SEASONAL VARIATIONS OF SOME TRACE METAL CONCENTRATIONS IN SOME FISH SPECIES ON A SRETCH OF RIVER KUBANNI, ZARIA.

BY

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ABSRACTS

In a semi-urbanized stretch of river Kubanni, Zaria, seasonal variations of some trace metals (copper, zinc and lead) in fish species (Clarias sp, Tilapia sp and Alestes sp) were investigated over a period of eight months. Water and fish were sampled monthly, pooled separately and seasonal analysis of each trace metals determined using atomic absorption method. The concentration of each of the elements in water was higher in the dry season than during the rainy season. The dry and rainy season concentrations of copper, zinc and lead were 6.85 ± 10.66 μgg⁻¹ & 1.45 ± 1.10 μgg⁻¹; 2.13 ± 1.68 μgg⁻¹ & 0.15 ± 0.05 μgg⁻¹; and 0.52 ± 0.50 μgg⁻¹ & 0.31 ± 0.14 μgg⁻¹ respectively. Similarly, all the three fishes accumulated more zinc and lead in the dry season than during the rainy season. Tilapia species and to some extent, Alestes species being pelagic had a higher concentration of trace metals than Clarias species which is a bottom dwelling fish. Tilapia species may therefore be a better indicator species than Clarias species for monitoring trace metals in water bodies. Reasons for the observed variations in the trace metals were discussed.

INTRODUCTION

During the recent years, serious concern has been voiced about the rapidly deteriorating state of freshwater bodies with respect to trace metal pollution. It is recognized that in freshwater systems, trace metals have high pollution potentials (Martin *et al.*,1976; Tariq *et al.*,1996) that could be measured through the use of fish(Noris and Lake, 1984; James, 1985; Adakole, 2000). In addition, the trace metals in such waters may undergo rapid changes affecting the rate of uptake or release by sediments (Boudou, 1981) thus influencing living organisms via the water-sediment chain. Relationships between the consumption of fish containing trace metals, and human exposure to trace metals (WHO, 1990, Paradis *et al.*, 1997) through fish consumption has been documented by various researchers. Over the years, metal contamination of fish has caused serious public hazards (James, 1985; WHO, 1996). Lawani and Alawode (1996) reported objectionable levels of lead and mercury in the tissues of the African Mudfish, *Clarias gariepinus* from River Niger in Nigeria.

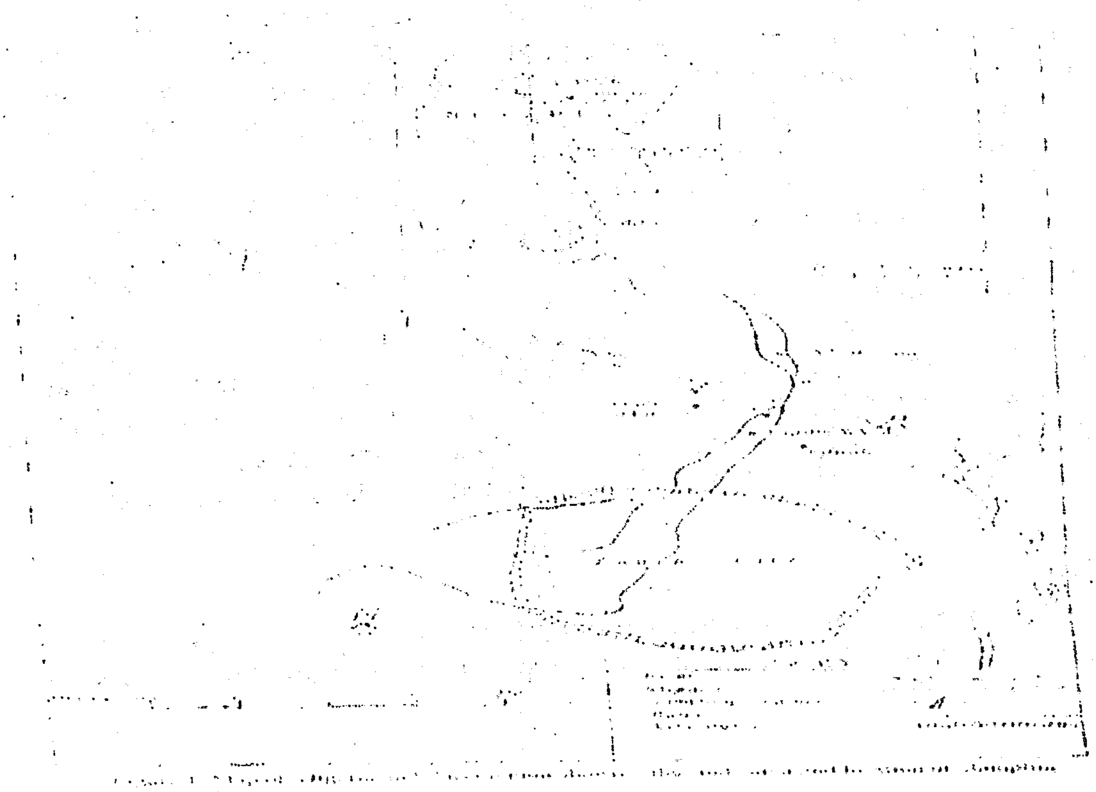
Nigeria, like other developing countries of the world, the level of metal pollution of freshwater bodies, especially the rivers is no longer within safe limits for human consumption. Earlier In base-line studies have identified elevated levels of certain trace metals in local freshwater systems, especially rivers (Omoregie et al., 2002) arising mainly from agricultural and industrial processes (Adakole, 2000). The assessment of metal pollution is an important aspect of most water quality assessment programmes. The Global Environment Monitoring System

(GEMS) programme GEMS/WATER includes ten metals: Al, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Zn. Arsenic and Se (which are not strictly metals) are also included (WHO, 2003). The United States Environmental Protection Agency (US EPA, 1985) considers eight trace elements as high priority: As, Cd, Cu, Cr, Pb, Hg, Ni and Zn. Most other countries include the same metals in their priority lists. The ability of a water body to support aquatic life, as well as its suitability for other uses, depends on many trace elements. Some metals, such as Mn, Zn and Cu, at increased concentrations in sewage, industrial effluents or from mining operations can have severe toxicological effects on humans when present in trace concentrations are important for the physiological functions of living tissue and regulate many biochemical processes (WHO, 2003). The same metals, however, discharged into natural waters and the aquatic ecosystem (UNESCO - UNEP - WHO, 1996). Thus, the present study was aimed at evaluating the seasonal concentration levels of Cu, Pb and Zn in the tissues of Clarias spp, Tilapia spp and Alestes spp in a stretch of river Kubanni.

MATERIALS AND METHODS

Study Area JK

Zaria, situated in the Northern guinea Savanna zone, possesses a tropical climate with distinct wet and dry seasons. The nature of Kubanni river channel varies noticeably both from station to station and from season to season. A dam is situated on the river's upstream which is used by the Ahmadu Bello University, Zaria for its water supply (Figure 1). Three sampling stations were chosen on a stretch of the river for the study. Station 1 in Tudun-Jukun is located upstream of station 2. Station 2 is in Sabon-gari/Tudun-wada is 20 meters downstream after river Kubanni had received effluents from Kamacha stream. Station 3 is close to the outskirts of the town. The distance



between the stations ranged from 1.30km to 1.50km.

Sampling

temperatures (oc) of the air (2m above water level), surface water (1cm below water surface) and water depth (1m below water surface) were determined in the field using a mercury thermometer. Water velocity was calculated using a floating plant material placed on the water surface and allowed to flow over a measured distance. Transparency was measuered using a Secchi disc. pH and electrical conductivity by using Pye Unicam model 292 pH meter at 25 ^{O}C and conductivity meter EBA/10 model respectively. Total dissolved matter and dissolved oxygen were analyzed as described (Lind, 1979). Total hardness and total alkalinity were determined by titration methods (APHA, 1985).

From each station, for each season, water samples were collected monthly, preserved by adding 1ml conc. HNO_3 to about 150ml of the sample and then pooled. From the pool, 50ml water sample taken was filtered and concentrated to about 30ml and 5.0ml HNO_3 was added. It was then made up to the 50ml mark in a 50ml volumetric flask with distilled water followed by analysis with Unicam 919 atomic absorption spectrophotometer. Similarly, during each season of the study period, fish samples caught from Kubanni River were bought from local fishermen, identified, weighed and grouped according to species. Each sample was then dried to a constant weight in an oven set at 60 ^{O}C. 4.0g of each fish was then ashed in a muffle furnace at a temperature of 525.0 ^{O}C. The ash obtained was then cooled and dissolved in 5.0ml conc. HNO_3 and made up to 50.0ml with de-ionized water. This solution was filtered and analyzed for metals using Unicam 919 atomic absorption spectophotometer.

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RESULTS

Mean seasonal values of water physicochemical characteristics are presented in Table 1.Except for the values of electrical conductivity, total dissolved matter, dissolved oxygen, total hardness and total alkalinity, values of other parameters were all not significant ($P > 0.05$) between the two seasons. Similarly, variation in total hardness, pH, transparency, velocity, and water depth temperature within the sampling stations were not significant ($P > 0.05$). The concentrations in water of each of the elements were higher in the dry season than in the rainy season (Figure 2). Copper is predominant at station 1 while lead predominates in station 2. Correlation analysis between the elements in water and fish tissue revealed a significant positive ($P < 0.05$) correlation coefficient for lead. However, the correlation coefficient between copper in water and copper in fish tissues was not significant ($P > 0.05$).

The accumulation of zinc and lead by all the three fishes were higher in the dry season than during the rainy season (Figure 3). Copper concentration in Alestes spp followed a similar trend. However Clarias spp and Tilapia spp accumulated more copper in the rainy season than in the dry season. Zinc was the most (82.20μgg^{-1}) accumulated while lead was the least (2.45μgg^{-1}). There was a seasonal high significant difference ($P < 0.05$) in the metals accumulated by the three fishes.

DISCUSSION

Using the criteria proposed by Federal Environmental Protection Agency (FEPA, 1991), the mean values of most of the parameters are within the range of values accepted as safe for aquatic life and for domestic water supply.

Seasonal mean values (± S.D) of water physicochemical characteristics recorded from three sampling stations along a stretch of river Kubanni

Parameter	Season	Sampling stations 1	2	3
Atmospheric temperature (^{O}C):	Rainy season	19.00 ± 4.32	22.25 ± 2.62	23.00 ± 2.82
	Dry season	22.00 ± 0.01	23.50 ± 1.73	24.25 ± 0.95
Water surface temperature (^{O}C)	Rainy season	20.00 ± 2.70	23.75 ± 1.25	23.50 ± 2.51
	Dry season	22.30 ± 0.80	23.13 ± 0.63	24.25 ± 0.50
Water depth temperature (^{O}C)	Rainy season	21.00 ± 3.82	22.75 ± 3.86	22.75 ± 2.21
	Dry season	25.12 ± 0.08	24.38 ± 1.10	24.62 ± 0.75
Velocity (m/sec.)	Rainy season	0.02 ± 0.02	0.13 ± 0.24	0.17 ± 0.32
	Dry season	0.15 ± 0.04	0.13 ± 0.06	0.14 ± 0.08
Transparency (m)	Rainy season	0.16 ± 0.05	0.36 ± 0.14	0.33 ± 0.11
	Dry season	0.12 ± 0.04	0.14 ± 0.14	0.13 ± 0.12
pH	Rainy season	7.50 ± 0.85	7.25 ± 0.31	7.66 ± 0.90
	Dry season	7.30 ± 0.52	7.08 ± 0.86	7.36 ± 0.80
Total alkalinity ($mg^{-1}.CaCO_3$)	Rainy season	56.50 ± 11.74	174.75 ± 122.82	179.87 ± 38.79
	Dry season	34.25 ± 7.59	42.87 ± 8.12	46.0 ± 7.61
Total hardness ($mg^{-1}.CaCO_3$)	Rainy season	158.65 ± 40.59	258.50 ± 134.02	182.50 ± 65.53
	Dry season	55.00 ± 12.48	72.00 ± 17.81	83.50 ± 10.37
Electrical conductivity (μS/cm)	Rainy season	351.25 ± 87.79	795.00 ± 120.41	667.50 ± 67.01
	Dry season	147.50 ± 25.00	211.25 ± 40.90	235.00 ± 31.09
Total dissolved matter (mg^{-1})	Rainy season	230.00 ±82.86	515.00 ± 77.24	435.00 ± 42.03
	Dry season	99.00 ± 16.45	137.50 ± 26.29	152.50 ± 22.17

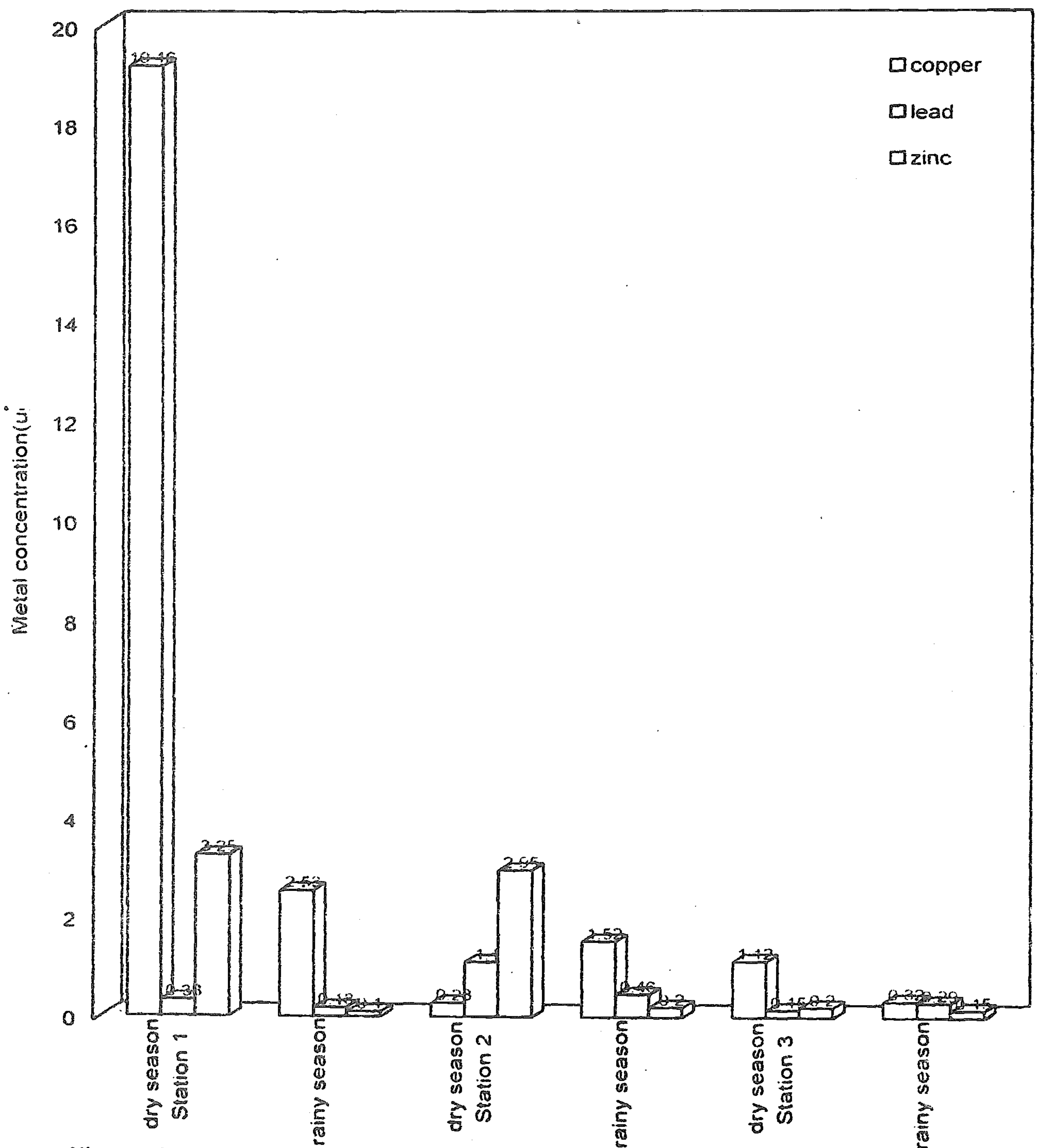

Figure 2: Mean seasonal variation in copper, lead and zinc along stations on a stretch of river Kubanni.

The occurrence of metals in the stretch of river kubanni. can be attributed to anthropogenic sources. Okoye et al., (1991) made similar conclusion on the heavy metal enrichment of Lagos lagoon. Metals in natural waters can exist in truly dissolved, colloidal and suspended forms (US EPA, 1985). The proportion of these forms varies for different metals and for different water bodies (Adakole, 2000). Consequently, the toxicity and sedimentation potential of metals change, depending on their forms. This probably partially accounts in for the different concentration levels of Copper, lead and zinc within the three stations and between the seasons. The comparatively high copper concentration in station 1 during the dry season may be due to leaching from nearby garbage while the higher lead concentration at station 2 may be attributed to its closeness to a high way and battery effluents. Lead is widely used as an additive in petroleum for automobiles and is emitted to the atmosphere in their exhaust gases, thereby entering the hydrological cycle (WHO, 1990, Paradis et al., *1997). Water pollution by heavy metals as a result of human activities could cause serious ecological problems. This situation is aggravated by the lack of natural elimination processes for metals (Bartram and Balance, 1996). As a result, metals shift from one compartment within the aquatic environment to another, including the biota, often with detrimental effects. There is also an increasing toxicological risk for humans (WHO, 2003).*

Many organisms have been found to accumulate certain contaminants in their tissues during their lifetime without detectable effects on normal physiological functions in a phenomenon known as bioaccumulation (UNEP - WHO, 1996). The contaminants are effectively detoxified and/or tolerated within the organism, often as a result of binding into particular tissues in the body. The bioaccumulation of copper, lead and zinc in both seasons (except for Zinc where in the dry season, *Clarias* spp had a higher zinc concentration than *Tilapia* spp) by *Tilapia* spp is higher than for *Clarias* spp. *Tilapia* spp may therefore be a better indicator species for monitoring trace metals concentration in fish communities than *Clarias* spp. If the correlation between the concentration of a contaminant in a water body and the concentration in the tissues of an aquatic organism is good, the organism may be used for chemical monitoring of the contaminant in the water body as an alternative-monitoring medium to water or particulate matter (Chapman, 1996). Biological tissues sometimes have the advantage that the contaminant concentrations being analysed are much higher than in water or particulate matter, thus requiring lower detection limits and, possibly, less sophisticated analytical techniques. In addition, biological tissues can be bulked together to give a greater total concentration.

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