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Endoparasitic Infestation of the Nile Squeaker, *Synodontis schall* (Bloch and Schneider, 1801) from the Cross River Estuary, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author EVO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author EEE managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The mean goal of this study was to determine the abundance, intensity, and prevalence of endoparasites of *Synodontis schall* from the Cross River Estuary, Nigeria, and the public health implications to fish consumers. A total of 150 fresh samples were collected between May and October 2013 from the catches of the artisanal fisheries at Nsidung beach and transported to the Fisheries and Aquaculture laboratory, University of Calabar, for identification and parasitological examination. The internal organs including intestines and stomach were removed and examined microscopically for parasites. The overall prevalence of endoparasites was 11.33% and endoparasites recovered belonged to nematode (*Camallanus kirandensi*), Cestode (*Diphyllobothrium sp.* and *Proteocephalus largoproglotis*), and Acanthocephalans (*Pomporhynchus laevis* and *Acanthela sp.*). Parasites were more prevalent in the intestine (28 endoparasites –

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59.57%) than the stomach (19 endoparasites – 40.43%) indicating that the intestine is a more favorable internal organ for endoparasites. Infestation rate was significantly higher (P<0.05) in 10 – 14.9 cm size class (53.33%), followed by 15 – 19.9cm (3.00%), followed by ≥ 20.0 cm (8.00%) and lowest in 5-9.9 cm size class (4.67%). Prevalence and abundance was significantly higher (P<0.05) in 15 – 19.9 cm size class, followed by 20 – 24.9 cm, followed by 10 -14.9 cm and lowest in 5 – 9.9 cm while intensity was highest in 10 – 14.9 cm size class, followed by 15 – 19.9 cm, followed by ≥ 20.0 cm and lowest in 5 – 9.9 cm. Intensity and abundance of endoparasites were significantly higher (P<0.05) in females than males whereas prevalence was higher in males than females. It can be concluded that the risk of zoonosis was extremely low because intestine and stomach of this fish were not consumed. However, to eliminate the risk of zoonosis, fish consumed should be previously washed with clean water and cooked properly.

Keywords: Endoparasites; abundance; intensity; prevalence; Synodontis schall; Cross River Estuary.

1. INTRODUCTION

Synodontis schall commonly known as the Nile Squeaker is a species of upside-down catfish belonging to the family Mochokidae. It is a commercially important species in the inland waters of West Africa including the Cross River Estuary, Nigeria. *S. schall* is a member of the largest genus of the Mochokidae family. According to Abu-Gideiri and Nasr [1], it is available all year round because of its ability to adapt to distinct types of food and habitat, thereby increasing the chances of survival. Its identification is easy due to the humeral process attached to its hardened head cap along with the strong bony spines located on its pectoral and dorsal fins. *S. schall* is a prized delicacy by inhabitants of the Cross River Estuary and other Nigerian coastal communities due to its nice flavor, taste and meat quality. Also, its nutritional profile reported by Steffens [2] consist of moisture, dry matter, protein, lipid, vitamins, minerals, and caloric value thereby increasing its demand. Fish is an important source of protein, low lipids, calcium, phosphorus, vitamins and minerals, and is generally favored over other white or red meats [3-5]. In Nigeria, the growing rate of industrialization is generally leading to contamination and deterioration of both aquatic and terrestrial environment. There is a general lack of adequate information linking the parasitic fauna of tropical fish with the concurrent environmental degradation and climate change [6,7]. Parasitic diseases of fish is one of the major problems confronting the Nigerian fishing industry. Endoparasites of bonyfish species in tropical waters have been studied by several authors [8-18], but there have been limited studies on the endoparasites of *Synodontis schall* in the Cross River Estuary. Therefore, the objective of this study was to investigate the abundance, intensity and prevalence of endoparasites of *Synodontis shall* from the Cross River Estuary, Nigeria and to recommend safety measures to curb the risk of zoonosis among fish consumers.

2. MATERIALS AND METHODS

2.1 Study Area Description

The Cross River Estuary located in the southern part of Nigeria lies approximately between latitudes 4ºand 8ºN and longitude 7º30 and 10ºE. It takes its rise from the Cameroon Mountain and meanders west ward into Nigeria and then south ward through high rainforest formation before discharging into Atlantic Ocean at the Gulf of Guinea [19]. The study area is rich in mangrove forest vegetation with climate characterized by long wet season from April to October and a dry season from November to March. It is also characterized by a cold, dry and dusty period between December and January which is known as harmattan season. Temperature ranges from 22°C in the wet to 35°C in the dry season with a relative humidity ranging from 60% (dry season) to above 90% during the wet season [20].

2.2 Collection and Identification of *Synodontis schall* and Their Sexes

One hundred and fifty freshly caught *S. schall* were collected between May and October 2013 from the catches of the artisanal fisheries at Nsidung beach, Calabar (Fig. 1) which is a major landing point of the artisanal fisheries of the Cross River Estuary. Fish samples were transported immediately in ice-packed containers to Fisheries and Aquaculture laboratory, Institute of Oceanography, University of Calabar, for further analysis. Identification of *S. schall* was based on identification key given by

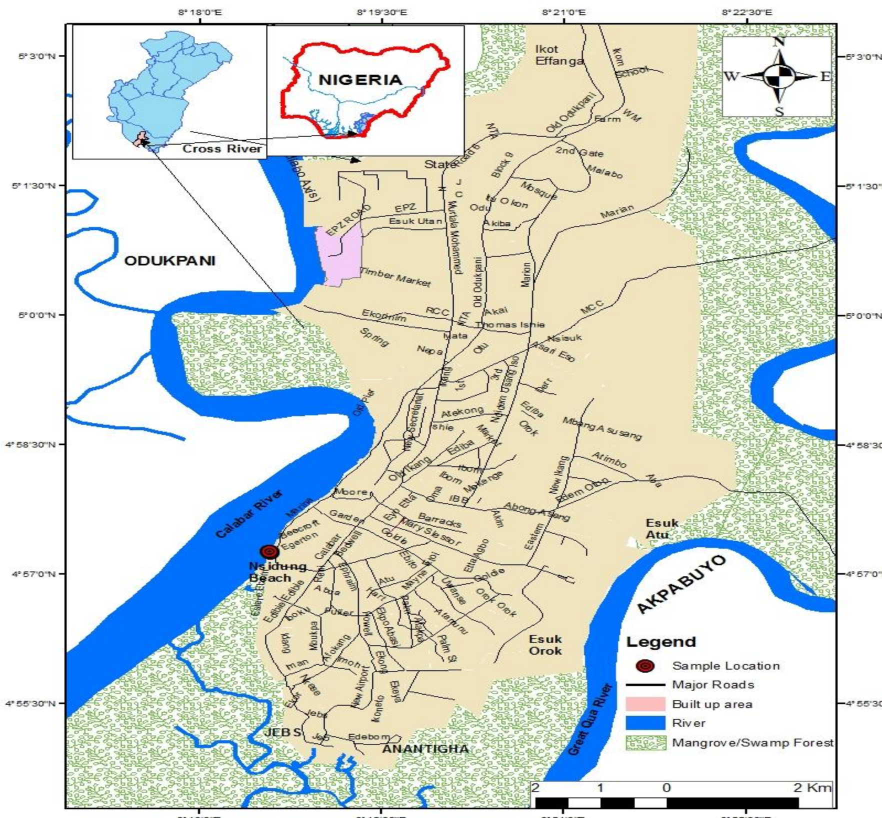

Fig. 1. Map of the Cross River Estuary showing the sampling area (Nsidung Beach)

Fischer et al. [21]. Also, a major taxonomic feature was the humeral process attached to its hardened head cap and the strong bony spines of its pectoral and dorsal fins. Differentiation of sexes was based on external features (anal opening) and internal features such as gonad [19].

2.3 Measurements of *Synodontis schall* Total Length (TL-cm) and Size Class Grouping

The total length of *S. schall* was measured from snout to the base of the caudal fin rays using a measuring board to the nearest 0.1 cm. The fish were grouped into four size class including 5 – 9.9 cm, 10 – 14.9 cm, 15 – 19.9 cm and ≥ 20.0 cm.

2.4 Examination of *Synodontis schall* for Endoparasites

The cavity of each fish was ventrally cut opened using a pair of sharp scissors and the internal organs including intestines and stomach were removed for examination. The intestine and stomach of each fish was opened with a pair of scissors, scrapped onto a clean glass slide and examined with unaided human eye and microscopically for parasites. Endoparasites recovered from infested fish were identified using parasite keys [22-25].

2.5 Processing, Preservation and Fixation of Endoparasites

Endoparasites recovered from *S. schall* fromthe Cross River Estuary were treated, preserved and stained according to Eyo et al. [6] as follows:

2.5.1 Cestodes

Cestodes were fixed in 4% neutral formalin and dehydrated in ethanol. Thereafter, they were then stained with Eosin (E) and mounted on a clean glass slide with Canada balsam.

2.5.2 Nematodes

Nematodes were fixed in 70% ethyl alcohol for 2 hours, decanted and stored in 5% glycerin.

Thereafter, they were stained with Eosin (E) and mounted on a clean glass slide with Canada balsam.

2.5.3 Acanthocephalans

Acanthocephalans were stored in a refrigerator overnight to relax and exude the proboscis and then fixed and dehydrated in 70% ethanol. Thereafter, they were stained with Eosin (E) and mounted on a clean glass slide with Canada balsam.

2.6 Evaluation of Parasitological Indices

Parasitological indices evaluated include Dominance (D), Prevalence (P) Mean Intensity (I) and Abundance (A). The dominance of endoparasites was calculated according to Roohi et al*.* [26] as given below:

$$\text{Dominance} = \left(\frac{N}{N\ Sum}\right)*100$$

Where N = abundance of endoparasite species and N sum = sum of the abundance of all endoparasite species found) and expressed as a percentage. The endoparasite were classified based on their dominance values according to Niedbala and Kasparzak [27] as follows: eudominant (>10%), dominant (5.1% - 10%), subdominant (2.1% -5%), recedent (1.1% - 2%) and subrecedent (<1.0%) of given species.

Prevalence (%), mean intensity and abundance were calculated according to Upadhyay et al*.,* [28] given below:

$$\text{Prevalence (\%)} = \left(\frac{No.of\ infected\ fish}{Total\ No.of\ fish\ examined}\right)*100$$

$$\text{Mean Intensity} = \frac{No.of\ collected\ parasites}{No.of\ infested\ fish}$$

$$\text{Abundance} = \frac{No.\ of\ parasites}{No.of\ fish\ examined}$$

2.7 Statistical Analysis

Prevalence, intensity and abundance of endo-parasites recovered from *S. schall* from the Cross River Estuary in the four size class was subjected to One-Way Analysis of Variance (ANOVA) to test for significant difference using Predictive Analytical Software (PASW) windows software program for statistical analysis (version 18.0). also, prevalence, intensity, and abundance of endo-parasites with regards to the sex of *S. schall* from the Cross River Estuary were subjected to T-test analysis. Effects with a probability of ($P<0.05$) was considered significant.

3. RESULTS

3.1 Number of Fish Examined, Infested and Parasites Recovered from *S. schall* from the Cross River Estuary

Out of one hundred and fifty (150) examined specimens, 17 specimens were infested with 47 endoparasites. In 5- 9.9 cm size class, only 1 out of 7 (4.67%) examined specimens were infested with 1 endoparasites. In 10- 14.9 cm size class, 5 out of 80 (53.33%) examined specimens were infested with 18 endoparasites. In 15- 19.9 cm size class, 9 out of 51 (34.00%) examined specimens were infested with 23 endoparasites. In ≥ 20.0 cm size class, 2 out of 12 (8.00%) examined specimens were infested with 5 endoparasites. Table 1 shows the number of fish examined, number of fish infested and number of endoparasites recovered.

3.2 Prevalence, Intensity and Abundance of Endoparasites Recovered from *S. schall* from the Cross River Estuary

Result obtained for prevalence (%), intensity and abundance of endoparasites in relation to size class (cm) is shown in Table 1. Prevalence was highest (17.65%) in 15 – 19.9 cm size class, followed by ≥ 20.0 cm (16.67%), followed by 10 - 14.9 cm (6.25%) and lowest in 5 – 9.9 cm (1.47 %). Intensity was highest (3.60) in 10 – 14.9 cm size class, followed by 15 – 19.9 cm (2.56), followed by ≥ 20.0 cm (2.50) and lowest in 5 – 9.9 cm (1.00). Abundance was highest (0.45) in 15 – 19.9 cm size class, followed by ≥ 20.0 cm (0.42), followed by 10 -14.9 cm (0.23) and lowest in 5 – 9.9 cm (0.14).

3.3 Prevalence, Intensity and Abundance of Endoparasites Recovered from *S. schall* in Relation to Sex

Out of one hundred and fifty specimens of *S. schall* examined in this study, 96 were females (64%) while 54 were males (36%). Out of 96 females examined, 10 specimens were infested with 31 endoparasites with prevalence (10.42%), intensity (3.10) and abundance (0.32). Out of 54 males examined, 7 specimens were infested with 16 endoparasites with prevalence (12.96%), intensity (2.29) and abundance (0.30). Table 2 shows the number of fish examined, prevalence, intensity and abundance of endoparasites recovered from *S. schall* in relation to sex.

3.4 Prevalence, Intensity, Abundance and Dominance of Endoparasites from *S. schall* in Relation to Organ Specificity

The prevalence of endoparasites recovered from *S. schall* in relation to organ specificity (Table 3.) showed that in 5 -9.9 cm size class, only 1 nematode (*Camallanus kirandensi*) was recovered from the intestine with a dominance value of 100.00 (Eudominant parasite), prevalence (14.29%), intensity (1.00) and abundance (0.14). In 10 -14.9 cm size class, endoparasites were most prevalent in the intestine and stomach. Four (4) *Diphyllobothrium sp* (Cestode) was recovered from the intestine with a dominance value of 22.22 (Eudominant parasite), prevalence (2.50%), intensity (2.00) and abundance (0.05). Nine (9) *Acanthela sp.* (Acanthocephala) was recovered from the stomach with a dominance value of 50.00 (Eudominant parasite), prevalence (2.50%), intensity (4.50) and abundance (0.11). Five (5) *Pomporhynchus laevis* (Acanthocephala) was recovered from the intestine with a dominance value of 27.77 (Eudominant parasite), prevalence (1.25%), intensity (5.00) and abundance (0.06). In 15 -19.9 cm size class, endoparasites were most prevalent in the intestine and least in the stomach. Eight (8) *Diphyllobothrium sp* (Cestode) was recovered from the intestine with a dominance value of 34.78 (Eudominant parasite), prevalence (5.88%), intensity (2.67) and abundance (0.16). Two *Acanthela sp.* (Acanthocephala) was recovered from the stomach with a dominance value of 21.74 (Eudominant parasite), prevalence (3.92%), intensity (2.50) and abundance (0.10). Six (6) *Pomporhynchus laevis* (Acanthocephala) was recovered from the intestine with a dominance value of 26.09 (Eudominant parasite), prevalence (5.88%), intensity (2.00) and abundance (0.12). Four (4) *P. largoproglotis* (Cestode*)* was recovered from the intestine with a dominance value of 17.39 (Eudominant parasite), prevalence (1.96%), intensity (4.00) and abundance (0.08). In ≥ 20.0 cm size class, 5 *Acanthela sp.* (Acanthocephala) was recovered from the stomach with a dominance value of 100 (Eudominant parasite), prevalence (16.67%), intensity (2.50) and abundance (0.42).

3.5 Numerical Abundance and Percentage of Endoparasites of *S. schall* in Relation to Organ

Numerical abundance and percentage of endoparasites of *S. schall* in relation to organ (Table 4) showed that 28 endoparasites (59.57 %) were recovered from the intestine (1 *Camallanus kirandensi*, 12 *Diphyllobothrium sp*, 11 *Pomporhynchus laevis* and 4 *P. largoproglotis*) and 19 *Acanthela sp* (40.43 %) was recovered from the stomach.

Table 1. Number and percentage of fish examined, prevalence, intensity and abundance of endoparasites recovered from *S. schall* from the Cross River Estuary

Size class (cm)	No. and % of fish examined	No. of fish infested	No. of parasites collected	Prevalence	Intensity	Abundance
5 – 9.9 cm	7 (4.67)	1	1	1.47 [a]	1.00 [a]	0.14 [a]
10 – 14.9 cm	80 (53.33)	5	18	6.25 [b]	3.60 [b]	0.23 [b]
15 – 19.9 cm	51 (34.00)	9	23	17.65 [c]	2.56 [c]	0.45 [c]
≥ 20.0 cm	12 (8.00)	2	5	16.67 [c]	2.50 [c]	0.42 [c]
Total	150 (100)	17	47	11.33	2.77	0.31

**column with the same superscript are not significantly different (P>0.05)*

Table 2. Number of fish examined, prevalence, intensity and abundance of endoparasites recovered in relation to sex

Sex	No and % of fish examined	No of fish infested	No. of parasites collected	Prevalence	Intensity	Abundance
Female	96 (64)	10	31[a]	10.42 [a]	3.10 [a]	0.32 [a]
Male	54 (36)	7	16[b]	12.96 [b]	2.29 [b]	0.30 [a]
Total	150 (100)	17	47	11.33	11.33	0.31

**column with the same superscript are not significantly different (P>0.05)*

Table 3. Dominance, prevalence intensity and abundance of endoparasites in relation to organ specificity

Size class (cm)	No. of fish examined	No. of fish infested	Parasite species	No. of parasites collected	Organs	Dom	Pre	Int	Abn
5 – 9.9 cm	7	1	*Camallanus kirandensi*	1	Intestine	100.00	14.29	1.00	0.14
Total	7	1		1		100.00	14.29	1.00	0.14
10 – 14.9 cm	80	2	*Diphyllobothrium sp*	4	Intestine	22.22	2.50	2.00	0.05
		2	*Acanthela sp*	9	stomach	50.00	2.50	4.50	0.11
		1	*Pomporhynchus laevis*	5	Intestine	27.77	1.25	5.00	0.06
Total	80	5		18		100.00	6.25	3.60	0.23
15 – 19.9 cm	51	3	*Diphyllobothrium sp*	8	Intestine	34.78	5.88	2.67	0.16
		2	*Acanthela sp*	5	stomach	21.74	3.92	2.50	0.10
		3	*Pomporhynchus laevis*	6	Intestine	26.09	5.88	2.00	0.12
		1	*P. largoproglotis*	4	Intestine	17.39	1.96	4.00	0.08
Total	51	9		23		100.00	17.65	2.56	0.45
≥ 20.0 cm	12	2	*Acanthela sp*	5	Stomach	100.00	16.67	2.50	0.42
Total	12	2		5		100.00	16.67	2.50	0.42

**Dom = Dominance, Pre = Prevalence, Int = Mean Intensity and Abn = Abundance*

Table 4. Numerical abundance and percentage of endoparasites from *S. schall* in relation to organ

Organs	Percentage of parasites in organs	Parasite Species	Number of ectoparasite species
		Camallanus kirandensi	1
Intestine	59.57	*Diphyllobothrium sp*	12
		Pomporhynchus laevis	11
		P. largoproglotis	4
Total			28
Stomach	40.43	*Acanthela sp*	19
Total			19
Overall Total	100		47

4. DISCUSSION

In this study, results obtained showed that 17 specimens were infested with 47 endoparasites out of one hundred and fifty (150) examined *S. schall*. Endoparasites recovered belonged to Nematoe (*Camallanus kirandensi*), Cestode (*Diphyllobothrium sp* and *P. largoproglotis*), and Acanthocephalans (*Pomporhynchus laevis* and *Acanthela sp.*) with an overall prevalence of 11.33%. The overall prevalence of endoparasites (11.33 %) obtained in this study is very low compared to 68.57% reported by Hassan et al. [41] for *Synodontis clarias*, 72.6% published by Eyo et al. [6] for *Synodontis batensoda* from Rivers Niger-Benue Confluence, Nigeria and 85.2% reported by Auta et al. [13] for *Synodontis sp*. in Zaria dam, Nigeria. It is also lower than 47.8% reported by Amare et al. [29] for fishes in Lake Lugo, Ethiopia. Amare et al. [29] attributed higher prevalence of fish endoparasites in water bodies to factors including the absence of proper waste disposal and management system, traditional fishing methods which damaged the phytoplankton or zooplankton population and environmental pollution (climate change). Variation of endoparasites reported by different authors in different water bodies suggests that endoparasites distribution varies according to habitat, host-parasite relationship and abiotic factors including dissolved oxygen, water temperature and pH [29,30]. Comparative evaluation of endoparasites in relation to size class showed that fish in 10 – 14.9 cm size class had the highest endoparasite infestation rate (53.33%), followed by 15 – 19.9cm (3.00%), followed by ≥ 20.0 cm (8.00%) and lowest in 5-9.9 cm size class with 4.67%. Prevalence and abundance was significantly higher (P<0.05) in 15 – 19.9 cm size class, followed by 20 – 24.9 cm, followed by 10 -14.9 cm and lowest in 5 – 9.9 cm while intensity was significantly higher (P<0.05) in 10 – 14.9 cm size class, followed by 15 – 19.9 cm, followed by ≥ 20.0 cm and lowest in 5 – 9.9 cm. This could be related to a large amount of food intake by fish in 10 – 14.9 cm and 15 – 19.9cm size class which is like findings of Ekanem et al. [17]. According to Abu-Gideiri and Nasr [1], *S. schall* is an omnivore, feeding mainly on phytoplankton, zooplankton, detritus, plant tissues, insects, crustaceans and insect parts. Also, these findings were equal to those obtained by Amare et al. [29], Allumma and Idowu [31] and Bichi and Ibrahim [32] who observed heavy parasitic infestation in larger fishes than the smaller ones. Fish length is highly correlated to fish age with younger fish having a smaller length and older fishes with a higher length except in peculiar condition where a fish may be stunt based on genetic or environmental conditions such as food availability and poor water quality. Poulin [33] reported that older fishes have longer time span exposure to the environment compared to younger fishes which may provide more internal space for endoparasites to accumulate in a larger surface area in the intestine and stomach. According to Emere [14] differences in the parasitic infestation between male and female fish is related to the degrees of resistance and infection. Evaluation of endoparasites in this study according to sex showed that intensity and abundance of endoparasites were higher in females than males whereas prevalence was higher in males than females. This observation agrees to the findings of Akinsanya et al. [16], Allumma and Idowu [31] and Mwita and Lamtane [34] who reported a higher rate of endoparasites infestation in male fishes than females. Mwita and Lamtane [34] further explained that spawning fish tend to be inactive hence reducing the chances of contacting the infective stages of the parasite. Müller [35] and Mwita [36] opined that changes in the level of hormone in fish could enhance the reduction of the number of parasite in females. However, our findings contradict the findings of Imam and Dewu [37], Bichi and Ibrahim [32], Mheisen et al. [38] and Emere [14] that female fishes were generally more susceptible to endoparasitic infestation than males. This observation was attributed to the difference in the physiological condition of the females from males especially gravid ones which resistance to parasites infection could be reduced [39]. The prevalence of endoparasites in relation to organ specificity in this study showed that parasites were more prevalent in the intestine with a total of 28 (59.57%) endoparasites including 1 *Camallanus kirandensi*, 12 *Diphyllobothrium sp.,* 4 *P. largoproglotis* and 11 *Pomporhynchus laevis* than the stomach with 19 (40.43%) *Acanthela sp*. In conformity to Rosas-Valdez and Perez-Ponce de Leon [40], parasites show some level of preference or specificity in the organs of the host they parasitize. According to Hassan et al. [41], series of pathological effects in fish could be induced by helminth infection. In this study, lesion such as intestinal inflammation and necrosis was observed in infected fish and the degree of inflammation and necrosis was observed to vary with the number of endoparasites recovered in infested fish. The number of acanthocephalan (30) isolated from *S. schall* in this study was higher than cestode

(16) and nematodes (1). This observation disagrees with findings of Ekanem et al. [17], Onyedineke et al. [42] and Ekanem et al. [18] who reported higher number of nematodes than other parasites in fishes from a tropical water body. However, organ specificity of endoparasites in this study conforms with findings of Ekanem et al. [17] in the Great Kwa River, Akinsanya et al. [16] in Lekki Lagoon, Onyedineke et al. [42] from River Niger and Olurin and Somorin [15] in fishes from Kainji Lake and Owa stream, South-West Nigeria. In this study, majority of the infested fish had single infestation of endoparasites with very few occurrences of multiple infestations. Amare et al. [29] ascribed multiple infestations of endoparasites in fish to favorable environment which supports several parasites species thereby exposing the host to simultaneous infection. Also, presence of one parasite species and its activity within the host is to weaken the resistance making the host susceptible to multiple.

5. CONCLUSION

Results of the present study in the Cross River Estuary showed the different internal parasitic infestation of *S. schall* and their occurrence in relation to size and sex. Endoparasites parasitizing *S. schall* belonged to Nematode (*Camallanus kirandensi*, Cestode (*Diphyllobothrium sp* and *P. largoproglotis*), and Acanthocephalans (*Pomporhynchus laevis* and *Acanthela sp*.) with an overall prevalence of 11.33%. Parasites were more prevalent in the intestine than the stomach indicating that the intestine of *S. schall* is a more favorable internal organ for endoparasites. Fish in a higher-class size are more susceptible to endoparasites due to longer time span exposure to the environment compared to younger fishes. It can be concluded that the risk of zoonosis was extremely low because intestine and stomach of this fish were not consumed. However, to eliminate the risk of zoonosis, fish consumed should be previously washed with clean water and cooked properly.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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