PARASITIC FAUNA OF TWO DOMINANT CLARIID (SILURIFORMES) CATFISHES IN A TROPICAL FRESHWATER ECOSYSTEM, NIGERIA

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ABSTRACT

Three hundred and sixty clariid catfishes comprising of 231 (64.17%) Clarias gariepinus and 129(35.83%) Clarias anguillaris caught with various fishing gears were studied for parasites for a period of 12 months (May 2013 to April 2014) in Anambra River, Nigeria. Out of the 360 fish specimens, 148 (41.1%) fish hosts were infected while 212 (58.89%) were uninfected. There was no significant ($p > 0.05$) difference in the prevalence of infection between C. gariepinus (44.2%) and C. anguillaris (35.7%). The total number of parasites recovered were 608, comprising two protozoans (Trichodina acuta and Epistylis sp.), two cestodes (Polyonchobothrium clarias and Monobothriode woodlandi) and two nematodes (Rhabdochona congolensis and Procamallanus laevionchus). Protozoan ciliates recovered from the gills and skin of fish hosts had the highest prevalence (25.55%) among the parasites recovered. The rest parasites were recovered from the intestine and the glandular stomach. The relationship of host size (weight and length) and parasite infection showed infection was significant ($p < 0.05$) in fish of larger weight (126 g+) and length (30 cm+). There was significant ($p < 0.05$) difference in the infection of sexes, with the males having more infections. Monthly/seasonal patterns of infection varied from one parasite to another. This study provides an overview of the parasites of some clariid species inhabiting the Anambra River.

Keywords: parasites, African catfish, Anambra River, prevalence, intensity, sexual dimorphism

INTRODUCTION

Clariid catfishes occur in most freshwater bodies of South East Asia and Africa where they constitute a significant component of the catches (Offem *et al*., 2010). According to Reed *et al.* (1967), the species are reputed to feed heavily on insect, copepods, mollusks and smaller fishes. They are common in commercial catches at the Anambra River where they contribute significantly to the income of the artisanal fishers and provide rich protein source in the diets of the populace (Ezenwaji, 2002). In Nigeria, fish consumption is increasing especially among the poor majority because it is affordability and has many health benefits (Ekanem *et al*., 2011) and also as a result of the increasing cost of other animal protein sources like beef etc. (Eyo and Iyaji, 2014). Parasites and diseases are among the major factors that limit fish production. They have been reported to cause a host of pathological debilities in fishes (Iyaji *et al*., 2009). Thus, this has raised a serious concern since they often produce a weakening of the hosts' immune system thereby increasing their susceptibility to secondary infection (Eyo and Iyaji, 2014), resulting in the nutritive devaluation of fish (Hassan *et al*., 2010) and subsequent economic losses (Onyedineke *et al*., 2009). Ibiwoye *et al.* (2004) reported that parasites of fish could also constitute health hazards to humans when ingested with poorly cooked fish.

Several researches on catfish parasites from Nigerian water bodies have been documented (Oniye *et al*., 2004; Olofintoyo, 2006; Ayanda, 2008; Eyo *et al*., 2013; Eyo *et al*., 2014). Apart from the work of Azugo (1978) on the ecology of the helminth parasites of the fish of Anambra river system, Ezenwaji *et al*., (2005) on the endo-helminth parasites of morchokid fishes of Anambra river basin and Nwani *et al*. (2008) that investigated the endoparasitic helminthes of four *Mormyrid* species of the same river, there is no other work on parasites of fishes of Anambra River. Hence, this present work, aimed at investigating the parasites of clariid catfishes of Anambra River with reference to the prevalence, mean intensity and abundance of the parasites in relation to the host size, sex and season of occurrence.

MATERIALS AND METHODS

Study area

This study was carried out in Anambra River (Figure 1). According to Azugo (1978), Anambra River has its source in Ankpa highlands of Kogi State of Nigeria about 100 km North of Nsukka. The river lies between latitudes 6°10′ and 7° 40′ East of the

Niger (Awachie and Hare, 1977). It has a southward course crossing the Kogi / Enugu States boundary. It then crossed through Ogurugu to Otuocha from where it flows down to its confluence with the Niger at Onitsha. The main river channel has a total length of about 207.40 km (Azugo 1978). The river bank is covered by plants like *Echinoclae* spp, *Salviniany mnellula, Ludiwigia decurrens, Imperita cylindirica, Andropogon* spp, *Jussiaea* spp, *Pennisetum* spp and *Cynodon* spp (Nwani, 2006). There are two seasons - rainy season (April – September / October) and dry season (October / November - March). Odo (2004) reported that the mean annual rainfall is between 150 cm and 200 cm. From December to January / February, the basin is influenced by the harmattan but their effect is not well marked. The water temperature and Secchi disc reading in the river range from 24^{o} C to 31^{o} C and 5 cm to 85 cm, respectively (Odo, 2004).

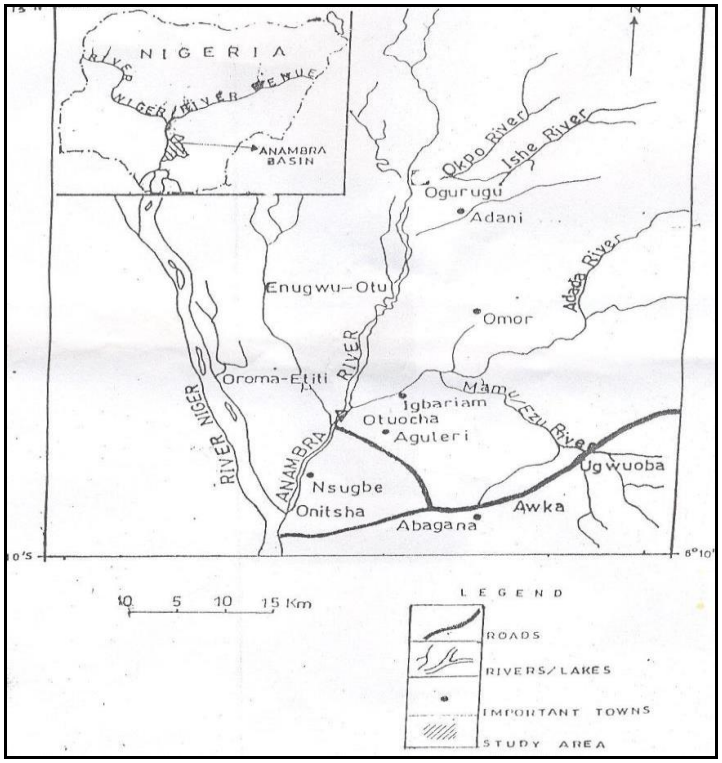

Fig. 1: Map of Anambra River showing the study area
Source: Odo*et al*. (2009)

Fish collection, identification, morphometrics and sex determination

Fish samples were collected for a period of twelve (12) months from fishers in the Otuocha River fish landing port along the Anambra River, Nigeria. The procedures for examining fish for parasites were adapted from Arthur and Albert (1994) and Marcogliese (2002). Fish were taken to the laboratory fresh from the sampling site. In the laboratory, preliminary data records such as: fish identification (Olaosebikan and Raji, 1998, IdodoUmeh, 2003), date caught and sex of the host fish (mature specimens) were taken. Total length was measured to the nearest 0.1 cm using a meter rule mounted on a dissecting board, while weight was measured to the nearest 0.1g using an electronic balance. The external surfaces – fins, gills and skins were brushed into petri dish containing normal saline and examined with hand lens for the presence of ectoparasites. Scrapings from the skin, fins and gills of each fish were taken and smeared on glass slides for examination of protozoan parasites and smaller metazoan parasites (Paperna, 1996; Hamish, 2010; Ekanem *et al.*, 2011). The gills were dissected out and each gill filament and arch examined with hand lens for the presence of monogeneans and myxosporidean cysts. Fish not

examined were kept overnight in refrigerator for examination the following day.

Examination of endoparasites

The fishes were dissected to expose the viscera. The visceral cavities and organs were examined for cysts and larval endoparasites. The guts were removed and placed in petri dishes. The contents were flushed with normal saline into beakers and then shaken to remove mucus and other intestinal debris. Parasites were recovered from the residue after centrifugation (1000 rpm) and decanting of supernatant (Iyaji, 2011). Recovered parasites were mounted on slides and viewed using Olympus microscope under higher magnification (×40) and identified. All parasites recovered were recorded. Fish not examined were refrigerated (-4 °C) overnight and examined the next day for parasites.

Treatment, Preservation and Fixation of Parasites
Microscopic parasites

Microscopic parasites were first stained for about 12 hours in Haematoxyline and Eosin and transferred to 45% acetic acid for 2 minutes and placed in methyl salicyclate for 1minute. The parasites were mounted in Canada balsam on clean slides (Iyaji, 2011).

Cestodes

Cestodes were fixed in 4% neutral formalin and dehydrated in ethanol. They were then stained with Eosin and mounted in Canada balsam on clean slides (Iyaji, 2011).

Nematodes

Nematodes were placed in 70% ethyl alcohol and 5% glycerin added for storage. They were later stained with Eosin and mounted whole in Canada balsam (Iyaji, 2011).

Identification of Parasites

Collected parasites were indentified to species level using the keys described by Yamaguti (1963), Paperna (1996) and Pouder *et al.* (2011).

Statistical Analysis

Prevalence (%), mean intensity and abundance were analyzed according to Jaywant *et al.* (2010). The relationship between host factors such as sex, weight, total length and parasitic infection were analyzed using SPSS (version 17.0). Chi-squre test was used to determine differences in parasite prevalence between sexes. Significant difference was set at $P < 0.05$.

RESULTS

A total of 360 clariid fish hosts were sampled and examined for parasites. The fish hosts comprised of *Clarias gariepinus*, 231(44.2%) and *Clarias anguillaris*, 129 (35.7%). A total of 148 (41.1%) fish hosts were infected while 212 (58.89%) were uninfected. However, there was no significant difference in parasite prevalence between the fish species (X^2= 2.468, P = 0.120) (Table 1). A total of 605 parasites were recovered, comprising the protozoan ciliates, *Trichodina acuta* and *Epistylis* sp.; the cestode, *Monobothroide woodlandi* (Caryophyllidae) and *Polyonchobothrium clarias* (Pseudophyllidae); the nematode, *Procamallanus laevionchus* (Camallanidae), and *Rhabdochona congolensis* (Rhabdochanidae) (Table 2). The *Trichodina acuta* and *Epistylis* sp. were recovered from the gills and skins of fish hosts while the endo-helminthes were recovered from both the intestines and the glandular stomach of their fish hosts.Among the parasites that infected the clariid fishes, infection by protozoans was generally high compared to other parasites. *Trichodina acuta* recorded the highest infection with 49 fish hosts (*C. gariepinus*, N = 31 and *C. anguillaris*, N = 17) infected, prevalence 13.4%, mean intensity 2.23 and abundance 0.31 for *C. gariepinus* and prevalence 13.2%, mean intensity 2.12 and abundance 0.28 for *C. anguillaris. Epistylis* sp. recorded a prevalence of 12.12% and 12.4% for *C. gariepinus and C. anguillaris* respectively. Prevalence recorded by other parasites included 3.46%, 2.16%, 8.23% and 7.79% by *Procamallanus laevionchus* ,*Rhabdochona congolensis*, *Polyonchobothrium clarias* and *Monobothroide woodlandi* respectively for *C. gariepinus.* While *C. anguillaris* recorded a prevalence of 2.33%, 0.78%, 8.53% and 6.20% for *Procamallanus laevionchus, Rhabdochona congolensis, Polyonchobothrium clarias* and *Monobothroide woodlandi* parasites respectively.

Infections of the clariid species by body weight showed a definite pattern, with the rate of infection increasing as the fish weight increases. *Trichodina acuta, Epistylis* sp. and *Procamallanus laevionchus* were absent in fishes with weight less than 75g. Whereas, *Rhabdochona congolensis, Polyonchobothrium clarias* and *Monobothroide woodlandi* infected fishes of all weight class. However, their infection rate increases as the fish weight increases. Hence, the highest prevalence of *Trichodina acuta* (25.95%), *Epistylis*sp. (24.43%), *Procamallanus laevionchus* (6.11%), *Rhabdochona congolensis* (2.29%), *Polyonchobothrium clarias* (13.74%) and *Monobothroide woodlandi* (14.5%) were recorded in 126 g+ weight class (Table 3). In

the length category, parasite infection where found to follow the same trend as in weight category, with most parasites found in 30 cm+ category (Table 4).

Monthly/seasonal rate of infections of clariid species showed no definite pattern. Whereas protozoan infections were found throughout the year, *Trichodina acuta* and *Epistylis* sp had their peak in the dry months with prevalence 23.3% (January) and 26.6% (February) for *Trichodina acuta* and 20% (January) and 16.67% (February) for *Epistylis* sp; their infection was found to be least in the rainy months. Among the Nematode parasites, infection by *Procamallanus laevionchus* were absent in the months of July, September and October (Rainy season), while *Rhabdochona congolensis* were present in the months of April, May and October (Rainy season). The cestode, *Polyonchobothrium clarias* infestation were found throughout the year with highest prevalence of infection of 16.677% and 13.33% in the months of May and April (rainy season) respectively. *M. woodlandi* infestation occurred throughout the year except in Dec (onset of dry season). However, the prevalence (13.33%) of *M. woodlandi* was highest in the month of Feb. (peak of dry season) (Table 5).

Infections were significant ($p < 0.05$) in the weight and length categories.

Infections of the clariid species by sex (Table 6) showed that male *C. gariepinus* and *C. anguillaris* were infected more by *Trichodina acuta, Rhabdochona congolensis, Polyonchobothrium clarias* and *Monobothroide woodlandi. Whereas, Procamallanus laevionchus* infected more female *C. gariepinus* than the males, *Epistylis* sp infected more female *C. anguillaris* than males.

Table 1: Comparative Prevalence of Parasites in Some Clariid Species of Anambra River Nigeria

Fish species	Sample number	Number infected (%)
Clarias gariepinus	231	102 (44.2)
Clarias anguillaris	129	46 (35.7)
X^2	**2.468**	
P – value	**0.120^{ns}**	

X^2 = Chi square, n.s. = no significant differences ($p > 0.05$)

Table 2: Parasites species composition, their prevalence and intensity in Fish species of Anambra River, Nigeria

Parasite species	***Clarias gariepinus* (N = 231)**					***Clarias anguillaris* (129 = 129)**				
	A	B	C	D	E	A	B	C	D	E
Trichodina acuta	31	72	13.4	2.23	0.31	17	36	13.2	2.12	0.28
***Epistylis* sp**	28	95	12.12	3.39	0.41	16	34	12.4	2.13	0.26
	59	**167**	**25.54**	**2.83**	**0.72**	**33**	**70**	**25.58**	**2.12**	**0.24**
P. laevionchus	8	33	3.46	4.13	0.14	3	18	2.33	6	0.14
R. congolensis	5	18	2.16	3.6	0.07	1	3	0.78	3	0.023
	13	**51**	**5.62**	**3.92**	**0.21**	**4**	**21**	**3.11**	**5.25**	**0.16**
P. clarias	19	93	8.23	4.9	0.40	11	44	8.53	4	0.34
M. woodlandi	18	104	7.79	5.78	0.45	8	55	6.20	6.9	0.43
	37	**197**	**16.06**	**5.32**	**0.85**	**19**	**99**	**14.73**	**5.2**	**0.77**

A= Number of hosts infected, B = Number of parasites recovered, C = % prevalence of parasites, D = Mean intensity of parasite, E = parasite abundance

Table 3: Parasites infection of fish species of Anambra River by body weight

	0 – 75 g N = 148					76 – 125 g N = 81					126 g+ N=131				
Parasites	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Trichodina acuta	0	0	0	0	0	14	30	17.28	2.14	0.37	34	78	25.95	2.3	0.60
Epistylis sp.	0	0	0	0	0	12	34	14.80	2.83	0.41	32	93	24.43	2.9	0.71
P. laevionchus	0	0	0	0	0	3	11	3.70	3.67	0.13	8	40	6.11	5	0.31
R. congolensis	1	2	0.68	2	0.014	2	5	2.47	2.5	0.06	3	15	2.29	5	0.11
P. clarias	1	3	0.68	3	0.020	10	31	14.35	3.1	0.40	18	103	13.74	5.72	0.79
M. woodlandi	1	6	0.68	6	0.041	6	38	7.41	6.33	0.47	19	115	14.5		0.88

A= Number of hosts infected, B = Number of parasites recovered, C = % prevalence of parasites, D = Mean intensity of parasite, E = parasite abundance

Table 4: Parasites infection of fish species of Anambra River by total length

	0 – 15cm N = 148					16 – 30cm N = 81					30cm+ N=123				
Parasite	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Trichodina acuta	0	0	0	0	0	18	34	10.4	1.89	0.2	32	74	26.0	2.3	0.6
***Epistylis* sp.**	0	0	0	0	0	15	29	8.7	1.93	0.17	29	94	23.6	3.2	0.8
P. laevionchus	0	0	0	0	0	2	9	1.2	4.5	0.05	9	41	7.3	4.56	0.33
R. congolensis	0	0	0	0	0	2	4	1.2	20	0.02	3	16	2.44	5.33	0.13
P. clarias	0	0	0	0	0	11	29	6.4	2.6	0.17	17	105	13.82	6.2	0.90
M. woodlandi	0	0	0	0	0	5	35	2.9	7	0.2	20	118	16.3	5.9	0.95

A= Number of hosts infected, B = Number of parasites recovered, C = % prevalence of parasites, D = Mean intensity of parasite, E = parasite abundance

Table 5: Monthly/Seasonal Patterns of Parasitic Infection of Fish Host of Anambra River

Variables	Months											
Parasite	**May 013**	**June 013**	**July 013**	**Aug. 013**	**Sept. 013**	**Oct. 013**	**Nov 013**	**Dec. 013**	**Jan. 014**	**Feb. 014**	**Mar. 014**	**Apr. 014**
Trichodina sp.												
Host infected	5	3	2	2	3	3	5	5	7	8	3	6
Parasite recovered	13	9	6	3	8	8	10	9	13	13	7	18
Prevalence	16.67	10	6.67	6.67	10	10	16.67	16.67	23.33	26.67	10	20
Mean intensity	2.6	3	3	1.5	2.67	2.67	2	1.8	1.89	1.63	2.33	3
Abundance	0.43	0.3	0.2	0.1	0.27	0.27	0.33	0.3	0.43	0.43	0.23	0.6
Epistylis sp.												
Host infected	4	4	2	3	2	1	2	4	6	5	4	3
Parasite recovered	10	12	7	6	9	6	8	11	15	12	9	15
Prevalence	13.33	13.33	6.67	10	6.57	3.33	6.67	13.33	20	16,678	13.33	10
Mean intensity	2.5	3	3.5	2	4.5	6	4	2.75	2.5	2.4	2.5	5
Abundance	0.33	0.4	0.23	0.2	0.3	0.2	0.27	0.37	0.5	0.4	0.3	0.5
P. laevionchus												
Hosts infected	2	1	0	1	0	0	1	1	3	0	2	2
Parasite recovered	11	8	0	5	0	0	2	6	6	0	5	11
Prevalence	6.67	3.33	0	3.33	0	0	3.33	3.33	10	0	6.67	6.67
Mean intensity	5.5	8	0	5	0	0	2	6	2	0	2.5	5.5
Abundance	0.367	0.267	0	0.17	0	0	0.067	0.2	0.2	0	0.17	0.37
R. congolensis												
Host infected	1	0	0	0	0	1	0	0	1	0	1	1
Parasite recovered	4	0	0	0	0	4	0	0	3	0	2	6
Prevalence	3.33	0	0	0	0	3.33	0	0	3.33	0	3.33	3.3
Mean intensity	4	0	0	0	0	4	0	0	3	0	2	6
Abundance	0.133	0	0	0	0	0.133	0	0	0.1	0	0.067	0.2
P. clarias												
Host infected	5	2	3	1	3	1	2	2	4	3	2	4
Parasite recovered	24	16	9	10	12	13	18	19	21	16	9	17
Prevalence	16.67	6.67	10	3.33	10	3.33	6.67	6.67	13.33	10	6.67	13.33
Mean intensity	4.8	8	3	10	4	13	9	9.5	5.3	5.33	4.5	4.3
Abundance	0.16	0.53	0.3	0.33	0.4	0.43	0.6	0.63	0.7	0.53	0.3	0.57
M. woodlandi												
Host infected	3	2	2	1	1	1	2	0	2	4	2	3
Parasite recovered	15	12	6	8	7	7	11	0	11	18	8	10
Prevalence	10	6.67	6.67	3.33	3.33	3.33	6.67	0	6.67	13.33	6.67	10
Mean intensity	5	6	3	8	7	7	5.5	0	5.5	4.5	4	3.3

Table 6: Parasites infection of fish species of Anambra River by sex

Host/parasite	Male N = 137					Female N = 94				
C. gariepinus	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
Trichodina acuta	22	51	16.1	6.2	0.37	9	21	9.6	10.4	0.22
Epistylis sp.	18	61	13.1	7.6	0.45	10	34	10.6	9.4	0.36
P. laevionchus	4	17	3.0	8.1	0.12	4	16	4.3	23.4	0.17
R. congolensis	3	11	2.2	12.5	0.08	2	7	2.1	47	0.07
P. clarias	12	64	8.8	11.4	0.47	6	29	6.4	15.67	0.31
M. woodlandi	11	64	8.0	12.5	0.47	7	40	7.4	13.4	0.43
	Male N = 76					**Female N = 53**				
C. anguillaris	**A**	**B**	**C**	**D**	**E**	**A**	**B**	**C**	**D**	**E**
Trichodina acuta	11	23	14.5	6.9	0.30	6	13	11.3	4.1	0.25
Epistylis sp.	8	17	10.5	9.5	0.23	8	13	15.1	4.1	0.25
P. laevionchus	2	12	2.6	38	0.6	1	6	1.9	8.8	0.11
R. congolensis	1	3	1.3	76	0.013	0	0	0	0	0
P. clarias	7	28	9.2	10.9	0.37	4	16	7.5	3.3	0.3
M. woodlandi	5	35	6.6	15.2	0.46	3	20	5.7	2.7	0.38

A= Number of hosts infected, B = Number of parasites recovered, C = % prevalence of parasites, D = Mean intensity of parasite, E = parasite abundance

DISCUSSION

The overall prevalence of parasites (41.1%) was low compared to the 59.2% recorded for fishes in the Nigeria River at Illushi, Edo state (Oyedineke *et al.*, 2010). It is however, higher when compared with records by other investigators in rivers from Nigeria who reported overall parasite prevalence of 17.1% in Osse River, 6.9% , 3.3% in Great Kwa River and 32.9% in Warri River (Okaka and Akhigbe, 1999; Ekanem *et al*., 2011; Eyo *et al*., 2014). These variations in rate of parasitism could be attributed to abiotic and biotic conditions of the environments where the studies were carried out (Eyo *et al*., 2013; Thompson *et al*., 2014). Unfavorable conditions may offset fish physiology favoring parasite infestation and invasion. Rohlenova *et al.* (2011) reported that unfavorable temperature may alter fish physiology including immune function favoring parasite invasion. Pollution of the fish environment also contributes to parasitizing of fish significantly (Kelly *et al*., 2010). Also, heavy parasitic infection in fish has been linked to environmental contamination by different pollutants, including heavy metals and hydrocarbons (Schludermann *et al*., 2003) and organic enrichment of sediments by domestic sewage (Marcogliese and Cone, 2001). Khan and Thulin (1991) reported that urban effluents promote aquatic pollution, thus, making aquatic organisms vulnerable to increase incidence of parasites. The relatively high infection rate of fishes from Anambra river could therefore, be attributed to the contamination of the river by various pollutants from the numerous market women who often uses the river as a means of waste disposal from Otuocha market, since Anambra River (Otuocha station where the fishes were sampled) lies parallel to Otuocha market.

The cestode parasites recovered from the fishes during the course of this study were the unsegmented Caryophyllaeidae, *Monobothriode woodlandi* and the segmented Pseudophyllidae, *Polyonchobothrium clarias*. The infections of cestode parasites in the Clariid fish species studied with prevalence of 15.56% were quite variable with the two forms, Caryophyllaeidae and Pseudophyllidae well represented. The findings have similarities with those reported from other freshwater bodies in the tropic. Laboni *et al*. (2012) reported prevalence as higher as 83.78% from Bangladash while Barson and Avenant-oldewange (2006) report 71% prevalence of cestode from the Rietvlei Dam, South Africa. However, Ayanda (2009a) reported extremely low infection prevalence of 5% from Asa Dam River in Nigeria.

The relatively high infection rate of some Clariid species of the Anambra River system by

cestode parasites in this study could be due to the ingestion of eggs, copepods and mollusks which serves as intermediate hosts of the larval stages of the cestodes (Paperna, 1996). Clariid species are reputed to feed heavily on insects, copepods, mollusks and smaller fishes (Reed *et al*., 1967). In the same vein, the low prevalence (3.88%) of nematode parasites in the Clariid species maybe as a result of the association of namatodes with fish hosts that feeds on mud, debris and detritus as found in most *Synodontis* species (Iyayi, 2011).

Protozoan parasites where found in all the species studied. However, the parasite have relatively low infection rate (25.55%) when compared with 69% prevalence recorded by Mahmoud *et al.* (2011) in tropical fresh water. The infection of the protozoa in the skin and gills of their fish hosts with mucus secretion in their gills could cause irritation and breathing problems. According to Klinger and Floyd (2002), the parasites cause serious skin and gill irritation displayed by flashing, rubbing, rapid breathing and excessive mucus secretion in gills.

Higher prevalence and mean intensity in fish of large weight class (126 g+) examined indicated the increase in parasitism with increase in size which is also related to age. Positive correlation in parasitism with host size has been found in several studies (Oniye *et al*., 2004; Ayanda, 2009a; Eyo *et al*., 2013; Eyo *et al*., 2014). An increase in size is a reflection of increase in length which is considered a measure of age (Torres *et al*., 1977; Lagler *et al*., 1979). Catfishes are known to be omnivorous fish at the adult stage with the tendency of being herbivorous at the juvenile stage. The higher parasitism observed in adults over juveniles might be as a result of change in diet of the fish from weeds, seeds, phytoplankton and zooplankton as juvenile to insect, larvae, snails, crustaceans, worms and smaller fishes as adulthood is attained (Reed *et al*., 1967; Ayanda, 2009b).

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 differences in reproductive investment by male and female fish (Skarstein *et al*., 2001; Simkova *et al*., 2008). Immune-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 (Reinchen, 2001).

In this study, the male fishes have higher parasitic infections than the females. These findings are in accordance with the observation of Folstad and Karter (1992); Wedekind and Jacobson (1998). These authors argued that males bear the cost of sexual selection through competition for mates. Kennedy (1975) summarized that the quantitative difference in parasite infection between sexes can be expected and may be explained as a consequence of different habitat occupied by males and females, differences in the diet and or physiology.

Seasonal patterns of parasitic infection showed that while some parasites have their highest infection rates in the dry months before the rainy season, others have their highest infection rates during the rainy season. The seasonal pattern of higher abundance of some parasites in the dry months before the rainy season in tropical areas has been observed in several studies and several suggestions have been offered to explain the phenomenon. Gee and Davey (1986) argued that the higher infection in autumn could result from life cycle of the parasites.

It was also argued that higher abundance of some parasites in the dry months before the rainy season in some tropical areas could be due to an increase in host density and greater overlap of intermediate and definitive host as water bodies shrink (Ezenwaji and Ilozumba, 1992) or due to pre-spawning congregation of hosts (Gupta *et al*., 1984), both of which facilitate transmission.

Higher abundance of parasites during the rainy months of the year has also been observed in other studied in the tropic (Granath and Esch, 1983; Marcogliese and Esch, 1989).

CONCLUSION

It could be deduced from the above that as much as other factors are important in explaining the variations in seasonal patterns of parasite occurrence, the most important single factor could be the life cycle of the parasites. Each of the parasite species found exhibited different patterns of occurrence which could only be explained by the differences in their life cycle patterns. The relatively high prevalence of parasites in the Anambra River is a setback to fish productivity in the zone. Parasites invasion and establishment in a fish compromised the efficiency of the fish in preventing further infection, lowering the fish reproductive efficiency and feed utilization. Thus to ensure optimal productivity of fish in the Anambra river, further studies need to be undertaken in order to ascertain the major cause of high rate of infection and the appropriate measures to be taken to ameliorate it.

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