Comparative Assessment of Soil Micro-arthropods in Open and Closed Refuse Dumpsites in Port Harcourt, Rivers State

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ABSTRACT

The distribution, abundance and diversity of soil micro-arthropods were assessed in two refuse dumpsite in Port Harcourt. One of the sites labeled A is an open dumpsite located at Ozuoba Junction in Obio-Akpor Local Government Area while site B is a closed dumpsite located at Njemanze street, mile one Diobu in Port Harcourt City Local Government Area. Soil samples were collected at three different depths (0-5cm, 5-10cm and 10-15cm) in each dumpsite and replicated thrice; soil micro-arthropods were extracted using modified Berlesse-Tullgreen funnel extractor. Species like Scheloribates sp., Galumna sp., Cryptophagus sp., Uropodidae sp., Mesoplophora ifensis and Mulierculia inexpectata belonging to three families of soil micro-arthropods (Oribatida, Mesostigmata and Collembolla) were observed in the two sites with highest species diversity in closed refuse dumpsite. Oribatida had more species diversity and abundance in the two dumpsites. The distribution of micro-arthropods in open dumpsite was high at the depth of 0-5cm and low at the depth of 10-15cm; in closed dumpsite it was high at the depth of 10-15cm and low at depth 0-5cm respectively. There was no significant difference between the physico-chemical parameter gotten from the refuse dumpsites but mean difference in moisture content and soil pH. The soils gotten from the two sites were acidic.

KEYWORDS: *Soil micro-arthropods,depth, open and closed dumpsites.*

INTRODUCTION

Soil is formed through weathering of the rocky parent material and this leads to fractioning of the parent material into finer particulate matter. The pioneer organisms (lichens, mosses, and liverworts) colonize the substrate; further break down the rock and incorporate detritus and organic compounds is formed through photosynthesis and nitrogen fixation (White, 1997; Jenny, 1980). In the process, they stabilize and moderate the micro-environment, creating conditions

favorable for later colonizers, eventually resulting in the establishment of higher plants and invertebrate animals (Whittaker, 1975). Soil harbors numerous organisms such as soil fauna. These soil fauna may represent as much as 23% of all described organisms, with arthropods comprising 85% of the fauna as they encompass a large proportion of the mesofauna and macrofauna of the soil(Decaëns *et al.,* 2006). The phylum Arthropod consists of five major classes and each class can be separated based on their shared characters, namely; Arachinda (Scorpions, Spiders, Mites, Ticks, etc); Crustacea (crabs, lobsters, shrimps, isopods, water fleas, copepods, etc); Diplopoda (Millipedes); Chilopoda (Centipedes) and Insecta (Hexapoda = all insects). Major groups of soil arthropods that are of significant importance in many terrestrial ecosystem food chains and webs include; Acarina, Collembola, Myriapods, Symphylla (garden centipedes) and insects from several orders (Badejo, 1982). Wallwork (1970) stated that the Acarina and Collembolans usually account for 90% of the soil arthropod fauna.

According to published literatures, arthropods function as litter transformer or ecosystem engineers i.e. they ingested plant debris, improving its quality as a substrate for microbial decomposition and fostering the growth and dispersal of microbial population and they also physically modify the habitat, directly or indirectly regulating the availability of resources to other species (Culliney, 2013; Lavelle *et al.,* 1995; Jones *et al.,* 1994). Soil micro arthropods are considered to be indicators of the state of soil conditions or health (Paolo *et al*., 2010; Lee *et al*., 2009; Rombke *et al*., 2006). Arthropods influence soil structure by creating pores/voids and formation of soil aggregates (Siddiky *et al.,* 2012; Lavella *et al*., 2006, Lynch and Bragg, 1985).

Dumpsites are municipal landfills used for disposal of solid waste. These solid wastes comprise of municipal garbage and industrial waste (Daniel and Daniel, 2003). Open dumping practices are commonly used as disposal option to manage solid waste for long times but the associated major environmental and health problems have just realized. The toxic compound and hazardous materials derived from the households/residents were mixed with other solid waste and dumped together. Closed dumpsite usually has a problem regarding soil quality as their top soil is affected by physical, biological and sometimes chemical degradation (Batstone *et al.,* 1989). Roffman and Bradford (1982) characterized that closed dumpsite is just as toxic as dumpsite in which residential and hazardous waste were co-disposed. Similarly, Brown and Donelly (1988) explained that the carcinogenic potency of a closed dumpsite is the same to the carcinogens potency of an open dumpsite while Pohland and Haper (1985) said unlike ammonia concentration, phosphate level remains generally through the live of the dumpsite whether closed or open.

Thus, the purpose of this study was to compare the soil micro-arthropods diversity and abiotic parameters such as soil pH, soil temperature and soil moisture content of two refuse dumpsites, anopen dumpsite and a closed dumpsite.

MATERIALS AND METHODS

Study Area

This experiment was carried out in two sites belonging to different Local Government Areas of Rivers state. Site A is an open refuse dumpsite located at Ozuoba Junction in Obio-Akpor Local Government Area, Port Harcourt and Site B is a closed refuse dumpsite located at Mile one Diobu, Njemanze Street in Port Harcourt City Local Government Area. The closed refuse dumpsite has been out of use for over nine years before the commencement of this research.

Collection of Experimental Samples

A quadrant was thrown randomly to pick the collection sites. Soil samples were collected at an interval of two weeks with a 16.1cm bucket type auger at depths (0-5cm, 5-10cm, 10-15cm). The auger was rotated clockwise and anticlockwise until the entire soil was taken (Gbarakuro *et al.*, 2010). Each sample was placed in a well labeled plastic bag and taken to the laboratory for analysis in a 3-stage process (extraction, sorting and identification). The equipment used was for extraction modified Bukard model of Berlese-Tullgreen funnel and extraction lasted for seven days.

Identification of the Micro-arthropods

The extract containing soil micro-arthropods were poured into a petri-dish and sorted under a dissecting microscope, the mites and Collembolans were carefully removed. Identification of the micro-arthropods was done using compound microscope at the Entomology research laboratory, Department of Animal and Environmental Biology, University of Port Harcourt. The identification keys used were according to the methods by McDaniel, 1979; Wooley, 1990; Gbarakoro *et al.,* 2010.

Evaluation of Physico-chemical Parameters

The parameters assessed from the dumpsite soils are temperature, moisture content and pH using the procedures of APHA(1998).

Data Analysis

The data collected from the dumpsite were replicated thrice and was analyzed using mean, percentage and tukey's method of treatment separation (Wahua, 1999; Minitab, 2010).

RESULTS

Result on the diversity and relative abundance of arthropods varied with depths. Three families (Oribatida, Mesostigmata and Collembolla) from the Order Acarina were isolated and identified in both site A and site B. In site A (Open dumpsite), the total number of species recorded at 0-5cm depth was 23. At 0-5cm depth, Oribatida was represented by two species *Scheloribates sp.* and *Galumna sp.*; Mesostigmata was represented by one specie *Uropodidae sp.* and Collembolla by one specie *Cryptophagus sp*. At depth 5-10cm, a total of 8 species was observed with two species from Oribatida, specie from Mesostigmata and specie from Collembolla. The specie abundance in 10-15cm was gotten from *Scheloribates sp.* and *Cryptophagus sp*. (Table 1). In site B (closed dumpsite) at 0-5cm depth, a total of 7 species was obtained with 6 from the family Oribatida (*Mulierculia inexpectata*, *Galumna sp.* and *Mesoplophora ifensis*) and 1 from the

family Collembolla (*Cryptophagus sp*.). In 5-10cm depth, a total of 9 species was observed with specie from Oribatida, specie from Mesostigmata and specie from Collembolla. The total number of specie abundance was 11 at 10-15cm depth (Table 2).

The physicochemical parameters of soils from site A and site B showed no significant difference (P>0.05) but only mean difference with site A having the highest mean value in moisture content (14.4) and lowest in soil pH (4.9) (Table 3).

Table 1: Species Diversity, abundance and distribution for site A (Open refuse dumpsite)

Species	Soil Depth				
	0-5cm	5-10cm	10-15cm	Total	Percentage
ORIBATIDA					
Scheloribates sp.	5	2	1	8	
Galumna sp.	6	2	0	8	
Total	11	4	1	16	49
MESOSTIGMATA					
Uropodidae sp.	5	2	0	7	
Total	5	2	0	7	21
COLLEMBOLLA					
Cryptophagus sp.	7	2	1	10	
Total	7	2	1	10	30
Grand Total	23	8	2	33	
Percentage (%)	70	24	6		

Table 2: Species Diversity, abundance and distribution for site B (Closed refuse dumpsite)

Species	Soil Depth				
	0-5cm	5-10cm	10-15cm	Total	Percentage
ORIBATIDA					
Mulierculia inexpectata	1	0	0	1	
Galumna sp.	2	2	1	5	
Mesoplophora ifensis	3	0	0	3	
Total	6	2	1	9	33
MESOSTIGMATA					
Uropodidae sp.	0	2	7	9	
Total	0	2	7	9	33
COLLEMBOLLA					
Cryptophagus sp.	1	5	3	9	
Total	1	5	3	9	33
Grand Total	7	9	11	27	
Percentage (%)	26	33	41		

Table 3: Physicochemical parameters for site A (Open dumpsite) and site B (Closed dumpsite)

Sample Location	Soil Temperature (°C)	Soil Moisture content	Soil pH
Site A	26.0[a]	14.4[a]	4.9[a]
Site B	26.0[a]	12.7[a]	5.0[a]

*Means with same letters are not significantly different P<0.05 by Tukey's Pair wise comparisons at 95% confidence intervals.

DISCUSSION

The total number of soil micro-arthropods at the site A (open refuse dumpsite) were more than those found in site B, because the open dumpsite have a lot of nutrients which the micro-arthropods require for their growth, development and enrichment. This agrees with the work of Mallow and Crossley (1984). In the vertical distribution of soil micro-arthropods in an open refuse dumpsite (site A) showed that the upper (0-5cm) depth had more micro-arthropods compared to other depths, this is because there is enough nutrient in the topsoil which soil micro-arthropods feed on, as they require it for their survival (Morrhead *et al.,* 2000). Increase in the number of species found in closed dumpsite was higher than that of open dumpsite; this variation is due to the fact that arthropods population increases when there is minimal disturbance of the soil. In site B, the soil micro-arthropods migrated from the top depth 0-5cm to depth 10-15cm. This migration corroborated with the findings of Coleman and Crossley(1996) who said uncontaminated habitat have soil micro-arthropods distributed mainly in the lower depths like 10-15cm and sometimes may not be found in the upper depths like 0-5cm. this is because they cannot withstand harsh weather conditions. As a result of this, there is decrease in the number of soil micro-arthropods which invariably could affect the soil structure and nutrient availability for plants among other related factors.

The family Oribatida had the highest abundance and were more in 0-5cm depth than in depth 5-10cm and 10-15cm respectively, this is in line with the reports of Shevchenko and Kolodochka (2014) who reported that Oribatida are detritophages as they are important in decomposition processes. However, this was in contrast with the statement of Culliney (2013) who stated that Oribatida has diverse feeding habit ranging from macrophytophages, microphytophages, coprophages and panphytophages.It is known that the Oribatida is a dominant group in soils with higher organic matter content (Ryke and Loots, 1967) and the open refuse dumpsite dump comprises of kitchen waste which acts as organic manure to the soil. This family is also more abundant in undisturbed soils (Crossley *et al.,* 1992) and this might explain the different abundances of these groups observed in these two sites.

The family Collembolla was high in depth 0-5cm in open refuse dumpsite and 5-10cm in closed dumpsite. Only specie (*Cryptophagus sp.*) from this family was observed in both open and closed dumpsite. This is because Collembolla is rarely found in very dry environment as they are mostly saprophagous in nature (Lale, 2006). Mesostigmata had the highest abundance in 0-5cm in an open dumpsite and 10-15cm in a closed dumpsite, this may be due to the fact that uncontaminated habitat have soil micro-arthropods distributed mainly in the lower depths like

10-15cm and not in the upper depths like 0-5cm (Coleman and Crossley, 1996). Lale (2006) stated that Mesostigmata family mainly feed on fungi and decomposed materials.

The relative moisture content for both site A (Open dumpsite) and site B (Closed dumpsite) was low because the sampling was done during dry season but there was no difference significantly between the physicochemical parameters assessed in this study. Moisture content (14.4%) in site A was more than the percentage moisture (13%) retained in un-burnt plots surveyed in Uyo. The soils of both sites in the study area were acid soils and this is because Rivers State soils are ultisols (Edem *et al.,* 2013).Edem *et al.,* (2013) further reported in their research that low soil moisture combined with relatively high soil temperatures likely combined to limit soil fauna activity and therefore, the rooting zone of Acid sand soils.

CONCLUSION

This study surveyed the soil micro-arthropods present in closed and open refuse dumpsites in Port Harcourt. The soil micro-arthropods found in the two dumpsites assayed belongs to three families: Oribatida, Mesostigmata and Collembolla with the highest percentage of micro-arthropods in open dumpsite is found at the depth of 0-5cm and depth of 10-15cm in closed dumpsite respectively. Site B (Closed refuse dumpsite) had more specie variation than site A (Open refuse dumpsite). The soils gotten from the two sites were acidic and had the same soil temperature but slight difference in the percentage moisture content.

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