PREVALENCE AND INTENSITY OF *ASCARIS* INFECTION AND HEAVY METAL ACCUMULATION IN *Battygobius soporator* (FRILFIN GOBBY) OF THE LAGOS LAGOON

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Abstract

An assessment of the prevalence and intensity of *Ascaris* infection as well as the heavy metal accumulation in the tissues and *Asacaris* parasites of the Frillfin Gobby, *Bathygobius soporator* was carried out over three months in the Lagos Lagoon. A total of one hundred fishes collected with gill nets and traps were examined for gastrointestinal helminthes and heavy metals. *Ascaris sp.* was observed in the fish gut with a prevalence of 47% (i.e. 47 fishes). Fishes with body weight range of 16-18 g had the highest prevalence (64.3%) and mean intensity of 10 parasites per fish; infestation rate was slightly lower in males (45.1 %) compared to the females (49.0 %). The overall worm burden was independent of fish sex, age and size (p>0.5). Analysis of heavy metals (Pb, Fe, Cd, Zn) in water, fish and fish parasites were also conducted using Atomic Absorption Spectrophotometry. Infected fishes and parasites had lower concentration of heavy metals compared to uninfected fishes. *B. soporator*, irrespective of infection status accumulated mostly Zn while the parasites accumulated mostly Fe. There were no traces of Pb in infected fishes but some parasites had detectable levels of Pb. The findings from this study showed that *B. soporator* which is a commonly harvested fish in the Lagos Lagoon for subsistence consumption may pose risk of zoonotic *Ascaris* infection if not properly cooked. The absence of Pb in infected fishes and its presence in some parasites implies that there is need to further investigate the mechanism of accumulation of this metal so as to provide possible explanation which may be of public health importance.

Keywords: helminth parasite, pollution, fish consumption, bioaccumulation.

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Introduction

The Lagos Lagoon is polluted, its fish populations live under stress which makes them susceptible to parasitic infection. Previous investigations have reported that sources of pollution in the lagoon are widely varied, ranging from chemical inputs and sewage to solid waste, with far reaching effects including foul odour, loss of aesthetics, deterioration in the water quality and reduced fish catch (Amaeze *et al*, 2012). The evidence for the reduced fish catch in this water body has earlier been published by Osae-Addo and Abigail (1992), who reported that fish catch fell to 10% of their output in 1980 to about 100,000 kg per annum in 1990.

The cause of pollution has since not been addressed, rather, in recent times, increased pollution is confounded by over-fishing due to population explosion. The diverse polluting activities have led to the leaching of heavy metals into the lagoon (Nubi *et al*, 2008; Oyewo, 1998) and the subsequent bio-accumulation in its fauna (Otitoloju, 2000; Otitoloju and Don-Pedro, 2004). Apart from heavy metals, the lagoon is also in receipt of organic wastes from sewage, which have the potential to distort the already delicate ecosystem balance and impair bio-diversity (Saliu and Ekpo, 2006). Stress, resulting from industrial effluents in the aquatic ecosystem has been linked with limiting distribution, reduction in abundance and reproductive potential of affected organisms which have the potential of changing an entire ecosystem (Skouras, 2002).

Parasitic infection, just like any other infection, is enhanced in immune-compromised individuals and pollution stress may either reduce immunity or confounds disease conditions (Sures, 2001). Majority of parasites infesting internal organs or gastrointestinal tract organs generally affect their host either mechanically or by inducing pathological reactions. Parasites cause injury to their fish host as a result of their movement, attachment, blocking of systems and withdrawal of materials that are necessary for the normal metabolism of the host (Paperna, 1996).Van Dan Broek (1979) revealed that the pathological conditions arising from parasitic infections range from physical discomfort to serious consequence especially the nutritive devaluation of the fish. In addition, allergic responses to toxic waste product of parasites may be evident by the consumers of the infected fish (Ukoli, 1990).

Pollutants might promote parasitism in aquatic animals, especially fish by impairing the host's immune response or favouring the survival and reproduction of the parasites in their host (Khan and Thulin, 1991). Parasites are now attracting increasing interest as potential indicator of environmental quality due to variety of ways in which they respond to anthropogenic pollution (Barak and Mason, 1990). Deteriorating state of the environment in the aquatic resources may be reflected by the increased degree of fish nematode parasitic infection and elevated metallic pollutants levels. Some trace heavy metals have been found to accumulate to higher extent in parasites than in tissues of their host a demonstration of parasites as good bio-monitors of environmental pollution (Schludermann *et al* 2003).

Arkoosh *et al* (1998) in their study on effect of pollution on fish diseases reported that juvenile salmon *Oncorhynchus* bio-accumulated chlorinated hydrocarbons and aromatic hydrocarbons, pollutants which have been linked to immunosuppression and increased disease susceptibility. Abiotic, biotic, and genetic factors are the key predisposing factors to disease conditions in fish (Snieszko, 1973). Arkoosh *et al* (1998) elaborated these factors to include the quality of the environment, differential susceptibility of individuals to the pathogen as a result of genetic predisposition or the physiological health of individual members of the host population, and the presence and virulence of the pathogen. Some of the factors that enhance parasitic infection in fishes include reduced oxygen content of water, increase in organic matter in the water, and also poor environmental conditions (Edema *et al,* 2008).

In this study, we examined the Frilfin gobby, *B. sororator* (Valenciennesin Cuvier, 1875) from the Lagos Lagoon for helminth parasite infestation and heavy metal accumulation in both fish and their parasites. *B. soporator* belongs to the family Gobidae occurring in marine brackish and fresh waters of the tropical and temperate regions. Gobidae is possibly the largest family of fishes (Robins and Ray, 1986). *B. soporator* are demersal (bottom-associated), characterized by the possession of dorsal fin and their non-migratory nature, living at depths that ranges between 0 to 16 m. Food habits of gobies are very diverse, most species are carnivorous, many are omnivorous and a few are herbivorous and this particularly makes them capable of picking up all sorts of contaminants in the sediments. However, the dermersal lifestyle of the gobby suggests that it may feed upon small invertebrates, fishes and detritus from rocky intertidal areas. Several species of gobies are fished commercially and are economically important like cod and haddock (Robins and Ray, 1986).

This study is therefore justified by the ecological importance of this gobby at the near substratum food chain of the Lagos Lagoon, its use as food for man and its potential for use as an indicator organism. Given its use as fish food, there is need to investigate its parasitic load so as to determine if there is risk for zoonotic transmission of such parasites to consumers of poorly prepared fish. An assessment of the heavy metal load in its tissues and the parasites would provide information on the potential risk of bio-magnification of the metal along the food chain and the relationship between heavy metal levels and parasitic infections.

Materials and methods

Study design

The study was conducted in a section of the Lagos Lagoon which is known to receive sewage and effluents from cottage industries. Sampling was done in two locations – Oworonshoki (N06° 31.655′, E003° 24.466′) and University of Lagos, lagoon front (N06° 31.388′, E003° 24.013′) (Figure 1). *B. soporator* (Plate 1), was selected for this study because it is commonly caught for use as food and there is limited information about this fish. Sampling was limited to areas where salinity is low enough to support *B. soporator* populations (Amaeze *et al,* 2012).

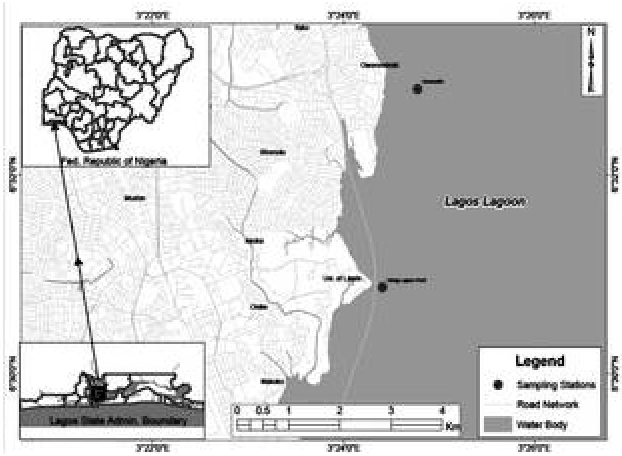

Figure 1. The sampling locations in the Lagos Lagoon.

Plate 2 (a and b): Sampling locations around Oworonshoki (a), and University of Lagos Lagoon front (b).

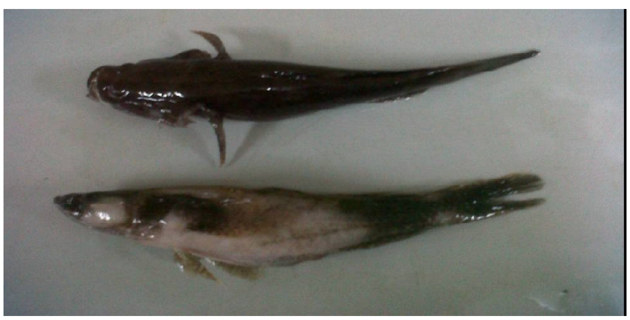

Plate 1. *Battygobius sororator* Rochebrune 1880 (Frilfin gobby).

Sample collection

A total of one hundred specimens of *B. soporator* were harvested from the lagoon to study the prevalence of parasitic infection and concentration of heavy metals in the fish and it's parasites between June to August, 2011 with the assistance of local fisherman on motorized canoes. Fishes were caught with the aid of gill nets (Emmanuel and Onyema, 2007) and non-return value traps, transported to the laboratory in aerated plastic containers and examined on the same day without prior preservation (Plates 2a and b).

Water samples were collected by surface grabs using 1 litre plastic kegs in triplicates from the two sampling locations and homogenized to get the final representative sample for a month. Samples for heavy metal analysis were preserved with a few drops of IM nitric acid.

Examination of fish specimen for parasites

Sex, body weight, total length, standard length of fishes and parasite intensity were determined in individual fish samples. Each fish was dissected from the anus using a sharp scalpel; gastrointestinal tracts were removed by means of a pair of dissecting scissors and placed in a petri dish containing physiological saline. The fish guts were longitudinally dissected and examined for nematode parasites under binocular light microscope. Nematode parasites were picked by means of a Pasteur pipette, placed in a specimen bottle containing 70% alcohol as preservative. Photomicrographs were made with a Viscicam camera 3.0 (ECN 630-1031) attached to a compound microscope.

Identification and micro-photography of parasites

The recovered parasites hitherto fixed in 70% alcohol were counted and recorded per fish. Whole mount of worms stained with haemotoxylin and eosin were prepared and examined under a microscope and photomicrographs for identification using the taxonomic keys of Paperna (1996). The terms prevalence and intensity were applied as defined by Ukoli (1990).

Measurement of heavy metals in water, parasite and fish

Water samples were collected at each of the three months of the period from the sample locations. They were digested using concentrated nitric acid and then sequentially evaporated and filtered after, which each sample was made up to 100 cm^3 with de-ionized water. Heavy metal concentrations were determined by Atomic Absorption Spectrophotometer (AAS) according to Don-Pedro *et al* (2004).

The parasites and the the fish tissues were digested separately using HNO_3 and H_2SO_4 for detection of heavy metals including Cadmium (Cd) Iron (Fe), Lead (Pb), and Zinc (Zn) in a closed system by AAS (APHA-AWWA-WEF 2005).

Statistical analysis

The level of significance of the relationship between prevalence and intensity of infection and standard length of the fishes as well as weight were determined using *chi*-squre analysis (SPSS Version 16).

Results

Physicochemical properties and pollution of the Lagos Lagoon

The major sources of pollution observed during this study include leachates from solid wastes, effluents from cottage industries and power station as well as discharges from canals returning municipal runoffs into the lagoon (Plate 2b). The levels of total dissolved solids (TDS) across the sampling months were significantly higher than the prescribed FEPA limit of 2000 mg/l (Table 1). Suspended solids, however, remained lower than the set limit. Also turbidity was very high especially during the raining months of June and July with values of more than 30 NTU respectively, which is significantly higher than the FEPA limit. The levels of chemical oxygen demand (COD) ranged from 1037.83 to 260.42 mg/l between the months of June and August. The levels of dissolved oxygen (DO) across sampling months remained close to the 5.0 mg/l set standard throughout the study period and pH ranged between slightly acidic to slightly alkaline. Average surface water temperatures within the sampling period was 25.97 ± 1.06 °C (Mean ± SD), while electrical conductivity was generally low (Table 1).

Table 1. Physicochemical characteristics of the sampling locations in the Lagos Lagoon during the sampling period.

Month	Temp. (°C)	Salinity (‰)	D.O. (mg/l)	pH	Cond. (ms/cm)	TDS (mg/l)	TSS (mg/l)	Turb. (FTU)	COD (mg/l)
June	26.01	6.00	5.64	7.38	3.91	3,787.25	21.50	30.11	1,037.83
July	26.05	1.50	4.57	6.45	2.05	4,843.92	22.42	31.58	1,385.17
August	25.85	5.50	4.87	6.87	14.00	4,495.58	6.00	5.25	260.42
Mean ± SD	25.97 ± 1.06	4.33 ± 2.50	5.03 ± 0.55	6.90 ± 0.47	6.65 ± 6.43	4,375.60 ±538.45	16.64 ± 9.23	22.31 ± 14.80	894.47 ± 575.91
FEPA Limit	40.00	NS	5.00	6-9	NS	2,000.00	30.00	10.00	NS

Prevalence and intensity of helminthes in Battygobius sororator

A total of 47% of the 100 fishes investigated were infected with *Ascaris* sp. (Plates 3a-c), indicating a high level of parasite burden in the fish population (Table 2). Specifically, females had a higher prevalence of infection (49%) compared to male fishes (45.1%). However, the difference in infection rate was not statistically significant ($p<0.05$). The mean intensity was approximately eight parasites per individual (Table 2), and infection per capita can be said to be moderately high, in the *B. soporator* populations sampled.

Heavier individuals had higher parasite prevalence than smaller sized ones ($p<0.05$) (Figure 2). The prevalence of *Ascaris* infection was also found to increase with the size of fish (standard length). Fishes with size range 9-11cm had a parasite prevalence of 19.4% while the largest size groups (15-17 cm) had an infection intensity of 61.5% (Table 3). However there were no significant differences in the mean intensity of *Ascaris* infection with respect to the standard lengths of the fishes (Table 3). Just as the case with the size groups, there was also a trend of increasing prevalence of infection with weight, with the least and highest weight groups, showing the lowest and highest prevalence of *Ascaris* infection respectively (Figure 2).

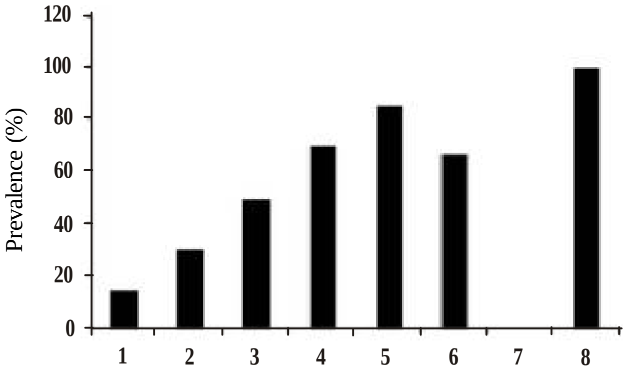

Figure 2. Prevalence of infection in *Bathygobius soporator* by weight.

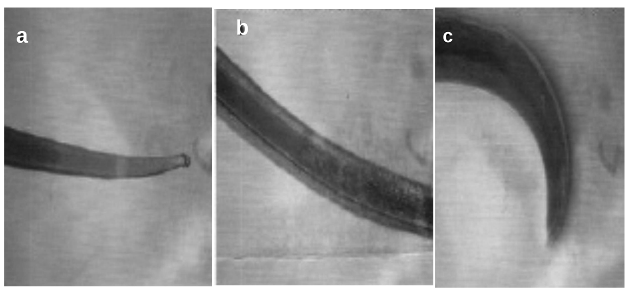

Plate 3a-c. Anterior (a), mid (b) and posterior region (c) of *Ascaris* sp. In *B. soporator* (x40).

Table 2. Prevalence and intensity of *Ascaris* infection in *Bathygobius soporator* by sex.

Sex of fish	No of fish examined	No of fish infected	Prevalence (%)	Intensity	Mean intensity
Male	51	23	45.1	189	8.2
Female	49	24	49.0	185	7.7
Total	100	47	47.0	374	8.0

Table 3. Prevalence and intensity of *Ascaris* infection in *Bathygobius soporator* by standard length.

Size of fish (cm)	No of fish examined	No of fish infected	Prevalence (%)*	Intensity*	Mean intensity
9-11	31	6	19.4	49	8.2
12-14	56	33	58.9	267	8.1
15-17	13	8	61.5	58	7.3
Total	100	47	47	374	8.0

* Significantly varied with size ($p<0.05$).

Heavy metal accumulation in the fishes

The findings from this study indicate that the concentrations of heavy metals were higher in uninfected fishes compared to infected individuals ($p<0.05$) (Table 4). The concentration of Fe in uninfected individuals was slightly higher than the FAO limit of 10 mg/kg for the metal concentrations in fish tissues. *Ascaris* sp., also accumulated a considerable amount of Fe, Pb, Cd and Zn. The calculated bio-accumulation factor (BAF) indicates that Fe and Zn were the most accumulated, with *B. soporator* accumulating as much as 201.50 and 191.33 times the concentration of Fe in the environment for infected and uninfected individuals respectively. Relative to the environmental media, there were evidence of biomagnification of Fe, Pb and Zn in *Ascaris* sp., with Zn levels in the helminth tissues 40 times higher than environmental concentrations (Table 4).

Table 4. Bio-accumulation of metals in the fish, *B. soporator* and its *Ascaris* parasite.

		Fe	Pb	Cd	Zn
FAO (1983) limit in fish (mg/kg)		**10**	**0.5**	**0.5**	**30**
Mean metal concentration in water from two sampling sites (mg/kg)		0.21±0.01	0.03±0.01	2.31±0.11	0.02±0.00
Bathygobius soporator (uninfected) (mg/kg)		10.84±0.12[a]	0.1±0.03[a]	0.07±0.02[a]	4.03±0.18[a]
Bathygobius soporator (infected with *Ascaris*) (mg/kg)		5.80±0.15[b]	0.00±0.00[b]	0.26±0.03[b]	3.83±0.23[b]
Ascaris sp.		3.28±0.31	0.67±0.12	0.11±0.03	0.80±0.04
Bioaccumualion factor (BAF)	*B. soporator* (uninfected)/water	51.63[a]	4.00[a]	0.03[a]	201.50[a]
	B. soporator (infected)/water	27.60[b]	0.00[b]	0.11[b]	191.33[b]
	Ascaris sp./*B. Soporator* (infected)	0.57	0.00	0.42	0.21
Biomagnification	*Ascaris* sp./water	15.62	22.33	0.05	40.00

Different alphabets (a, b) implies significant difference.

Discussion

Parasitic infection of wild fish species is not uncommon in coastal lagoons of western Nigeria. Previous investigations in the Lagos and Lekki Lagoons have reported parasitic helminthes in the gut and blood of fishes (Akinsanya *et al,* 2008; Elezuo *et al,* 2012). The link between pollution and fish parasites have also been earlier inferred by Hassan *et al* (2010), in a study conducted to determine the impacts of helminth parasites on *Clarias gariepinus* and *Synodontis clarias* of Lekki Lagoon, near the Lagos Lagoon system. Key physicochemical characteristics of the surface water in the sampling areas such as chemical oxygen demand (COD) and total dissolved solids (TDS) were high, indicating some level of chemical inputs and wastes from coastal runoffs. The prevailing environmental conditions were therefore suited for infection given that positive correlation between characteristics such as Biological Oxygen Demand (BOD) and TDS with helminth parasites, have earlier been established (Sosanya, 2002). Therefore, the 47% prevalence of *Ascaris* sp. infection observed appears to follow the trend of the pollution levels determined. The helminth infection in *B. soporator* however was not sex dependent, much unlike the report of Hassan *et al* (2010) in fishes of the Lekki Lagoon.

The singular helminthes species reported in the gut of *B. soporator* in this study however is not a common occurrence in fishes from Nigerian waters (Elezuo *et al,* 2012; Hassan *et al,* 2010; Oniye *et al,* 2004). In particular, Oniye *et al* (2004) reported a range of phyla including cestodes, nematodes and acanthocephalans in *C. garipinus* from rivers around Zaria, in the northern Nigeria. Akinsanya and Otubanjo (2006), reported three cestodes species, *Polyonchobothrium clarias*, *Stocksia pujehuni* and *Wenyonia acuminata* and a nematode, *Paracamallanus cyathopharynx*. The low helminthes species density observed in *B. soporator* in this study may be explained by the relatively higher levels of pollution in the Lagos Lagoon compared to the other waters sampled. It may also be linked to immunological responses in the fish which and/or the ability of *Ascaris* sp. to specifically evade such protective measures. Pollution induces stress in all fauna (Don Pedro, 2013) irrespective of phyla, whether fish or helminthes. In fishes, host and pathogen interaction is particularly modulated by environmental variables and this is a key determinant of susceptibility to disease incidence (Arkoosh *et al,* 1998). The triad of fish, parasite and pollution is dynamic and infection by an individual parasite or susceptibility of a fish to infection may be ultimately linked to individual organismal tolerance threshold to the prevailing ad-mixture of pollutants in the water body.

The fact that *B. soporator* swims close to the substratum and feeds on a wide variety of decomposing materials, including faeces which enters the water unregulated, could be attributed as the reason for the high *Ascaris* infection. The coast line of this lagoon is characteristically filthy, receiving all sorts of wastes (Amaeze *et al,* 2012) and the heavier masses settle down on the substratum. Faecal discharges into the lagoon were untreated in the past (Akpata and Ekundayo, 1978) and have so far remained so (Amaeze *et al,* 2012), with possibility of having human *Ascaris* eggs which eventually infect the gobby. This area of the lagoon also receives untreated sewage from canals and poorly treated sewage from the University of Lagos Sewage Treatment Plant (Longe and Ogundipe, 2010). It is also in receipt of heavy metals which are leached into the lagoon from solid waste dumps, municipal runoffs and industrial effluents (Oyewo, 1998) all of which contributes to the overall stress of the sampling areas.

Heavy metal bio-accumulation is not uncommon in Lagos Lagoon fauna with reports of accumulation in several fish species (Ajagbe *et al,* 2012), molluscs and arthropods (Otitoloju, 2000). The contamination of water bodies and aquatic animals by heavy metal is of concern and this concern is largely due to the persistence, toxicity, bio-accumulative and non-bio-degradable nature of such metals (Azmat *et al,* 2008; Bhattacharya *et al,* 2008). In this study, the frillfin gobby, *B. soporator* was found to accumulate substantial heavy metals, Cd, Fe, Pb and Zn to varying degree depending on their infection status. Ali and Fisher (2005) reported that fish and some benthic invertebrates accumulate heavy metals from water and sediment, with molluscs and crustaceans accumulating higher concentrations than other invertebrates because of their association with bottom sediments.

The relatively higher concentration of heavy metal accumulated in uninfected gobies compared to infected ones can be explained as relating to uptake of some amount of metals by the *Ascaris* sp. as observed in this study. There was considerable magnification of Fe, Pb and Zn concentrations in the parasites relative to concentrations in their surrounding habitat water. The implication of this amplification of heavy metal concentrations, however, may imply greater risk of metal accumulation in humans, given that the parasites are obligate in nature and their heavy metal load adds up to the overall metal content of the consumed fish. This may eventually have far reaching effects on humans who buy gobies from local markets at Ilaje and Bariga for consumption. Mercury (Hg) accumulation in fishes was the cause of wide spread deaths of humans and domestic animals in Japan (Kurdland 1960) and recently Nigeria, lead poisoning resulting from illicit gold mining led to the death of 400 children (*Environment and Health*, 2012). Although the metals accumulated in this study are not as toxic as Hg, there remains the possibility of effects resulting from habitual consumption of these fishes. The possibility of zoonotic transmission of the *Ascaris* cysts if fish meals are not well cooked before eating, raises an important concern for public health.

Conclusion

There is no doubt that the fauna inhabiting the Lagos Lagoon bear the stress of its pollution, but parasitic infections confounds this, impairing fish health as well as the quality of consumed fishes. The parasites store up metals which when added to the levels already taken up by the fishes, makes the gobies unwholesome for consumption. The metal levels together with the possibility for zoonotic *Ascaris* infection are a cause for public health concern and threaten the future utility of the Lagos Lagoon fisheries' resources. Once again there is a call on respective law enforcement agencies to step up efforts towards mitigating pollution in the Lagos Lagoon.

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