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Impact of soil types and petroleum effluents on the earthworm, *Eudrilus eugeniae*

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Abstract: *Earthworm, Eudrilus eugeniae, exposed to different concentrations of dump-site soil and petroleum effluents exhibited different morbidity and mortality responses. Lake sediments caused varied fluctuations in weight over a 20 day exposure period. Colour changes and mortality up to 15% were observed in earthworms cultured in 100% lake sediment, while weight loss, coiling and sluggish movement were observed in 50% lake water. The effects of 100% dump-site soils were more pronounced as 40% death, swelling, body lesions, stiffening, coiling and low reproduction were recorded. Earthworms were useful as an organism in testing the toxicity of dump-site soils and effluent from a petroleum industry. Dump-site soils and soils polluted with petroleum effluent reduced populations of earthworms and this could subsequently affect other components of the ecosystems associated with earthworm activities.*

Key words: *Dump-site, Population, Activities*

Introduction

Activities of earthworms in the soil show that they are of great importance. They feed on decayed organic matter and leaves which are dragged into their burrows thereby acting as decomposers (Edwards and Bohlen, 1996). They ingest large quantities of soil during their life cycle and enrich the soil by bringing subsoil to the surface to mix with topsoil. Thus, they are truly soil dwelling organisms with their bodies in direct contact with soils throughout their life cycle. They help improve soil drainage, aeration and root growth (Joschko *et al.,* 1989) and have a high biomass in soil. The toxic effects of chemicals or heavy metals through soil contamination and land particles will affect their populations, activities and subsequently the grazing and detritus food chains. It has been observed that the earthworms are sensitive indicators in oil contaminated soils (Dorn and Salanitro, 2000). They have also been observed to be valuable as index organisms in evaluating the impact of soil borne contaminants (Ireland, 1979; Callahan *et al.,* 1991; Schaefer, 2001). With the increasing rate of industrialization and urban development, there is no doubt that the environment we live in today is exposed to greater pollution. There is need, therefore, to evaluate an offsite test for assessing the impact of dumpsite soils and petroleum effluent from a drilling company on the activities of the earthworm species *Eudrilus eugeniae*.

Materials and Methods

An artificial lake was created by channeling all effluents produced as a result of oil drilling operations in the vicinity of an oil drilling company in Delta State, Nigeria. Sediments from the bottom of the artificial lake were collected. The sediments and lake water were used for the treatments in experiments I and II. Adult earthworms weighing between 1.0-1.5 g per worm and identified by the clittelium on segments 13 to 18 were used in this study. The worms were harvested from a culture in the Biological Gardens of the University of Lagos.

In the first experiment, ten adult earthworms were placed in each plastic bucket filled to about 25 cm depth with normal loamy soil (this served as the control – treatment I) while the following soil mixtures were treatments II to IV respectively.

II - 80% loamy soil to 20% lake sediment
III - 50% loamy soil to 50% lake sediment
IV - 100% lake sediment.

Each treatment was replicated twice. To ensure the free flow of air and water, holes were bored at the bottom of the buckets. The plastic buckets were also lined at the bottom and covered at the top with a mesh to prevent worms from escaping and to allow free drainage of water. To ensure that the earthworms were incubated in an environment close to their natural habitat and because of the length of the incubation period, they were fed with additional food of ground rat dung at the rate of 1.5 g per container every other day (Ebere and Akintonwa, 1995). Water (100 ml) was added daily to ensure that the containers remained moist in order to prevent dehydration of the worms.

In the second experiment, ten adult earthworms were placed in each plastic bucket filled to about 25 cm depth with normal loamy soil. The treatments were as followed:

I - Control – use of purified water (water that had not passed through water pipes collected directly from the water plant)
II - 80% purified water + 20% artificial lake water
IICI - 50% purified water + 50% artificial lake water

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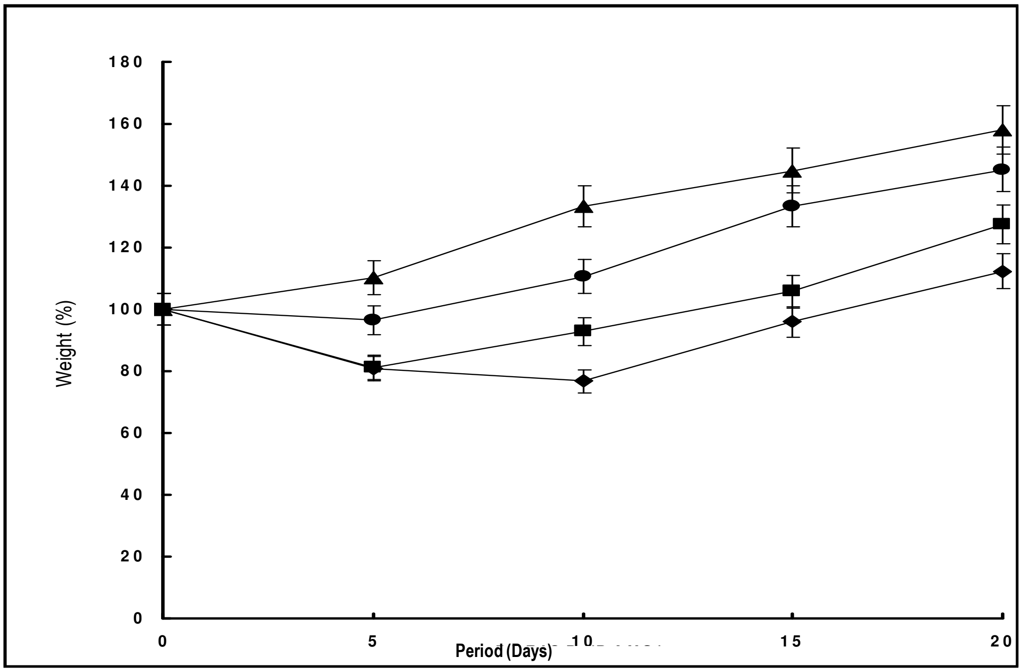

Fig. 1: Weight changes in earthworm using lake sediments lomy soil over a 20 day period
(▲) Control; (●) 20% lake sediment; (■) 50% lake sediment; (◆) 100% lake sediment

The experiment was repeated twice. To moisten the soil for each treatment daily, 100 ml of water mixtures and control were used.

In the third experiment, soil from a dump-site at Isolo area of Lagos State, Nigeria was used. The dump-site receives solid wastes from homes and industries. The treatment details were same as in experiment I, but dump-site soil replaced lake sediment.

All the experiments were monitored over a 20 day period. The characteristic features monitored as test end points included mortality rates and morbidity responses, which included lesions on body, swellings, coiling and stiffening, These were examined by hand sorting of the worms (Callahan *et al.,* 1991). The worms were weighed prior to the start of the experiment and at 5 day intervals up to the end of the experiment by carefully washing them with tap water and placing them on wet filter paper for 12 hours to empty their guts. This gave an index of weight changes (biomass development) over the period of the experiment. Results were tested for significance at 5% level using t test.

Results and Discussion

There were significant variations in the biomass of the earthworm (Fig. 1, 2 and 3). Earthworms treated with artificial lake water (Fig. 2) and dumpsite soil (Fig. 3) show a remarkable reduction in the weight of the earthworms except for the control. However, there was a greater weight loss in earthworms treated with dumpsite soil. Although, earthworms in the 100% dumpsite soil showed a remarkable reduction in weight by the 10th day of incubation, gradual increase was noticed till the 20th day of incubation. The results in the three experiments show some sensitivity of the earthworms to the treatments.

Although, dung is a highly nutritious food for the growth of earthworms (Ebere and Akintonwa, 1995), weight loss was recorded in virtually all treatments indicating that soil and effluent probably contained some toxic substances that caused biomass losses. Ejisackers (1987) as cited by Curry (1994), opined that biological adaptations and niche problems made earthworms to avoid feeding on contaminated soils. These may be responsible for the eventual weight loss as the worms choose to starve rather than feed on the soils.

Observations of earthworms in lake sediment showed that they changed colour from coffee brown to pink with their guts appearing empty. Earthworms tolerated the lake sediments more than the lake water and dumpsite soils as they had no lesions on their body with no swellings. Moreover, the earthworms were not stiffened and only 5% of them coiled up. Coiling was more intense in the dumpsite soil where it was 60% for the treatment with 50% dumpsite soil and 80% coiling for 20% and 100% dumpsite soils compared to 25% and 40% coiling for 20% and 50% lake water respectively. Death was however more pronounced in the dumpsite soil where 40% death occurred in 100% dumpsite soil and 15% death was observed for 100% lake water. Analysis of the soils for heavy metals showed that high morbidity responses in the dumpsite soil may be due to high

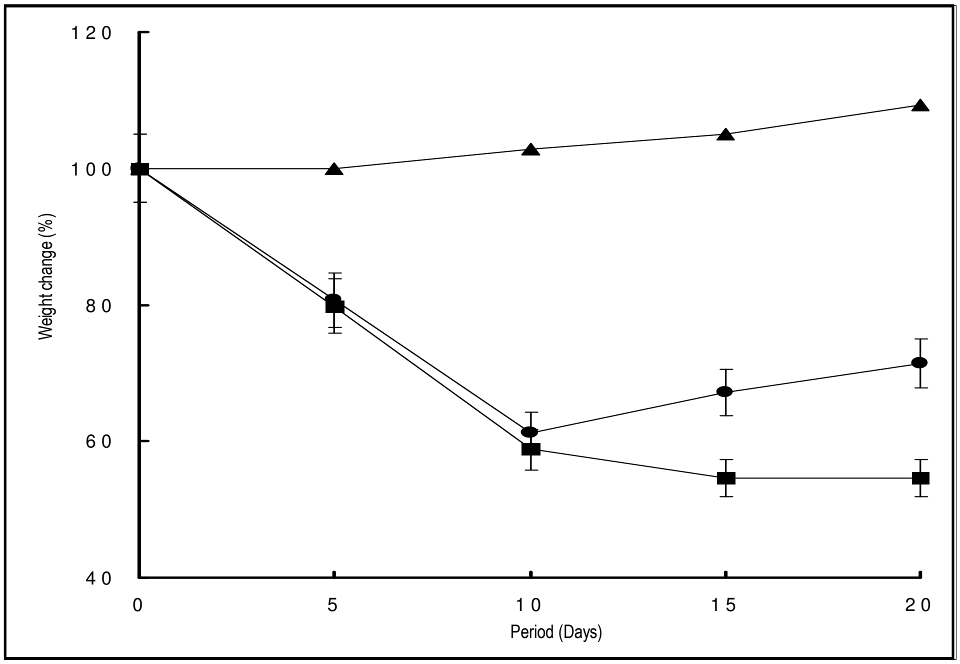

Fig. 2: Weight changes in earthworm using artificial lake water over a 20 day period
(▲) Control; (●) 20% artificial lake water; (■) 50% artificial lake water

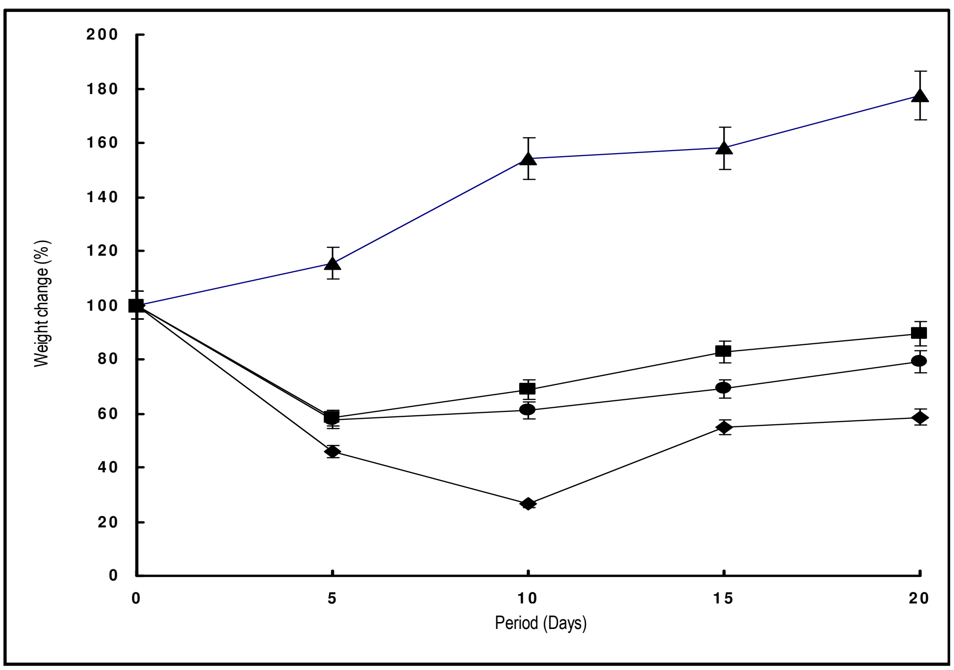

Fig. 3: Weight changes in earthworm using dump site soil over a 20 day period
(▲) Control; (●) 20% dump site soil; (■) 50% dump site soil; (◆) 100% dump site soil

levels of heavy metals in the soil. Lead levels were 70 mg/kg, Zn 114 mg/kg and 122 mg/kg with a pH of 8.6. These levels were 20 times higher than the other treatments except for Fe in the lake sediment, which was 2650 mg/kg, thus they were more tolerant in their responses.

There is no doubt that areas where wastes are usually dumped become toxic with high concentration of metals and organochlorides. The chosen site is a landfill site earmarked by the Lagos State Waste Management Agency over 15 years ago and it receives its wastes from both domestic and industrial sources. Intense coiling in earthworms has been attributed to lack of sufficient soil moisture as coiling helps conserve body moisture (Callahan *et al.,* 1991). Thus although the soils were moistened regularly, the high level of contaminants may have been responsible for moisture not been readily available to the earthworms.

Earthworms are known not to suffer significant morbidity responses and direct mortality from exposure to organochlorides and heavy metals but they may accumulate the residues in their tissues even above the amount in the soil they inhabit (Ireland, 1979; Curry, 1994). These substances have been confirmed to affect sexual development and cocoon production (Cikutovic *et al.*, 1993). Specifically, heavy metals such as zinc, lead, cadmium, manganese and high concentration of sodium chloride as metals/ compound affect reproduction in earthworms (Fisher *et al.,* 1997). This is evident from the few number of offspring observed in the experiment with the dumpsite soil where only two offsprings were produced in the treatment with 100% dumpsite soil.

The results from this study confirm that the dumpsite soil, petroleum effluent and lake sediments had detrimental effects on the earthworm *E. eugeniae* to varying degrees. The reduction in weights reduced reproductive ability and the possibility of accumulation of heavy metals in their tissues may eventually have long term consequences on earthworm populations and subsequently on the food chain.

References

Callahan, C. A., C. A. Menzie, D. E. Burmaster, D. C. Wiborn and T. Erns: On site method for assessing chemical impacts on the soil environment using earthworms. A case study at the Baird and McGuire superfund site. *Environ. Toxicol. Chem.,* **10**, 817-826 (1991).

Cikutovic, M. A., L. C. Fitzpatrick, B. J. Venables and A. J. Goven: Spermcount in earthworms (*Lumbricus terrestris)* as a biomarker for environmental toxicology: Effects of cadmium and chlordane. *Environ. Pollut.,* **81**, 123-125 (1993).

Curry, J. P : Grassland Invertebrates: Ecology, influence on soil fertility and effects on plant growth. Chapman and Hall, London, Glasgow and New York. p. 437 (1994).

Dorn, P. B. and J. P. Salanitro: Temporal ecological assessment of oil contaminated soils before and after bioremediation. *Chemosphere,* **40**, 419-426 (2000).

Ebere, A. G. and A. Akintonwa: Acute toxicity studies with earthworms *Lumbrius terrestis. Bull. Environ. Contam. Toxicol.,* **55**, 766-770 (1995).

Edwards, C. A. and P. J. Bohlen: Biology and ecology of earthworms. Chapman and Hall Ltd., London. p. 112 (1996).

Fisher, E., L. Molnar and C. A. Edwards: Growth and reproduction of *Eisenia foetida* (Oligochaeta, Lumbriadae) in semi natural soil containing various metal chlorides. *Soil Biol. Biochem.,* **29**, 667-670 (1997).

Ireland, M. P.: Metal accumulation by earthworms *Lumbricus rubellus, Dendrobaena veneta* and *Eisenia tetraedra* living in heavy metal polluted sites. *Environ. Pollut.,* **13**, 66-69 (1979).

Joschko, M., H. Diestel and O. Larink: Assessment of earthworm burrowing efficiency in compacted soil with a combination of morphological and soil physical measurements. *Biol. Fert. Soils,* **8**, 191-196 (1989).

Schaefer, M.: Earthworms in crude oil contaminated soils: Toxcity tests and effects on crude oil degradation. *Environ. Asses. Remed.,* **8**, 35-37 (2001).