Annual Review & Research in Biology
3(4): 584-595, 2013

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Relevance of Nematode Parasitic Burden in Channid Fishes of Orogodo River, Southern Nigeria to Organic Pollution

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Authors' contributions

This work was carried out in collaboration between all authors. Author FOA designed the study, performed the statistical analysis, and wrote the first draft of the manuscript. Author KEU managed the analyses of the study. All authors read and approved the final manuscript.

Research Article

Received 15th March 2013
Accepted 17th June 2013
Published 28th June 2013

ABSTRACT

Aims: To ascertain the gastrointestinal nematode burden on the channids, *Parachanna obscura and Parachanna africana* (Steindachner, 1879) (Family: Channidae) in the down reaches of Orogodo River at Evboesi and Ekwuoma-Abavo, southern Nigeria and its relationship to the levels of organic pollution.
Study Design: A total of 220 channid fish were collected from two stations of the river experiencing different degree of organic pollution and dissected for gastrointestinal nematode parasites
Place and Duration of Study: The study lasted for a period of six months (Jan to Jun 2010) with collections of fishes done monthly at two sampling stations of Orogodo River in southern Nigeria.
Methodology: A total of 220 channid fishes were examined. Their stomachs and intestines were cut open and the contents were emptied into Petri dishes containing water and were examined for nematode parasites. These were quickly stained with Giemsa stain and viewed under a light microscope.
Results: A total of 100 (45.5%) were infected with gastrointestinal nematode parasites. The prevalence of infection reveals that *Parachanna obscura* recorded 62.5% while

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Parachanna africana had 66.7% in fishes collected from station 1 and 20.1% and 28.6% respectively from fishes collected at station 2. The nematode parasites recovered were *Cucullamus* sp., *Camallanus* sp. and *Procamallanus laevionchus*. The overall parasitic burden reveals that the prevalence infection was statistically significant ($p< 0.05$) in the species examined. The distribution of infrapopulations of the parasites varied significantly with size class and weight of the fish peaking in most cases in larger size classes. The chemical parameters of the river water at station 1 showed the water to be stressed with high BOD and nutrients levels when compared with station 2. This may explain the high parasitic burden recorded in the channids at station 1.
Conclusion: The intensity of the parasites in the host fish agree with previous hypotheses suggesting that environmental pollution does affect parasite population.

Keywords: Fish; helminth; parasitology; bioindicator; Orogodo River; Nigeria.

1. INTRODUCTION

Nematode parasites of fish are of importance not only to fish health but also to the understanding of the water quality status of a water body. Nematodes infect many species of aquaculture and wild fish including the channids [1]. Small numbers of nematodes often occur in healthy fish, but high numbers could cause illness or even death [2]. The typical characteristics of parasites as bioindicators of pollution have been identified and reviewed [3,4,5]. These include: Single-host life cycle, differences in prevalence of infection and mean intensity, high degree of site specificity, longer life span, suitable environmental conditions that should fall with the physiological range of tolerance of the parasites, and no marked pathological effect of parasite on host. Specifically, the role of nematodes as indicators have also been outlined to include (i) they are among the simplest metazoa which occur in any environment providing a source of organic carbon, under all climatic conditions and in habitats that vary from pristine to extremely polluted areas; (ii) they do not rapidly migrate from stressful conditions and many species survive dehydration, freezing or oxygen stress; (iii) nematodes are transparent, their diagnostic internal features can be seen without dissection, and can therefore, be identified without biochemical procedures; (iv) there is a clear relationship between structure and function, and nematodes respond rapidly to disturbance and enrichment: increasing microbial activity leads to changes in the proportion of bacterial feeders in a community.

Fishes have high economic and nutritive values. The demand for their protein consumption has increased dramatically and this has led to an increasing interest in the study of fish production, growth, management, parasites and diseases [6]. A myriad of parasites are associated with fishes both in the wild and cultural environments and less conditions may cause some irritation, inconveniences or discomfort, or severe cases may cause disease condition, deformities or even death especially when treatment and control measures are applied [5]. Furthermore, parasites can interact with environmental pollution and so can be used as effect indicators and as accumulation indicators because of the variety of ways in which they respond to anthropogenic pollution [7,8]. Therefore, Changes in the diversity and structure of parasite communities of different fish hosts have therefore received increasing attention due to the possible application of parasites as indicators of ecosystem integrity and health [9,10,11,12]. The African snake head, *Parachanna obscura* and *Parachanna africana* used for this study are very common and commercially important fish in tropical waters. They are predatory fishes and have high culture potential in aquaculture [13]. Like most Nigerian

freshwater fishes, they are exposed to various pathological conditions and one of these is helminthiasis which is attributable to infection by helminth parasites including nematodes [14,15,16]. In Nigeria, parasitological studies have focused on agents, which cause commercially significant diseases such as protozoans, fungi, nematodes, trematodes and cestodes [17,15,16,18]. On the other hand, studies on nematode parasites of the channids is sparse and the use of these parasites as bioindicators for environmental pollution is still at its primordial stage, therefore this study was carried out to:

1. Determine the nematode parasites of the channids: *Parachanna obscura* and *Parachanna africana* in Orogodo River, southern Nigeria
2. Investigate the prevalence and mean intensity of gastrointestinal nematode species in the host fish in relation to fish size and sex.
3. Evaluate the relevance of the parasites as bioindicators of environmental pollution.

This will further contribute to our knowledge and understanding of nematode parasite community diversity of freshwater fishes in the tropics.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out along the down reaches of Orogodo River at Evboesi in Orhionwon Local Government Area of Edo State, Nigeria. The river lies between Latitude 5^0 $10^{'}$ – 6^0 $20^{'}$N and Longitude 6^0 $10^{'}$ – 6^0 $26^{'}$ E within the rain forest belt of Delta and Edo States, Nigeria (Fig. 1). The sampling stations were located 60 km and 50 km from the water source. The depth ranged between 0.60 and 0.80 m at the downstream reaches.

2.2 Sampling and Laboratory Procedure

The samples were collected on monthly basis between January and June 2010. The channids were caught using hook and line, fish traps and gill nets of mesh sizes 2.5 cm, 5.0 cm and 7.0 cm. The fish samples collected were placed in plastic tanks with the river water and immediately transferred to the research laboratory where they were kept in aquarium and sacrificed within 24 hours. Fish were killed by

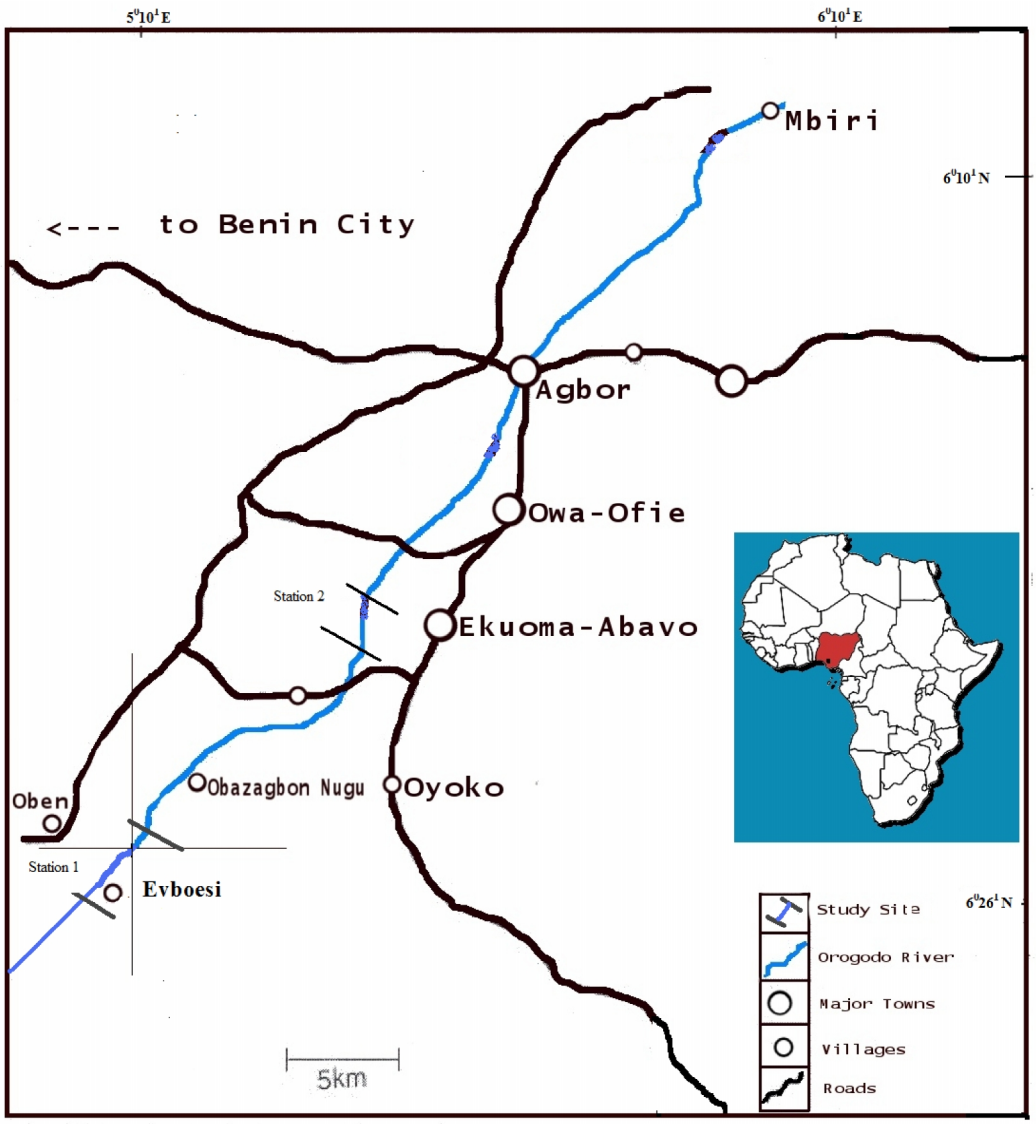

Fig. 1. Map of Orogodo River, southern Nigeria showing the location of the sampling stations at Evboesi and Ekuoma-Abavo

vertebral dislocation. The fish specimens taken to the laboratory were identified and confirmed to generic and species levels using the standard taxonomic work of [19] and [20]. The Morphometric measurements recorded were in standard lengths (distance from the snout to the base of the caudal fin) and total lengths (distance from the snout to the tip of the caudal fin). These measurements were recorded to the nearest tenth of a centimeter (0.10cm) using a metre rule mounted on a dissecting board. In addition, the weight of each fish was also measured and recorded to the nearest 0.10g on a top loading electronic balance. Each fish specimen was assigned a reference number for efficient and accurate recording.

The sexes of the fish were determined only after dissecting the fishes. Furthermore, the stomachs and intestines of the fish were cut open and the contents were emptied into Petri dishes containing water and were examined for helminth parasites. These were quickly stained with Giemsa stain and viewed under a light microscope.

2.3 Parasite Identification and Preservation

The parasites recovered were identified and confirmed to generic and species levels using the key of Systema Helminthum by [21], [22] and [23]. The parasites recovered from the fish stomachs and intestines were stored and preserved in vials containing 70% ethanol.

2.4 Physical and Chemical Parameters of the Water Body

At each sampling station, water temperature and pH were measured using mercury in glass thermometer and a pH meter respectively. Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), alkalinity, Nitrate nitrogen (NO_3 – N) and Phosphate Phosphorus (PO_4 – P) were determined in the laboratory using methods described in [24].

2.5 Statistical Procedure

The total number of parasites was determined directly by numerical count. Prevalence and abundance of each parasite species were determined according to [25]. One way ANOVA and Tukey Honest Test were used to compare the data among size classes at the level of 0.05, while the helminth infection in relation to sex was tested using the Chi-squared (χ^2) test between the male and female fish.

3. RESULTS

The dissolved oxygen varied between 5.7 and 7.1 mg/L while the BOD varied between 3.91 and 7.45 mg/L in station 1 and between 5.8 and 7.5 mg/L of DO and 1.91 and 2.95 mg/L BOD in station 2. The pH was slightly acidic and ranged from 5.5 to 6.8 during the period of study. Nutrients values, that is nitrates and phosphate values were significantly ($p<0.05$) higher in station 1 (Table 1).

A total of 112 fishes were examined for gastrointestinal nematode parasites in station 1, out of which 72 (64.3%) were infected. On the other hand, out of the 104 channid catfish examined in station 2, 48 (46.2%) were infected. Chi square test indicated that station 1 had significantly higher ($p<0.05$) infection rate. The incidence of nematode parasites infection in the channids showed that *P. obscura* had similar infection rate (46.4%) and *P. africana* (46.2%) (Table 2). In addition, the prevalence of gastrointestinal nematode parasites infection in relation to the sex of the fish sampled showed no significant (chi-square χ^2 *calculated* 0.845*, p*>0.05) difference. A total of three (3) species were found in 100 of the examined specimens of channids from Orogodo River. These were *Cucullamus* sp., *Camallanus* sp., and *Procamallanus laevionchus.* Overall prevalence was 35.7%, 35.7% and 28.6% respectively.

Table 1. Physical and chemical parameters of the surface water at the sampling site

Parameter	Station 1	Station 2	T-test Value
1. Water temperature (^oC)	26.1 ± 0.22 (25.0 – 26.5)	26.4 ± 0.32 (24.0 – 27.1)	0.84
2. Dissolved oxygen (mg/L)	6.44 ± 1.24 (5.7- 7.1)	6.52 ± 1.16 (5.8- 7.5)	1.24
3. Biochemical oxygen demand BOD (mg/L)	4.34 ± 2.06 (3.91- 7.45)	2.35 ± 1.06 (1.91- 2.95)	4.57*
4. pH	6.2 (5.5 – 6.8)	6.4 (5.7 – 6.8)	1.87
5. Alkalinity mg/L $CaCO_3$	10.24 ± 3.10 (8.00 – 24.10)	9.24 ± 2.10 (8.00 – 14.70)	6.67*
6. Nitrate (mg/L)	0.98 ± 0.47 (0.44 – 1.96)	0.48 ± 0.17 (0.24 – 0.76)	9.94*
7. Phosphate (mg/L)	0.08 ± 0.01 (0.06 – 0.01)	0.06 ± 0.01 (0.06 – 0.01)	5.68*

Note: Values are mean ± Standard deviation. Ranges are in parentheses

Cucullamus spp was recorded in both fish species where as *Camallanus* species was only present in *P. obscura* and *Procamallanus laevionchus* was restricted to *P. africana*. Data on the prevalence, mean intensity, standard deviation and maximum intensity of the three helminth species in six size classes of the channids in Orogodo River is given in Table 3. Significant differences were found in the intensity levels of *Cucullamus* sp. between the different size classes sampled. Prevalence was higher in the largest size fish closely followed by the fish of size class V. Fishes of size class III however recorded the highest mean intensity of the parasite (19.60). *Camallanus* sp. showed an increasing prevalence with increase in the fish size. Fish size class I had a percentage prevalence of 19.38 whereas fish size class VI recorded a prevalence of 62.5 %. Similarly, very high intensity of this parasite was recorded in the larger size fishes. Tukey *Post hoc* test showed that the percentage prevalence in the size VI class were significantly different ($p< 0.05$) from other size classes. Fishes of size class II recorded the lowest percentage prevalence. *Procamallanus laevionchus* also showed a significantly higher prevalence in the largest size class (VI) of fish followed by size classes II and III. Overall, fishes of size classes III, IV, V and VI recorded higher percentage of infected fish (75.00 – 82.61%) than the smaller size fish of class I and II with only 38.4 % and 54.8% of infected fish respectively. The relationship between the numbers of fishes infected in relation to the weight in station 1 is depicted in Fig. 2. Again, the larger size fishes recorded a higher prevalence of infected fish. No fish of weight 140.0 to 189. 9 g were caught from the river.

Table 2. Prevalence of gastrointestinal nematode parasites in the channids caught in Orogodo River

Channids	Station	No. examined	No. infected	% infected	Sex	No. examined	No. infected (%)	x^2 calculated
P. obscura	Stn 1	64	40	62.5	M	24	16 (66.7)	0.845
					F	40	24 (60.0)	
	Stn 2	52	12	20.1	M	28	8 (28.6)	
					F	24	4 (16.7)	
P. africana	Stn 1	48	32	66.7	M	16	8 (50.0)	0.874
					F	32	24 (75.0)	
	Stn 2	56	16	28.6	M	24	9 (37.5)	
					F	32	7 (21.9)	
Total		**220**	**100**	45.5		220	100(45.5)	

Table 3. Prevalence, mean intensity and maximum intensity of helminthes in the six size classes of fish studied at station 1

Size class	I	II	III	IV	V	VI
Length (cm)	15.0 – 19.9	20.0 – 24.9	25.0 – 29.9	30.0 – 34.9	35.0 – 39.9	40.0 – 44.9
No. of channid fish examined	13	31	10	23	27	8
Cucullamus sp.						
Prevalence (%)	15.38[a]	12.90[a]	30.00[b]	34.78[b]	62.96[c]	75.00[c]
Mean intensity	9.00	13.66	19.60	9.33	11.26	13.50
(SD)	(2.42)	(5.93)	(15.31)	(6.04)	(4.82)	(6.94)
Maximum intensity	12	17	48	14	13	17
Camallanus sp.						
Prevalence (%)	19.35[a]	15.38[a]	40.00[b]	34.78[b]	51.85[c]	62.50[d]
Mean intensity	5.00	7.50	15.78	9.86	18.00	22.43
(SD)	(2.65)	(2.80)	(9.33)	(4.12)	(8.71)	(8.95)
Maximum intensity	8	14	21	28	38	54
P. laevionchus						
Prevalence (%)	27.38[b]	12.90[a]	40.00[c]	30.43[b c]	40.74[c]	50.00[d]
Mean intensity	9.66	13.23	12.40	24.10	17.80	35.25
(SD)	(2.08)	(7.46)	(9.20)	(18.56)	(9.88)	(27.58)
Maximum intensity	17	23	38	57	35	68
Overall no. of fish infected (%)	5(38.4)	13(54.84)	8(80.00)	19(82.61)	21(77.78)	6(75.00)

Note: SD standard deviation, different superscript in a row show statistically significant means detected by Tukey Honest Test at $p<0.05$ level.

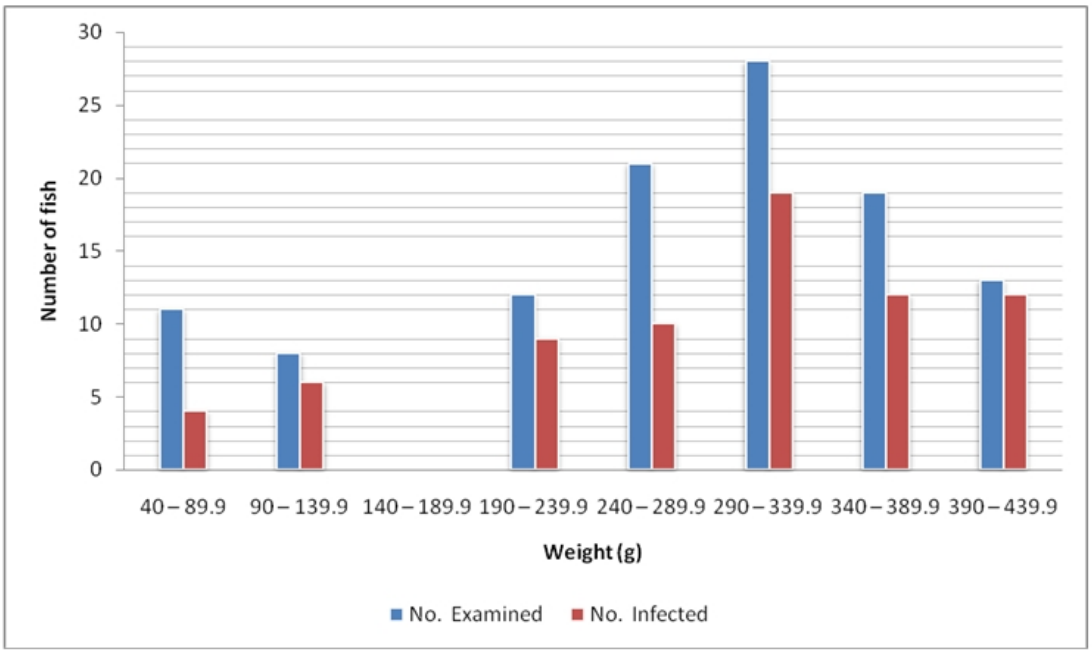

Fig. 2. Prevalence of gastrointestinal nematode parasite at station 1 in relation to weight

4. DISCUSSION

The chemical parameters of the water body showed that it was slightly acidic. This is because the river is a typical forest stream with inputs of detritus and humic acids from plant remains that often lead to elevation in the acidic concentration of the water [26]. The fairly high BOD recorded in station 1 is attributable to the high organic matter content of the water resulting from various anthropogenic activities in the river at this section of the river. The nutrients values were also significantly higher than in station 2. [26] and [27] had earlier reported the high organic pollution status of this river at this station. Pollution can increase parasitism if, for example, the host defense mechanisms are negatively affected, thereby increasing host susceptibility, or by simply increasing the population densities of suitable intermediate or final hosts [5]. In this study therefore, increase in parasitism in the fish species could be partly attributed to increase in the organic pollution status of the river. Most of the human impacts on the aquatic environment affect the health of the resident fish fauna, eventually causing disease and associated mortalities [28]. Consistent with this finding, [29] reported an increase in prevalence and intensity of acanthocephalans in the cunner, *Tautogolabrus adspersus* exposed to municipal and industrial effluents, while [30] reported an increase in the density of Trichodinid ciliates in the three-spined stickleback *Gasterosteus aculeatus* exposed to various forms of organic pollution. On the other hand, [31] reported that the nematodes larvae, *Paracamallanus cyathopharynx, Procamallanus laevionchus* and *Contracaecum* spp decreased in prevalence in the catfish along the pollution gradient showing their high sensitivity to organic pollution. In this study however, *Procamallanus laevionchus* was recovered from channids in organically polluted waters. This agreed with the earlier work of [28] and [32] who reported that nematode infection often give an indication of the quality of the water body since they generally increase in abundance and

diversity in more polluted waters. *Camallanus* spp have been used extensively as bioindicators of water pollution [33,34]. Their presence in the channids examined in this study is therefore a clear indication of the deteriorating water conditions of the river.

On examining the 220 channids, 100 were infected with three species of nematode parasites which were *Cucullamus* sp*., Camallanus* sp. and *Procamallanus laevionchus*. In general, the overall prevalence of 64.3% of nematode parasites infection observed in channids in station 1 compared well with the 66.66% reported by [16] for cichlids in the upper Orogodo River and 63.35% reported by [15] for cichlids in Ethiope River but higher than the observations of 40.14% reported by [35] for the catfish, *Clarias gariepinus* in Wase dam, Kano-Nigeria and 37.0 % reported by [18] for *Malapterurus electricus* in Lekki Lagoon, Lagos-Nigeria but lower than that of 68.8% reported by [36] for cichlids in Ikpoba River, Nigeria and 70.51% reported by [37] for freshwater fishes in Mini dam, Pakistan. This suggests that the occurrence of parasitism varies from one habitat to another and it could be due to host - parasite relationship and abiotic factors [38].The nematodes, *Procamallanus laevionchus* and *Camallanus* sp. had earlier been described in the fishes of some freshwater bodies in Plateau State, Nigeria by [17] and in the fishes of Benin and Ossiomo Rivers, Nigeria by [14]. *Cucullamus* sp. and *Camallanus* sp. had also been recovered from the fishes of Orogodo River at Agbor, Nigeria by [16].

There was affinity of *Cucullamus* sp. to the stomach of the fish while *Procamallanus laevionchus* and *Camallanus* sp. were mostly recovered from the intestines of the fish. These parasites could cause lesions and mechanical pressure as a result of burrowing and blockages which may cause inflammation, disease condition, deformity and death especially when no treatment or control measures are applied. In other words the nutritive values of the fish may be degraded through the activities of these parasites [39] and this can result to the deficiency and devaluation in protein content of the fish.

The intensity of infection of the parasites recovered in this study was higher in the largest size classes than in the small fishes. The result of the present study is consistent with the findings of [40] and [41]. They independently reported positive relationship between the parasite intensity and host size. They opined that the older fish provide more space for parasite attachment hence the higher infection levels in larger fish.

5. CONCLUSION

Gastrointestinal nematode parasites of the channids, *Parachanna obscura and Parachanna africana* which are among the dominant fish species in the river showed the presence of three nematode parasites namely *Cucullamus* sp., *Camallanus* sp. and *Procamallanus laevionchus*. The overall parasitic burden reveals that the prevalence of infection could be attributed to the present organic pollution status of the water especially in station 1. The present water quality of the river is compromised by pollution from industrial and human activities. The intensity of the parasites in the host fish agree with previous hypotheses suggesting that environmental pollution does affect parasite population. Additionally, the growth rate of the fishes may be impaired due to protein deficiency and devaluation; therefore urgent measures should be taken to avoid their proliferation so that our waters can have healthy fish for human consumption.

ACKNOWLEDGEMENTS

This study was partially supported by the Delta State University Abraka, Nigeria. The author would like to thank the anonymous reviewers for providing helpful suggestions on an earlier draft of the manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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