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Research Paper

Evaluation of Parasitofauna of Four Economically Important Fish Species (Synodontis Budgetti, Chrysichthys Nigrodigitatus, Bagrus Docmac and Heterobranchus Bidorsalis) From River Okpokwu, Apa, Nigeria

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ABSTRACT

The parasitic fauna of four economically important fish species comprising of Synodontis budgetti, Chrysichthys nigrodigitatus, Bagrus docmac and Heterobranchus bidorsalis from River Okpokwu, Apa, Nigeria, was investigated. A total of 161 fish samples comprising of 57 S. budgetti, 48 C. nigrodigitatus, 24 B. docmac and 32 H. bidorsalis were randomly purchased and subjected to parasitological examination. The overall parasite prevalence of all the fish species was 36.60% out of which S. budgetti, C. nigrodigitatus, B. docmac and H. bidorsalis accounted for 14.30%, 11.20%, 1.90% and 9.30%, respectively. However, the prevalence of infection by each fish species were 40.40%, 37.50%, 12.50% and 46.90% for S. budgetti, C. nigrodigitatus, B. docmac and H. bidorsalis, respectively. There was no significant difference in parasite prevalence for fish species (p>0.05) though, S. budgetti had the highest prevalence of infection (14.70%) with B. docmac recording the least (1.90%). Also, while the highest prevalence of infection was recorded for nematode (17.40%), the least (3.70%) each was recorded for trematode and copepode, respectively. Of the parasitic taxa, nematode was the most abundant (56.50%) and had the highest prevalence (17.40%). The parasites recovered from the fish species belonged to a species of acanthocephala (Neoechinorhynchus rutili), copepode (Argulus africanus.) trematode (Clinostomum complanatum), 2 species of cestode (Ligula intestinalis and Diphillobothrium latum) and 4 species of nematode (Capillaria philippinensis, Eustrongylides tubifex, Camallanus polypteri and Procamallanus laevionchus). Out of the total number (292) of parasites recovered from the infested body parts of the fish, intestine had the highest percentage parasite load (62.30%) and prevalence (29.80) while the gill had the least 16(5.50%) parasite load and prevalence of 3.10. Generally, the prevalence of parasites (43.00%), percentage parasite recovered (56.50%), mean abundance (2.60) and mean intensity (5.90) were higher for the female fish samples compared to the males with the prevalence of parasites, percentage parasite recovered, mean abundance and mean intensity of (32.00%), (43.50%), (1.30) and (4.10), respectively. However, there was no significant difference (p>0.05) by sex in the prevalence of parasites of all the fish species. The size class related prevalence showed an increase in parasitic infections (24.60%) and (20.80%) in S. budgetti and C. nigrodigitatus) in the length groups of 13.00 to 15.90cm and 19.00 to 22.90cm while the least (5.30%) and (6.30%) were recorded for S. budgetti and C. nigrodigitatus in the length groups of 10.00 to 12.90cm and 15.00 to

18.90cm, respectively. However, while the highest prevalence (8.30%) and (21.90%) were recorded for smaller samples of B. docmac and H. bidorsalis in the length groups of 10.00 to 20.90cm and 13.00 – 21.90cm, the least (4.20%) and (3.10%) were recorded in length groups of 41.00 to 50.90cm and 39.00 – 54.90cm for bigger samples of B. docmac and H. bidorsalis, respectively.

Keywords: Parasitofauna, River Okpokwu, Prevalence, Nematode, Sex

INTRODUCTION

One of the major problems facing freshwater and marine fishes all over the world today are parasites which are important most especially in the tropics (Bichi and Dawaki, 2010; Ekanem et al., 2011). They (parasites) constitute a major limiting factor to the growth performance of fish in Nigeria (Bichi and Yelwa, 2010) and are known to pose different effects on their hosts (fish).

The different effects of parasites on fish have been revealed by different authors; nutrient devaluation (Hassan et al., 2010); alteration of biology and behaviour (Lafferty, 2008); lowering of immune capability, induction of blindness (Echi et al., 2009 a, b); morbidity, mortality, growth and fecundity reduction (Nmor et al., 2004) and mechanical injuries depending on the parasite species and burden (Echi et al., 2009 a, b).

Various studies have revealed the parasitic fauna in freshwater fishes ranging from ectoparasites (Idoko, 2018, Oniye et al., 2004) to endoparasites (Omeji et al., 2022, Osimen and Anagha, 2020, Omeji et al., 2018; Edeh, and Solomon, 2016) which affect fish health, growth and survival. In the survey of freshwater parasites according to (Marcogliese, 2002), the economic important parasitic groups include the microparasites; protozoans - microsporideans and myxozoans while the macroparasites group is comprised of helminthes such as monogenea and the diagenes trematodes (flukes), cestodes (tapeworms), nematodes (roundworms) and Acanthocephala (thorny headed worms). The arthropod parasites are represented mainly by the copepods while the annelid parasites are the leeches. This is the first paper to provide information on the parasitic prevalence of infection, mean abundance and mean intensity of the studied four economically important fish species (S. budgetti, C. nigrodigitatus, B. docmac and H. bidorsalis) from River Okpokwu, Apa, Benue State Nigeria.

MATERIALS AND METHODS

The study area

River Okpokwu is one of the relief features in Apa LGA of Benue State, Nigeria which provides one of the highest fishing ground in Zone C senatorial district. It is located on longitude 7.80oE and latitude 7.58oN. The River is about 4km away from Ugbokpo, Apa Local Government Headquarters. River Okpokwu meets river Ochekwu at Odejo, Agatu LGA where they flow into River Benue. Unlike other rivers within the locality, River Okpokwu never dries up completely during dry season and its volume and size increase drastically during rainy season. Thus, it sustains high agricultural and fishing activities. The dense vegetation along the river consists of trees, climbers, shrubs and grasses which create room for the inhabitation of the intermediate hosts which harbour the infective larval stage of parasites, making them available to fish in the water. These constitute potential sources of parasitic load of the fish species in the river.

Collection of fish specimen for parasitological study

One hundred and sixty-one (161) fish samples comprising of 57, 48, 24 and 32 samples each of S. budgetti, C. nigrodigitatus, B. docmac and H. bidorsalis were purchased from fishers at the bank of the river.

Sex determination and measurement of length and weight

Purchased fish samples were transported in four (4) plastic containers to the Fisheries Laboratory, Joseph Sarwuan Tarka University, Makurdi for morphological and parasitological studies. In the laboratory, the taxonomic identity of the fish samples was confirmed; the sexes of the fish were determined by examination of their papillae, total length was measured to the nearest 0.1 centimetre (cm) using a meter rule mounted on a dissecting board while the weight was measured to the nearest 0.1gram (g) using an electronic weighing balance (Golden Mettler, Model: GW: 1.3kg, NW; 1kg - US).

Examination of parasites

Freshly caught fish were examined for parasites using procedures described by Arthur and Albert (1994) as follows:

Examination of ectoparasites

Fins and skins were gently brushed into a plastic Petri dish containing normal saline solution (0.90% NaCl) and examined with a hand lens for the presence of ecto-parasites. Scrapings from the skin and fins of each fish were smeared on glass slides follow by addition of few drops of 0.9% saline solutions and examined under10x magnification of a light binocular microscope for the presence of external parasites.

Detection of parasites from the gills of the fish samples was carried out using the methods described by Bichi and Ibrahim, (2009) and Ahmad (2007). Gills were cut open using a pair of scissors, placed in a Petri-dish and gill filaments were dissected using anatomical needle and examined under the microscope. Gill scrapings were later placed on few drops of water previously placed on to the glass slides then covered with cover-slide and examined under the phase-contrast microscope. Detected parasites were viewed using Zpix Digital Microscope, MM 640 connected to a computer (Lap top 6735s). Observed parasites were identified using identification guidelines based on morphological features of parasites (Paperna, 1996), counted and recorded.

Examination and identification of endoparasites

An incision was made on the ventral side of the fish from the anal opening to the lower jaw using dissecting scissors to expose the body cavity and internal organs. The stomach and intestine were gently separated and kept in different sample plates containing 0.9% NaCl (normal saline) solution. Contents of the stomach and intestine were washed in the normal saline solution for sedimentation and floatation (The water from the washed was poured into test tube and centrifuged, using an ordinary centrifuge at 4500 rpm for 5 min. The supernatant was decanted and the sediment was examined under a light microscope). A drop of the residue was placed on the slide and the wet mount was examined for parasites under the microscope for various parasites. The recovered parasites were identified using a standard key by Ajala and Fawole (2014) and Kawe et al., (2016). Recovered parasites from the stomach and intestine were recorded and counted.

Statistical Analysis

The prevalence, mean abundance and mean intensity of parasitic infection were calculated as follows;

$$P = \frac{N}{n} \times 100$$ Bush et al., (1997)

Where:

P = Prevalence (%), N = Number of infected fish, n = Number of examined fish

$$A = \frac{\Sigma P}{n}$$ Ejere et al., (2017)

Where:

A = Mean abundance, P = Number of parasites, n = Number of examined fish

$$I = \frac{\Sigma P}{N}$$ Bush et al., (1997)

Where:

I = Mean intensity (parasite/fish), P = Number of parasites, N = Number of infected fish.

The relationships between factors such as fish sex, weight, total length, and parasitic infection were obtained from pooled data using analysis of variance (ANOVA). All statistical analysis was performed using Statistical Package for the Social Science (SPSS) version 21.0.

RESULTS

The overall prevalence and prevalence by infection of each fish species examined are presented in Table 1 while the Parasite abundance in the examined fish species from River Okpokwu is presented in Table 2.

From Table 1, a total of 161 fish samples, comprising of 57 S. budgetti, 48 C. nigrodigitatus 24 B. docmac and 32 H. bidorsalis, were sampled from River Okpokwu. The overall parasite prevalence of all the fish species was 36.60% out of which S. budgetti, C. nigrodigitatus, B. docmac and H. bidorsalis accounted for 14.30%, 11.20%, 1.90% and 9.30%, respectively. However, the prevalence of infection by each fish species were 40.40%, 37.50%, 12.50% and 46.90% for S. budgetti, C. nigrodigitatus, B. docmac and H. bidorsalis, respectively. There was no significant difference in parasite prevalence for fish species ($p > 0.05$) though; S. budgetti had the highest (14.70%) prevalence of infection with B. docmac recording the least (1.90%). Also, while the highest prevalence of infection was recorded for nematode (17.40%), the least (3.70%) each was recorded for trematode and copepode, respectively.

From Table 2, out of the 161 fish samples examined for parasites, a total of 292 parasites were recovered from the 59 infested fish samples. Out of the 292 parasites, while S. budgetti recorded the highest number (percentage) parasite load 125(42.80%), the least 22(7.50%) was recorded for B. docmac. Based on the taxa presentation of the recovered parasites, nematode had the highest number/ percentage parasite load 165(56.50%) while the least 14(4.80%) was recorded for trematode. Also, nematode had the highest prevalence 28(17.40%) while the least (3.70%) each was recorded for trematode and copepode, respectively. All the identified parasites belonged to a species of acanthocephala (Neoechinorhynchus rutili.), copepode (Argulus africanus.) trematode (Clinostomum complanatum), 2 species of cestode (Ligula intestinalis and Diphillobothrium latum) and 4 species of nematode (Capillaria philippinensis, Eustrongylides tubifex, Camallanus polypteri. and Procamallanus laevionchus).

Table 1. Overall prevalence of parasites in the examined fish species from River Okpokwu

Fish species	Number (%) of fish examined	Number (%) of fish infested	Number (%) of fish infested with acanthocephala	Number (%) of fish infested with nematode	Number (%) of fish infested with trematode	Number (%) of fish infested with cestode	Number (%) of fish infested with copepoda	Prevalence (%) of infection by fish species
S. budgetti	57(35.40)	23(14.30)	5(3.10)	8(5.00)	4(2.50)	6(3.70)	0(0.00)	23(40.40)
C. nigrodigitatus	48(29.80)	18(11.20)	2(1.24)	9(5.60)	2(1.20)	3(1.90)	2(1.20)	18(37.50)
B. docmac	24(14.90)	3(1.90)	0(0.00)	2(1.20)	0(0.00)	1(0.60)	0(0.00)	3(12.50)
H. bidorsalis	32(19.80)	15(9.30)	2(1.20)	9(6.20)	0(0.00)	0(0.00)	4(3.10)	15(46.90)
Total	161(100.00)	59(36.60)	9(5.60)	28(17.40)	6(3.70)	10(6.20)	6(3.70)	59(36.60)

Table 2. Parasite abundance (%) in the examined fish species from River Okpokwu

Fish species	Number of parasites recovered per taxonomic group						Total
	NFI	Acanthocephala	Cestode	Trematode	Nematode	Copepoda	
S. budgetti	23(14.30)	22(17.60)	37(29.60)	8(6.40)	58(46.40)	0(0.00)	125(42.80)
C. nigrodigitatus	18(11.20)	9(10.00)	15(16.70)	6(6.70)	53(58.90)	7(7.80)	90(30.80)
B. docmac	3(1.90)	0(0.00)	5(22.70)	0(0.00)	17(77.30)	0(0.00)	22(7.50)
H. bidorsalis	15(9.30)	9(16.40)	0(0.00)	0(0.00)	37(67.30)	9(16.40)	55(18.80)
Total	**59(36.60)**	**40(13.70)**	**57(19.50)**	**14(4.80)**	**165(56.50)**	**16(5.50)**	**292(100.00)**

NFI = Number of fish infested

The parasites species spectrum, prevalence and abundance in the fish species examined from River Okpokwu are presented in Table 3 while the infestation status in relation to the body parts of the studied fish species from River Okpokwu are presented in Table 4.

From Table 3, out of the 161 total fish samples examined for parasitological study, 23(14.30%), 18(11.20%), 3(1.90%) and 15(9.30%) 0f S. budget, C. nigrodigitatus, B. docmac and H. bidorsalis, respectively were infested with different parasite species. Multiple infestation was however common to all the species of fish examined. Camallanus polypteri occurred in all the fish species; being highest in H. bidorsalis (12.70%) but lowest (3.10%) in B. docmac.

From Table 4, Neoechinorhynchus rutili. was recovered from the intestine and stomach of S. budgetti, stomach of C. nigrodigitaus. Argulus africanus was recovered from the gills of H. bidorsalis and C. nigrodigitaus, respectively. Clinostomum complanatum was recovered from the intestine and stomach of S. budgetti and stomach of C. nigrodigitaus, Ligula intestinalis was recovered from the stomach of B. docmac, Diphillobthrium latum was recovered from the intestine and stomach of S. budgetti, C. nigrodigitaus, Capillaria phillipinensis was recovered from the intestine and stomach of S. bugetti, C. nigrodigitaus and B. docmac, Eustrongylides tubifex was recovered from the intestine and stomach of S. budgetti, and intestine of B. docmac, Camallanus polypteri. was recovered from the intestine and stomach of H. bidorsali, S. budgetti, C. nigrodigitatus and stomach of B. docmac while Procamallanus laevionchus was recovered from the intestine and stomach of S. budgetti and C. nigrodigitatus, respectively.

Generally, out of the total number (292) parasites recovered from the body parts of the infested fish, intestine had the highest percentage parasite load (62.30%) and prevalence (29.80) while the gill had the least 16(5.50%) parasite load and prevalence of 3.10.

Table 3. Parasites species spectrum, prevalence and abundance in the fish species from River Okpokwu

Parasites Taxa/species	**Fish species/ infestation status**															
	S. budgetti				***C. nigrodigitatus***				***B. docmac***				***H. bidorsaris***			
	Nfi	**Npr**	**Prv**	**Ma**	**Nfi**	**Npr**	**Prv**	**Ma**	**Nfi**	**Npr**	**Prv**	**Ma**	**Nfi**	**Npr**	**Prv**	**Ma**
ACANTHOCEPHALA																
N. rutili	4	22	7.00	0.40	1	9	2.10	0.20	0	0	0	0	2	9	6.30	0.30
NOMATODA																
C. polypteri	7	26	12.30	0.50	7	27	14.60	0.60	4	9	16.40	0.10	8	37	25.00	1.20
P. laevionchus	6	10	10.50	0.20	5	11	10.40	0.20	0	0	0	0	0	0	0	0
E. tubifex	5	14	8.80	0.20	0	0	0	0	2	3	8.33	0.40	0	0	0	0
C. philippinensis	6	8	10.50	0.10	6	15	12.50	0.30	2	5	8.33	0.20	0	0	0	0
CESTODA																
L.intetinalis	0	0	0	0	0	0	0	0	1	5	4.20	0.20	0	0	0	0
D. latum	4	37	7.00	0.60	2	15	4.20	0.30	0	0	0	0	0	0	0	0
TREMOTODA																
C. complanatum	3	8	5.30	0.10	3	6	6.30	0.10	0	0	0	0	0	0	0	0
COPEPODA																
A. africanus	0	0	0	0	2	7	4.20	0.10	0	0	0	0	3	9	9.40	0.30

Nfi = Number of fish infested, Npr = Number of parasite recovered, Prv = Prevalence, Ma = Mean abundance

Table 4. Host fish species, parasites species and their site of attachment in hosts from River Okpokwu

Fish species/Number (N) examined	Parasite species	Parts/infestation status											
		Gills				Intestine				Stomach			
		Nfi	Npr	Prv	Ma	Nfi	Npr	Prv	Ma	Nfi	Npr	Prv	Ma
S. budgetti	*N. rutili*	0	0	0	0	3	17	5.30	0.30	1	5	1.80	0.10
N = 57	*C. polypteri*	0	0	0	0	2	14	3.50	0.20	3	12	5.30	0.20
	P. laevionchus	0	0	0	0	4	7	7.0	0.10	2	3	3.50	0.10
	E. tubifex	0	0	0	0	1	5	1.80	0.10	4	9	7.0	0.20
	C. philipinensis	0	0	0	0	5	5	8.80	0.10	2	3	3.50	0.10
	D. latum	0	0	0	0	3	26	5.30	0.50	1	11	1.80	0.20
	C. complanatum	0	0	0	0	2	5	3.50	0.10	1	3	1.80	0.10
C. nigrodigitatus	*N. rutili*	0	0	0	0	1	9	2.10	0.20	0	0	0	0
N = 48	*C. polypteri*	0	0	0	0	3	16	6.25	0.30	2	11	4.20	0.20
	P. laevionchus	0	0	0	0	5	6	10.40	0.10	2	5	4.20	0.10
	C. philipinensis	0	0	0	0	4	9	8.30	0.20	2	6	4.20	0.10
	D. latum	0	0	0	0	1	9	2.10	0.20	1	6	2.10	0.10
	C. complanatum	0	0	0	0	3	6	6.25	0.10	0	0	0	0
	A. africanus	2	7	4.20	0.10	0	0	0	0	0	0	0	0
B. docmac	*C. polypteri*	0	0	0	0	0	0	0	0	2	5	8.30	0.10
N = 24	*E tubifex*	0	0	0	0	2	12	8.30	0.40	0	0	0	0
	L. intestinalis	0	0	0	0	1	5	4.20	0.20	0	0	0	0
H. bidorsalis	*N. rutili*	0	0	0	0	2	9	6.30	0.30	0	0	0	0
N = 32	*C. polypteri*	0	0	0	0	3	22	9.40	0.70	5	15	15.60	0.50
	A. africanus	3	9	9.40	0.30	0	0	0	0	0	0	0	0
Total (%)		**5(8.50)**	**16(5.50)**	**3.10**	**0.10**	**48(81.40)**	**182(62.30)**	**29.80**	**1.10**	**28(47.50)**	**94(32.20)**	**17.40**	**0.60**

N = Number, Nfi = Number of fish infested, Npr = Number of parasites recovered, Prv = Prevalence, Ma = Mean abundance

The overall prevalence, abundance and intensity of parasites in male and female fish species from River Okpokwu are presented in Table 5. The prevalence of parasite was higher in female *S. budgetti* (60.23%), *C. nigrodigitatus* (41.20%) and *B. docmac* (33.30%) than the male (25.00%), (35.50%) and (0.00%), respectively. On the contrary, the prevalence of parasite was higher in male *H. bidorsalis* (63.20%) than the female (23.10%). Variation in percentage parasite load between the male and female fish species examined existed being higher in female *S. budgetti* (55.20%) *C. nigrodigitatus* (56.79% and *B. docmac* (100%) than the males with percentage parasite load of (44.89%), (43.30%) and (0.00%), respectively. However, percentage parasite load was higher for male *S. budgetti* (52.20%) than the female (41.80%). Mean abundance in female *S. budgetti* (2.80), *C. nigrodigitatus* (3.00), *B. docmac* (2.40) and *H. bidorsalis* (1.80) were higher than the male with the mean abundance of (1.80), (1.30), (0.00) and (1.70) for *S. budgetti*, *C. nigrodigitatus*, *B. docmac* and *H. bidorsalis*, respectively. Mean intensity for female *C. nigrodigitatus* (7.30), *B. docmac* (7.30) and *H. bidorsalis* (7.70) were higher than the male with the mean intensity of (13.50), (0.00) and (2.70) for *C. nigrodigitatus*, *B. docmac* and *H. bidorsalis*, respectively. However, Mean intensity was higher in male *S. budgetti* (7.00) than the female (4.60).

Generally, the prevalence of parasites (43.00%), percentage parasite recovered (56.50%), mean abundance (2.60) and mean intensity (5.90) were higher for the female fish samples compared to the males with the prevalence of parasites, percentage parasite recovered, mean abundance and mean intensity of (32.00%), (43.50%), (1.30) and (4.10), respectively. However, there was no significant difference ($p>0.05$) by sex in the prevalence of parasites of all the fish species.

Table 5. Overall prevalence and intensity of parasites in male and female fish species from River Okpokwu

Fish species/sex	Number (%) of fish examined	Number (%) of fish Infested	Number (%) of parasite recovered	Mean abundance	Mean intensity
S. budgetti					
Male	32(56.10)	8(25.00)	56(44.80)	1.80	7.00
Female	25(43.90)	15(60.23)	69(55.20)	2.80	4.60
Total	**57(100.00)**	**23(40.40)**	**125(100.00)**	**2.20**	**5.40**
C. nigrodigitatus					
Male	31(64.60)	11(35.50)	39(43.30)	1.30	3.50
Female	17(35.40)	7(41.20)	51(56.70)	3.00	7.30
Total	**48(100.00)**	**18(37.50)**	**90(100.00)**	**1.90**	**5.00**
B. docmac					
Male	15(62.50)	0(0.00)	0(0.00)	0.00	0.00
Female	9(37.50)	3(33.30)	22(100.00)	2.40	7.30
Total	**24(100.00)**	**3(12.50)**	**22(100.00)**	**0.90**	**7.03**
H. bidorsalis					
Male	19(59.40)	12(63.20)	32(58.20)	1.70	2.70
Female	13(40.60)	3(23.10)	23(41.80)	1.80	7.70
Total	**32(100.00)**	**15(46.90)**	**55(100.00)**	**1.70**	**3.70**
Overall summary					
Male	97(60.20)	31(32.00)	127(43.50)	1.30	4.10
Female	64(39.80)	28(43.00)	165(56.50)	2.60	5.90

Table 6 shows the prevalence of parasitic infection in relation to body size (total length) of each fish species from River Okpokwu. Highest prevalence (24.60%) and (20.80%) were recorded for bigger samples of *S. budgetti* and *C. nigrodigitatus* in the length groups of 13.00 to 15.90cm and 19.00 – 22.90cm while the least (5.30%) and (6.30%) were recorded for smaller samples of *S. budgetti* and *C. nigrodigitatus* in the length groups of 10.00 to 12.90cm and 15.00 – 18.90cm, respectively. However, while the highest prevalence (8.30%) and (21.90%) were recorded for smaller samples of *B. docmac* and *H. bidorsalis* in the length groups of 10.00 to 20.90cm and 13.00 – 21.90cm, the least (4.20%) and (3.10%) were recorded in length groups of 41.00 to 50.90cm and 39.00 – 54.90cm for bigger samples of *B. docmac* and *H. bidorsalis*, respectively.

Table 6. Prevalence of parasitic infection in relation to body size (total length of each fish species from River Okpokwu

Fish species/length groups	Number (%) of fish examined	Number (%) of fish infested	Prevalence (%)
S. budgetti			
10.00 - 12.90	8(14.00)	3(37.50)	5.30
13.00 - 15.90	33(57.90)	14(42.42)	24.60
16.00 – 18.90	14(24.60)	6(10.50)	10.50
19.00 – 21. 90	2(3.50)	0(0.00)	0.00
	57(100.00)	**23(40.40)**	**40.40**
C. nigrodigitatus			
15.00 - 18.90	13(27.10)	3(23.10)	6.30
19.00 - 22.90	18(37.50)	10(55.60)	20.80
23.00 – 25.90	11(22.90)	0(0.00)	0.00
26.00 – 28. 90	6(12.50)	5(83.30)	10.40
	48(100.00)	**18(37.50)**	**37.50**
B. docmac			
10.00 - 20.90	13(54.20)	2(15.40)	8.30
21.00 - 30.90	4(16.70)	0(0.00)	0.00
31.00 – 40.90	3(12.50)	0(0.00)	0.00
41.00 – 50. 90	4(16.70)	1(25.00)	4.20
	24(100.00)	**3(12.50)**	**12.50**
H. bidorsalis			
13.00 - 21.90	14(43.80)	7(50.00)	21.90
22.00 - 38.90	5(15.60)	2(40.00)	6.30
39.00 – 54.90	3(9.40)	1(33.30)	3.10
55.00 – 70. 90	10(31.30)	5(50.00)	15.60
	32(100.00)	**15(46.90)**	**46.90**

DISCUSSION

The parasitofauna of four economically important fish species from River Okpokwu, Apa, Nigeria was evaluated using 161 fish samples comprising of 57 *S. budgetti*, 48 *C. nigrodigitatus*, 24 *B. docmac* and 32 *H. Bidorsalis*. The overall prevalence of parasites (36.60%) recorded in this study was low compared to the 47.00% recorded for *Malapterurus electricus* from upper River Benue (Omeji *et al.*, 2014), 45.60% recorded for three Economically important fishes (*Ethmalosa fimbriata*, *Chrysichthys nigrodigitatus* and *Sarotherodon melanotheron*) from Lagos Lagoon, Southwestern Nigeria (Emmanuel and Aromodiu, 2017) 59.20% parasite prevalence recorded for fishes in the Niger River at Illushi, Edo State, a Niger Delta area in Nigeria (Oyedineke *et al.*, 2010). It was, however, higher when compared with the records by other researchers from other rivers who reported overall parasite prevalence of 17.1% in the Osse River, 6.9% in the Okhuo River and 3.3% in the Great Kwa River (Okaka and Akhigbe, 1999; Edema *et al.*, 2008; Ekanem *et al.*, 2011).

The variations in the rate of parasitism could be due to the abiotic and biotic factors of the river where the fish samples were collected for parasitological study. This observation is in agreement with the reported work of Thompson and Larsen (2004). Unfavourable conditions may offset fish physiology favouring parasite infestation and invasion. Rohlenova *et al.*, (2011) has reported that unfavourable temperature may alter fish physiology including immune function favouring parasite invasion. Pollution of the fish environment can also contribute to parasitizing of fish significantly (Kelly *et al.*, 2010). The relatively high prevalence of parasites in the examined fish in this study may be as a result of the relatively high pollution of the River due to influx of unwanted materials into the river caused by flood, the dense vegetation along the river which consists of trees, climbers, shrubs and grasses that could create room for the inhabitation of the intermediate hosts which harbour the infective larval stage of parasites, making them available to fish in the water. These could constitute potential sources of parasitic load of the fish species in the river. This assertion is in line with the reported work of Ejere *et al.*, (2017) (Aghoghovwia, 2011; Olele, 2012). The high prevalence of nematode and cestode parasites may be attributed to the presence of appropriate intermediate host (Nmor *et al.*, 2004), trophic linkage with the fish (Lagrue *et al.*, 2011) and efficiency in transmission of parasite to fish host (Iyaji *et al.*, 2009).

The highest prevalence of parasites in *S. budgetti* may be due to several factors such as feeding habit and diet of the fish (Rolbiecki, 2006), immuno-competence of the fish (Folstad and Karter, 1992), as well as the behavioural pattern of the fish (Ejere *et al.*, 2017) . Feeding on gastropods, worms, crustaceans and detritus by *S. budgetti* may facilitate infection by parasites (Lagrue *et al.*, 2011). The high prevalence for *S. budgetti* may also be attributed to the suitability of the fish host in provision of appropriate ecological requirements of the parasite (Akinsanya *et al.*, 2008; Lagrue *et al.*, 2011). Similarly, the high nutritional content of the *S. budgetti* intestine may possibly account for their preference, restriction and abundance in them (Akinsanya *et al.*, 2008).

The genera, *Camallanus* was present in all fish species and was the most abundant of all the parasites. Thus the parasite showed no generic specificity for fish species. The very small size of *Camallanus* and, possibly, low nutritional demand may have necessitated its non-site specificity as specificity generally is a product of adaptation (Lively and Dybdahl, 2000). Similar observation had been made by Ejre *et al.*, (2017).

Differences in the number/percentage parasite load and prevalence of infection of the infested body parts of the studied fish samples existed. Generally, highest number of parasites was recorded for the intestine of the infected fish samples while the least was recorded for the gill. The highest number of parasites recorded for the intestine of the infected fish samples in this study could be attributed to the favourable nutritional advantage presented by the hosts' intestine to the parasites; this assertion agrees with the findings of Solomon *et al.,* (2018), Agbabaka *et al.,* (2017), Kawe *et al.,* (2016) and Akinsanya *et al.* (2008), who made similar observations. The few parasites that were found on the gills could be due to the continuous movement of water current over the gills which may not encourage attachment, establishment and survival of parasites there. This observation is in line with the reported work of Onyedineke *et al.*, (2010) in their reported work on helminth parasites of some freshwater fish from River Niger at Illushi, Edo State, Nigeria.

Variation in percentage parasite load between the male and female fish species examined existed being higher in female *S. budgetti* (55.20%) *C. nigrodigitatus* (56.79% and *B. docmac* (100%) than the males with percentage parasite load of (44.89%), (43.30%) and (0.00%), respectively. The higher percentage parasites infestation recorded in the female than the male fish samples could be due to the physiological state of the females as most gravid females could have had reduced resistance to infection by parasites; this is because the immune system of the females is highly compromised during pregnancy. This agrees with the reported works of Solomon *et al.* (2018), Ogonna *et al.*, (2017) and and Ayuba *et al*., (2016).

However, percentage parasite load was higher for male *S. budgetti* (52.20%) than the female (41.80%).

Parasitism in fish has been reported to be sex biased, with males suffering greater susceptibility. This sex linked parasitism has been explained as resulting from difference in reproductive investment by male and female fish (Simkova *et al.,* 2008). Immuno-suppression by steroid hormone during spawning in males has been suggested as a major factor contributing to the greater susceptibility of males to parasite invasion (Folstad and Karter, 1992). Other factors suggested include competition for mate (Folstad and Karter, 1992) and cost of territorial defense (Reimchen, 2001). This observation agrees with the reported work of Solomon *et al.,* (2018), Afolabi *et al.,* (2020), Omeji *et al.,* (2013), Kawe *et al.,* (2016) who reported more parasite infestation in males *Clarias gariepinus* than the female.

The overall parasite prevalence in females (43.00%) was also higher than that in males (31.6%). The observed higher overall parasite prevalence in females may be suggestive of difference in ecological requirements between the female and male fish (Iyaji *et al.,* 2009) and greater susceptibility of ovigerous females to parasite (Simkova *et al.,* 2008). However, the observed difference in parasite prevalence according to sex in this study was not significant (p>0.05). The non-significant difference in parasite prevalence classified by sex is in line with the earlier observation by Akinsanya *et al*., (2007) who recorded a non-significant (p>0.05) difference in the infection rate of male (37.7%) and female (35.5%) *Malapterurus electricus* in Lekki Lagoon, Lagos State, Nigeria. In Bagauda Fish Farm, Kano, female *Clarias gariepinus* had higher occurrence of both the gill (20.7%) and gastrointestinal tract (34.6%) of parasites than that of the gill (11.8%) and gastrointestinal tract (23.6%) of males, although the difference was not significant (p>0.05) (Bichi and Yelwa, 2010). Similarly, a non-significant difference (p>0.05) in the infection rate of females and males of four fish species (*Puntius schwanenfeldii*, *Puntius gonionotus*, *Hampala macrolepidoata* and *Notopterus notopterus*) examined at Tasik Merah,

Perak, Peninsular, Malaysia have been reported (Rahman and Saidin, 2011).
The size class related prevalence showed an increase in parasitic infections (24.60%) and (20.80%) in bigger samples of *S. budgetti* and *C. nigrodigitatus*) in the length groups of 13.00 to 15.90cm and 19.00 – 22.90cm while the least (5.30%) and (6.30%) were recorded for smaller samples of *S. budgetti* and *C. nigrodigitatus* in the length groups of 10.00 to 12.90cm and 15.00 – 18.90cm, respectively. However, while the highest prevalence (8.30%) and (21.90%) were recorded for smaller samples of *B. docmac* and *H. bidorsalis* in the length groups of 10.00 to 20.90cm and 13.00 – 21.90cm, the least (4.20%) and (3.10%) were recorded in length groups of 41.00 to 50.90cm and 39.00 – 54.90cm for bigger samples of *B. docmac* and *H. bidorsalis*, respectively. The observed variation in parasitic prevalence among the various size groups (total length) of the fish samples used for the study may be attributed to the random selection of the fish samples that might have favoured the most parasitized samples and the possibility of repeated infection as the fish grew older. This agrees with the reported studies of Sikoki *et al.*, (2013), Bello *et al.*, (2011), *Ekanem et al.*, (2011) and Obano and Odiko (2004).

CONCLUSION

the relatively high prevalence of parasites in the River Okpokwu, Nigeria could be a menace to fish productivity in the Local Government area and Benue/Nigeria as a whole. Parasite invasion, attachment and establishment in a fish compromise the efficiency of the fish in preventing further infection, lowering the fish reproductive efficiency, feed utilization and economic devaluation of the fish. Therefore, in order to ensure maximum productivity of fish in River Okpokwu, further studies need to be embarked on so as to ascertain the major causes of the high rate of infection, and the appropriate measures to be taken to ensure better productivity.

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