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Evaluation of Arthropod Diversity and Abundance in Contrasting Habitat, Uyo, Akwa Ibom State, Nigeria

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ABSTRACT: This study was conducted to determine the abundance and diversity of soil arthropods in Anua and Ekpri Nsukara farmland communities, Uyo, Nigeria from September to November, 2012. Soil arthropods were sampled using pitfall trap. A total of 707 Individuals of soil arthropods were encountered during the study period. Of the total number, 203 individuals were encountered in Anua while 504 in Ekpri Nsukara. *Hymenoptera* were the dominant taxa while the least was *Blattodea* in the two communities. Higher Shannon diversity index 1.3 was recorded in Anua while lower diversity index 0.86 was recorded in Ekpri Nsukara. Evenness ranged from 0.006 to 0.80 in Ekpri Nsukara and 0.02 to 0.61 in Anua. The lower abundance of soil arthropod in Anua community as compared to Ekpri Nsukara could be attributed to the partially open vegetation which exposes the arthropods to avoidable predators.

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Soil arthropods are sometimes called bugs and these bugs make their home in the soil. They are the most diverse group of invertebrates on earth and are found everywhere (Basset *et al*., 2003). These soil arthropods are vital link in the food chain as decomposers. Arthropods aerate and mix the soil, regulate the population size of other soil organisms, and shred organic materials. Soil arthropods are increasingly recognized to impact plant performance, plant competition and thus plant community composition (Trombetti and Williams, 1999; Wardle *et al*., 2004; Weisser and Sieman, 2004; Bardgett, 2005). These impacts, however, are due to a variety of mechanisms such as below ground herbivory (Schadler *et al*., 2004), and an acceleration of nutrient cycling via the action of arthropod detritivores (Masters, 2004; Endlweber and Scheu, 2007).

The number of arthropod species associated with tropical trees is one of the key determinants of species diversity in the tropics (Basset *et al*., 1996; Odegaard, 2000) and this constitutes a most important ecological variable in studies of biotic relationships and processes that are important for the maintenance of biodiversity in tropical forest (Basset *et al*., 2003; Novotny *et al*., 2003). The number of species associated with one plant species varies considerably, and it is influenced by several factors such as geographic range, local abundance and recent geological history, biochemical composition, habitat diversity and structural complexity of the host plant ((Fowler and Lawton, 1982; Lawton, 1983; Strong *et al*., 1984). Physical and biological factors such as temperature and rainfall patterns, biotic interactions and primary productivity can affect them in their rate of reproduction, adaptation and longevity (Molina *et al*., 1999; Boyer *et al*., 2003). However, the loss of biodiversity due to anthropogenic factors such as urbanization, transformation and loss of habitats, environmental pollution and illegal trade of species have threatened most of the natural areas and their inhabitants, becoming one of the most important ecological problems (Mclntyre, 2000). Predation is also one of the factors that affects the diversity, abundance and distribution of soil arthropods (Hairston *et al*., 1960). Many other studies have shown that community structure, abundance and diversity of soil micro-arthropods are influenced by the availability of organic matter, substrate quality, concentrations of macro and micro nutrients and age, and biodiversity of the rehabilitating habitat ((Zheng *et al*., 1997; Loranger *et al*., 1998). The aim of the study was to determine arthropod abundance and diversity in Anua and Ekpri Nsukara farmland communities.

MATERIALS AND METHODS

Study Area: This study was carried out in Anua and Ekpri Nsukara farmlands of Uyo Local Government Area. It is situated on the Southern part of Nigeria. It lies on latitude 5^0 02^1 06.72^{11} N and longitude 7^0 57^1 28.76^{11} E. The study area is characterized by both rainy and dry seasons, with rainy season and dry season lasting from March to October and from November to March respectively. The relative humidity of this location varies between 86% for September, 89% for October and 87% for November. The vegetation is characterized by a great variety of grasses, herbs, shrubs and trees. Soils are derived from igneous rocks and are shallow with much sand,

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silt and organic matter. People living in these communities practice subsistent farming such as cultivation of cassava, water leaf and yam.

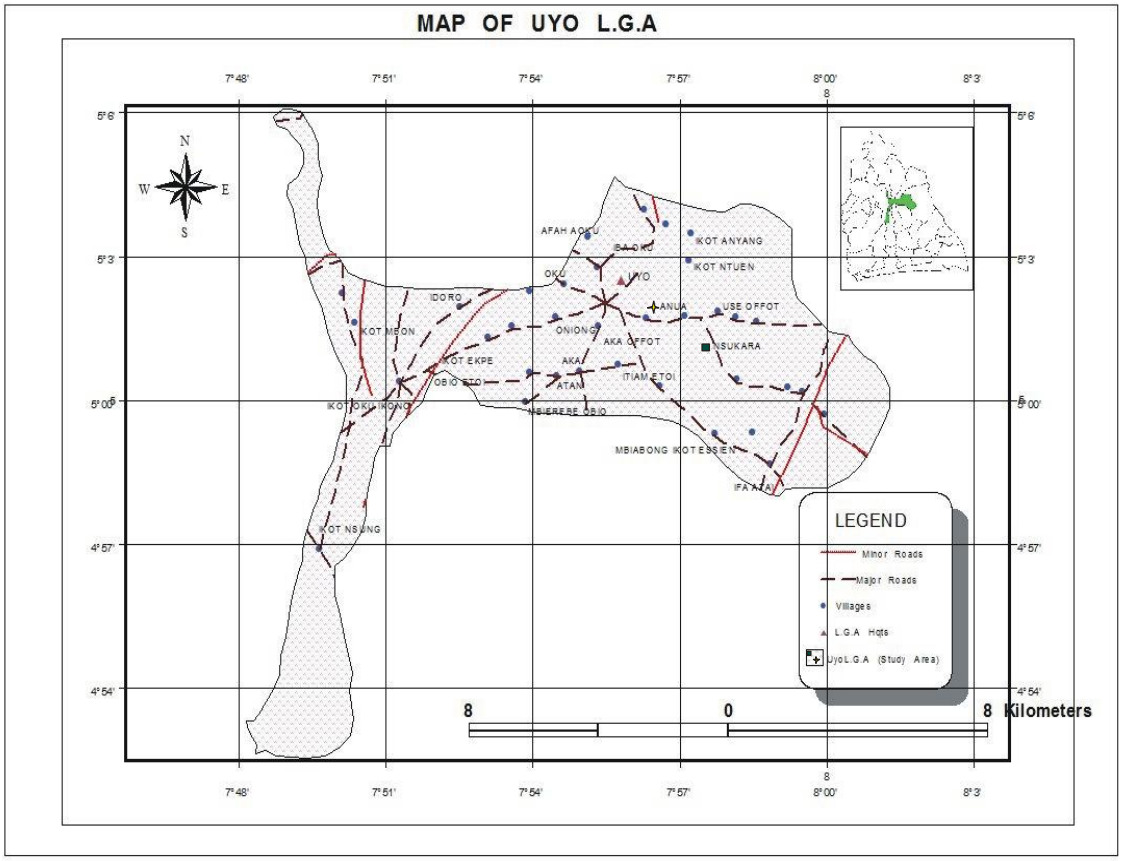

Fig. 1: Map of Study Area showing the sampling stations

Collection of samples: The study area is an expanse of land measuring 900m^2 (30 x 30m) in Anua and Ekpri Nsukara farmland communities each. Two sampling plots were divided into three stations. A pitfall trap consisting of plastic container measuring 22cm in length and 19.5cm in diameter, funnel measuring 19.5cm and formalin of about 4% was used in collection of the soil arthropods. Each of the containers was placed in a hole of about 23cm such that the aperture could level with the soil surface in order to enhance easy passage of arthropods into the container. After about 48 hours, the arthropods collected were transported to the Zoology laboratory, University of Uyo for sorting and counting. They were identified using appropriate guide book of Pennak (1978). Shannon-wierner diversity index (H) and Evenness (E) were determined using PAST3 software.

RESULT AND DISCUSSION

A total of 707 arthropods representing 7 taxa and 7 families were encountered. In Anua farmland, 203 individual arthropods were encountered, while 504 were encountered in Ekpri Nsukara farmland (Table 1).

In Anua farmland, the dominant taxa was *Hymenoptera* (60.6%), followed by *Collembolla* (14.29%) while the least was *Coleoptera* (1.97%) (Table 2). In Ekpri Nsukara farmland, the dominant taxa was *Hymenoptera* (79.76%), followed by *Orthoptera* and *Julida* (5.56%) while the least was *Blattodea* accounting for less than (1%) of the percentage abundance, (Table 2). Of the 203 species encountered in Anua farmland, *Formica rufa* was the dominant with 123 species, followed by C*eratophysella bengtssoin* with 29 species, while the least was *Notiophilus biguttalus* with about 4 species (Table 3). In Ekpri Nsukara farmland, of the 504 species of arthropods encountered, *Formica rufa* was the dominant with 402 species, followed by *Gryllus penesylvanicus* and *Blaniulus guttulatus* with 28 species, while the least was *Nezora robusta* with 3 species (Table 4). Shannon's wierner Diversity index (H) and Evenness (E) of Ekpri Nsukara and Anua farmlands are shown in Tables 3 and 4.

Table 1: Relative Abundance of the Different Soil Arthropods Taxa

Month	Insect order	Scientific name	Common name	Anua	Ekpri Nsukara
September	*Orthoptera*	*Gryllus penesylvanicus*	Cricket	1	10
	Araneae	*Araneus diadematus*	Spider	5	1
	Hymenoptera	*Formica rufa*	Ant	26	153
	Julida	*Blaniulus guttulatus*	Millipede	4	9
	Coleoptera	*Notiophilus biguttalus*	Beetles	0	7
	Blattodea	*Nezara robusta*	Termite	5	0
	Collembolla	*Ceratophysella bengtssoni*	Springtail	8	5
		Total		**49**	**185**
October	*Orthoptera*	*Gryllus penesylvanicus*	Cricket	7	13
	Araneae	*Araneus diadematus*	Spider	3	5
	Hymenoptera	*Formica rufa*	Ant	84	175
	Julida	*Blaniulus guttulatus*	Millipede	6	13
	Coleoptera	*Notiophilus biguttalus*	Beetles	3	8
	Blattodea	*Nezara robusta*	Termite	7	0
	Collembolla	*Ceratophysella bengtssoni*	Springtail	15	8
		Total		**125**	**222**
November	*Orthoptera*	*Gryllus penesylvanicus*	Cricket	0	5
	Araneae	*Araneus diadematus*	Spider	3	0
	Hymenoptera	*Formica rufa*	Ant	13	74
	Julida	*Blaniulus guttulatus*	Millipede	3	6
	Coleoptera	*Notiophilus biguttalus*	Beetles	1	4
	Blattodea	*Nezara robusta*	Termite	3	3
	Collembolla	*Ceratophysella bengtssoni*	Springtail	6	5
				29	**97**

Table 2: Percentage Abundance of Soil Arthropods Taxa Encountered During the Study Period

	Anua farmland		**Ekpri Nsukara farmland**	
Order	**Number of species**	**% Number**	**Number of species**	**% Number**
Orthoptera	8	3.94	28	5.56
Araneae	11	5.42	6	1.19
Hymenoptera	123	60.6	402	79.76
Julida	13	6.40	28	5.56
Coleoptera	4	1.97	19	3.77
Blattodea	15	7.39	3	0.60
Collembolla	29	14.29	18	3.57
	Total = 203		**504**	

Table 3: Diversity and Evenness of Soil Arthropods in Anua farmland

Individual species	**Total Number (N)**	**Evenness**	**Diversity (H)**
Gryllus penesylvanicus	8	0.04	0.13
Araneus diadematus	11	0.05	0.15
Formica rufa	123	0.61	0.3
Blaniulus guttulatus	13	0.06	0.17
Notiophilus biguttalus	4	0.02	0.08
Nezara robusta	15	0.07	0.19
Ceratophysella bengtssoni	29	0.14	0.28
	N = 203		**ΣH^1 = 1.3**

Table 4: Diversity and Evenness of Soil Arthropods in Ekpri Nsukara farmland

Individual species	**Total Number (N)**	**Evenness**	**Diversity (H)**
Araneus diadematus	6	0.01	0.05
Gryllus penesylvanicus	28	0.06	0.17
Formica rufa	402	0.80	0.18
Blanitus guttulatus	28	0.06	0.17
Notiophilus biguttalus	19	0.04	0.13
Nezara robusta	3	0.006	0.03
Ceratophysella bengtssoni	18	0.04	0.13
	N = 504		**ΣH^1 = 0.86**

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Many arthropod taxa are often sensitive to changes in environmental conditions and they can be utilized as indicators of soil pollution or other anthropogenic disturbance such as agricultural practices (soil tilling, mulching, pesticides and herbicides application, bush burning e.t.c.). Soil arthropods have been suggested as valuable indicators of restoration / rehabilitation success as a result of over-exploited / pollution stress of soil ecosystem (Kreman *et al*., 1993; Burger *et al*., 2003; Karr and Kumberling, 2003). Many other studies have shown that community structure of soil arthropods are influenced by the availability of organic matter, substrate quality, concentration of macro and micro nutrients, age and biodiversity of the rehabilitating habitat (Zheng *et al*., 1997; Loranger *et al*., 1998).

The differences in soil arthropods encountered in Anua and Ekpri Nsukara could be attributed to the fact that there are more desirable trees, plants and crops that could attract soil arthropods and create a conducive environment for soil arthropods habitats. Also, biotic interactions and primary productivity can affect soil arthropods in their rate of production, adaption and longevity (Wolda, 1988; Molina *et al*., 1999; Boyer *et al*., 2013). The most important order in terms of abundance in Anua were Hymenoptera (*Formica rufa*) > Collembolla (*Ceratophyselia* spp.) > Blattodea (*Nezara robusta*) while Ekpri Nsukatra were Hymenoptera (*Formica rufa*) > Orthoptera (*Gryllus penesylavanicus*) and Julida (*Bianiulus guttalatus*). Similar community pattern were reported by Gardner *et al*.,(1995), Molina *et al*., (1999) and Lagos (2004).

Soil arthropods widely reported as bioindicators includes Ants (Hymenoptera), Springtail (Collembolla), and Termites (Blattodea) (Peck *et al*., 1998; Mayer, 1994; Badji *et al*., 2007). In this present study, Ant (hymenoptera) was a central component of soil arthropod abundance representing about 60% and 80% of total soil arthropods population in Anua and Ekpri Nuskara respectively. Ant (Hymenoptera) is common in virtually all types of terrestrial habitat of low and mild elevation (Holldobler and Willson, 1990). They are major predators of other arthropods (Floren *et al*., 2002) and their presences can contribute to indirect plant resistance by reducing herbivory and enhancing plant fitness (Kosumek *et al*., 2009).

Collembolla (Springtail) form an important component of soil food web (Coleman *et al*., 2004), such as recycling of soil nutrient for plant and by feeding on soil bacteria and fungi (Hopkin, 1997; Theenhaus *et al*., 1999; Filser, 2002; Partsch *et al*., 2006). The abundance of springtail (Collembolla) in Anua and Ekpri Nuskara readily reflects the microbial biomass of its soil ecosystems.

Predation is one of the factors that affect diversity, abundance and distribution of soil arthropods (Hairson *et al*., 1960; Marc *et al*., 1999; Nyffeler, 1999; Brown *et al*., 2003). Spiders (Araneae) play an important role such as exertion of its predator influences over other soil arthropods population (Riechert and Bishop, 1990; Wise, 2004).

The Shannon-weiner diversity index shows higher diversity index in Anua than Ekpri Nsukara even when Ekpri Nsukara recorded higher individual number of soil arthropods. Adekunle, (2006) reported that the physical complexity of an environment such as soil characteristics could affect soil arthropods abundance and diversity, hence the higher diversity in Anua farmland. Also, Adebuntan (2007) reported that high diversity of soil arthropods taxa are generally found where light penetrate, litters of leaves falls, food and rocky ground. Soil invertebrates play an integral part in the functioning of the soil ecosystem and provide ecosystems services such as decomposition, nutrient cycling, pest suppression and soil bioremediation. The elevation exposure to sunlight and partly cover of plants strongly influences the structure of soil arthropods in this study.

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