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LEVELS OF CADMIUM, CHROMIUM AND LEAD IN DUMPSITES SOIL, EARTHWORM (*LYBRODRILUS VIOLACEOUS*), HOUSEFLY (*MUSCA DOMESTICA*) AND DRAGON FLY (*LIBELLULA LUCTOSA*)

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Chemical analyses of cadmium, chromium and lead in dumpsites soil, earthworm *(Lybrodrilus violaceous)*, housefly (*Musca domestica*) and in indigenous dragonfly (*Libellula luctosa*) were performed by atomic absorption spectrophotometry to estimate the degree of metal pollution in two Lagos dumpsites located at Iba Housing Estate (dumpsite A) and Soluos along LASU - Isheri road (dumpsite B). Soil pH and moisture content were also determined. Chromium was not detected (ND) in most of the samples except in the soil samples whose mean and standard deviation (SD) were 0.43 ± 0.37 µg/g and 0.23 ± 0.37 µg/g, respectively for dumpsites A and B, and the earthworm samples harvested from dumpsite B (1.00 ± 1.41 µg/g). The cadmium levels were 4.00 ± 3.16 µg/g and 7.50 ± 6.37 µg/g for earthworm; 2.86 ± 1.43 µg/g and 4.29 ± 3.74 µg/g for housefly, 0.75 ± 1.26 µg/g and 1.25 ± 0.95 µg/g for dragonfly, respectively for dumpsites A and B. However, the concentration of lead in the invertebrates were, 130.00 ± 112.58 µg/g and 105.75 ± 94.44 µg/g for earthworm; 145.71 ± 101.87 µg/g and 225.71± 79.31 µg/g for housefly; 165.00 ± 69.78 µg/g and 85.00 ± 69.73 µg/g for dragonfly respectively for dumpsites A and B. Cadmium and lead levels were found to be higher in the invertebrates harvested from the dumpsites than those collected from the non-dumpsites. The non-dumpsite values for cadmium were 1.24 ± 0.94 µg/g, 0.45 ± 0.56 µg/g and 0.38 ± 0.14 µg/g for earthworm, housefly and dragonfly, respectively. Similarly, the non-dumpsite lead levels for earthworm, housefly and dragonfly were 23.12 ± 10.11 µg/g, 20.75 ± 11.85 µg/g and 33.62 ± 14.95 µg/g, respectively.

Key words: Heavy metals, Pollution, Dumpsites, Cadmium, Chromium, Lead, Earthworm, Housefly, Dragonfly.

Introduction

All trace metals are natural constituents of soils and enter the food chain mainly through uptake from soils (Rain 1995; Freedman 1996; Jinadasa *et al* 1997; Starr and Taggart 1998).The dumping of waste on soils has been found to increase their heavy metals content (Harrop *et al* 1990; Adeniyi 1996; Spurgeon and Hopkin 1996). The disposal of wastes pose a major environmental problem in heavily populated cities, especially in developing countries (Main 1995). This result in urban pollution and unsanitary conditions (Alloway and Ayres 1994; Van der Watt *et al* 1997). Organisms habiting contaminated soils take up heavy metals (John and Morgan 1990; Khan and Weiss 1993; Garate *et al* 1993; Pize and Josen 1995; Dudka *et al* 1996; Abdul-Rida 1996; Krivolutsky 1996; Marinussen *et al* 1997; Nuortev and Elberg 1999).Heavy metals uptake by earthworms and other soil animals is known to be influenced by a number of factors such as soil metal concentration, soil pH, soil texture and soil organic matter as well as the balance between uptake and egestion by the organisms (Crawford *et al* 1996; Smolders *et al* 1998). Insects are also known to take up metals through feeding in a contaminated habitat (Peters 1988; Rain 1995). The use of invertebrates as indicators of heavy metals pollution is of interest in cities like Lagos where dumpsites are now in the heart of residential/ industrial areas. The documented adverse health effects of cadmium and lead have led to public concern over soil contamination with these metals (Naqvi and Howell 1993; Spurgeon and Hopkin 1996; Dudka *et al* 1996).

The objective of the study is to evaluate the levels of cadmium, chromium and lead in dumpsite soil, earthwortm, housefly and dragonfly. The out come is expected to provide baseline data that will assist the appropriate agencies in the formulation and enforcement of a sustainable environmental action plan for waste management in Nigeria's sprawling cities.

Materials and Methods

Sampling. Samples were collected randomly from two dumpsites (A and B). Dumpsite A is located at Iba Housing Estate, Ojo, while dumpsite B is located opposite Soluos Hotel

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Table 1
Heavy metals in the soil and animals samples

Metals		Mean levels µg / g ± SD				$F_{(0.05)}$
		Soils	Earthworm	Housefly	Dragonfly	
Cd	*a)	1.01 ± 0.63	4.00 ± 3.16	2.86 ± 1.43	0.75 ± 1.26	0.92
	b)	0.61 ± 0.26	7.50 ± 6.37	4.29 ± 3.74	1.25 ± 0.95	1.92
	c)	0.21 ± 0.04	1.24 ± 0.94	0.45 ± 0.56	0.38 ± 0.14	4.09**
Cr	a)	0.43 ± 0.37	ND	ND	ND	2.48
	b)	0.23 ± 0.37	1.00 ± 1.41	ND	ND	3.13
	c)	ND	ND	ND	ND	-
Pb	a)	13.00 ± 6.30	130.00 ± 112.58	145.71 ± 101.87	165.00 ± 69.78	1.97
	b)	14.00 ± 13.56	105.75 ± 94.44	225.71 ± 79.31	85.00 ± 69.73	1.26
	c)	4.13 ± 2.35	23.12 ± 10.11	20.75 ± 11.85	33.62 ± 14.95	6.35*

*a, Dumpsite A; b, Dumpsite B; c, Control site. **, Significant difference between the metal levels in the soil and animal samples at $p < 0.05$; SD, Standard deviation; ND, Not detected.

along LASU - Isheri Road. While control samples were collected from a non-dumpsite (within the premises of Lagos State University, Ojo) far from the dumpsites. Samples of soil and animals were collected between July-October 1999 and July-October 2000. The wastes in dumpsite A are essentially domestic as the dumpsite is located within a residential estate, while that of dumpsite B are predominantly agricultural / industrial waste materials trucked to the site. In both sites, the wastes are burnt in continually smoldering fires that emitted foul smoke and gases leaving residual wastes.

The soil samples were collected from the two dumpsites and a non-dumpsite (control site) with the aid of locally made soil auger (screw down and pull) from the soil surface (0-15 cm, Adeniyi 1996). Earthworms *(Lybrodrilus violaceous)* were collected from the respective sites by digging the soil to about 15 cm depth and the soil handpicked for worms. The collected earthworms were washed with distilled water and identified. Similarly, housefly *(Musca domestica)* and dragonfly *(Libellula luctosa)* were collected with the aid of a sweep net. After collection the insects were sorted out and identified using morphological structures. Only adult insects and matured earthworm with clitellium were used. The earthworm and insects were then dried in the oven between 50 - 60°C for four days (Garate *et al* 1993; Idowu 1994; Mackay *et al* 1997).

Instrumentation. The determination of the heavy metals were performed with the use of a Perkin Elmer and Oak Brown Atomic Absorption Spectrophotometer. The instrument's settings and operational conditions were done in accordance with the manufacturer's specifications. The instrument was calibrated with analytical grade standard solutions (1 mg/dm^3) in replicate.

Physico-chemical analysis. The animal samples were prepared for analysis by following the methods described by Nuorteva and Elberg (1999), Pize and Josen (1995) using 0.5g of dried sample in 10 ml conc. HNO_3.

The soil pH and moisture content were determined according to Adeniyi *et al* (1993). The heavy metals were extracted from the soil samples for analysis using 5 g of sieved air-dried samples with 2N HNO_3 (Adeniyi 1996; Abdul-Rida 1996).

Statistical analysis. ANOVA was used to estimate statistically significant levels of metals at 95% confidence level (Pentecost 1999).

Results and Discussion

Chromium was not detected (ND) in most of the samples (Table 1), earthworms harvested from dumpsite B had a chromium level of 1.00 ± 1.41 µg/g; soil samples had 0.43 ± 0.37 µg/g and 0.23 ± 0.37 µg/g for sites A and B, respectively (Fig 1). However, chromium was not detected in the housefly and dragonfly samples (dumpsites and non-dumpsite) and in the earthworms harvested from dumpsite A (Table 1).

This trend had been observed by earliers (Pize and Josen 1995; Adeniyi 1996; Marinussen 1997). These differences were however, statistically non-significant at 95% confidence level.

The cadmium and lead concentration (Table 1) in the earthworm, housefly and dragonfly samples were higher than in soils in both the dumpsites and control site. Fig 2 and 3 and may be taken as an indication of bio-accumulation of metals by the animals (Peters 1988; Khan and Weis 1993; Abdul-Rida 1996; Nuorteva and Elberg 1999). The contamination of these animals by cadmium and lead (Table 1) is of concern because

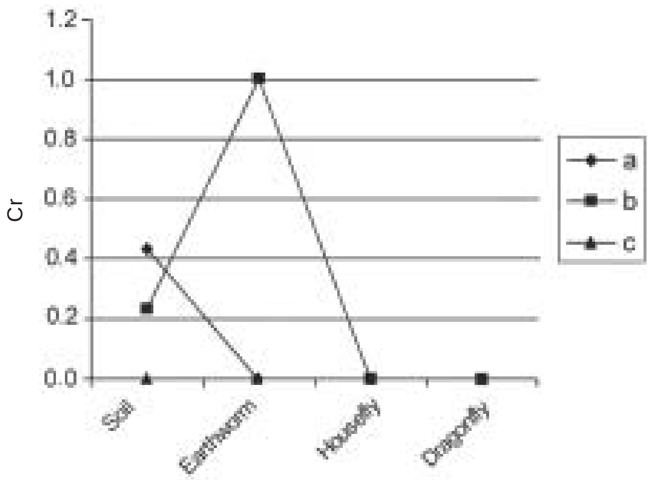

Fig 1. Concentration of chromium in the soil and animal samples collected from the dumpsites (A and B) and control site (C).

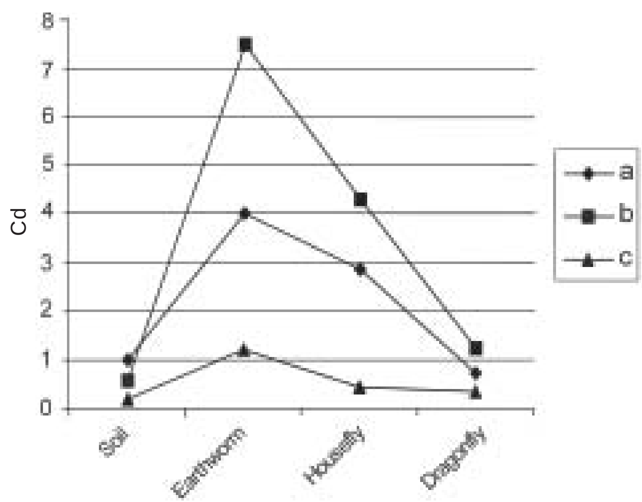

Fig 2. Concentration of cadmium in the soil and animal samples collected from the dumpsites (A and B) and control site (C).

they are important links in the complex food web (Spurgeon and Hopkin 1996; Starr and Taggart 1998).

In dumpsite B (Table 1), where the waste materials were predominantly agricultural / industrial, the Pb concentration in the housefly samples was higher than for dumpsite A and control samples. Earlier studies have shown that cadmium and lead concentrations in earthworms, housefly and dragonfly varied widely depending on the nature of the sites (Marino *et al* 1995; Crawford *et al* 1996). This observation is equally true for the present study (Fig 2 and 3). It should be noted however, that the chromium, cadmium and lead levels observed for the non-dumpsite samples were generally lower than for the dumpsites values. The differences in the levels of chromium, cadmium and lead in the dumpsites A and B soil, and animal samples are non-significant at 95% confidence

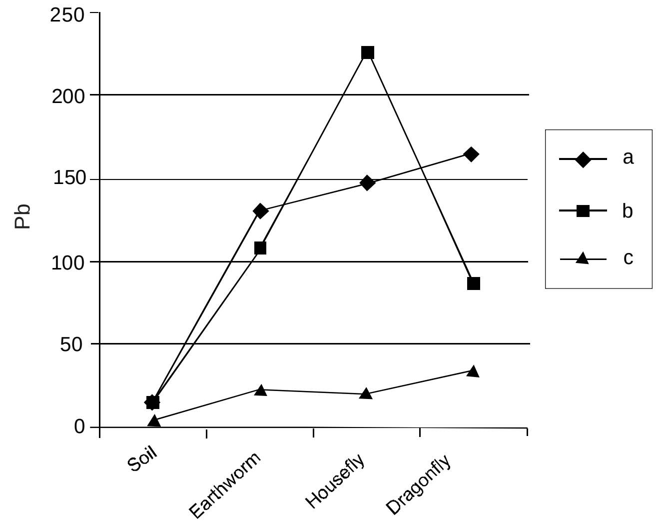

Fig 3. Concentration of Lead in the soil and animal samples collected from the dumpsites (A and B) and control site (C).

Table 2
Some characteristics of the sampled soils

Parameters	a	b	c
pH	8.94 ± 0.20	10.14 ± 0.20	7.21 ± 0.38
Moisture content (%)	35.15 ± 6.24	16.34 ± 4.23	44.47 ± 3.46
Texture*	SL	SL	SCL

SL, Sandy loam; SCL, sandy clay loam; a, dumpsite A; b, dumpsite B; c, non-dumpsite (Control site).

level. This is an indication that the metals detected in the soil and animal samples collected from the two dumpsites is point source (that is form the waste materials dumped in the respective sites). (Pize and Josen 1995; Freedman 1996; Krivolutsky 1996; Bagatto and Shorthouse 1996). The levels of these metals in the animals and soil samples are of concern since these metals are known to bioaccumulate as they journey through the environmental and biological reservoirs (Harrop *et al* 1990; Wang and Demshar 1992; Garate *et al* 1993; Rain 1993; Bartsh *et al* 1999). Moreover, these animals are important links in the complex food web (Peters 1988; Freedman 1996; Spurgeon and Hopkin 1996).

Table 2 shows characteristics of the sampled soils. The soil pH value of 8.94 ± 0.20, 10.14 ± 0.20 and 7.21 ± 0.38 for dumpsites A, B and control site, respectively agreed with the trend reported before for Lagos dumpsite soils (Adeniyi *et al* 1993; Adeniyi 1996). While the soil moisture content were 35.15 ± 6.24%, 16.34 ± 4.23% and 44.47 ± 3.46%, respectively for dumpsites A, B and control site. These values are expected for tropical soils with sandy loam (SL) and sandy clay loam (SCL) texture (Adeniyi and Oyedeji 2001).

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