COMPOSITION AND DIVERSITY OF SOIL INSECT FAUNA IN EKEKI, SOUTHERN NIGERIA

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Abstract

This study analyzes the composition and diversity of soil dwelling insect fauna in Ekeki community, Bayelsa State, Southern Nigeria for a period of two years. Soil corer was used in taking soil samples and Berlese–Tullgren Funnel method was employed in extracting soil insects. A total of 2830 individuals grouped into 4 orders, 12 families, 26 genera and 28 species were collected, of which 5 represented new genera in the area. The collected orders included Collembola, Hymenoptera, Isoptera and Coleoptera. Collembola dominated the collections in the number of families (41.66%), species (39.29%) and abundance (79.29%). The overall pattern of diversity of the study area showed a generally diverse community of soil insects with species richness of 3.397, Shannon-Wiener index of 2.711 and dominance value of 0.9098. The results from this study could be used to further knowledge concerning the biodiversity in similar areas and to indicate conservation priorities.

Keywords: Composition, diversity, insect fauna, soil, Southern Nigeria.

1. Introduction

Soil is the medium that connects all habitat of the land, it is a distinct realm and one on which green plants and all forms of terrestrial life depends (Daley *et al.,* 1978).

Fauna is an essential part of soil environment. It is involved in many aspects of organic matter decomposition, partial regulation of microbial activities, nutrient cycles and crumbly structure. Soil fauna are closely linked both to each other and to microorganisms, plants and soil, they are a vital key to understanding the soil ecosystem (Steen, 1983; Cortet *et al.,* 2000).

The class insect forms a major group of soil invertebrate communities (Larink, 1997). The soil surface and underlying litter of plant debris are inhibited by at least some members of nearly all insect orders (Daley *et al.,* 1978). Soil insects are a vital link in the food chain (Trimbetti & Williams, 1999), and also play important role in the renewal of soil resources (Daley *et al.,* 1978). The fact that they are particularly sensitive to environmental disturbance makes them good indicators of environmental health and stability (Paoletti & Bressan, 1996). Furthermore, studies of soil insects are important to understanding the general biodiversity of terrestrial ecosystem (Parisi *et al.,* 2005).

Despite the vast knowledge concerning the ecology of terrestrial insects, the same is not true of soil insects in the Niger Delta region of Nigeria except for some recent studies (Iloba & Jarrett, 2007; Iloba & Odon, 2007; Uwagbae *et al.,* 2014 a&b; Rotimi *et al.,* 2014). Within this context, this study analyzed the composition and diversity of soil insects in the Niger Delta region of Nigeria.

2. Experimental Section

2.1. Study Area

The study sites were located in Ekeki community (Latitude 05^0 55’ 47” N and Longitude 06^0 17’ 45” E in Bayelsa State of Nigeria (Fig. 1). Beyelsa State is rich in crude oil and high activities involving extraction and transportation of crude oil occurs with incidents of oil spill on the environment (Awobajo, 1981; LN, 2008), this have adverse effects on soils and soil fauna. Ekeki community however have not been grossly affected by oil spill incidence, the soil in this community are relatively unpolluted and retains a relatively natural state. Soils at the study area are sandy-loam (Ministry of Environment, 2008). The area is uncultivated and dominated by gamba grass (*Andropogon gyanus*).

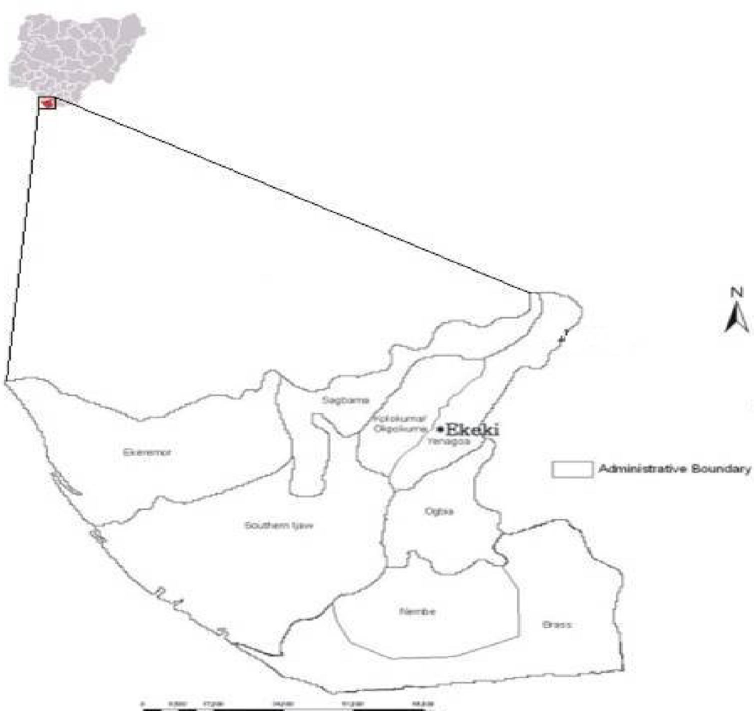

Fig. 1: Map of Bayelsa State showing the various Local Government Areas and the sampled community, Ekeki.

2.2. Sampling Design

In order to quantify soil insect population in soil, monthly sampling was done for two successive years from January 2008 to December, 2010. Soil samples were collected using a cylindrical core sampler (diameter 7.5cm) from marked 10m x 10m sampling grid. Each grid was subdivided into one hundred $1m^2$ microplots, after random sampling, a microplot on the north and southern positions were sampled as replicates. In each microplot, three soil cores were taken, the first core contained 0-10cm soil layer, the second core contained 10-20cm soil layer and the third core, 20-30cm soil layer. This is a modified procedure of Battigelli & Marshall (1993). Each core was carefully sealed in a separate polythene bag and taken to laboratory for extraction. Berlese-Tullgren Funnel method was used for the extraction of soil insects which were collected in vials on account of their negative phototrophic behavior (Hopkins, 2002). The samples were placed in the funnel for 48 hours and the fauna were collected in containers with 70% alcohol mixed in propylene glycol. Before the soil insects were extracted and collected, sorting of larger sized insects was done with the aid of binocular dissecting microscope. Individual species were removed from the debris by means of a fine camel hairbrush under a microscope and by suction using sucking pipette.

Identification of Collembola followed Christiansen *et al.* (2010), while other insects were identified with the help of the staff of the Department of Biological Sciences, Entomology Unit, Niger Delta University, Bayelsa State, Nigeria.

2.3 Diversity Measures

Overall insect diversity was expressed as species richness, abundance and Simpson diversity indices. Paleontological statistics (PAST 3.0) (Hammer *et al.,* 2001) was used to compute the diversity indices.

Species richness is the simplest way to describe community and regional diversity of which it captures much of the essence (Magurran, 1988; Sarkar and Margules, 2002). This was calculated by the Margalef index. Abundance is the kind of diversity measure that has inclusively been considered as equivalent to biodiversity *per se* (Peet, 1974) and referred to the sum of individuals in an area. Abundance is a concept used for evaluating faunal composition within a given area (Perez-Rodriguez, *et al.,* 2013). This was calculated using Shannon-Wiener index. Dominance was calculated using the Simpson index. Simpson diversity index (D) is nearly the most tractable and statistically useful calculation; it takes into account the representativeness of the species with the highest value (Perez-Rodriguez *et al.,* 2013). Analysis of variance (ANOVA) was used to test for differences among the soil insects at different soil depths.

3. Results and Discussion

3.1 Soil insect Composition

A total of 2830 insect specimens were collected during the sampling period from the study sites, the soil insects were grouped into 4 orders, 12 families, 26 genera and 28 species (Table 1). The total number of taxa reported in this study is high when compared with earlier studies (Iloba & Jarrett, 2007; Iloba & Odon, 2007; Uwagbae *et al,* 2014 a&b; Rotimi *et al,* 2014). This may be due to the undisturbed nature of the sampled area which is not polluted by oil spill incidence as compared to other areas in the same State [15]. The results form this study further confirm the presence of insect orders and families in a tropical soil of the Niger Delta (Iloba & Jarett, 2007; Iloba & Odon, 2007).

The outcome of the insect orders collected in this study included Collembola, Hymenopetera, Isoptera and Coleoptera. Collembola ranked the most abundant in the number of families (41.66%), species (39.29%) and abundance (79.29%) among the collected orders (Table 2). The higher values of the families, species and abundance of the order Collembola over other groups further confirm the dominant position of Collembola among soil dwelling insects (Ministry of Environment, 2008).

Five new genera from the order Collembola were encountered from the study area for the first time, these included *Hypogastrura* (family: Hypogastruridae), *Mesophorura* (family: Onchiuridae), *Onchiurus* (family: Onchiuridae), *Sminthurus* (family: Sminthuridae) and *Siminthurinus* (family: Sminthuridae).

The genus analysis showed that *Hypogastrura* is the most abundant in this study, with 570 specimens, followed by *Folsomia* (389) and *Sminthurinus* (190)**.** These results further supports the view that species in the order Collembola is one of the most abundant group of soil insects (Ministry of Environment, 2008).

All orders recorded occurred varying density and distribution among the different soil depths, except Coleoptera which were found only in the upper depth (0 – 10cm) (Fig. 2). The different distribution detected a highly significant difference (ANOVA F = 20.8, P <0.001).

On the overall, distribution and abundance of soil insects were found to be more in the upper soil layer (0 – 10cm) when compared with the mid (10 – 20cm) and lower (20 – 30cm) layers. In general, a gradual decrease in species richness in relation to soil depths was observed. These reported outcomes supports the influence of soil depth on the species composition and diversity of soil insects. The higher taxa richness on the upper soil layer could be as a result of the favourable condition of this layer compared to the deeper layers. The structure of soils and environmental factors such as temperature could be contributory to this differential in taxa richness; At greater depths, the soil is more compact and has smaller pore spaces, also, in the upper layer of soil, air is replenished by direct gaseous diffusion from the atmosphere so that the air content in the upper soil is richer, the air volume decreases with increase in depth (Daley *et al.,* 1978). In another vein, owing to the low thermal conductivity of soil, the heating and cooling of deeper layers lags behind in temperature of the soil surface creating a steep, vertical gradient in temperature (Daley *et al.,* 1978), which consequently could reflect on soil insect composition difference at successive layers of the soil.

3.2. Overall Pattern of Diversity

The overall pattern of diversity of the sampled area are stated in this study as species richness, abundance and dominance. The values are presented in Table 3. The indices calculated showed that species richness value (Margalef Index) = 3.397, Shannon – Wiener index of abundance (H) = 2.711 and Simpson dominance index (1 – D) = 0.9098.

The indices used in describing the study area are generally referred to as alpha biodiversity indices. Alpha diversity is the richness of species in a homogeneous community (Perez-Rodriguez *et al.,* 2013). The high value of margalef species richness index is an evidence of the richness of the sampled area, this shows the proportion to which the species are added by expansion of the sample and establishes a functional relationship between member of species and the total number of specimens (Moreno, 2001).. This value indicate the degree of uniformity in species representation while considering all samples (Perez-Rudriguez *et al.,* 2013).

Dominance represents equity and it takes into account the representativeness of the species with the highest value of importance, without assessing the contribution from the rest of the species (Perez-Rudriguez *et al.,* 2013). The species assemblage was dominated by *Hypogastrura* sp.

4. Conclusions

In conclusion, the results have shown that the study area is rich in soil insect assemblage with collembolans ranking as the most abundant in the number of the families, and species. Information about the high taxa richness of the study area could be used to further knowledge concerning the biodiversity in similar areas. Furthermore, because of the high diversity of soil insects as found in this study, they could be used to indicate conservation priorities and assess restoration in tropical soil.

Five new genera were encountered for the first time in the study area, and one of these, *Hypogartrura*, accounted for the most abundant and dominant group. This show the importance of this genus. Much needs to be learned about these organisms, including their biology and patterns of in-site diversity.

Finally, more soil insects were found in the upper layer (0 – 10cm) than the mid and lower sub-soil layers of soil. It is therefore important to understand the variation in densities and distribution of species within a single site and the factors that may be responsible for explaining these observed patterns.

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Table 1: The composition and abundance of soil insects extracted from the study area.

Order	**Family**	**Species**	**Abundance**
Coleoptera	Carabidae	*Amara* sp.	4
Coleoptera	Carabidae	*Carabus* sp.	4
Coleoptera	Carabidae	*Cicindela* sp.	3
Coleoptera	Carabidae	*Cotalpa* (larva)	2
Coleoptera	Carabidae	*Cotalpa* sp.	5
Coleoptera	Carabidae	*Geopinu* sp.	4
Coleoptera	Carabidae	*Pheropsophus* sp.	5
Coleoptera	Scarabeidea	*Aphodius* sp.	12
Collembola	Entomobryidea	*Entomobrya* sp.	120
Collembola	Entomobryidea	*Lepidocyrtus* sp.	92
Collembola	Hypogastruridae	*Hypogastrura* sp.	570
Collembola	Isotomidae	*Folsomia* sp.	389
Collembola	Isotomidae	*Hydroisotoma* sp.	153
Collembola	Isotomidae	*Isotoma* sp.	147
Collembola	Isotomidae	*Isotomurus* sp	169
Collembola	Onchiuridae	*Mesophorura* sp.	168
Collembola	Onchiuridae	*Onchiurus* sp.	85
Collembola	Sminthuridae	*Sminthurus* sp.	161
Collembola	Sminthuridae	*Sminthurinus* sp.	190
Hymenoptera	Formicidae	*Camponotus* sp.	13
Hymenoptera	Formicidae	*Formica* sp.	131
Hymenoptera	Formicidae	*Lasius niger*	70
Hymenoptera	Formicidae	*Solenopsis* sp.	79
Hymenoptera	Myrmicidae	*Meranoplus* sp. (Juv)	20
Hymenoptera	Myrmicidae	*Meranoplus* sp.	15
Hymenoptera	Poneridae	*Ectatomma* sp.	20
Isoptera	Rhinotermitidae	*Coptotermes* sp.	134
Isoptera	Termitidae	*Macrotermes* sp.	65

Table 2: Relative Percentage of Families, Species and Abundance in the Insect Orders in the Study Area.

Collected Orders	**Families**	**Spacies**	**Abundance**
Collembola	41.66%	39.29%	79.29%
Coleoptera	16.6%	28.57%	1.38%
Hymemptera	25.0%	25.0%	12.30%
Isoptera	16.67%	7.14%	7.03%

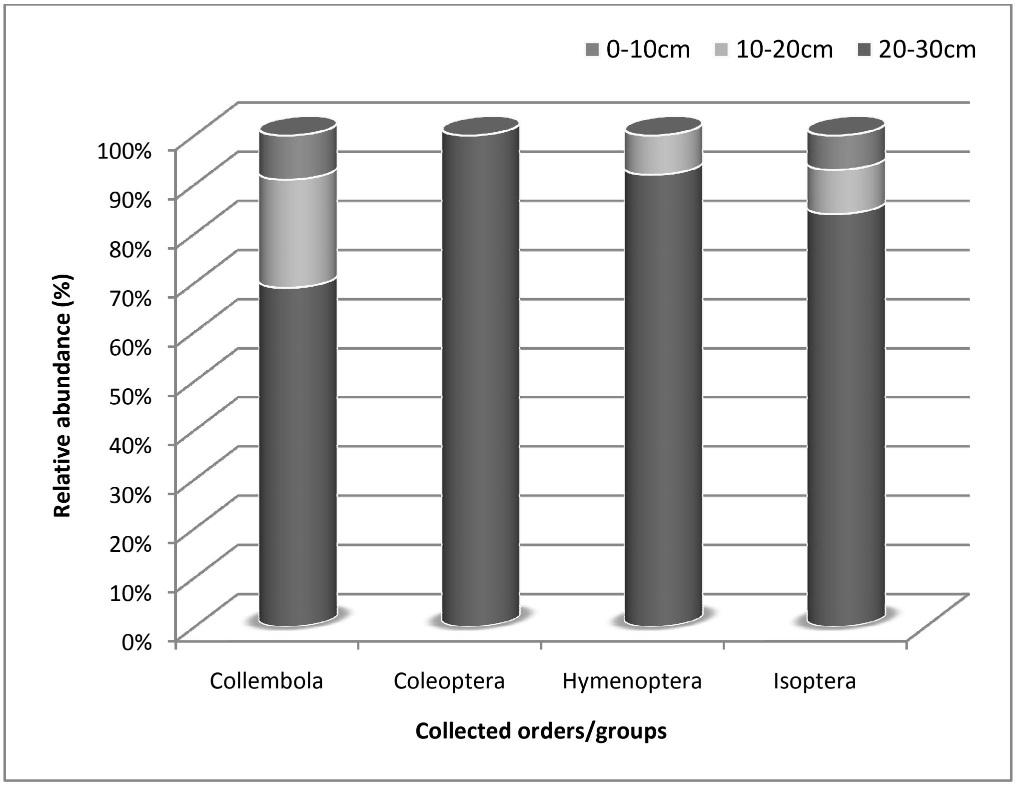

Fig. 2: Spatial variation of the relative abundance in the collected orders (ANOVA, $F(2,13) = 1.9$, $P < 0.21$) at different layers of soil depths of the study area.

Table 3: Diversity and abundance values of soil insect species in Ekeki, Nigeria.

Data	**Values**
Number of Species	28
Number of individuals	2,830
Mergalef Index (species richness)	3.397
Shannon-Wiener index	2.711
Simpson Index (dominance)	0.9098