DIVERSITY OF EARTHWORMS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

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Abstract

Studies reveal that not up to 50% of earthworm species have been described in the world and the understanding of earthworm diversity is finite in most countries including Nigeria. The study was aimed at evaluating the diversity of earthworms and environmental factors affecting their abundance. Earthworms were collected from three (3) different sampling locations in Nnamdi Azikiwe University, Awka. Descriptive statistics and estimation of species abundance, dominance and diversity were used to analyze the data obtained from the study. From the study, four (4) species of earthworms were identified and recorded from the three sampling locations. *Eudrilus eugeniae* (54.9%) was the most abundant species followed by *Hyperidrilus africanus* (20.3%), *Libyodrilus violaceus* (19.6%) and *Alma millsoni* (6.3%) with the least abundant species. The result of the diversity indices showed Science village (1.13) as the most diverse habitat followed by Emelda hostel (0.86) and Boys' hostel (0.84) with the least diversity of species. Soil pH ranged from 2.25 to 4.06 and total organic matter ranged from 14.10 to 16.36%. Soil temperature was uniform with an average value of 27°C for the three sampling locations. The soil moisture content ranged from 11.19 to 14.12%. The conductivity recorded the lowest value (25.60µS/cm) in Emelda Hostel and highest value (111.8 µS/cm) in Science village. The study provided understanding into the patterns of earthworm populations in Nnamdi Azikiwe University, Awka and the need for the conservation of earthworm diversity. Better understanding about habitat and living conditions of earthworms is required to provide suitable and enhanced production of vermicompost in different geographic conditions.

Keywords: Abundance; Earthworm; Environmental factors; Habitat; Vermicomposition

1.0 Introduction

Earthworms are important invertebrates in most soil communities because of their influential role on the soil ecosystem and their relatively large number of species. It is now universally accepted that earthworms are important in the soil. The vital roles of earthworms have been widely reviewed and the roles they play in soil fertility have extensively been studied and reported by many authors (Lavelle *et al.*, 2006; Tunira and Krishan, 2010). Earthworms are divided into 23 families, more than 700 genera and more than 700 species. The population of earthworms contributes to about 40 to 90 percent and 8 percent of soil faunal biomass in most ecosystems (Sinha *et al.*, 2011). Earthworms have little contribution to total soil biomass in intensively cultivated farm lands (Blouin *et al.*, 2013). According to Gonzalez *et al.* (2006), earthworms are important invertebrates which affect the functions of soil ecosystem. Earthworms are also known to increase soil density, water holding capacity, water infiltration, litter decomposition, soil organic matter and plant growth (Chandran *et al.*, 2012). Earthworms function in the reclamation of ecosystem services through direct and indirect mechanisms especially in a situation where soils are degraded after mining (Jouquet *et al.*, 2008; Boyer *et al.*, 2015). However, many studies have shown that the diversity of earthworms is greatly reduced and native species lost due to the presence of invasive species, forest conservation and agriculture (Hairiah *et al.*, 2010). It is a known fact that studies relevant to the diversity of earthworms are limited in South Eastern Nigeria. This study evaluated earthworm diversity in Nnamdi Azikiwe University Awka.

2.0 Materials and Method

2.1 Study area

Three locations were selected for the study namely; Emelda hostel, Boys' hostel and Science village to reflect a range of landscapes encountered in the three regions all within Nnamdi Azikiwe University Awka located at the capital city of Anambra state which has a geographical coordinate of 6°12'N and 7°04'E, in the South Eastern zone of Nigeria (Onyido *et al.*, 2011). It also has a minimum and a maximum average rainfall of about 7mm and 306mm respectively. Awka has an ambient temperature range of 27°C and 34°C respectively.

2.2. Sampling of Earthworms

Earthworms were collected from the soil using a hand sorting method. This was done by making a quadrant with a measurement of 100cm length and 100 cm width. 0.5% formalin was poured on the marked soil after which a depth of 30cm was dug using a spade and earthworms were collected using forceps. Earthworms were first of all segregated according to age and species by hand sorting. Soil samples were collected at 30cm depth and air-dried, ground and sieved. They were later analyzed for moisture using wet-weight method. Soil pH and temperature were also analyzed following dilution method and thermometer. After analysis, earthworms were finally washed with tap water and stored using test tubes (Baretta *et al.*, 2007).

2.3. Earthworm preservation, identification and determination of composition

The earthworms were identified using the descriptions of Sims and Gerrard (1985) as well as with assistance of an authority at Department of Soil Science, Nnamdi Azikiwe University Awka. Earthworm species were numbered serially and fundamental field data including habitat, locality, soil texture, colour and vermicomposition observed. Clitellate individuals were examined by noting morphological parameters such as the length of the body, the skin coloration, the diameter of the body, the clitellum position, the number of total body segments, and the type of prostomium. The morphotypes were used as an indicator of species diversity (Gift, 2009).

Fig. 1: Map of Nnamdi Azikiwe University Awka showing the study locations

2.4. Statistical Analysis

- Descriptive statistics such as means were used to calculate the physicochemical parameters. Estimation of species abundance, diversity and dominance of earthworms in the three sites were calculated using the diversity indices stated below:
- Margalef's Richness Index (d): this quantifies the diversity by relating species richness to the total number of individuals;

$$d = S - 1 / \sqrt{N}$$
- Shannon -Weiner Diversity Index is denoted by H' (Shannon and Weaver, 1963)

$$H' = (\sum P_i \ln P_i)$$
- Species Equitability (Evenness) was measured with evenness index given by Pielou (1975).

$$E = H' / H'_{max}$$
- Simpson's Index (D) was calculated using the formula of Simpson (1949):

$$D = \sum P_i^2$$

3.0 Results

The mean physico-chemical parameters of soil samples collected from the three locations during the study period showed soil pH which ranged from 2.25 to 4.06 and total organic matter (TOM) which ranged from 14.10 to 16.36%. Soil temperature was uniform with an average value of 27°C for the three sample locations. The soil moisture content ranged from 11.19-14.12%. The conductivity recorded the lowest value (25.60 μ S/cm) in Emelda Hostel and highest value (111.8 μ S/cm) in Science village (Table 1).

From Emelda hostel sampling site, 16 *Eudrilus eugeniae*, 5 *Libyodrilus violaceus*, 0 *Hyperidrilus africanus* and 5 *Alma millsoni* were collected in June. In July, 25 *Eudrilus eugeniae*, 17 *Libyodrilus violaceus*, 0 *Hyperidrilus africanus* and 0 *Alma millsoni* were collected. In August, 9 *Eudrilus eugeniae*, 14 *Libyodrilus violaceus*, 0 *Hyperidrilus africanus* and 0 *Alma millsoni* were collected (Table 2).

From Science village sampling site, 16 *Eudrilus eugeniae*, 4 *Libyodrilus violaceus*, 3 *Hyperidrilus africanus* and 11 *Alma millsoni* were collected in June. In July, 26 *Eudrilus eugeniae*, 7 *Libyodrilus violaceus*, 8 *Hyperidrilus africanus* and 1 *Alma millsoni* were collected. In August, 23 *Eudrilus eugeniae*, 3 *Libyodrilus violaceus*, 10 *Hyperidrilus africanus* and 0 *Alma millsoni* were collected (Table 2).

From Boys' hostel sampling site, 6 *Eudrilus eugeniae*, 0 *Libyodrilus violaceus*, 6 *Hyperidrilus africanus* and 0 *Alma millsoni* were collected in June. In July, 9 *Eudrilus eugeniae*, 2 *Libyodrilus violaceus*, 17 *Hyperidrilus africanus* and 0 *Alma millsoni* were collected. In August,

16 *Eudrilus eugeniae*, 1 *Libyodrilus violaceus*, 11 *Hyperidrilus africanus* and 0 *Alma millsoni* were collected (Table 2).

A total number of 50 *Eudrilus eugeniae* representing 54.9%, 36 *Libyodrilus violaceus* representing 39.6% and 5 *Alma millsoni* representing 5.49% were recorded in Emelda Hostel. A total number of 31 *Eudrilus eugeniae* representing 45.6%, 3 *Libyodrilus violaceus* representing 4.41% and 34 *Hyperidrilus africanus* representing 50.0% were recorded in Boys' Hostel. A total number of 65 *Eudrilus eugeniae* representing 58.0%, 14 *Libyodrilus violaceus* representing 12.5%, 21 *Hyperidrilus africanus* representing 18.75% and *Alma millsoni* 12 (10.7%) were recorded in Science village. The relative abundance of *Eudrilus eugeniae* sampled from the three locations was the highest (53.9%) followed by *Hyperidrilus africanus* (20.3%), *Libyodrilus violaceus* (19.6%) and *Alma millsoni* having the least abundance (6.3%). This is depicted in fig. 2.

The diversity indices of earthworms sampled in the three locations are presented in the table above. Emelda Hostel recorded a Margalef richness index of 0.210 and Simpson dominance index of 1. Boys' Hostel recorded a Margalef richness index of 0.243 and Simpson dominance index of 1. Science village recorded a Margalef richness index of 0.314 and Simpson dominance index of 1. The Shannon-Weiner diversity index for the three study sites is depicted in the pie chart below (fig 3).

Table 1: Mean values of physico-chemical parameters from the three sample locations

S/N	Parameters	Sample Location		
		Emelda Hostel	Boys' Hostel	Science Village
1	pH	3.60	2.25	4.06
2	Conductivity (μ S/cm)	25.60	100.2	111.80
3	Temperature (°C)	27.00	27.00	27.00
4	Moisture Content (%)	13.74	11.19	14.12
5	Total Organic Matter (%)	15.47	14.10	16.36
6	Calcium (ppm)	10.70	8.98	8.02

Table 2: Composition of earthworms sampled in the three study sites from June-August, 2017

Species	Study Location		
	Emelda Hostel	Boys Hostel	Science Village
<i>Eudrilus eugeniae</i>	50	31	65
<i>Libyodrilus violaceus</i>	36	3	14
<i>Hyperidrilus africanus</i>	0	34	21
<i>Alma millsoni</i>	5	0	12
Total	91	68	112

Fig. 2: Relative abundance of earthworm species sampled at the three locations

Table 3: Diversity indices of earthworms sampled in the three study sites

S/N	Parameter	Sample Location		
		Emelda Hostel	Boys' Hostel	Science Village
1	S	3	3	4
2	N	91	68	112
3	H'	0.862	0.842	1.129
4	d	0.210	0.243	0.314
5	D	1	1	1

Fig. 3: Shannon-Weiner diversity indices of the three sampled locations

4.0 Discussion

The physico-chemical properties of the study locations, Emelda Hostel, Boys' Hostel and Science village was recorded during the period of sample collection and compared with the previous works of other scholars. The results obtained showed that most of the parameters were not within permissible range. The low pH range of 2.25-4.06 obtained from this study is similar to the work of Beyer *et al.* (1992), which reported pH range of 3.0-5.5 having a negative effect on the composition of earthworm in metal contaminated dredged sediment substrate while higher number of earthworms was found on older landfill with a higher pH. However, Ogunlaja and Morenikeji (2013), from their study reported a higher value pH range of 5.3-6.5 which showed no negative impact on earthworm abundance.

The temperature of the sample locations was uniform and generally high while the moisture was relatively low. This is in line with the speculations of Reddy and Pasha (1993) that soil temperature and moisture remain the most compelling factors for the diversity of earthworms. Therefore, low distribution of earthworm at the three sample locations could be linked to low soil moisture content and migration (Baker *et al.*, 1992). According to Bisht *et al.* (2003), environmental condition in tropical soil ecosystems is highly affected by season because earthworms migrate during aestivation. The most abundant species throughout the study was *Eudrilus eugeniae* followed by *H. africanus*. This is in line with the findings of Bisht *et al.* (2003) where their abundance was attributed to the presence of the

higher percentage of organic matter and moisture. According to Chaudhuri and Bhattacharjee (2011), *Eudrilus eugeniae* are distinct breeders which reproduce mostly during rainy season. The highest number of all the earthworm's species during the study period were observed in July followed by August. Actually, relative humidity increases in the month of July and August during rainy season (Mohan *et al.*, 2013). Unlike dry season period, a greater distribution of earthworm during rainy season in Science village could be attributed to higher breeding rate of earthworms (Edwards and Bohlen, 1996). Low distribution of earthworms in Boys' Hostel could be attributed to high mortality rate of juveniles which increases in the presence of appropriate growth parameters (McCredie *et al.*, 1992).

The differences in species composition among earthworms indicate the importance of habitat heterogeneity to the diversity of earthworms (Baker *et al.*, 1992). The Shannon-Wiener diversity index ranged from 0.842-1.129 with dominance indices of 1. Magurran (2004) postulated that Shannon-Weiner diversity index range between 1.5-3.5 and rarely greater than 4 for an ideal ecosystem. The gradual decrease in diversity index with increase in species dominance could be linked to increased composition of dominant earthworm *Eudrilus eugeniae*.

According to Edwards and Bohlen (1996), several ecological factors play vital roles in diversity and abundance of earthworms. Earthworm species from three study locations occurred in soils with less than 20 percent moisture, less than 5.0 pH, less than 20 percent organic matter and 27°C temperature. Moisture and temperature are inversely

related and together affect metabolism, growth, reproduction osmoregulation and respiration of earthworms (Edwards, 2004). According to Edwards and Bohlen (1996), temperature decreases diversity of earthworm due to its inverse relationship with moisture.

According to Edwards (2004), pH limits the diversity of earthworms. Ghabbour and Shakir (2002) stated that increase in diversity and abundance of earthworms could be associated with increased organic matter content in agricultural soils. Dey and Chaudhuri (2013) also reported increase in soil organic matter content which led to the increase in diversity of earthworms at the Pineapple Plantation of West Tripura.

According to Blanchart and Julka (2005), there is high species diversity of earthworms with organic matter ranging between 2.4% and 4.5%. Increased earthworm diversity with low organic matter could be linked to more dominant species in Science village.

5.0 Conclusion

The diversity of earthworms in different soil conditions in Nnamdi Azikiwe University was studied and four different earthworm species were found and there was unequal distribution in terms of abundance. Soil temperature, moisture and pH were identified as contributory regulatory factors for earthworm distribution in the three study sites. This research indicated that better understanding about habitat and living conditions of earthworms would provide suitable and enhanced production of vermicompost in different geographic conditions. Furthermore, agricultural practices need to be developed with the hope of conserving earthworm species for long term soil productivity. Therefore, conservation and management of earthworms which require more foundational knowledge, capacity-building and substantial resources should be developed.

Conflict of Interest

The authors declare no conflict of interest.

Authors Contribution

Conception: OCO, OJJ, ECD

Design: OCO, OJJ, ECD, OCJ

Execution: OCO, CCO, ECC, OJJ, ECD, OCJ

Interpretation: OCO, OJJ, ECD

Writing the manuscript: OCO, CCO, ECC

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