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Arthropod Abundance and Diversity in Pwadzu Dumpsite Wukari, Taraba State

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Abstract

This study examined the Arthropod abundance and diversity in Pwadzu Dumpsite Wukari, Taraba State with coordinates 7.8847° N, 9.7717° E, the objectives of the study includes; Identification and distribution of Arthropods in Pwadzu Dumpsite in Wukari Local Government Area, evaluation of the abundance and distribution of the Arthropods using ecological indices of abundance and assessing the physical and chemical parameters of the soil in the dumpsite. Three sampling methods were used to collect arthropods from the different survey sites namely: water traps, sweep nets and handpicking with the aid of forceps and hand gloves. Arthropods collected from the survey site were recorded in order to study the relative abundance and distribution of the species found in the dumpsite. The arthropods were placed in specimen bottles before taking to the laboratory for identification and preservation, the soil samples were analyzed for moisture content, organic matter, phosphorus, nitrogen and potassium. Analysis of variance (ANOVA) was used to test for statistical difference between the mean of the physical parameters of the soil and arthropods of the sites; Duncan's Multiple comparison of mean so as to measure similarities of the sampling stations. A total of 986 occurrence of arthropods were collected in Pwadzu dumpsite, A total of 15 arthropods species belonging to 14 families of 11 arthropod orders namely: Diptera,

Coleoptera, Hymenoptera, Isopoda, Dictyoptera, Orthoptera, Spiropolida, Ixolida, Araneomorpha, Scorpionida and Lepidoptera, Meanwhile, the percentage value of the soil samples are: nitrogen (0.69), available phosphorus (130.83), Calcium (0.11), Potassium (4.55) respectively. The percentage of organic carbon was 2.39, percentage organic matter 4.13 and the percentage moisture is 12.41. The month of November indicated high value of Shannon-Wiener index (H^1 = 1.821) which suggested this habitat of dumpsite had high diversity at that month than the October and December months period with values of 1.742 and 1.649 respectively. It indicated that there were high arthropod species diversity and abundance in Pwadzu suggests that there are relatively few successful species in this habitat in October and November. This study recommends that more studies should be done in order to establish the abundance and different types of arthropods inhabiting Pwadzu dumpsites.

Keywords: Arthropods, Abundance, Soil, Diversity, Pwadzu dumpsite, Wukari

INTRODUCTION

In developing countries like Nigeria, the prevailing practice of municipal solid waste disposal is to dispose the solid waste in dumpsites (El-Fadel *et al.,* 1995; Asian Institute of Technology (AIT) 2004). Dumps are isolated locations where solid wastes are discarded which are usually left bare for direct sunlight and rainfall. There are many of these dumps in urban and semi-urban cities in Nigeria that mostly contain wastes from households, markets, schools, and health and commercial institutions. These wastes are dumped in a manner that negates environmental health and sustainability. In Nigeria, many of the sites are chosen without observing international best practice for waste disposal and management (Nwosu and Pepple, 2016).

The open dumping of solid wastes in designated places in the urban and semi-urban centers of Nigeria cities was earlier acceptable as the only way to manage solid wastes, but presently such practice is associated with environmental and health problems due to lack of evacuation logistics.

Dumps in Nigeria and their environmental challenges range from the redistribution of refuse on the streets from windblown litter (Abdus-Salam, 2009) to presence of non-biodegradable waste materials that contain heavy metals and hazardous substances as well as biodegradable solids. The decomposition of the biodegradables attracts pathogens and invertebrate fauna. Some of the invertebrates are capable of vectoring pathogens of

economic and health importance. The environmental health concern of the dumps includes leachates emanating from the dumps and the prevalence of arthropod vectors resident in them. Leachates percolate beneath the dump after rain had fallen on the dump that moves through the soil horizons and contaminate groundwater. Dissolution of heavy metals in leachate poses severe pollution threat to the soil and water biodiversity (Abdus-Salam, 2009; Oni *et al.,* 2011; Magaji, 2012; Nartey *et al*., 2012; Popoola and Amusat, 2015; Tanee and Eshalom-Mario, 2015; Esenowo *et al*., 2017).

Nevertheless, the ecological roles of some invertebrates of dumps are copious (Morales and Wolff, 2010; Gbarakoro *et al*., 2015; Oka and Bassey, 2017) and their health implications (Onyido *et al*., 2009 and 2011 and Ahmed, 2011).

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 (Wardle et al., 2004; Weisser and Sieman, 2004; Bardgett, 2005).

The presence of arthropods in dumpsites, which are increasingly becoming focal points for environmental and public health concerns, raises a significant problem in need of investigation. These diverse and abundant groups of insects, arachnids, and crustaceans are known to play vital roles in waste decomposition and nutrient cycling within ecosystems. However, our understanding of the abundance and distribution of arthropods in dumpsite environments remains limited, presenting a critical knowledge gap.

One fundamental challenge lies in the insufficient knowledge of the biodiversity of arthropod species inhabiting dumpsites and their specific ecological functions in waste decomposition. To develop effective management and mitigation strategies, a comprehensive assessment of the arthropod fauna within these sites is essential.

The study on "Arthropod Abundance and Distribution in Dumpsites" holds substantial significance on several fronts. It contributes to our understanding of the ecological roles of arthropods in waste decomposition and nutrient cycling within dumpsite ecosystems. This knowledge is crucial for optimizing waste management practices and reducing the environmental impact of dumpsites. By comprehending how arthropods contribute to

breaking down waste materials, we can devise more effective and sustainable strategies for waste disposal and resource recycling.

Furthermore, the study's findings are vital for assessing the environmental implications of arthropod presence in dumpsites. Understanding their role in the spread of disease vectors, contamination of water sources, and the transfer of pollutants is essential for developing measures to mitigate these risks and protect ecosystems and public health.

The aim of this study is to determine the Arthropods abundance and distribution in Pwadzu dumpsite in Wukari, Taraba State, and the specific objectives are:

i. Identification and distribution of Arthropods in Pwadzu Dumpsite in Wukari Local Government Area
ii. Evaluation of the abundance and distribution of the Arthropods using ecological indices of abundance

METHODS

Area of Study

This study was carried out in Pwadzu Dumpsite with coordinates 7.8847° N, 9.7717° E located in Wukari Local Government of Taraba State. Wukari is the headquarter of Wukari Local Government Area of Taraba State. It is located between latitude 7˚51'N to 7˚85'N and longitude 9˚46'E to 9˚78'E of the Greenwich meridian. Wukari Local Government area is situated in the southern part of Taraba State. It is about two hundred kilometers away from Jalingo the state capital.

Sampling Methods

Three sampling methods were used to collect arthropods from the different survey sites namely: water traps, sweep nets and handpicking with the aid of forceps and hand gloves as prescribed by Onyido et al., (2011).

10 pit falls were implanted in Pwazu dumpsite within an area of 100m x 100m square so as to have a good spread through the dumpsite. The pitfalls were designed with tins of about 450ml in volume and the diameter of opening of 9cm (Abhulimen, 2010) were buried into the ground so that the rim of the collecting containers were flushed with the surface of the surrounding ground which served to capture ground dwelling arthropods. The containers were covered with flat metals which were placed about 2cm above the ground directly to

exclude the rain. The pitfalls were arranged to mimic the surrounding environment by using dirt in the environment to cover it as used by Abhulimen (2010).

Each pitfall was three quarter filled with four percent formalin to kill and trap arthropods and preserve them. Pitfalls would be emptied and replaced once every two weeks. The formalin and the caught arthropods were poured into a container and the arthropods were painstakingly picked by scapular and placed into a small specimen bottles containing 90% ethanol to preserve the arthropods and taken to the laboratory for further analysis. This method used is essentially the same as the one used by Lapuente, *et al.* (2014) at Garraf landfill near Barcelona in North West Spain.

Sorting of Arthropods

Arthropods collected from the survey site were recorded in order to study the relative abundance and distribution of the species found in each dumpsite. The arthropods were placed in specimen bottles before taking to the laboratory for identification and preservation.

Preservation and Identification of Collected Arthropods

Arthropods were grouped into respective orders and families according to Winchester, 1992 and identified to species level and common names. The species were listed against the relevant families they belonged to and the identification of the specimen was done in the Biological Sciences Laboratory in Federal University Wukari (FUW), Taraba State, Nigeria.

Soil Analysis

10 soil samples were collected from the site from October to December using soil auger to collect soil samples to a depth of 6cm which were analyzed in Soil Science Laboratory, Federal University Wukari, Nigeria. The soil samples were analyzed for moisture content, organic matter, phosphorus, nitrogen and potassium.

Statistical Analysis

Analysis of variance (ANOVA) was used to test for statistical difference between the mean of the physical parameters of the soil and arthropods of the sites (Ogbeibu, 2005). The degree of association within species and between samples of arthropods was determined using the following bio-diversity indices, Shannon index, Equitability or Evenness and Species Richness index (Ogbeibu, 2005).

For the calculation of arthropods abundance in the sites, unidentifiable specimen was included. For the calculation of diversities, unidentifiable juvenile were included where no adults are found, while all parts fragments are included.

Results

Faunal Composition

A total of 986 occurrence of arthropods were collected in Pwadzu dumpsite, Wukari, Taraba State for the month of October to December is shown in table 1. A total of 15 arthropods species belonging to 14 families of 11 arthropod orders namely: Diptera, Coleoptera, Hymenoptera, Isopoda, Dictyoptera, Orthoptera, Spiropolida, Ixolida, Araneomorpha, Scorpionida and Lepidoptera.

The total number of arthropod for each month ranged from 269 to 366 individuals and from 15 arthropods species. The percentage abundance of individual species per arthropod is shown in table 2 of which the most prominent were Hymenoptera 57.3% and Coleoptera 14.2%.

Shannon-Weiner's diversity index (H^1) shows a relative uniformity of data with the highest value of 1.821 in the month of November as seen in table 3.

Evenness (E) shows the most equitable in the month of November with the value of 0.690.

Margalef's species richness index (d) show the richness in the month of November 0.854

Table 1: List of Athropods collected in Pwadzu dumpsite, Wukari, Taraba State

ORDER	FAMILY	SPECIES	Oct	Nov.	Dec.	TOTAL
Diptera	Musidae	*Musca domestica* (House fly)	50	30	20	100
Coleoptera	Tenebrioniidae	*Opatropis hispida* (Darkling beetle)	50	20	70	140
Hymenoptera	Formidae	*Dorylus nigricans* (soldier ant) *Componctus consobrinus* (sugar ant)	150 50	100 70	150 45	565
Isopoda	Armadillidae	*Armadilldum vulgare* (bug)	5	10	5	20
Dictyoptera	Blattidae	*Blattera sp.* (Nymph)	20	15	20	55

Orthoptera	Gryllidae locustidae	*Scapsipedus marginata* (Cricket) Melanoplus differentialis (Grasshoper)	4 5	3 2	4 5	23
Spiropolida	Spirobolie	Narceus americanus (millipede)	15	5	13	33
Ixolida	Ixolidae	*Ixodes ricinus* (Tick)	1	1	1	3
Araneomorpha	Lycosidae	*Hogna carolinesis* (Wolf spider)	2	1	1	4
	Orbicullaridae	*Argiope aurontia* (Orbi-weaving spider)	1	1	1	3
Scorpionida	Buthida	*Buthus oceitanus* (Yellow scorpion)			1	1
Lepidoptera	Notuidae Donaidae	*Pseudaletia unipuncta* (army worm) *Donaus chrysippus* (Adult butterfly)	3 10	4 7	5 10	39
Total no. of individual per month			366	269	351	986
Total no. of species per month			14	14	15	

Table 2: Summary of Various Arthropods collected in Pwadzu Dumpsite, Wukari Taraba State with values of Numbers of Orders, Species, family and their percentage values

ORDER	No. Of Sp. **Abundance**	**% Species Abundance**	**No. Of Family Abund Ance**	**% Family Abundance**	No. Of Ind. **Abundance**	% Ind. **Abundance**
Diptera	1	6.7	1	7.1	100	10.1
Coleoptera	1	6.7	1	7.1	140	14.2
Hymenoptera	2	13.3	1	7.1	565	57.3
Isopoda	1	6.7	1	7.1	20	2.0
Dictyoptera	1	6.7	1	7.1	55	5.6
Orthoptera	2	13.3	2	14.9	23	2.3
Spiropolida	1	6.7	1	7.1	33	3.3
Ixodida	1	6.7	1	7.1	3	0.3
Lepidoptera	2	13.3	2	14.9	39	4.0
Araneomorpha	2	13.3	2	14.9	7	0.7
Scorpionida	1	6.7	1	7.1	1	0.1
	15		14		986	

Table 3: Species Richness, Species Diversity and Evenness of the three months in Dump site of Pwadzu

	OCTOBER	NOVEMBER	DECEMBER
Margalef's species (d)	0.732	0.854	0.801
Shannon-Weiner's Index (H)	1.742	1.821	1.649
Species Evenness (€)	0.660	0.690	0.609

Source: Field work

Soil Analysis

Table 4 shows the mean sand variations of the soil parameters for the period of October to December in Pwadzu dumpsite. The percentage of nitrogen (0.69), available phosphorus (130.83), Calcium (0.11), Potassium (4.55). The percentage of organic carbon was 2.39, percentage organic matter 4.13 and the percentage moisture is 12.41.

Table 4: Value of soil Parameters analyzed for Pwadzu Dumpsite, Wukari, Taraba State

PARAMETERS OR SAMPLE DESCRIPTION	VALUES
% Organic Carbon	2.39
% Organic matter	4.13
% Moisture	12.41
% Nitrogen	0.69
% Available phosphorus (mg/kg)	130.83
Potassium (mg/100g)	4.55
Calcium (mg/100g)	0.11

DISCUSSION

A total of 986 arthropods individuals which belonged to 15 arthropod species from October to December, 11 arthropod orders and 14 families were collected during study on the diversity and abundance of terrestrial arthropods at case study of dumpsite habitat in Pwadzu, Wukari Local Government, Taraba State.

The bio-diversity indices used to determine the degree of association within species and between samples of arthropods that which the Shannon index indicated that there was high diverse of the species of arthropod in the dumpsite and it rises with the number of species

and the evenness of their abundance and the Margalef index indicate the species richness in the farm.

The abundance of arthropods found in this study was lower than that in Mbeya University of science and Technology, Tanzania (MUST), where a total of 1719 arthropods individuals belonging to 63 species under 12 orders and 46 families were collected from grassland and woodland habitats (Fredrick, 2016). It was also slightly lower than that found in Abaeku dumpsite, Ibadan (Abhulimen, 2010) having 1081 individual of arthropods belonging to 26 species and 23 families, 16 orders. This could be due to the longer period of months sampled.

Additionally, the abundance of arthropods between October, November and December period indicated a significant difference. The unlikeness in abundance of arthropod species between the three month could be due to differences in availability of food resources and ecosystem stability stated (Adjaloo *et al.*, 2012 and Jaganmohan *et al.*, 2013).

Moreover, in the November period the dumpsite was less disturbed compared to the other month's results. The dumpsite habitat was dominated by different tree and ground cover grasses young trees were established, and hence less food resources, poor ecological niches and microhabitats to support many insect species. It was further observed that the October and December dumpsite community experiences regular human disturbances such as shortage of rainfall harvesting of agricultural crop and cultivation of soil for crop production. Therefore, the presence of disturbance, less food resources and shelter in the dumpsite could be the reason for the less abundance and diversity of arthropod species in the habitat. Furthermore, on the same study according to Crane and Baker (2011), ground cover and woody debris and organic matter provide habitats for many arthropods and are food for the foragers. Therefore, due to the presence of high organic matter (4.13) less ground cover and grass debris in the dumpsite habitat there were high arthropod species, diversity and abundance. The difference in abundance and number of species shows that there are differences between these periods in the factors that affect arthropods growth. Ranio and Niemela (2003) underlined that, changes in species abundance such as a decrease or increase is often due to environmental disturbances. Moreover, the percentage showed similarity of arthropod species in Pwadzu dumpsite, Hymenoptera, Orthoptera, Lepidoptera, Araneomorpha showed similar highest percentage (13.3%) of species in the

dumpsite and Diptera, Coleoptera, Isopoda, Dictyoptera, Spiropolida, Ixodida, Scorpionida are also similar in percentage (6.7%).

Arthropod orders, Hymenoptera showed high individual abundance in dumpsite habitats. The high abundance of Hymenoptera in the sites may possibly be due to their ability to inhabit different habitats (Sharkey, 2007). A maximum number of arthropod species recorded was that belonged to Hymenoptera (2), Orthoptera (2), Lepidoptera (2) and Araneomorpha (2).

Total abundance of each order with respect to the number of arthropods in dumpsites. The most abundant orders of arthropod were Hymenoptera (57.3%), Coleoptera (14.2%) and Diptera (10.14%), constituting 81.64%) of the total, whereas the least abundant were Ixodida (0.304%) and Scorpionida (0.101%). On the other hand, the most dominant family was Orthoptera (2), Lepidoptera (2) and Araneomorpha (2) individuals. The result shows the partial and variations of the soil parameters for the period of October to December in Pwadzu dumpsite, meanwhile, the percentage of nitrogen (0.69), available phosphorus (130.83) and calcium (0.11). The percentage of organic carbon was 2.39% and the percentage of organic matter was 4.13%. These were the results of soil parameter analyzed in Pwadzu dumpsite that suggest the arthropod species in dumpsite habitat but according to Doran and Safely (1997), defined soil health as a living system that has the capacity to sustain biological productivity; promote the quality of air and water environments; and maintain plant, animal and human health. Therefore, the result indicated low alkalinity of the soil as according to soil analysis in Pwadzu dumpsite as well as low percentage of calcium in the soil which have high negative effect on biodiversity of arthropod and can reduce the species diversity and abundance of arthropod in Pwadzu dumpsite.

Finally, arthropod is the most diverse and dominant constituent of biodiversity in terrestrial ecosystems. It is the largest animal phylum constituting about 85% of all known animals in the world (Odegard, 2000). It is estimated that, worldwide, arthropod species is around 1, 170, 000 (Balakrishnan *et al.*, 2014 and Odegard, 2000). All invertebrates including insects make up more than 75% of all described global species diversity (Adjaloo *et al.*, 2012). They occur in different habitats, in both terrestrial and fresh water ecosystem (Nazir *et al.*, 2014 and Gulian and Cranston, 2005). Arthropods have adapted to nearly every possible type of ecosystem (Belamkar and Jadesh, 2012) and play an important role in the ecology of many habitats (Belasubramanian *et al.*, 2005). Therefore base on these relative review the species

diversity and abundance of arthropods in dumpsites of Wukari is small in abundance base on the factors affecting them and comparison as mentioned above.

CONCLUSION

Arthropod is the most diverse and dominant constituent of biodiversity in terrestrial ecosystems but base on this research study of diversity and abundance of arthropod in dumpsite of Pwadzu result and comparison, it indicated that there was high arthropod species diversity and abundance in Pwadzu suggests that there are relatively few successful species in this habitat in October and November. This ecosystem is probably having few ecological niches and microhabitats, thus only few arthropod species are adapted. Food webs on the other hand seem to be relatively simple in the habitat, possibly have serious effects on the abundance and diversity of arthropods. Whereas high abundance and species diversity in Pwadzu dumpsite habitat suggests a larger number of successful arthropod species, stable ecosystem, enough ecological niches and microhabitats likely to be less disturbed. Therefore, result indicates that the dumpsite habitat has the potential to support arthropod diversity and act as effective refugee for some arthropods from month of November. Additionally, this study recommends that more studies should be done in order to establish the abundance and different types of arthropods inhabiting Pwadzu dumpsites.

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