significant correlation between the organisms and soil pH, soil organic carbon or available phosphorus. Enami, *et al.* [16] reported correlation of pH and soil organic matter content with macrofauna suggesting that the soil organic matter and litter quality are of main importance in changing the above and belowground habitat in plantation. But present results do not show the natural condition as in all the forest area the leaf fallen from the trees were totally swept off by the peoples staying besides the hill areas.

Table 3: Species richness and abundance of soil fauna

Organisms		Lagerstroemia speciosa			Acacia auriculiformis			Dipterocarpus turbinatus			Tectona grandis			Acacia margium			Eucalyptus camaldulensis		
		L*	M	T	L	M	T	L	M	T	L	M	T	L	M	T	L	M	T
Oribatids	No. of species	5	7	7	13	14	17	4	6	12	13	15	16	3	10	13	6	6	9
	Individual no.	30	42	34	45	60	82	45	55	56	48	52	58	42	64	54	31	50	54
Earth-worms	Individual no. in 1 m <sup>2</sup>	66	22	22	13	22	α	9	22	44	176	132	110	22	22	22	7	7	5
Macro-arthropods	Individual no.	19	30	20	31	35	45	32	28	21	27	29	29	30	35	25	18	28	28

\* L = Level, M = Middle, T = Top

Table 4: Correlation coefficients between soil fauna and soil properties.

Soil fauna	pH	Organic Carbon	Total Nitrogen	Available Phosphorus
Oribatid Mites	0.423	0.308	0.915**	0.449
Earthworms	-0.036	0.290	0.481*	0.271
Macro arthropods	0.306	0.312	0.729**	0.437

\*\*significant at 0.01% and \*significant at 0.05% level

Species richness and abundance of Oribatids are indicated in the Table 3. Species number of Oribatids and individual numbers of macroarthropods differed among the forests. The highest number of species was found in *A. auriculiformis* and *T. grandis*. *Lagerstroemia speciosa* plantations had a poor macrofauna and several taxa were lacking. Oribatids play an important role in the decomposition of organic substances in the soil by feeding on various diets, from microbes to dead remains of higher plants. The number of Oribatids was correlated with the concentration of nitrogen regardless of the soil types (Table 3). The number of Oribatids was found positively correlated with the concentration of nitrogen which was similar with the work observed by Noti *et al.* and Wallwork [6, 7]. This fact may indicate that the determination of the number of Oribatids is a useful indicator of the amount of nitrogen mineralized from organic matter. Co-relation between of macro arthropods and physico-chemical properties of soil were also done and it was found that the number of macro arthropods was positively correlated with the concentration of nitrogen of soil. The results are very similar with the work done by Kautz *et al.* [17].

### CONCLUSION

Soil macrofauna may serve as an indicator of environmental conditions or particular ecological processes in the soil. In this study, attempts were made to study the relation of the soil fauna, especially oribatid mites, earthworms and macroarthropods which were

considered to be more useful as indicators than other types of fauna based on preliminary investigations in hilly soils under various kinds of tree species. More detailed research will be necessary to identify organisms and attempting to link this diversity to functional communities.

The hill soils distributed over the area within Chittagong University are poorly to moderately fertile. The cycling of nutrients and decomposition of forest litter could not happen as litters were collected by the peoples staying beside the hills. So, soil properties such as organic matter, amount of nitrogen were found very low. Abundance of faunal varied considerably and significantly with soil type and under different tree cover. Systematic and detail works in this regard seem necessary and beside afforestation program proper nutrient cycling should be maintained to protect the ecological balance.

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