



# Assessment of Some Heavy Metals in Two Species of Goby (*Porogobius Schelegelii* and *Bathygobius Soporator*) From Buguma Creek, Niger Delta

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## Abstract

This study investigated the heavy metal concentrations in different organs such as gills, muscles, liver and gastrointestinal tract (GIT) of two species of Goby: *Porogobius schelegelii* and *Bathygobius soporator* from Buguma Creek, Rivers State, Nigeria. The fish samples were collected from the creek and were preserved in ice chest box and transported to the laboratory for analysis. Samples were digested by using standard laboratory methods. The concentrations of metals were analyzed using a Varian AA240 Fast Sequential Flame Atomic Absorption Spectrophotometer (AAS). The Results obtained indicated that heavy metals such as Chromium (Cr), Lead (Pb), Zinc (Zn), Cadmium (Cd), and Nickel (Ni) were significantly higher ( $p < 0.05$ ) in the liver of the two species than in the muscle, gills and the GIT. Comparatively, the concentrations of these metals were higher in the specie *B.soporator* than *P. schelegelii* in all the organs of the fishes under consideration. The heavy metal concentrations recorded in this study were above the limits recommended by Food and Agricultural Organization/ World Health Organization. The high concentration of heavy metals above permissible level suggests the need for caution during the consumption of these species from Buguma Creek due to health implications associated with heavy metals.

**Keywords:** Heavy metals; Aquatic environment; Creek; Pollution; Goby.

## 1. Introduction

Heavy metals are classified as non-biodegradable in nature and are considered as major environmental pollutants causing harmful effects in living organisms especially in aquatic environments Kpobari, *et al.* [1]. Conversely, most of the aquatic organisms have the capacity to accumulate heavy metals from various sources such as sediments, soil erosion and discharges of wastewater from domestic and industrial sectors [2, 3]. Hence, build up of heavy metals in aquatic organisms can pose a long lasting effect on biogeochemical cycling in the ecosphere [3]. According to Swaibuh Lwanga, *et al.* [4], heavy metals are introduced into the environment by a wide range of both natural and anthropogenic sources. Natural sources include volcanic activities; erosion and occurrence of some natural disasters such as earthquakes, and cyclones [5]. While, the commonest forms of anthropogenic sources of heavy metals are industrial and domestic activities. However, Industrial wastes, such as petroleum exploration and exploitation are common phenomenon in Niger delta region of Nigeria [6]. Heavy metals that are obtained from all these sources constitute potential dangers to the environment. Industrial discharges, domestic sewage, non-point source such as urban run-off and atmospheric precipitation are the main sources of toxic heavy metals that enter aquatic systems in both rural and urban centers of the world [7].

The need for a better understanding of heavy metal concentration and dispersion patterns in different aquatic environments and organisms have been reported following the discovery of high levels of some toxic heavy metals (particularly cadmium and lead) in fish and other living organisms [8]. Heavy metal concentrations in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and biota, which generally exist in low levels in water and attain considerable concentration in sediments and biota [9]. Fish, which is often at the top of the aquatic food chain concentrate large amount of these metals from the surrounding waters. Fishes are important and the largest groups of vertebrates in the aquatic system and heavy metals can be accumulated through both food chain and water [10].

Fishes have been considered good indicators for heavy metal contamination in aquatic systems because they occupy different trophic levels with different sizes and ages. Fishes can be considered as one of the most significant indicators in fresh, brackish and marine water systems for the estimation of metal pollution level [11]. In addition, fishes are widely consumed in many parts of the world by humans, and polluted fish may endanger human health. Tank goby (*Porogobius schelegelii*) and frill fin goby (*Bathygobius soporator*) belongs to the member of the family Gobiidae, which is the largest family of marine, brackish and fresh water fishes occurring worldwide in tropical and temperate regions. They are demersal and non-migratory species that inhabits various depths of depth of brackish

water [12]. Information on the heavy metal concentrations in these species are limited, necessitating the need for this work. This study therefore evaluated the heavy metal levels in two species of goby from Buguma creek, Niger delta.

## 2. Materials and Methods

### 2.1. Sampling Location

The study was carried out in Buguma, Creek in Asari Toru Local Government Areas of Rivers State, Nigeria. These areas are surrounded by large water bodies and the natural vegetation in this area varies from the mangrove to the freshwater swamp forests. The prevailing climate hydrographic conditions thus favour a thriving fishery, artisanal and aquacultural activities.

### 2.2. Experimental Fish

Plate-1a. *P.schelegelii*



Plate-1b. *B. soporator*



### 2.2. Fish Sampling and Experimental Procedure

Fish samples (*Porogobius schelegellii* and *bathygobius soporator*) were taken fortnightly from artisanal fishers at landing site in Buguma Creek. Fifty (50) fish samples of each the specie were measured and weighed at each sampling. The fish samples were prepared by oven-drying, dry-ashing and digested using a mixture of 5 ml of 1 N nitric acid and 10 ml of 1 N hydrochloric acid, afterwards, the acid digest was filtered and made up to 20 ml by diluting to volume with distilled water. Heavy metal concentrations (Nickel, Chromium, Lead, Cadmimu and Zinc) for all extracts were determined using Agilent Technologies 200 series AA Atomic Absorption Spectrophotometer (AAS) as described by AOAC [13].

### 2.3. Statistical Analysis

All the data were expressed as mean and standard deviation of mean. The statistical package, SPSS Version 22 was used for the data analysis. The data were analyzed using two way ANOVA and the means were separated using Duncan multiple range test (DMRT) and the means were considered significant at 5 % ( $P < 0.05$ ).

### 3. Results

Heavy metal concentrations in some organs of *P. schelegelli* from Buguma Creek are presented in Table 1. The values of all the metals under consideration were significantly ( $P < 0.05$ ) higher in the liver when compared to other organs. The same trend were however observed in the specie *B.soporator* (Table 2), where the values of the metals were significantly higher ( $P < 0.05$ ) in the liver when compared to other organs. The Comparative values of chromium (Cr) in the two species of goby fish considered in this study are presented in Figure 1. The highest value (1.89mg/Kg) of Cr was observed in the liver of *B.soporator*, while the lowest (0.094) was recorded in the GIT of *P.schelegelli*. Comparatively, the values of lead (Figure 2) was consistently higher in *B.soporator* than that of the specie *P. schelegelli* in all the organs, with the highest value of 0.27mg/Kg in the liver of *B.soporator* and the lowest (0.05mg/Kg) in the muscle of *P.schelegelli* (Figure 2). Furthermore, the comparative values of Zinc in two species of goby fish from Buguma creek are presented in Figure 3. The results indicated that higher values of Zinc were observed in all the organs except in the gills. However, the values of Zinc were consistently higher in *B.soporator* than that of *P.schelegelli* (Figure 3). Comparative value of Cadmium (Cd) in the two species of goby fish are presented in Figure 4. The highest value (0.09mg/Kg) was recorded in the liver of *B.soporator* and the lowest (0.03mg/Kg) also in the muscle of *B.soporator* specie. Moreover, Figure 5 shows the comparative values of Ni in the two species of goby fish from Buguma crrek. The results obtained revealed that the values of Nickel were higher in the specie *B.soporator* than that of *P. schellegelli* in all the organs (Figure 5).

Table-1. Heavy metals in some organs of *P. schelegellii* from Buguma Creek, Niger Delta

Organs	Heavy metals (mg/Kg)				
	Cr	Pb	Zn	Cd	Ni
Gills	1.04±0.01 <sup>b</sup>	0.12±0.01 <sup>b</sup>	0.19±0.01 <sup>a</sup>	0.04±0.01 <sup>a</sup>	1.01±0.01 <sup>b</sup>
Muscles	0.98±0.02 <sup>a</sup>	0.05±0.02 <sup>a</sup>	0.78±0.02 <sup>b</sup>	0.06±0.02 <sup>a</sup>	0.99±0.02 <sup>a</sup>
Liver	1.17±0.01 <sup>b</sup>	0.19±0.02 <sup>b</sup>	0.81±0.01 <sup>b</sup>	0.07±0.01 <sup>a</sup>	1.88±0.01 <sup>b</sup>
GIT	0.94±0.01 <sup>a</sup>	0.09±0.01 <sup>a</sup>	0.97±0.01 <sup>b</sup>	0.03±0.01 <sup>a</sup>	0.99±0.01 <sup>a</sup>
FAO/WHO [14] Limits	0.50	0.03	0.50	0.50	1.50

Means within the same column with different superscripts are significantly different ( $P < 0.05$ )

Table-2. Heavy metals in some organs of *B.soporator* from Buguma Creek, Niger Delta

Organs	Heavy metals (mg/Kg)				
	Cr	Pb	Zn	Cd	Ni
Gills	1.67±0.11 <sup>b</sup>	0.25±0.01 <sup>b</sup>	0.35±0.01 <sup>a</sup>	0.05±0.01 <sup>a</sup>	1.97±0.22 <sup>b</sup>
Muscles	1.11±0.13 <sup>a</sup>	0.09±0.02 <sup>a</sup>	0.99±0.01 <sup>b</sup>	0.03±0.02 <sup>a</sup>	1.03±0.10 <sup>a</sup>
Liver	1.89±0.22 <sup>b</sup>	0.28±0.02 <sup>b</sup>	0.89±0.01 <sup>b</sup>	0.09±0.01 <sup>a</sup>	1.99±0.30 <sup>b</sup>
GIT	1.04±0.10 <sup>a</sup>	0.13±0.01 <sup>a</sup>	0.91±0.02 <sup>b</sup>	0.04±0.01 <sup>a</sup>	1.02±0.12 <sup>a</sup>
FAO/WHO [15] Limits	0.50	0.03	0.50	0.50	1.50

Means within the same column with different superscripts

Figure-1. Comparative Values of Chromium (Cr) in two species of Goby Fish in Buguma Creek

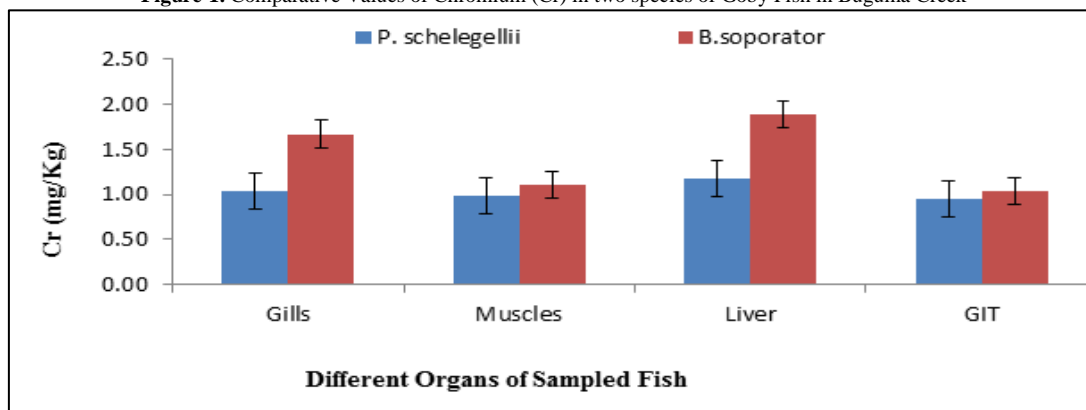


Figure-2. Comparative values of lead (Pb) in two species of Goby Fish in Buguma Creek

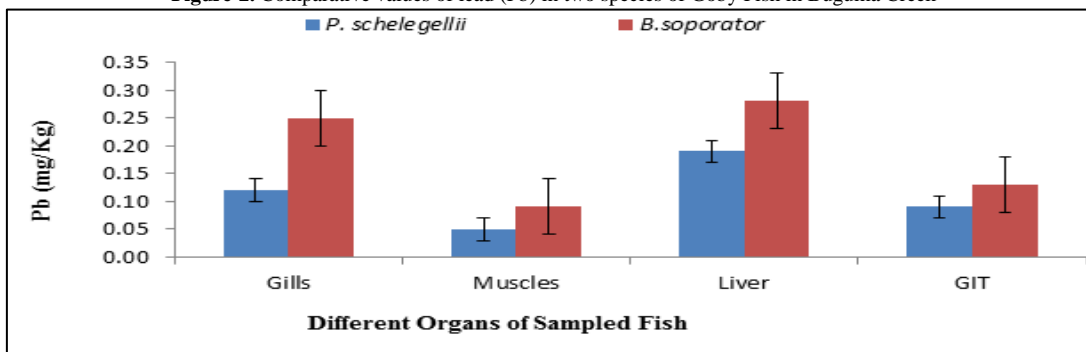


Figure-3. Comparative Values of Zinc (Zn) in two species of Goby Fish from Buguma Creek

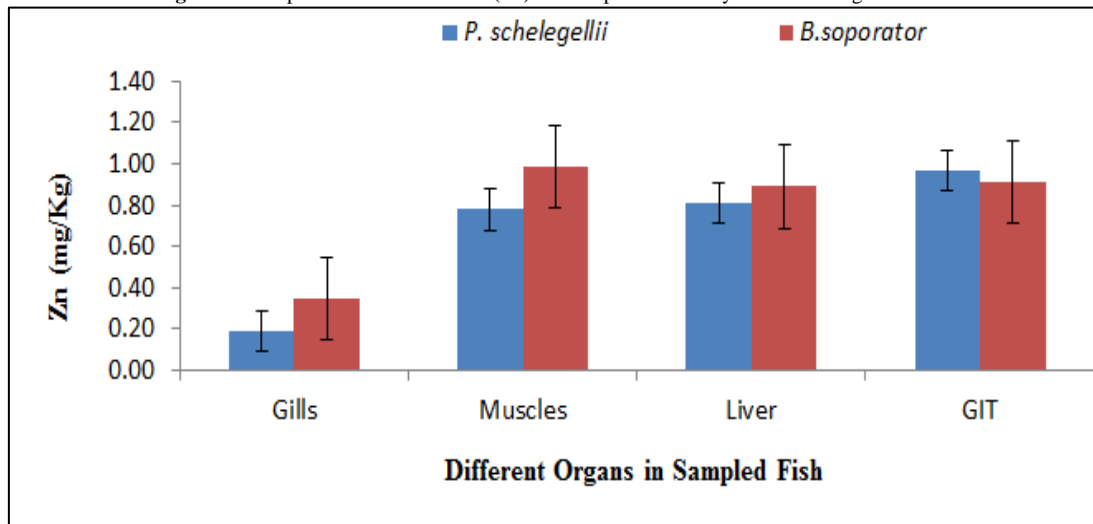


Figure-4. Comparative Values of Cadmium (Cd) in two species of Goby Fish from Buguma Creek

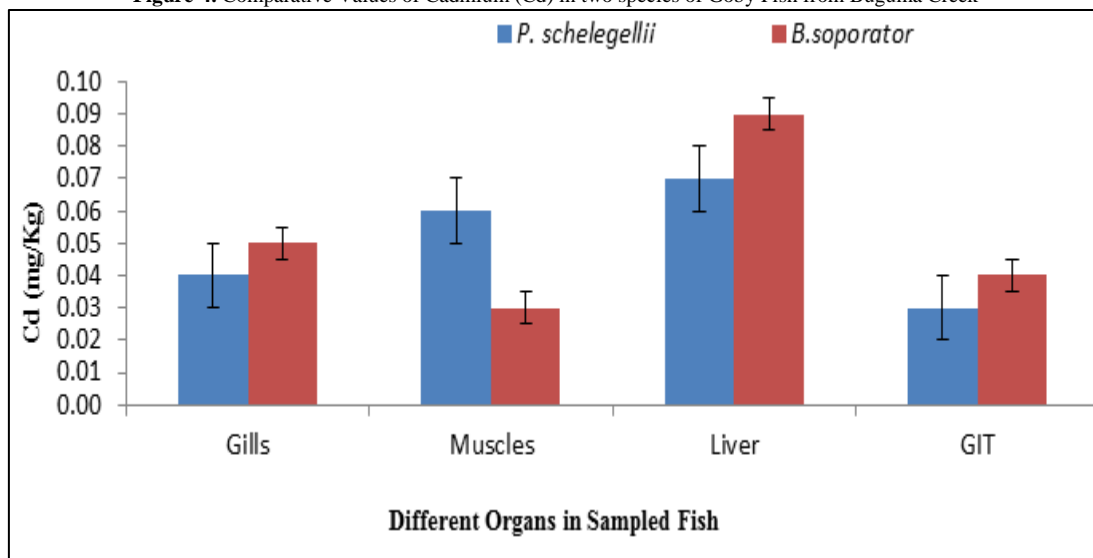
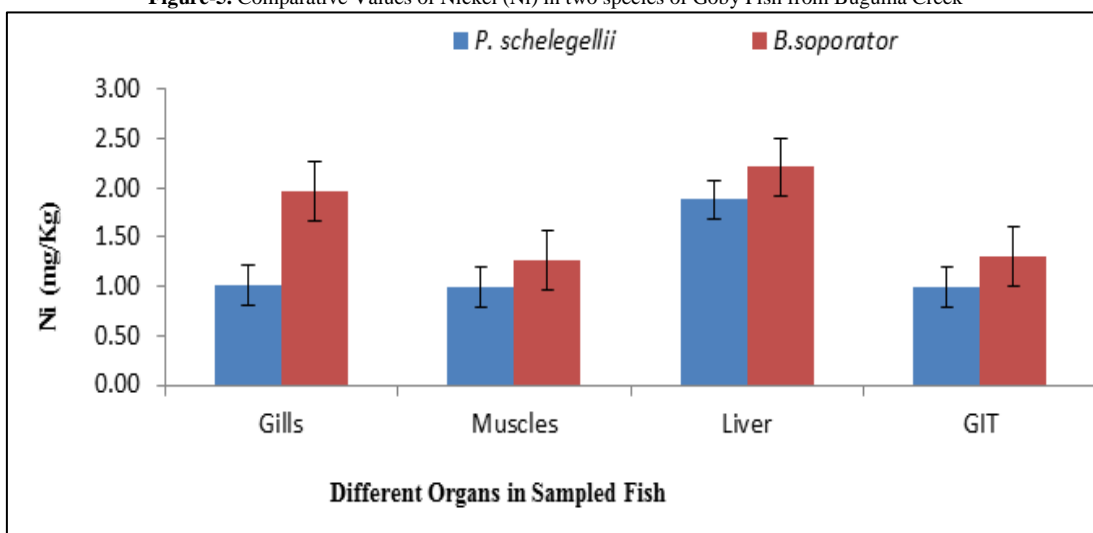


Figure-5. Comparative Values of Nickel (Ni) in two species of Goby Fish from Buguma Creek



#### 4. Discussion

The results of this study indicated that the specie *B. saporator* from this creek were bigger that of *P. schellegelli*, hence, they have accumulated higher concentration of heavy metals which contradicts the results of the study reported by Al-Kahtani [16] that the concentration of heavy metals in smaller fish is always higher than in bigger fish. However, the results of this study agreed with that of Al-Weher [17], who reported that aquatic microflora and fauna which constituted fish food are capable of incorporating and accumulating heavy metals into their living cells from their environment thus, implying that bigger fish will need more food and therefore accumulate more heavy

metals. Similarly, the results of this study corroborate with the report of Ademoroti [18] that size of organism is one of the major factors influencing bioaccumulation, although Silene and Sandra [8] reported that bioaccumulation of metals like chromium, cadmium, copper and zinc is independent of body size. In the organs of goby fish studied, the metals were bioaccumulated to varying levels. The specie *B.soporator* had higher mean metal loads. The general pattern of accumulations in both species was similar with nickel being the most bioaccumulated. This observation agrees with the results obtained by Larsson, *et al.* [19], where they recorded higher concentration of nickel in the organs of they studied. However, in the organs of the goby fish species sampled, cadmium was the least bioaccumulated probably because it was the least available metal in the water.

The concentration of different heavy metals obtained in this study was lesser than the values previously reported in some fishes from the region [20]. Cadmium and Zinc concentrations were below the level that can cause any toxicological distresses such as vomiting, cramps, convulsions and worst still death. The variation in the values of heavy metals obtained in this study indicates different anthropogenic activities, contamination level in the area and fish species [21]. Conversely, Jennett, *et al.* [22], reported that biochemistry of fish affect the bioaccumulation of heavy metals. Also, age/size of the fish, lipid content and feeding habits have also been implicated [23]. Despite this, tissue/organ, exposure period, mechanisms of uptake, intrinsic factors could also affect bioaccumulation level in fisheries [24].

The results of this study showed that the highest heavy metal concentrations were found in the gills and livers of both sampled fishes. These results are similar to other studies that showed the bioaccumulation of heavy metals in the gills and livers of fishes was higher than the concentrations of heavy metals in the muscles of fishes and other organs [25]. The mean concentrations of heavy metals in the gills, livers, GIT and muscles of both fish samples (*B.soporator* and *P. schellegelli*) from the creek were much higher than the World Health Organization (WHO) and Food and Agriculture Organization of the United Nations (FAO) maximum permissible levels of heavy metals in freshwater fishes [26]. The high concentration of heavy metals in the gills of *B.soporator* and *P. schellegelli* was due to the fact that the gills in freshwater fishes are the main entry point for any dissolved heavy metals [27]. One of the reasons for such high concentrations of metals in the organs of the sampled fishes was the recent prevalence of artisanal refinery in the area. Most this discharges their wastes into the creek from time to time.

## 5. Conclusion

This study showed that the levels of heavy metals in gill, liver and muscle of the two species of goby are higher than the acceptable limit recommended by FAO and WHO except in Cd and Zn. This accumulation of heavy metals especially in fish liver is of great health concern to human. It is therefore, become pertinent for government to formulate a policy on the restriction of discharge of wastes into the environment and create public awareness on the implication of heavy metal accumulation in food on human health.

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