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Research Article

Report of *Paradilepis* Sp. (Cestoda) and Proximate Composition of *Tilapia guineensis* from Rumuola Borrow Pit, Port Harcourt-Nigeria

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Abstract

Paradilepis sp. has been poorly reported in fishes of Nigeria. This may be due to sparse distribution or difficulty with its identification. Here, we present a report of the species in *Tilapia guineensis* from Rumuola borrow pit, Port Harcourt-Nigeria. We also report recovery of the metacestodes from the African Common Moorhen (*Gallinula chloropus meridionalis*). Fish species were harvested with fishing nets from the borrow pit and examined for parasites using standard procedures. The proximate composition of fish tissues and water quality assessment were done following standard protocols. Fish specimens were of mean total length, wet body weight and condition factor of 17.3±2.4cm, 109.3±2.4g and 2.0±0.2, respectively. *Paradilepis* sp. was recovered at a prevalence of 52%, and intensity of 4-90 parasites per infected host. Cysticercoids were detached from the intestinal wall of *T. guineensis* while metacestodes were recovered from the intestine

of *G. c. meridionalis*. Proximate composition of *T. guineensis* from Rumuola borrow pit showed the fish had moisture content of 72.2%, crude protein 19.88% and carbohydrate 2.32%. The crude ash, fat and fibre contents were 1.64%, 2.69% and 1.27%, respectively. Results of the water quality analysis showed that heavy metals (Pb [0.05mg/L] and Fe [0.44mg/L]), organic matter (0.41mg/L), and total suspended solids (68.0mg/L) were above the permissible limits of 0.01mg/L, 0.30mg/L, 0.01mg/L and 30mg/L, respectively. It is recommended that piscivorous birds from Port Harcourt be examined for the possible recovery of adult *Paradilepis* sp. in order to complete its life cycle. The study concluded that residents of Rumuola should desist from indiscriminate disposal of household and other wastes into the borrow pit, and avoid consuming fish harvested from the pit to prevent metal poisoning.

Keywords: *Paradilepis*; Tilapia; Borrow pit; Heavy metals; Nigeria; Africa

1. Introduction

Paradilepis species are gryporhynchid tapeworms belonging to the family Dilepididae that use freshwater fishes as intermediate hosts and cormorants and Pelecaniformes as definitive hosts (Prudhoe and Hussey [1]; Williams et al., [2]; Gonzalez-Acuna et al., [3]). Cysticercoids of this parasite are often found embedded in the intestinal wall of fish intermediate hosts. Metacestodes have also been reported from fishes (Scholz et al., [4]. In Africa, they have been reported to use *Tilapia niloticus* as intermediate hosts (Prudhoe and Hussey [1]) whereas several other freshwater fish species have been reported to serve as their intermediate hosts in other parts of the world (Monteiro et al., [5]; Williams et al., [2]; Blasco-Costa et al., [6]).

In addition to the reports by Prudhoe and Hussey [1] in South Africa, Scholz et al., [4] also reported on *Paradilepis* sp. and other gryporhynchid tapeworms from freshwater fishes collected from several African countries including Burundi, Madagscar and Sudan. In Nigeria, larval forms of *Paradilepis* sp. have been reported from cultured *Oreochromis niloticus* in Abeokuta, Ogun State, and Jos, Plateau State (Ezeri [7]). This (Ezeri [7]) appears to be the first report from Nigeria as there is paucity of other related literature. This report thereby presents further distribution of *Paradilepis* in *Tilapia guineensis* from a freshwater habitat, Rumuola borrow pit, in Port Harcourt, Nigeria.

Proximate composition analyses are important in monitoring the nutritional status and physiological condition of fish and to determine if they are safe for human consumption (Moses et al., [8]. Several reports on the proximate composition of Tilapia indicate the impact of diet and environmental pollution on the quality of the nutritional characteristics of fish specimens (Gaber [9]; Jim et al., [10]; Moses et al., [8]). According to Jim et al., [10], water quality is very important in determining fish quality.

The availability of nutrients in the water and the ability of the fish to absorb them are important determinants of the nutritional composition of fish (Yeannes and Almandos [11]; Fawole et al., [12]). Rumuola borrow pit receives domestic waste products from the neighbouring community. This research therefore, examines the parasitic infections and

proximate composition of *Tilapia guineensis* which is often harvested for food from the water body.

2. Materials and Methods

2.1 The study area

Rumuola Borrow pit (Figure 1) is located between longitude 7°00'01.0 to 7°03'09.7E" and latitude 4°50'08.5" to 4°50'14.2"N. The borrow pit soil was mined for civil construction in 1982 and that gave rise to this large borrow pit with an area of about 135,000 m^2 and a depth of about 7.68 meters. The depth to the ground water table is 8 ft 5 inches according to Ubong et al., [13]. This water body harbours some species of fishes like *Tilapia* species, Catfish (*Bagrus* spp), mudskippers (*Bostrychus africanus*) and African snake head fish (Ubong et al., [13]).

Figure 1: A view of the Rumuola Borrow Pit.

2.2 Collection of fish samples

A total of 54 fish samples comprising of 50 *Tilapia* sp., 3 *Bagrus* sp. (catfish) and 1 *Bostrychus africanus* (mudskipper) were bought directly from fishers at the Rumuola Borrow pit in the months of May and June, 2019. The fish samples were transported in ice chest to the Entomology and Parasitology Laboratory, Department of Animal and Environmental Biology for identification and examination for parasitic infections.

2.3 Identification and parasitic examination of the fish samples

The fishes were identified using taxonomic keys (Froese and Pauly [14]). For the survey of parasites, the fish scales and fins were examined for ectoparasites. Fish specimens were dissected and each section of the digestive tract (stomach, intestine and rectum), liver, swim bladder were removed examined in separate Petri dishes containing normal

physiological saline. Each organ was then slit longitudinally and examined under a compound microscope for parasites. The muscles were also examined. The gills were also carefully removed and kept in a sterile specimen bottle with normal saline solution, shaken vigorously and poured into a Petri dish for examination under a microscope at 40x magnification lens. Parasites obtained were counted and fixed.

2.4 Parasite identification and fixation

The parasites were fixed in 5% formol saline, and identified according to Prudhoe and Hussey [1].

2.5 Calculation of condition factor and parasite ecological parameters

The total length and standard length were taken using meter rule. Wet body weight of each fish sample was measured using a sensitive weighing balance (Denver instrument, model TP-512A) and each sample was assigned a reference number for proper documentation of records.

Condition factor (CF) was computed according to Zhelev et al., [15] as follows:

$CF = BM / TL^3 \times 10^2$.

Parasite ecological parameters (prevalence and mean intensity) were computed according to Bush et al., [16]. Prevalence was computed as percentage of infected hosts while mean intensity was computed as number of parasites per infected host. Photographs of the parasites were taken using a digital camera attached to the eye piece of a light microscope.

2.6 Proximate analysis of Tilapia fish

Proximate analysis of *T. guineensis* muscle was carried out following the protocols of the Association of Official Analytical Chemists (AOAC [17]. The components analyzed for were the moisture content, ash content, fat content, protein content and crude fiber.

2.7 Water quality analysis

Tests to determine the chemical oxygen demand (COD), total suspended solids (TSS) and turbidity were done according to APHA [18]. Total dissolved solids (TDS) was determined according to the standard methods of APHA [19]. Total alkalinity of the water sample was measured by titration method (Jenkins and Moore [20]); Calcium and Magnesium were measured by gravimetric method (Saxena [21]). Sulphate determination was carried out following turbidimetric procedure as described in APHA [22]. The nitrate value was determined using Brucine method as recommended by APHA [22] which was based on the reaction of nitrate with Brucine in an acidic medium to produce a yellow colour at moderate temperature.

Colour of the water sample was determined by visual comparison. About 20ml of the sample and 20ml of distilled water were taken in two separate wide mouthed test tubes. The results were tabulated (as clear, greenish, greyish, brownish, blackish, etc) by comparing the colour of the sample with distilled water.

Hardness was estimated by following EDTA titration method (Betz and Noll [23]). Total iron (Fe) and lead (Pb) concentrations were measured by Spectrophotometer (phototube 880 nm) phenanthroline method (APHA [24]).

2.8 Statistical analysis

Descriptive statistics was used to compute the mean and standard deviation of the morphometric

measurements. This, and the computation of the condition factor, was done using MS Excel.

3. Results

3.1 Morphometric characteristics of fish species

Fifty-four fish specimens examined in the course of the research were comprised of catfish (*Bagrus* sp.), mudskipper (*Bostrychus africanus*) and *Tilapia guineensis*. The morphometric measurements and condition factor of the species is presented in Table 1. *Tilapia guineensis* had a mean total length of 14.1±2.0cm. Their body weight ranged between 19.0 to 177.0g while their condition factor was good for all specimens, ranging from 1.64 to 2.85. Among the *Bagrus* sp., the total length ranged between 23.3-31.0cm and body weight, from 144.0 to 219.0g. Only one specimen had a condition factor of up to one; their mean condition factor was 0.83±0.27. The only *Bostrychus africanus* examined had a standard length of 23.0cm, total length of 28.5cm, body weight of 177.0g and a condition factor of 0.76.

Table 1: Body Weight (BW), Standard Length (SL), Total Length (TL) and Condition Factor of *Tilapia guineensis*, *Bagrus* sp. and *Bostrychus africanus* from Rumuola Borrow Pit, Port Harcourt, Nigeria.

Species		**Range**	**Mean±S.D**
Tilapia guineensis	BW (g)	19.0-177.0	109.3±40.6
(n=50)			
	SL (cm)	8.8-17.0	14.4±2.0
	TL (cm)	10.0-20.5	17.3±2.4
	CF	1.64-2.85	2.0±0.2
Bagrus sp.			
(n=3)	BW (g)	144.0-219.0	177.3±38.2
	SL (cm)	21.0-28.0	25.0±3.6
	TL (cm)	23.3-31.0	28.1±4.2
	CF	0.63-1.14	0.83±0.27
Bostrychus africanus			
(n=1)	BW (g)	177.0	177.0
	SL (cm)	23.0	23.0
	TL (cm)	28.5	28.5
	CF	0.76	0.76

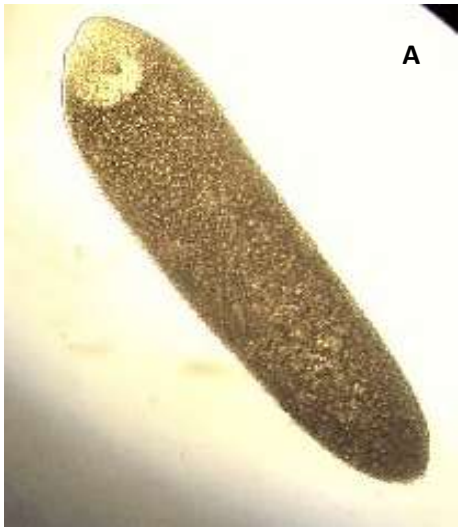
S.D= Standard deviation

3.2 Parasites in infected fish specimens

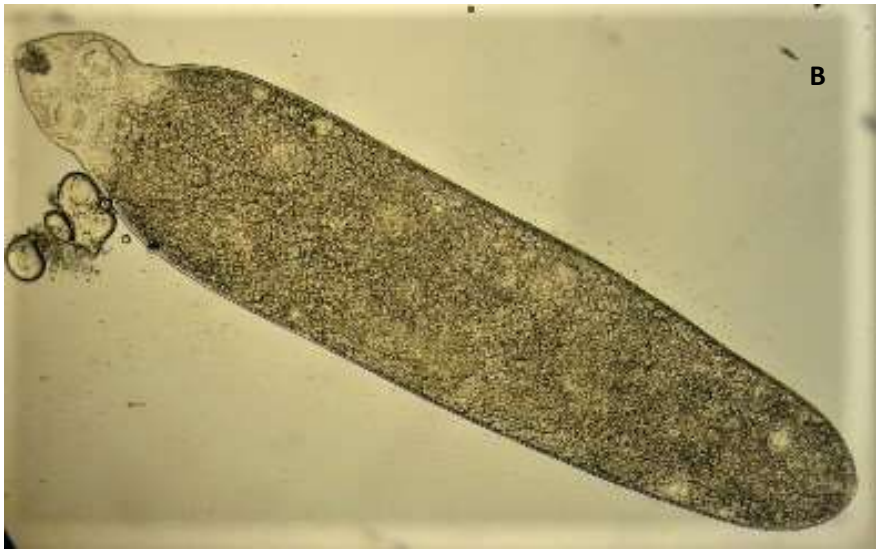
Parasites were recovered from *T. guineensis* specimens. These were larval tapeworms (cysticercoids) of the genus *Paradilepis*, collected from their attached sites on the intestinal surface wall. They were aggregated and firmly attached to the

entire surface of the intestine. Two forms were found: the invaginated and evaginated forms (Plate 1).

Plate 1: Cysticercoid of Paradilepis sp. from *Tilapia guineensis*, Rumuola Borrow Pit, Port Harcourt, Nigeria.



A: *Paradilepis* sp., larva infecting *T. guineensis* (Anterior inverted) (x10).



B: *Paradilepis* sp., larva infecting *T. guineensis* (Anterior everted) (x10).

In the course of the study, a dead specimen of the African Common Moorhen (*Gallinula chloropus meridionalis*) commonly found around the borrow pit was examined for *Paradilepis* sp. Two larval stages

(metacestodes) of the parasite (Plate 2) were recovered from the moorhen. Adult parasites were not found.

A total of 548 parasites were recovered from twenty-six *T. guineensis* specimens accounting for a prevalence of 52%; mean intensity of infection was 21.1 (±4.3) parasites per infected host. The parasite burden ranged from four (4) to ninety (90) parasites in the infected hosts. Parasite burden in infected hosts showed that most of the specimens were infected with one to ten parasites, followed by 11-20, 21-30, and 41-50 parasites. One host specimen each was infected with 51-60 and 81-90 parasites (Figure 2).

3.3 Nutritional composition of *T. guineensis*

The result of the proximate analysis of muscles of *T. guineensis* showed that the moisture content was 72.20%, while the crude protein was 19.88%. The ash content and crude fibre were 1.64% and 1.27%, respectively. The results are presented in Table 2.

3.4 Water quality

Results of the water quality tests of Rumuola Borrow-pit are presented in Table 3. The pH, conductivity, turbidity, total hardness, total alkalinity, chloride, total dissolved solids, total solids, nitrate, sulphate as well as calcium, magnesium, BOD and COD were within the WHO [25] acceptable limits. However, other parameters such as, odour, color, total suspended solids, organic matter content, iron and lead concentrations were above the acceptable limits.

Figure 2: Parasite burden of *Paradilepis* sp. in *T. guineensis*, Rumuola Borrow Pit, Port Harcourt, Nigeria.

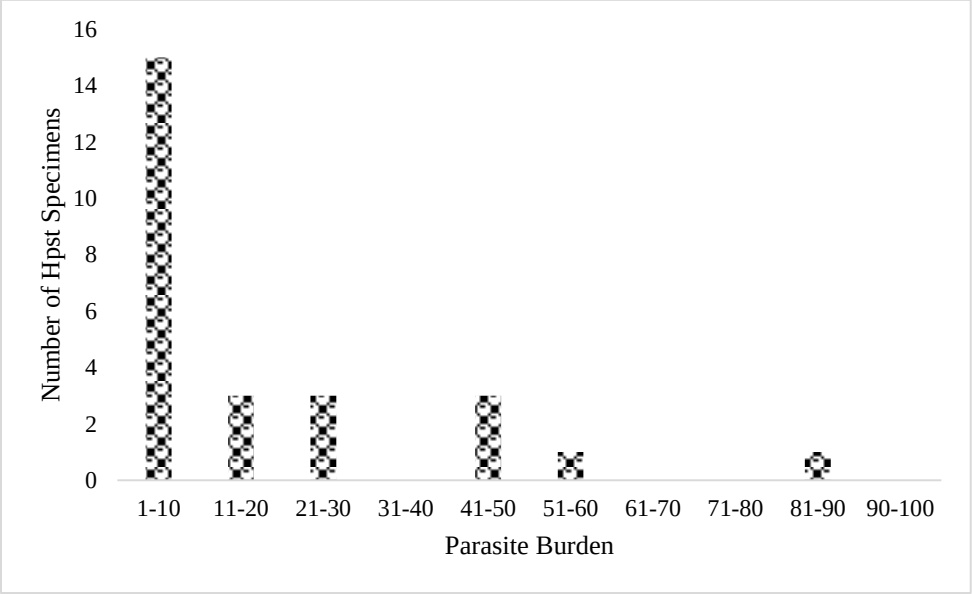


Plate 2: A-B: Larval stage 2 of *Paradilepis* sp.; A=scolex, B= posterior region (cleared in lactophenol). C-D: Larval stage 3 of *Paradilepis* sp.; C=scolex, D= posterior region (not cleared).

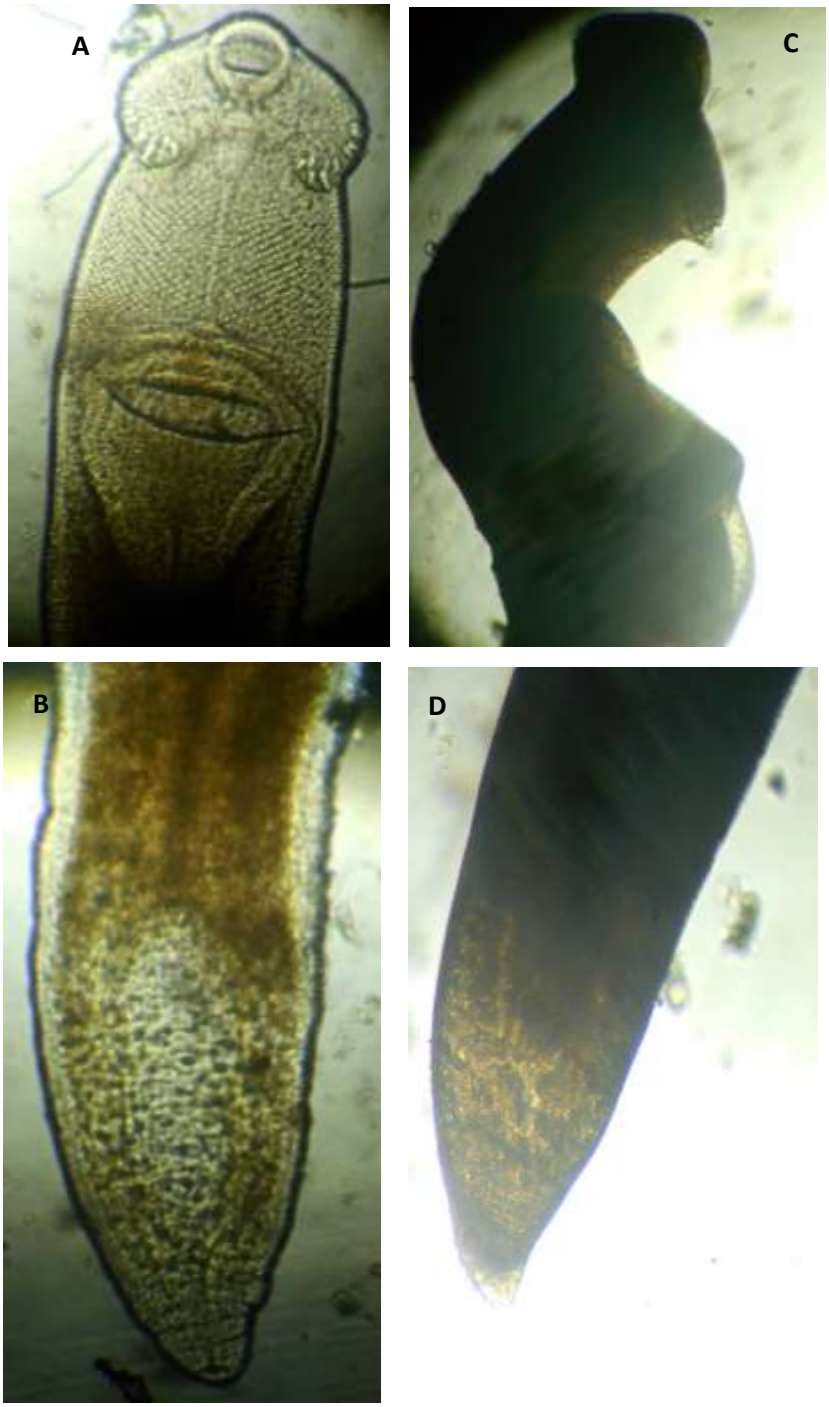


Table 2: Proximate analysis of *Tilapia* sp. from Rumuola Borrow Pit, Port Harcourt, Nigeria.

Parameter	**Value**
Moisture (%)	72.20
Ash content (%)	1.64
Fat (%)	2.69
Crude fibre (%)	1.27
Crude protein (%)	19.88
Carbohydrate (%)	2.32

Table 3: Water quality values of Rumuola Borrow Pit, Port Harcourt, Nigeria.

Parameter	Value	Reference/Standard (WHO [25])
Odour	Objectionable	Unobjectionable
Colour (Hazen Units)	17.0	15.0
pH	7.03	6.5-8.5
Conductivity (µS/cm)	140.0	1000.00
Turbidity (NTU)	1.00	5.0
Total Hardness (mg/l)	25.10	100.00
Total alkalinity (mg/l)	19.05	200.0
Chloride (mg/l)	105.00	250.00
Total Suspended Solids (mg/l)	68.00	30.00
Total Dissolved Solids (mg/l)	117.00	500.00
Organic matter (mg/l)	0.41	0.01
Nitrates (mg/l)	4.90	10.00
Sulphate (mg/l)	83.30	250.00
Calcium (mg/l)	11.80	70.00
Magnesium (mg/l)	2.55	30.00
BOD_5 (mg/l)	14.22	15.00
COD (mg/l)	33.30	40.00
Total Iron (mg/l)	0.44	0.30
Lead (mg/l)	0.05	0.01

4. Discussion

This research represents the first report of *Paradilepis* sp. from fishes from Rumuola Borrow Pit. The only other work that had been reported from this study location was on the polycyclic aromatic hydrocarbons (PAHS) of the fish tissues (Ubong et al., [13]).

A total of 54 fish specimens belonging to 3 families - Cichlidae (*Tilapia guineensis*), Bagridae (*Bagrus* sp.) and Butidae (*B. africanus*)- were examined for parasitic infection. Of these species, only *Tilapia guineensis* was infected, and with only one parasite- cysticercoids of the tapeworm, *Paradilepis* sp., found attached to the intestinal wall of the specimens. Prevalence of infection was 52.00% while the mean intensity was 21.1 (±4.3) parasites per infected host.

In this research, the parasite burden ranged from four (4) to ninety (90) parasites in the infected hosts, indicating that the hosts were heavily infected. Similar parasite burdens in tropical freshwaters have been described (Vidal-Martinez and Kennedy [26]; Karvonen and Valtonen [27]). Such parasite burden in an ecosystem poses high risk of infection to both fish and man, especially when fish serve as intermediate hosts to human parasites or where fish is co- host of zoonotic parasites.

The parasite (*Paradilepis* sp.) was recovered only from *T. guineensisis*. Its absence from the other hosts could be due to their lower sample size or the parasite's preference for *Tilapia* as intermediate hosts in Africa. This is supported by the observation that earlier researchers had reported cysticercoids (larvae) of the species in the intestinal wall of *Tilapia nilotica* from Sudan (Prudhoe and Hussey [1]). However, these parasites have also been recovered from common bullies, *Gobiomorphus cotidianus* and *G. breviceps,* fresh water fishes in New Zealand (Blasco-Costa et al., [6]) and from *Gasterosteus aculeatus, Carassius carassius, Scardinius erythrophthalmus, Tinca tinca* etc from UK (Williams et al., [2]), suggesting it could use varying intermediate host species in different locations. Prudhoe and Hussey [1] found the adult parasite (*Paradilepis delachauxi*) in the intestine of *Phalacrocorax africanus* (comorrants) in Transvaal, South Africa. The parasite, which is sparsely encountered in parasitological examinations in Nigeria, is known to use piscivorous birds as hosts with fishes serving as intermediate hosts. They complete their entire life cycle in the aquatic environment (Blasco-Costa et al., [6]). The high prevalence observed in this study indicates that the adult tapeworm is present in a predatory bird in the study location, most likely in the common Moorhen (*Gallinula chloropus meridionalis*) from which the metacestodes were recovered.

In reports from other parts of the world, the adult tapeworm is mostly recovered from cormorants. Monteiro et al., [5] reported *Paradilepis caballeroi*, at a prevalence of 87.23%, from the Neotropical cormorant, *Phalacrocorax brasilianus*, from Lago Guaiba, State of Rio Grande do Sul, Brazil. Violante-Gonzalez et al., [28] reported *P. caballeroi* at a prevalence of 66.67% from *P. brasilianus* in Guerrero State, Mexico. In their recent research, Gonzalez-Acuna et al., [3] also reported *P. caballeroi* in same host species in Chile. These authors reported that the genus *Paradilepis* consists of fourteen species, and commonly parasitize birds of the family, Pelecaniformes, and cormorants. They also noted that *Paradilepis* species had been reported from birds in the United States, Canada, Mexico, Cuba and Brazil

while their report was the first in Chile. In Africa, available records include those of Prudhoe and Hussey [1] in South Africa and Scholz et al., [4] in several African countries. The first report of *Paradilepis* sp. in Nigeria was made by Ezeri [7] in *Oreochromis niloticus* from Ogun and Plateau States. This is therefore, the second report in Nigeria. Molecular tests will enable the specific identification of the *Paradilepis* sp. of *T. guineensis* and African common Moorhen (*Gallinula chloropus meridionalis*) of Rumuola borrow pit in future studies.

It was observed that larger fishes had more parasites than smaller ones. This corroborates the finding of Torres et al., [29] who reported that the longer and bigger the fish, the greater the susceptibility to parasitic infections. In addition, it was observed that parasitic infection of *T. guineensis* increased with advancing dry season. This is because more parasites were encountered during the earlier part of the study when the amount of rainfall was still low. As the rainy season became more intense, however, fewer parasites were recovered from infected hosts. Rainfall does a lot of cleansing to water bodies. Volumes of water decrease with advancing dry season, thus increasing the population of parasitic organisms per unit volume of water, as reported by Osineye et al., [30].

With reference to the nutrient composition of the *Tilapia guineensis* examined in this research, it was found that the moisture content was 72.2%. Olapade et al., [31] found that Nile Tilapia (*Oreochromis niloticus*) had moisture content of 81.39%, while the hybrid Tilapia had 80.09% moisture. Adejonwo et al., [32] reported 79.50% moisture content for both *T. guineensis* and *T. melanotheron*. The percentage reported in the present research is therefore lower than those reported by these other researchers. Also comparing with the findings of Olapade et al., [31], the crude protein, fat and ash content of the *T. guineensis* examined here were higher than those of *O. niloticus* and hybrid *Tilapia*. While the values obtained in this research were 19.88%, 1.64% and 2.69% for crude protein, ash and crude fat, respectively, Olapade et al., [31] reported 13.66%, 1.36% and 0.4% for crude protein, ash and crude fat, respectively in *O. niloticus*; and 14.93%, 1.36% and 0.59% for crude protein, ash and crude fat, respectively in the hybrid Tilapia. In their own research, Adejonwo et al., [32] reported crude protein, 18.65% and 18.74%, for *T. guineensis* and *T. melanotheron*, respectively; total lipid, 0.55% and 0.70%, for *T. guineensis* and *T. melanotheron*, respectively; and total ash, 1.30% and 1.06%, for *T. guineensis* and *T. melanotheron*, respectively.

These show that *T. guineensis* examined in the present research was lower in moisture content, but higher in crude protein, ash and fat (lipid content) when compared with these other reports. Geographical location, water quality and diet are presumed to have contributed to the observed differences (Jim et al., [10]; Moses et al., [8]). However, the values for *T. guineensis* from Rumuola borrow pit were within the normal ranges for other Tilapia species (*Oreochromis niloticus*; Gaber [9]).

Results of water quality analysis showed that most of the parameters tested for were within the acceptable limits of WHO [25]. However, the odour, colour, total suspended solids, organic matter and the heavy metals (Fe and Pb) were above the acceptable limits. Though heavy metals were not determined in fish tissues, bioaccumulation of such pollutants in fish is a

recognized fact (Moslen [33]; Moslen and Miebaka [34]; Bawuro et al., [35]).

5. Conclusion and Recommendations

Cysticercoids of the cestode, *Paradilepis* sp., were recovered from the intestinal wall of *T. guineensis* obtained from Rumuola borrow pit at a prevalence of 52%. This is the first report of *Paradilepis* sp. in Rivers State, and second in Nigeria.

The composite analysis of *T. guineensis* showed that the moisture content was 72.2%, crude protein 19.88% and carbohydrate 2.32%. The crude ash, fat and fibre contents were 1.64%, 2.69% and 1.27%, respectively. Results of the water quality analysis showed that heavy metals (Pb and Fe), organic matter, and total suspended solids were above the permissible limits.

It is recommended that piscivorous birds from the environs of Rumuola borrow pit be examined for the possible recovery of adult *Paradilepis* sp. Also, studies on the parasites of fishes should also examine the water quality to enable establishment of limits of parameters that favor parasite transmission. Since the odour and color, organic matter, total suspended solids, Fe and Pb contents of the water body were above acceptable limits, residents of Rumuola are advised to desist from indiscriminate disposal of household and other wastes into the borrow pit, and to avoid consuming fish harvested from the pit to prevent metal poisoning.

Conflicts of Interest

The authors declare no conflicts of interest.

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