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Metal Contents in Water and Aquatic Plant (Macaranga Heudelotic) from Ora River Around Nigerian Cement Factory, Nkalagu

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Abstract: Heavy metals in water and Macarange hendelotic from Ora River by the Nigerian cement factory's location, were determined. Metals such as Na, K, Mg, Ca, Zn, Fe, Cu, Pb and Cd were analysed using atomic absorption spectrophotometry (Atomic Absorption/Emission spectrometer 200-A). The results showed that lead concentrations were below detection limit in water samples whereas all the metals analysed in Macaranga hendelotic were all detected. Metals (Cu, Zn, Pb and Cd) concentration in Macaranga hendelotic in this study were within those levels obtained by scientist from Avicema Marine community in Shenzhen, China. Statistical analysis using spearman rank order correlation showed that Ca, Mg, K, Zn, Fe and Pb were not significant. Only Cd showed positive relationship whereas, Na and Cu were inversely correlated. Monthly variations of metal concentrations were recorded. The results further showed that Macaranga hendelotic is an adequate biological indicator of heavy metal in Nigerian Rivers.

Key words: Ora Rive, Macaranga Hendelotie, spectrophotometry, Nigerian Rivers, biological indicator

INTRODUCTION

Pathways by which trace element can enter terrestrial and aquatic environments include atmospheric deposition and point and non point source releases to surface water. Heavy metals in the atmosphere derive from natural sources such as volcanic emissions and anthropogenic sources such as combustion of municipal solid waste and of fossil fuels in coal and oil-fired power plants (Rice, 1999), releases from metal smelters, automobile emissions and biomass burning. Point sources of trace elements include municipal sewage sludge, effluents to surface waters from coal-fired power plants, releases directly to water courses from industrial uses and in some areas, acid mine drainage (Forstner and Wittmann, 1981). Nonpoint sources of trace elements include natural weathering of geologic materials and anthropogenic sources such as runoff of manure and artificial fertilizers from farm fields and releases from wear of automobile parts.

High concentrations of arsenic in drinking water result from either anthropogenic contamination, or weathering of naturally occurring subsurface materials (Peters *et al.*, 1999). Dust produced by the cement industry and the shipyard is usually metal-enriched and affects the marine environment, where it is often deposited (Angelidis *et al.*, 1980; Scoullos and Dassenakis, 1982, 1983[a]). Studies of Ndiokwere and Ezihe (1990) revealed high concentrations of heavy meals in soils and plants in the vicinity of Delta Steel Company and Nigerian National Petroleum Corporation Refinery with the concentrations of cadmium, chromium, copper, nickel, lead and zinc being inversely correlated to distance from the industrial complexes. The accumulation and the dissolution of metal elements cause serious river pollution, a critical problem for minas Gerais Government, studies of freshwater ecosystems in Minas Gerais are just beginning and ecological problems have been identified in rivers, lakes and reservoirs (Coelho and Giano; 1994, Jordao *et al.*, 1999). Heavy metals today have a great ecological significance due to their toxicity and accumulative behaviour (Purvis, 1984). A major contributor to high levels of arsenic, mercury chromium, nickel and iron in River Ramos is proximity of activities of various oil companies and accumulative behaviour (Purvis, 1984). A major contributor to high levels of arsenic, mercury chromium, nickel and iron in River Ramos is proximity of activity of various oil companies and geochemical processes. All the pollution loads from up north and South are transported down to the marine water (Nwajei, 2002). Dust from a cement industry in Benue State, Nigeria was sampled and analysed, the result obtained showed that the dust is chemically composed of silicon, aluminum, calcium and iron. It was observed that highest concentration of the dust as well a its chemical content occurred nearest the factory and decreased with increasing distance from the

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factory (Nst and Sahllsuku, 2002), the level of some trace element in water lily and lettuce along the banks of Angwon Rogo stream in Jos, Nigeria found by Salami and Non, (2000) indicated that the concentrations of most of the elements decreased down stream suggesting their removal by the aquatic plants. They observed that water lettuce contained higher concentration of the trace elements than water lily. The availability of lead in plants is dependent upon a contamination of soil condition and the response of the root to lead in the soil water (Andrews *et al*., 1989). When lead is bound highly by plants tissue, little translocation occurs (Alstad *et al*., 1982). Roadsides plants contain more lead than plants from control sites (Prince *et al*., 1974). Accumulation of cadmium in agricultural soils from atmospheric deposits and its increased uptake is of worldwide concern compared to relatively few critical situation in aquatic systems (Keller and Brunner, 1983).

The objectives of this research are therefore: to determine the concentrations of heavy metals in water and aquatic plant from Ora River; to identity the possible sources of metal contaminants and to compare the relationships of metals between water and aquatic plant.

MATERIALS AND METHODS

Two sample points were located along the Ora River in Ebonyi States shown in Fig. 1. Sample point 01 was located by the bridge along Eha-Amufu road and sample 02 was located just after the water pumping station of Nigeria cement factory, at Nkalagu. At the same sample 02 location, Macaranga heudelotic (Aquatic plant) was collected.

Water and Macaranga heudelotic samples were collected for the period between February to September 2003. water samples from Ora River were collected in 100 mL polyethylene stoppered bottles which have been washed with soap solution, rinses three times with pure water and then rinsed another three times with 1% HNO_3. The river water to be collected was use to rinsed the bottle and stoppers for three times. The final samples were collected at a depth of several centimeters. The water samples were stoppered and labeled. Filtration was done on location by passing water samples through a 0.45µm Millipore membrane filter placed in an all glass Millipore filtering system. The membrane filters had been washed with 1% HNO_3 followed by rinsing in high purity water prior to filtration (Bordin *et al*., 1992). The water samples were taken to the Laboratory and stored in cold at 4°C prior to digestion.

One Hundared of each water sample was transferred into a beaker and 5.00 cm^3 of concentrated HNO_3 was added. The beaker containing the solution was place on a hot plate and evapourated to near dyness making sure that the sample does not boil. The beaker containing the residue was cooled. Then 5.00 cm^3 of the concentrated

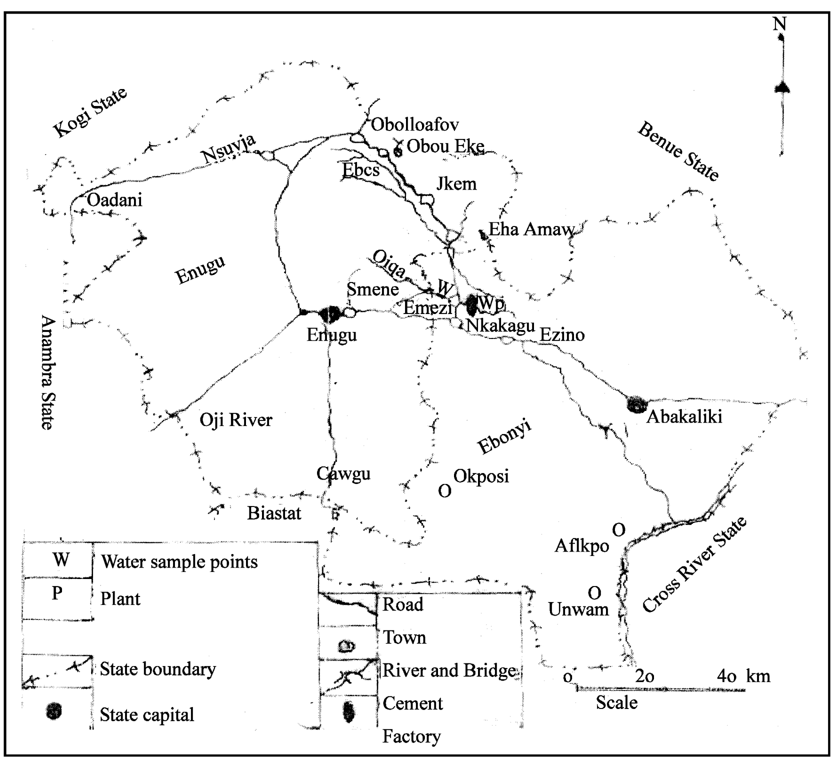

Fig. 1: Map of Enugu and Ebonyi States Showing the Sample Points

HNO_3 was further added. This was returned to the hot plate until digestion was completed. Then 2.0 cm^3 of concentrated HNO_3 was added and the beaker was warmed slightly to dissolve the residue (APHA, 1990). The digested sample was filtered. The filtrate was made upto 50 cm^3 mark with deionised water. The solutions were returned to the laboratory and kept in the refrigerator before they were analysed. The blank were also prepared using the sample procedure of digestion as in samples.

The leaves of Macaranga heudelotic (aquatic plant) were collected from Ora River in clean dried black polyethylene bags. The leaves were air-dried and stored for digestion (Zurera *et al*., 1978). Dried leaves of aquatic plant (5 g) were weighted out and digested with an acid mixture (40 mL) prepared by mixing equal volumes of $HClO_4$ and HNO_3 (Greenberg *et al*., 1992). The resultant solutions in the conical flask were placed on hot plate with constant stirring before they were transferred into the fume cupboard and allowed to stand overnight. After cooling, the mixture was filtered and the filtrate was made up to 100 mL in a volumetric flask with deionizer water. The solutions were stored in the refrigerator, prior to metal determination by atomic absorption spectrophotometry (Atomic Absorption/Emission Spectrometer 200-A).

RESULTS AND DISCUSSION

Mean concentration of the metals analysed in water and Macaranga heudelotic from Ora River are given in Table 1 and 2, respectively.

Lead was below detection limit in water samples taken from Ora River, also copper was not detected in water obtained from sampling site 02. Metals such as Na, K and Fe were found to have high concentrations when compared with those of Ca, Mg, Cu, Pb and Cd. This study revealed that there were no significant mean difference between sampling sites 01 and 02. This implies that the presence of metals in water samples can be traced to the same source.

The mean metal concentrations in Macaranga heudelotic as shown in Table 2 revealed that all the metals analysed were detected. Calcium is the most abundant metal in Macaranga heudelotic studied. Metals such as Mg, K and Fe are also considered to have high concentrations in Macaranga heudelotic. The metal contents in Macaranga heudelotic exceeded those obtained in water from the same river. These high concentrations of metals in Macaranga heudelotic is an indication of bioaccumulation. Monthly variations of metal contents in water and Macaranga, heudelotic were recorded in this study.

Spearman rank order correlations studied between river water and aquatic plant as shown in Table 3 revealed that only cadmium was positively correlated whereas sodium and copper were inversely correlated. The positive relationship found for cadmium indicates that aquatic plant is contaminating the water through leaching. The inverse relationship recorded for sodium and copper implies that non is polluting each other. According to Bordin *et al*. (1992) inverse correlations can occur if the metal uptake by aquatic plant is more rapid than the uptake by water. The statistical analysis further revealed that metals such as calcium, magnesium, potassium, zinc, iron and lead were not significant. This is an indication that the sources of these metals are not from the Ora River. Therefore the sources of these metals are traced to soil leaching., runoff occasioned by the rainfall, effluents and emissions from the Nigerian cement factory at Nkalagu.

The concentrations of copper, zinc lead and cadmium recorded in Macaranga heudelotic in this study were within the elevated elemental ranges (1.8-13.6, 3.4-69.5, 0.4-3.61 and 0.013-0.295 $\mu g\ g^{-1}$ dry weight for Cu, Zn, Pb and Cd, respectively) reported by Peng *et al*. (1997) from Avicemia Marine community in Shenzhen, China.

Table 1: Mean concentrations of metals (ppm) in water from Ora River

	Sampling site 01		Sampling site 02	
Element	Mean	Range	Mean	Range
Ca	0.358	0.227-0.583	0.335	0.191-0.583
Mg	1.029	0.30-3.09	0.785	0.302-2.93
Na	3.58	0.61-13.077	3.588	0.56-13.31
K	2.382	0.90-6.82	1.781	0.91-3.75
Cu	0.033	0.00-0.038	ND*	-
Fe	2.36	0.912-4.55	2.491	0.385-4.60
Zn	0.056	0.00-0.138	0.042	0.01-0.078
Pb	ND*	-	ND*	-
Cd	0.004	0.00-0.006	0.009	0.00-0.037

* Not Detected

Table 2: Mean concentrations of metals (mg kg^{-1} dry weight) in Macamaga Heudelotic from Ora River

Element	Mean	Range
Ca	1065.429	40.33-3000.00
Mg	100.505	3.626-245.609
Na	19.155	4.917-49.37
K	360.347	9.108-2350.88
Cu	2.430	0.33-14.67
Fe	108.978	8.45-684.67
Zn	3.368	1.169-5.22
Pb	0.981	0.00-2.40
Cd	0.201	0.011-1.24

Table 3: Spearman rank correlation between River Water and Aquatic Plant (RW/AP)

Metal	RW/AP
Ca	NS
Mg	NS
Na	-0.918*
K	NS
Cu	-0.989*
Zn	NS
Fe	NS
Pb	NS
Cd	0.98*

*<0.01 NS = Not Significant

CONCLUSION

Metals analysed in water and Macaranga heudelotic from Ora River revealed the lead was below detection limit in water samples. Metals such as calcium, magnesium, potassium and iron were considered to have high concentrations in Macarnaga heudelotic. The metals analysed in Macaranga heudelotic were found to have exceeded those in water. This is an indication of bioaccumulation. The monthly variations of metal levels were recorded.

Statistical analysis carried out using the spearman rank order correlation, showed that metals such as calcium, magnesium, potassium, zinc, iron and lead were not correlated. Cadmium was found to be positively correlated whereas sodium and copper were inversely correlated. The presence of metals in water and Macaranga heudelotic are attributed to soil leaching, runoff causes by rainfall, effluents and emissions from the Nigeria cement factory at Nkalagu. It is also possible that accumulated toxic metals in Macaranga heudelotic such as cadmium, sodium and copper can contaminate the water through leaching. Macaranga heudelotic is an adequate biological indicator of heavy metal pollution in Nigerian Rivers.

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