DIVERSITY, ABUNDANCE AND TISSUE MINERAL COMPOSITION OF INDIGENOUS EARTHWORM SPECIES OF SAWMILLS OF ABEOKUTA, SOUTH-WESTERN NIGERIA

J. A. Bamidele*, A. B. Idowu, K. O. Ademolu and S. O. Bankole

* Department of Pure and Applied Zoology, Federal University of Agriculture, P.M.B. 2240, Abeokuta, NIGERIA. E-mail: julius.bamidele@yahoo.com

[**Bamidele, J. A., Idowu, A. B., Ademolu, K. O. & Bankole, S. O.** 2016. Diversity, abundance and tissue mineral composition of indigenous earthworm species of sawmills of Abeokuta, South-Western Nigeria. Munis Entomology & Zoology, 11 (1): 63-67]

ABSTRACT: The influence of earthworm's environment on its biology needs to be well understood. This study investigated the impact of sawmilling activities on the diversity, abundance and mineral composition of the tissues of earthworm species in Lafenwa, Sapon, Isale-Ake and Kotopo sawmills of Abeokuta (7°9'12"N-3°19'35"E). The arboretum of the Federal University of Agriculture, Abeokuta was used as control. Earthworms were sampled in the morning hours from four random samples of 25x25x30cm and carefully counted. Weight of the earthworms was taken and tissues mineral composition determined using Atomic Absorption Spectrophotometer. Average population of earthworms were significantly higher ($P<0.05$) (140–516 earthworms/m^2) in the sawmill soils than in the soil of the control site (96 earthworms/m^2). A total of five earthworm species were identified from the study locations. Mean weight of adult *E. eugeniae* from Sapon (1.18g) and Kotopo (1.21g) sawmills were significantly higher than that of the control site (0.92g). K and Na were higher in the tissues of earthworms from Sapon sawmill. Significantly lower ($P<0.05$) Ca and Mg concentrations were recorded in the tissues of *E. eugeniae* from the control site compared to those of Kotopo and Sapon sawmills. Sawmilling activities is therefore not totally detrimental to earthworms' habitation.

KEY WORDS: Earthworm species, population density, sawmill, tissue minerals, diversity, soil, environment.

Earthworms have been reported to play important roles in the terrestrial ecosystem. Some of these roles include soil aeration (Olayinka et al., 2011; Owa et al., 2002), humus formation (Renu et al., 2006) and organic matter recycling (Satchell, 1967). In the tropics, they are known to help in plant residue decomposition (Tian et al., 1995) and also convert plant residue into soil organic matter (Lavelle, 1988).

Sawmills are a very common industry in the south-western part of Nigeria (Bamidele et al., 2014). This sawmills, over the years has been a major enterprise providing direct and indirect employment for thousands of people in the tropical rain forest region of Nigeria where there is abundance of trees (Ihekwaba et al., 2009). Sawdust which is the major residue of sawmilling operations is a by-product of wood processing and is generally regarded as waste (Lennox et al., 2010). Bamidele et al. (2014) reported that the sawdust produced in the sawmills are usually spread over the sawmill soils especially during the wet season.

Earthworms, being the most abundant and common soil fauna found around sawmills (Bamidele et al., unpublished) has been reported to possess more gut microflora diversity which could be needed to aid the digestion of wood particles from the abundant sawdust in the sawmills, thereby serving as a cheap source of nutrient for the earthworms' use (Bamidele et al., 2014).

Type of vegetation was regarded as a major biotic factor which determines the distribution and diversity of earthworms (Ramanujam et al., 2000). Lalthanzara et al. (2011) submitted that different land use systems may affect the abundance and diversity of soil and litter fauna. Although some literature has been documented on earthworm ecology, there is still the need to monitor the abundance, diversity and tissue mineral composition of earthworm species based on land use system. This study therefore aims at evaluating the diversity, abundance and mineral composition of the tissues of indigenous earthworm species in major sawmills of Abeokuta, South-western Nigeria.

MATERIALS AND METHODS

Experimental Site: Four major sawmills located in Abeokuta, south-western Nigeria namely Lafenwa (7°09'44" N-3°19'35" E), Sapon (7°09'12" N-3°20'49" E), Isale-Ake (7°09'48" N-3°21'23" E) and Kotopo (7°11'05" N-3°25'39" E) sawmills were selected and used for this study. They are very busy in activities and supply most of the processed wood and wood products used in Abeokuta and neighbouring towns. Earthworm samples were collected from each of the study sawmill respectively. Earthworms collected from the arboretum of the Federal University of Agriculture, Alabata, Abeokuta (7°10'00" N-3°02'00" W) were used as control.

Earthworm sample collection: Sexually mature earthworms as determined by the presence of the clitellum (Oboh et al., 2007) were collected according to the method described by Owa et al. (2013). The soil was carefully turned using a spade while the earthworms were handpicked into containers and transported to the laboratory where they were washed with distilled water. The worms were kept under refrigeration for three to four hours in order to kill them without causing any harm to them.The earthworm species were then identified to species level.

Earthworm abundance: Earthworms were collected in the morning hours from four random samples of 25 x 25 x 30 cm (Lalthanzara et al., 2011). Earthworms present in each of the sample points were carefully counted using hand-sorting method. Density of the earthworms was calculated as the number of earthworms present per meter square.

Earthworm species common to the both the control site and the study sawmills was selected for weight measurement and tissue mineral analysis while the available earthworm species was used where only one species was identified.

Weight measurement: Thirty (30) adult earthworms were randomly selected, killed for 3 – 4 hours in the refrigerator and the weight of the earthworms was taken using a sensitive electric weighing balance (Mettler PM11-K).

Mineral analysis: Earthworm samples were oven dried at the temperature of 60°C for 48 hours. Dry matters of each of the earthworms were weighed and crushed to powder. To 1g each of the powdered samples, 7ml of hydrochloric acid and 21ml of nitric acid was added and boiled on heating mantle until the colour turns colourless. The mixture was allowed to cool, filtered, and then diluted with distilled water to 100ml. An Atomic Absorption Spectrophotometer (AAS Buck 210VGP System) was used to determine the concentration of magnesium while flame photometer was used in the determination of calcium, sodium and potassium in the digested samples.

Statistical analysis: Data collected were subjected to statistical analyses which included descriptive statistics and Analysis of Variance (ANOVA) using the Statistical Package for Social Sciences (SPSS) version 16.0. Post Hoc test was done using S-N-K. P-value was set at 0.05.

RESULTS

Earthworm Species Identified

A total of five earthworm species were identified from all the study locations (Table 1) which were *Eudrilus eugeniae, Dichogaster modiglani, Alma millsoni, Hyperiodrilus africanus* and *Libyodrilus violaceous*. The greatest earthworm diversity was found in Sapon sawmill with four different earthworm species while only one earthworm species was discovered in Lafenwa and Isale Ake sawmills respectively. *Alma millsoni* was only found in the control site (Table 1). *H. africanus* and *L. violaceous* were found to be common among the earthworms of the study sawmill sites but absent in the control site while *E. eugeniae* found in the control site was also found both in Kotopo and Sapon sawmills.

Earthworm Abundance

The result of the population sampling of the earthworms on the sawmill soils is presented in Table 1. Average population of earthworms were significantly higher (140 – 516 earthworms/m^2) in the sawmill soil than in the soil of the control site (96 earthworms/m^2).

Average population of the earthworms recorded in all the locations followed the trend: Sapon sawmill > Lafenwa sawmill > Isale-Ake sawmill > Kotopo sawmill > Control site. *E. eugeniae* occurred most in the control site, Sapon and Kotopo sawmills, *H. africanus* in Isale Ake sawmill and *L. violaceous* in Lafenwa sawmill.

Mean weight of the earthworm species

The mean weight (g) of the most abundant earthworm species found in all the study location was presented in figure 1. The mean weight of adult *E. eugeniae* from Sapon (1.18g) and Kotopo (1.21g) sawmills were significantly higher ($P<0.05$) than that of the control site (0.92g) with those from Kotopo sawmill recording the highest mean weight. Average weight of 1.03g and 1.14g respectively were recorded for *H. africanus* and *L. violaceous* from Isale Ake and Lafenwa sawmills respectively.

Mineral analysis

Na, K, Ca and Mg were detected in the tissues of the earthworms collected from the sawmill locations and the control site (Table 2). Levels of Na and K recorded in the tissues of *E. eugeniae* from the sawmills and the control site were not significantly different ($P > 0.05$). However, Ca and Mg were significantly different in the tissues of *E. eugeniae* from the study locations (Table 2).

K and Na concentration were recorded higher in the tissues of earthworms collected from Sapon sawmill. Significantly lower ($P < 0.05$) levels of Ca and Mg were recorded in the tissues of *E. eugeniae* collected from the control site compared to those of Kotopo and Sapon sawmills.

DISCUSSION

This study revealed a higher population density of earthworms in the sawmills than in the control site. The sawmill soils are usually moist, particularly under sheds, beside and under piles of logs and planks awaiting processing most especially during the wet season. This is conducive for the proliferation of earthworms as clusters of earthworm casts were present there.

The activities of earthworms in sawmill soil were believed to be connected with their role in the degradation of sawdust as well as soil humidification and their pedobiological roles (Bamidele et al., 2014). Aina et al. (2006) estimated about 2288m^3 of wood waste as being generated daily from sawmills in Abeokuta. However, Bamidele et al. (2014) reported that the high volume of wood wastes released to the sawmill soils could make an enhanced litter composition of the sawmill soils and this may serve as a cheap source of nutrient for the earthworms' use. Mishra and Ramakrishnan (1988) earlier reported that the first factor determining high values of earthworm population in an area is the litter composition of the soil. Hence, the higher earthworm population recorded in the sawmills than the control site might be due to the presence of more litter composition in form of wood residue and wood dust in the sawmill soils.

The success of the earthworms from the sawmills than those of the control site in term of mean weight could also be associated with the presence of more organic matter from wood residue and wood dust on the soil of the study sawmills. Bamidele et al. (2014) earlier reported higher microbial load in the gut of earthworms from sawmills and this was assumed to be responsible for the utilization of wood dust as a source of carbon and energy in the gut of these earthworms.

Because of the constant disturbing activities and anthropogenic influence on the sawmill soils, the earthworms of the sawmill areas may need to be more active than those of the undisturbed location. This might be the reason for the higher levels of Ca and Mg recorded in the tissues of *E. eugeniae* from the study sawmills than those of the control site. In order to perform their various physiological bioactivities, Dedeke et al. (2010) suggested that the earthworm must maintain a constant electrical potential of the nerve and muscle cells and needed for this is the higher calcium and magnesium concentration. Calcium and Magnesium have been shown to be involved in regulating nervous excitability and muscular contraction i.e. maintaining the electrical potential in nerve and muscle cells (Ganong, 1995). The levels of Mg, K and Na recorded in for *E. eugeniae* in this study were higher than those reported by Dedeke et al. (2010) for *E. eugeniae*. The values of K and Mg recorded in the tissues of *H. africanus* and *L. violaceous* in this study were also higher than those recorded for *H. africanus* and *L. violaceous* by Dedeke et al. (2010).

LITERATURE CITED

Aina, O. M., Adetogun, A. C., Adedokun, M. O. & Onilude, M. A. 2006. Alternative Cooking Fuels From Sawmill Wastes. Farm Management Association of Nigeria (FAMAN) Journal, 8 (1): 45-49.

Bamidele, J. A., Idowu, A. B., Ademolu, K. O. & Atayese, A. O. 2014. Microbial diversity and digestive enzyme activities in the gut of earthworms found in sawmill industries in Abeokuta, Nigeria. Revista de Biologia Tropical, 62 (3): 1241-1249.

Dedeke, G. A., Owa, S. O. & Olurin, K. B. 2010. Macromineral Profile of Four Species of Earthworm *Hyperiodrilus africanus, Eudrilus eugeniae, Libyodrilus violaceus* and *Alma millsoni* from Nigeria. Current Research Journal of Biological Sciences, 2 (2): 103-106.

Ganong, W. F. 1995. A review of Medical Physiology. 7th Edn. Prentice Hall, New Jersey, USA.

Ihekwaba, A. E., Nwafor, A. & Adienbo, O. M. 2009. Lung Function Indices in Primary and Secondary Sawmill Workers in Port Harcourt, Nigeria. African Journal of Applied Zoology & Environmental Biology, 11: 101-105.

Lalthanzara, H., Ramanujam, S. N. & Jha, L. K. 2011. Population dynamics of earthworms in relation to soil physico-chemical parameters in agroforestry systems of Mizoram. India Journal of Environmental Biology, 32: 599-605.

Lavelle, P. 1988. Earthworms and the soil system. Biol. Fertil. Soil, 6: 237-251.

Mishra, P. C. & Ramakrishnan, P. S. 1988. Earthworm population dynamics in different Jhum fallows developed after slash and burn agriculture in north-eastern India. Proceedings: Animal Sciences, 97 (4): 309-318.

Olayinka, O. T., Idowu, A. B., Dedeke, G. A., Akinloye, O. A., Ademolu, K. O. & Bamgbola, A. A. 2011. Earthworm as Bio-indicator of Heavy Metal Pollution around Lafarge, Wapco Cement Factory, Ewekoro, Nigeria. Proceedings of the Environmental Management Conference, Federal University of Agriculture, Abeokuta, Nigeria, 489-496 pp.

Owa, S. O., Dedeke, G. A. & Yeye, A. J. 2002. Earthworm cast characteristics under Bahama grass and the question of why earthworms cast. African Journal of Science and Technology, 3 (1-2): 33-35.

Owa, S. O., Olowoparija, S. B., Aladesida, A. & Dedeke, G. A. 2013. Enteric bacteria and fungi of the Eudrilid earthworm *Libyodrilus violaceus*. African Journal of Agricultural Research, 8 (17): 1760-1766.

Ramanujam, S. N., Roy, B. & Jha, L. K. 2000. Inventory studies on the earthworm population in agroforestry systems of Mizoram. Proceedings of International Workshop on Agroforestry and Forest Products, Aizawl, 191-194 pp.

Satchell, J. E. 1967. Lumbricidae. In A. Burges & F. Raw (eds.). Soil biology. Academic: London. 259-322 pp.

Tian, G., Brussard, L. & Kang, B. T. 1995. Breakdown of plant residues with contrasting chemical compositions: Effect of earthworms and millipedes. Soil Biology and Biochemistry, 27: 277-280.

Table 1. Earthworm species diversity and abundance (earthworm/m^2) in the study locations, Abeokuta, Nigeria.

	EARTHWORM SPECIES	EARTHWORM POPULATION
Control	*Eudrilus eugeniae,* (Kinberg,1866) *Dichogaster modiglani* (Rosa,1896) *Alma millsoni* (Grube, 1855)	96[d]
Kotopo sawmill	*Hyperiodrilus africanus,* (Beddard,1890) *Eudrilus eugeniae,* *Libyodrilus violaceous* (Beddard,1891)	140[cd]
Sapon sawmill	*Hyperiodrilus africanus,* *Eudrilus eugeniae,* *Libyorilus violaceous,* *Dichogaster modiglani*	516[a]
Isale Ake sawmill	*Hyperiodrilus africanus*	264[bc]
Lafenwa sawmill	*Libyorilus violaceous*	364[b]

**Mean values of earthworm population having the same superscripts are not significantly different *(P* >0.05)

Table 2. Mineral composition (mg/g) of the earthworm tissues.

	Earthworm species	Na	K	Ca	Mg
Control	*E. eugeniae*	1.50±0.30[a]	1.60±0.30[ab]	1.49±0.01[c]	1.98±0.00[c]
Kotopo	*E. eugeniae*	1.60±0.30[a]	1.30±0.30[b]	1.54±0.01[b]	2.11±0.01[a]
Sapon	*E. eugeniae*	2.00±0.20[a]	2.00±0.20[a]	1.87±0.01[a]	2.04±0.00[b]
Isale-Ake	*H. africanus*	2.30±0.30	2.00±0.20	1.93±0.00	2.45±0.00
Lafenwa	*L. violaceous*	1.20±0.20	1.20±0.20	1.83±0.00	2.16±0.01

*Mean values (±Standard Deviation) for *E. eugeniae* in the same column having the same superscripts are not significantly different (*P* > 0.05)

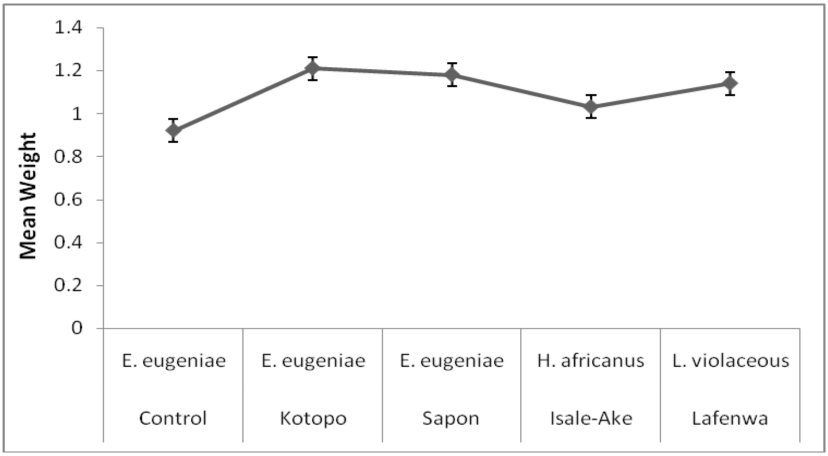

Figure 1. Mean weight of the most abundance earthworm species in the study locations.