academicJournals

Vol. 12(20), pp. 3029-3039, 15 May, 2013
DOI: 10.5897/AJB12.1934
ISSN 1684-5315 ©2013 Academic Journals
http://www.academicjournals.org/AJB

African Journal of Biotechnology

Full Length Research Paper

Parasitic infestation of *Synodontis batensoda* (Rüppell, 1832, Siluriformes, Mockokidae) at Rivers Niger-Benue Confluence, Nigeria

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Accepted 26 September, 2012

The Mockokid, upside down catfish, *Synodontis batensoda* caught with various fishing gears were studied for parasites for a period of 12 months (March 2007 to February 2008) in Rivers Niger and Benue at the Confluence. Out of 84 fish specimens examined, 61 (72.6%) fish hosts were infected, while 23 (27.4%) were uninfected. The total parasites recovered were 1196, comprising one protozoan ciliate (Trichodinids), two Digeneans (*Allocreadim ghanensis* and Metacercariae of *Pygidiopsis genata*), four Cestodes (*Monobothrioides woodlandi*, *Bothriocephalus acheilognathii, Proteocephalus largoploglotis* and *Caryophyleus* sp.), six Nematodes (*Procamallanus laevionchus, Rhabdochona congolensis, Spinitectus guntheri, Oxyuris equi, Contracaecum microcephalum, Strongylides* sp and larval Nematodes) and the Acanthocephalans (*Acanthocephalus* sp., *Neoechinorhynchus prolixum* and *Acanthella* sp. - the immature stages). Acanthocephalans had the highest prevalence among the parasites recovered. All parasites were recovered from the intestines except the Trichodinids which were recovered from the gills and skin of fish hosts. The relationship of host weight and parasite infection showed infection was highly significant ($p < 0.01$) in fish of larger weight of 76 to 100 g and above. There was no significant ($p > 0.01$) difference between the male and female fish hosts, both being equally infected. Multiple infections were recorded in several fish hosts, an indication of the rich parasitic fauna of the localities. This study provides an overview of parasites of *S. batensoda* in Rivers Niger and Benue at the Confluence.

Key words: Parasites, protozoan, helminths, nematodes, cestodes, acanthocephalans, *Synodontis batensoda,* Rivers Niger-Benue Confluence, Nigeria.

INTRODUCTION

Parasite communities of the tropical freshwater fishes are generalized as being isolationist, poor and of low diversity (Kennedy et al., 1986; Kennedy, 1995). Although much research on the parasites of catfish species have been published both nationally and internationally as evidenced by the works of Boomker (1982), Alfred-Ochiya (1985), Obiekezie et al. (1987), Ezenwaji and Ilozumba (1992), Anosike et al. (1992), Auta et al. (1999), Oniye et al. (2004), Taveres and Luque (2004), and Owolabi (2008) among others, there is a general perception that more information is needed on the parasitic fauna of tropical fish (Kennedy, 1995; Chondhury and Dick, 2000) specifically with reference to environmental degradation and climatic change. The confluence area of Niger and Benue Rivers provides a very strategic area for the study of the parasitic fauna

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of the tropical freshwater fishes. The two rivers have their sources outside Nigeria. The Niger River, for instance, rises in the Fouta Djalon Mountains of Guinea and flows through Mali, Niger, the Republic of Benin and Nigeria where the river enters the Gulf of Guinea. The Benue River, on the other hand, rises in the Adamoua massif of Cameroon and joins the Niger River at Lokoja (Lae et al., 2004). The parasitic fauna of fishes of the confluence area would be a reflection of the parasitic fauna not only of Nigeria but also of the neighbouring West and Central African countries. These freshwater rivers are teeming with fisheries resources (Reed et al*.,* 1967; Olaosebikan and Raji, 1998).

Synodontis species belonging to the family Mockokidae are endemic to Africa (Teugels, 1996) and generally very common throughout the year. They are probably more important in the commercial catches than any other fish species in the confluence area. *Synodontis batensoda* (Synonyms: *Synodontis membranaceus*, *Brachysynodontis batensoda*) attains the biggest size among the *Synodontis* species (Reed et al*.,* 1967). The flesh is of excellent flavor and highly regarded by consumers in Lokoja and environs. *Synodontis* is also popular among aquarists due to its upside down swimming habits in aquarium (Otubisin, 1986; Teugels, 1996). Various studies on the biology *of S. batensoda* including food and feeding habits have been carried out by several researchers (Bishai and Abu-Gideiri, 1965; Imevbore, 1970; Willoughby, 1974; Owolabi, 2007) but information on the parasite fauna is quite rare. However, Khalil (1969) reported 2 to 5 unidentified acanthocephalan worms in 60% of *Synodontis* sp. examined in Sudan and Owolabi (2008) reported 15.89% prevalence of infection by the nematodes, *Procamallanus laevionchus*, 11.92% by *Cucullanus* species and 8.44% by the cestode, *Polynchobothrium* species in *S. membranaceus* examined in Jebba lake, Nigeria. This study aimed at identifying the parasites of *S. batensoda* and to determine the prevalence, mean intensity and abundance of the parasites in relation to the host size and sex.

MATERIALS AND METHODS

The study area was located around the confluence of the two major rivers in Nigeria, Niger River and Benue River between latitude 7° 45N to latitude 8° 12N and longitude 6° 39E to longitude7° 00E (Figure 1). There are extensive flood plains with numerous perennial ponds and marshes on both banks of the rivers before and within the confluence. The vegetation along the rivers comprises mainly of wooded savanna grassland with shrubs and trees. The climate of the area consists of two seasons, the dry season and wet season. The wet season begins towards the end of March and ends towards the end of October or early November while the dry season begins in November and lasts until late March. Fish were sampled from fisherman using a variety of fishing gears (set nets, cast nets, hooks, gill nets, etc) at the three localities: locality 1: Ohono village, along Lokoja - Koton Karfe road (Niger River); locality 2: Mozum village, located on the eastern bank (Benue River) and locality 3: Ganaja village, below the confluence of the two rivers (confluence).

Fish were sampled from each locality for a period of 12 months, and examined for parasites. 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 sites. In the laboratory, preliminary data recorded were; fish identity (Reed et al*.,* 1967; Olaosebikan and Raji, 1998), date caught, locality from which the samples were taken and sex of fish hosts (matured specimens). Total length and standard length were measured to the nearest 0.1 cm using a meter rule mounted on a dissecting board, while weight was measured with a digital top loading balance to the nearest 0.1 g. The external surfaces - fins and skins were examined with brush and hand lens for the presence of ectoparasites. The gills were cut and removed, and each gill filament and arch examined with hand lens for the presence of myxosporidean cysts and monogeneans. Fish not examined were kept overnight in refrigerator for examination the following day.

Examination of endoparasites

The abdomen of individual fish was cut open ventrally. The internal organs and visceral cavities were examined for cyst and larval parasites. The guts were removed and placed in Petri dishes. The contents were washed into beakers with normal saline and shaken to remove mucus and other host debris. Parasites were allowed to settle before decanting and the residue examined with compound Olympus microscope. Individual parasites were mounted on slides and viewed under higher magnification (x40) for clearer view and identified. All parasites recovered were recorded.

Treatment, preservation and fixation of parasites

The parasites obtained were treated, preserved and stained as follows:

Microscopic parasites

Recovered microparasites were differentially stained in Haematoxylin-Eosin (H&E) in small staining glass trough for 12 h and then transferred to 45% acetic acid and then into methyl salicylate for proper differential staining of cells of the microparasites. The parasites were mounted on clean slides with Canada balsam.

Trematode digeneans

The parasites were placed in water for 2 h to relax and stretch out fully before fixing in alcohol-formol-acetic acid. They were mounted on clean slide with Canada balsam.

Cestodes

They were fixed in 4% neutral formalin and dehydrated in ethanol. They were then stained with Eosin (E) and mounted whole on clean slide with Canada balsam.

Nematodes

Nematodes were placed in 70% ethyl alcohol for 2 h, decanted and stored in 5% glycerin. They were later stained with Eosin (E) and

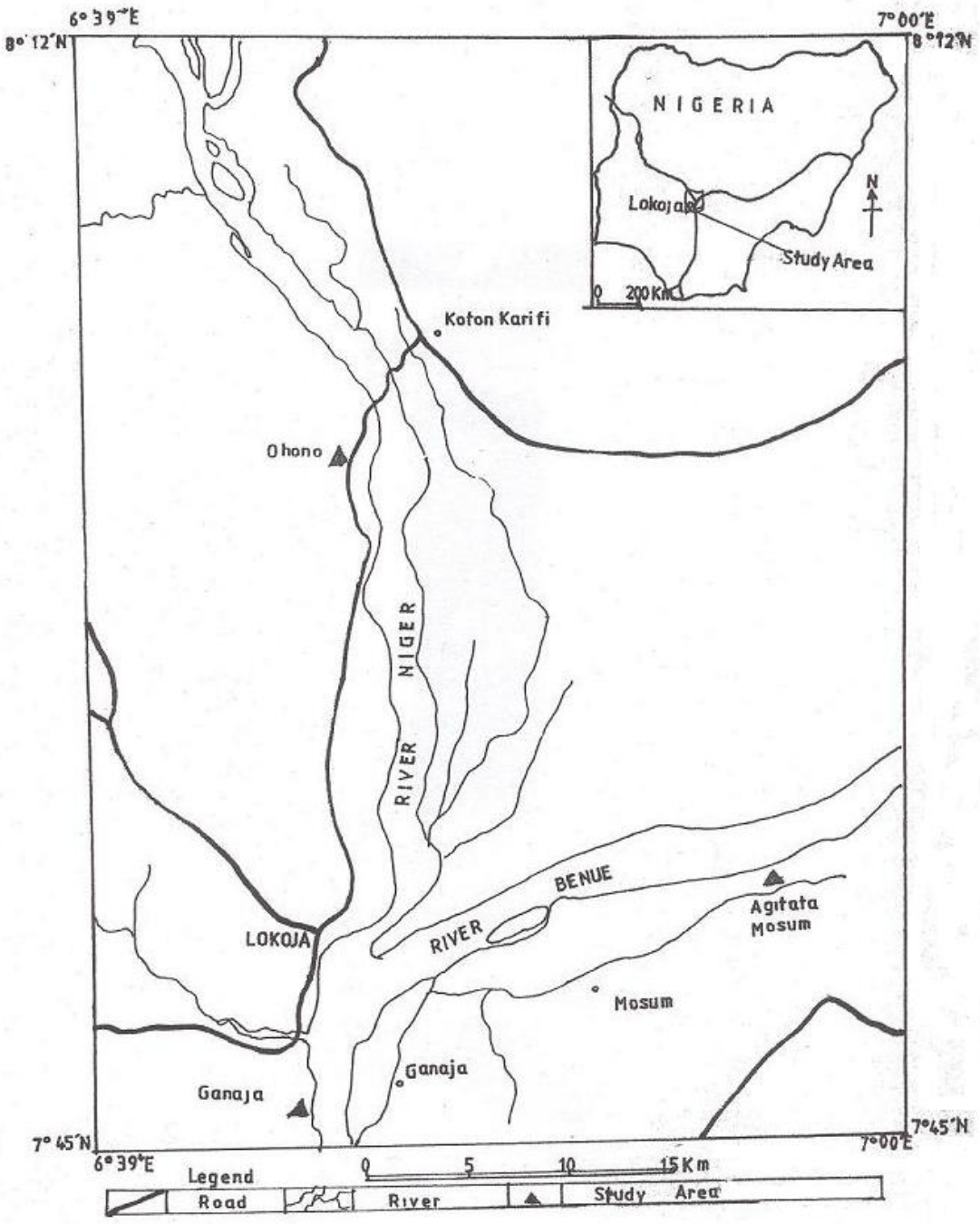

Figure 1. Map of the study area showing the confluence of rivers Niger/Benue at Lokoja Nigeria. Source: Shell Petroleum Development Company map of Nigeria (2000).

mounted whole on clean slide with Canada balsam.

Acanthocephalans

Acanthocephalan parasites were left overnight in a refrigerator to relax and exude the proboscis and then fixed and dehydrated in 70% ethanol. They were then stained in Eosin and mounted on clean slides with Canada balsam.

Collected parasites were identified (Travassos et al., 1963; Yamaguti, 1971; Pavanelli and Rego, 1989; Paperna, 1996; Moravec, 1998; Chambrier and Vaucher, 1999) to species level.

Statistical analysis

The ecological terms: prevalence (%), mean intensity (that is, the number of individual parasite species in a single infected host) and

abundance were analyzed according to Bush et al. (1997). The relationships between host factors such as sex, weight and standard length and parasite infection were examined from data pooled from the three localities using analysis of variance (ANOVA). All statistical analysis were done using SPSS version 15 for windows.

RESULTS

Out of the 84 *S. batensoda* hosts examined for parasites, 61 (72.6%) were infected while 23 (27.4%) were uninfected. The total parasite recovered was 1196. The fish hosts were distributed unevenly in the three localities. In River Niger (locality 1), 13 hosts were examined, 9(69.23%) hosts were infected and the total parasites recovered was 412. In River Benue (locality 2) out of 44 fish examined, 31 (70.45%) were infected, total parasites recovered was 346, while in the confluence (locality 3), 27 were examined, 21 (77.77%) were infected and the total parasites recovered was 438.

Parasite taxa and species encountered included; the protozoan ciliates Trichodinids, the trematode digeneans, *Allocreadium ghanensis* and metacercariae of *Pygidiopsis genata*, the Cestodes, *Monobothrioides woodlandi, Bothriocephalus acheilognathii*, *Proteocephalus largoproglotis* and *Caryophyleus* sp., the Nematodes, *P. laevionchus*, *Rhabdochona congolensis*, *Spinitectus guntheri*, *Oxyuris equi, Contracaecum microcephalum*, *Strongylides* sp. and larval nematodes and the acanthocephalans, *Acanthocephalus* sp., *Neoechinorhynchus prolixum* and *Acanthella* (the immature stages). All parasites were recovered from the intestines except the trichodinids which were recovered from the gills and the skin.

Infection by acanthocephalans was generally high compared to other parasites. *Acanthocephalus* sp. recorded the highest infection with 30 fish hosts infected, prevalence 35.71%, mean intensity 4.13 ± 3.68 and abundance 1.48; *N. prolixum* recorded a prevalence of 16.67%, while *Acanthella* (immature stage) recorded a prevalence of 15.48%. Prevalence recorded by other parasites included 17.8% for *O. equi,* 16.67% for metacercariae of *P. genata*, and 15.48% for *S. guntheri* (Table 1). Trichodinids had the highest prevalence of 46% in River Niger, 9.1% in River Benue and 3.7% in the confluence. *Acanthocephalus* sp recorded a prevalence of 23.1% in Niger River, 40.9% in Benue River and 33.3% in the confluence. Both *P. laevionchus* and metacercariae of *P. genata* were recorded in all localities but the highest prevalence of 23.1% was recorded in Niger River (Table 2).

Multiple infections were frequently observed in the three localities. 41 (48%) *S. batensoda* were infected by 1 to 2 parasite sp, 15 (17.9%) were infected by 3 to 4 parasite sp, 4 (4.8%) by 5 to 6 and 1 (1.2%) by seven parasite sp (Table 3). All the parasite species in the individual hosts (infrapopulation) examined showed that 49 (58.3%) of sampled *S. batensoda* haboured a total of 1 – 25 worms, 6 (7.1%) haboured 26 to 50 worms, 3 (3.6%) haboured 51 to 100 worms and another 3 (1.2) haboured 100 to 146 worms (Table 4). Similarly, the intensity of infection showed that a maximum of 120 trichodinids were recorded in an individual host. The intensity of infection for other parasites was 51 *S. guntheri*, 49 *O. equi*, *43 P. laevionchus*, 26 *Strongylides* sp and 21 metacercaria of *P. genata* (Table 5).

Parasitic infection of *S. batensoda* by body weight showed that *Acanthocephalus* sp had the highest prevalence of 44.4% in 51 to 75 g category although there was no defined pattern because while prevalence decreased to 25% in 76 to 100 g, there was increase to 40% in 100 g and above. This trend was followed by both *N. prolixum* and the *Acanthella* sp. The trichodinids had more infections in fish with weight categories of 76 to 100 g and above, with prevalence of 25.0% in 76 to 100 g category. Metacercariae of *P. genata* infection increased steadily from prevalence of 3.0% in 26 to 50 g to 25.0% in 76 to 100 g and decreased to 16.0% in 100 g and above. The cestode *M. woodlandi* was found only in 26 to 75 g with the highest prevalence of 11.1% in 51 to 75 g, while the rest had no defined pattern of infection. The nematodes, *P. laevionchus* and *C. microcephalum* had more infections in fish of higher weight category of 100 g and above with prevalence of 16.7% and 20.0%, respectively, while *O. equi* and *S. guntheri* had more infections in fish of 26 to 100 g (Table 6). Infections of *S. batensoda* varied significantly ($p < 0.05$) in 76 to 100 g with groups and highly significant ($p < 0.01$) in 100 g and above.

Infections in the standard length categories also revealed that the protozoans, digeneans and the cestodes infected fish of standard lengths between 11 to 21 cm, while the nematodes and acanthocephalans infected fish between 0 to 20 cm but with highest prevalence in fish between 0 to 10 cm (Table 7). Infections were significant ($p < 05$) among fish of 0 to 10 cm.

Infections of *S. batensoda* by sex (Table 8) showed that females were more infected *with* trichodinids, metacercaria of *P. genata, Caryophyleus* sp, *P. laevionchus, O. equi, C. microcephalum* and the immature stages of acanthocephalans, while males had more infections of *S. guntheri, Acanthocephalus* sp and *N. prolixum*. Both male and female *S. batensoda* were heavily infected. The stomach contents of *S. batensoda* contained a variety of food materials mainly plant materials, insect parts and digested materials.

DISCUSSION

S. batensoda in Niger and Benue Rivers at the confluence area in Lokoja were found with a rich parasitic fauna, involving five parasite taxa and up to 17 parasite

Table 1. Parasitic infection of *S. batensoda* at the River Niger-Benue Confluence.

Parasite Taxa	Parasite	Hosts examined	Hosts infected	Parasite recovered	Prevalence (%)	Intensity	Abundance
Protozoan	Trichodinids	84	11	397	13.10	36.09 ± 45.10	4.73
Digenean	*A. ghanensis*	84	1	2	1.19	2	0.02
	Met. of *P. genata*	84	14	102	16.67	7.29 ± 6.36	1.21
Cestode	*M. woodlandi*	84	2	3	2.38	1.5	0.04
	B. acheilognathii	84	2	3	2.38	1.5	0.04
	Caryophyleus sp	84	3	4	3.57	1.33 ± 0.58	0.05
	P. largoproglotis	84	1	1	1.19	1	0.01
Nematode	*P. laevionchus*	84	8	97	9.52	12.13 ± 15.69	1.15
	R congolensis	84	3	6	3.57	2	0.07
	S. guntheri	84	13	156	15.48	12	1.86
	O. equi	84	15	127	17.86	8.47 ± 12.77	1.51
	C. microcephalum	84	7	27	8.33	3.86 ± 2.19	0.32
	Larval nematodes	84	2	35	2.38	17.5 ± 3.54	0.42
	Strongylides sp	84	3	12	3.57	4 ± 2.65	0.14
Acanthocephalan	*Acanthocephalus* sp	84	30	124	35.71	4.13 ± 3.68	1.48
	N. Prolixum	84	14	45	16.67	3.21 ± 2.55	0.54
	Acanthella sp	84	13	20	15.48	1.53 ± 0.66	0.24

species. While the infections with some parasites were quite common in the three localities, others infected fish occurred in one or two localities. For instance, the trichodinids and acanthocephalans (*Acanthocepaleus* sp. and *Acanthella* sp.) were common in the three localities with high prevalence while others though common, occurred with low prevalence. According to Kennedy et al. (1986) the number of parasite species a fish host harbours varies widely from one fish to another and from one locality to another. The distributions are almost always aggregated or over dispersed, meaning that most of the parasites in a population may be found in a small number of hosts and most potential hosts may be infected or uninfected, though there are exceptions (Marcogliese, 2002). The overall parasite infection of 72.6% in this study compared favourably with 85.2% recorded in similar wild population of *Synodontis* sp. in Zaria dam (Auta et al*.,* 1999). Among the parasite species recovered, acanthocephalan species had the highest infection incidence. Out of the total of 84 fish hosts examined; 57 (67.9%) were infected by acanthocephalans (*Acanthocephalus* sp. 35.70%, *N. polixum* 16.67% and the immature stages *Acanthella* sp. 15.48%). The high infection rate of acanthocephalan worms in *S. batensoda* in the study was in conformity with other findings in freshwater ecosystems in tropical Africa (Khalil, 1969, 1971; Troncy and Vassilides, 1973; Douellou, 1992a, b). Khalil (1969) reported unidentified acanthocephalan in 60% of *S. batensoda*. This could be due to ingestion of intermediate hosts. Paperna (1996) listed the intermediate hosts of acanthocephalan worms as amphipods, isopods, copepods or ostracods. Reed et al. (1967) had earlier reported that *S. batensoda* feeds on insect larvae, zooplankton

Table 2. Parasitic infection of *S. batensoda* at the three localities (R. Niger, R. Benue and confluence).

Parasite	River Niger (13)					River Benue (44)					Confluence (27)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Trichodinids	6	349	46.2	58.2 ± 52.4	26.9	4	46	9.1	11.5 ± 5.6	1.1	1	2	3.7	2	0.1
A. ghanensis	0	0	0	0	0	0	0	0	0	0	1	2	3.7	2	0.1
Met. of *P. genata*	3	14	23.1	4.7 ± 2.5	1.1	5	61	11.4	12.2 ± 9.2	1.4	6	27	22.2	4.5 ± 2.8	1
M. woodland	0	0	0	0	0	1	1	2.3	1	0.02	1	2	3.7	2	0.1
B. acheilognathii	1	1	7.7	1	0.1	0	0	0	0	0	1	2	3.7	2	0.1
Caryophyleus sp	1	1	7.69	1	.0.1	0	0	0	0	0	2	3	7.4	1.5 ± 0.71	0.11
P. largoproglotis	0	0	0	0	0	0	0	0	0	0	1	1	1.19	1	0.01
P. laevionchus	3	11	23.1	3.7 ± 1.5	0.9	1	1	2.3	1	0.02	4	85	14.8	21.2 ± 18.6	3.2
R. congolensis	1	2	7.7	2	0.2	1	2	2.3	2	0.05	1	2	3.7	2	0.1
Spinitectus guntheri	2	18	15.4	9 ± 1.4	1.4	5	27	11.4	5.4 ± 6.1	0.6	6	111	22.2	18.5 ± 24	4.1
Oxyuris equi	2	4	15.4	2	0.3	8	42	18.2	5.2 ± 3.4	0.1	5	81	18.5	16.2 ± 20.8	3
C. microcephalum	0	0	0	0	0	1	5	2.3	5	0.1	6	22	22.2	3.6 ± 2.3	0.8
Larval nematode	0	0	0	0	0	0	0	0	0		2	35	7.4	17.5 ± 3.54	1.3
Strongylides sp	1	1	7.69	1	0.1	3	38	6.8	12.7 ± 11.9	0.86	1	6	3.7	6.0	0.22
Acanthocephalus sp	3	8	23.1	2.7 ± 0.6	0.6	18	81	40.9	4.5 ± 3.7	1.8	9	35	33.3	3.9 ± 4.3	1.3
N. prolixum						9	35	20.5	3.8 ± 2.8	0.8	5	10	18.5	2	0.4
Acanthella sp	2	3	15.4	1.5 ± 0.7	0.2	5	7	11.4	1.4 ± 0.5	0.2	6	10	22.2	1.7 ± 0.8	0.4

Number in parenthesis = number of fish hosts examined, A = number fish hosts infected; B = total number of parasites recovered per host; C = percentage prevalence; D = mean intensity of parasite; E= abundance of parasite.

and vegetable matter. These intermediate hosts (amphipods, isopods, copepods or ostracods) ingest acanthocephalan eggs evacuated from fish hosts while the intermediate hosts are in turn ingested by the fish hosts like *S. batensoda* where they grow to adult stages.

In the fish hosts where acanthocephalans were recovered, damage to the intestinal walls due to the anchorage of the proboscis (Paperna and Zwerner, 1974; Kabata, 1985) was obvious. Some of the *N. prolixum* worms recovered were quite large, filling a large proportion of the intestine. There could have been mechanical obstruction of the intestines without perforation of the wall as reported by Douellou (1992 a, b) who observed a single attached specimen of *Acanthogyrus tilapiae* in juvenile cichlids (< -60 mm) which obstructed the digestive tube, apparently without clinical implications. Nematode parasites, though occurring with low prevalence in this study, were diversified. Up to six species of nematodes, including larval forms were recovered from the intestines and visceral cavities of *S. batensoda*. The diversity of nematode parasites in fish hosts is not new in tropical freshwater ecosystems. Khalil and Polling (1997) reported over 40 species of adult nematodes representatives of nine families from fish in Africa with the majority occurring in the alimentary system and a few in tissues or inner cavities. Heaviest infections of nematode parasites of Mockokid fish hosts were also reported in Niger and Benue Rivers at the confluence (Iyaji, 2011). The low prevalence of nematode parasites in *S. batensoda* in this study could be attributed to the ecological habitat of *S. batensoda.* The species spend much time swimming upside down at the water surface where they feed on plant materials, insect larvae, zooplanktons, mollusks, debris and smaller fish (Willoughby, 1974; Fagade, 1983) while other Mockokid fish species are mainly bottom dwellers, feeding on mud, detritus and debris (Reed et al., 1967) which may explain their heavy nematode load unlike *S. batensoda*. The occurrence of larval nematodes in the visceral cavities of fish in this

Table 3. Multiple parasitic infections of *S. batensoda* at the Niger-Benue River Confluence.

Occurrence of parasitic species per host	Frequency	%
0	23	27.4
1	22	26.2
2	19	22.6
3	5	6.0
4	10	11.9
5	3	3.6
6	1	1.2
7	1	1.2
Total	84	100

Table 4. Total number of parasites recovered from *S. batensoda* at the Niger-Benue River confluence.

Number of worms per host	Frequency	%
0	23	27.4
1 - 25	49	58.3
26 - 50	6	7.1
51 - 100	3	3.6
100 - 146	3	3.6
Total	84	100

Table 5. Intensity of parasitic infection of *S. batensoda* at Niger- Benue River confluence**.**

Parasite	Number of worms per host			
	Minimum	Maximum	Mean	Variance
Trichodinids	0	120	4.7 ± 19.9	395.12
A. ghanensis	0	2	0.02 ± 0.22	0.05
Met. of *P. genata*	0	21	1.21 ± 3.80	14.46
M. woodlandi	0	2	0.04 ± 0.24	0.06
B. acheilognathii	0	2	0.04 ± 0.24	0.06
Caryophyleus sp	0	2	0.05 ± 0.26	0.07
P. largoproglotis	0	1	0.01 ± 0.11	0.01
P. laevionchus	0	43	1.15 ± 5.79	33.58
R. congolensis	0	2	0.07 ± 0.37	0.14
S. guntheri	0	51	1.86 ± 7.85	61.59
O. equi	0	49	1.53 ± 6.21	38.59
Strongylides sp	0	26	0.54 ± 3.06	9.38
C. microcephalum	0	8	0.32 ± 1.22	1.50
Larval nematodes	0	20	0.42 ± 2.71	7.35
Acanthocephalus	0	15	1.48 ± 2.95	8.71
N. prolixum	0	10	0.54 ±1.57	2.47
Acanthella sp	0	3	0.24 ± 0.61	0.38

study had earlier been reported in other research findings for freshwater fishes (Khalil, 1969; Obiekezie et al*.,* 1987; Salgado-Maldonado et al*.,* 2004). They all noted that pisciverous birds feed on nematode infected fish and when they defecate the eggs are released in the water, this in turn infects the fish. The high infection of the protozoan ciliate, trichodonids in the skin and gills of 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

Table 6. Parasitic infection of *S. batensoda* by body weight at the River Niger-Benue confluence.

Parasite	26 – 50 g (N = 35)					51 – 75 g (N = 9)					76 – 100 g (N = 8)					100 g+ (N = 30)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Trichodinids	4	190	11	5	5	0	0	0	0	0	2	58	25	7.3	7.3	5	149	17	5	5
A. ghanensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3.3	0.1	0.1
Met. of *P. genata*	1	2	3	0	0	3	42	33.3	4.7	4.7	3	29	38	3.6	3.6	7	29	23	1	1
M. woodland	1	2	3	0	0	1	1	11.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0
B. acheilognathii	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3.3	0.1	0.1
Caryophyleus sp	1	1	2.9	1	0.3	0	0	0	0	0	0	0	0	0	0	2	3	6.7	1.5	.10
P. largoproglotis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. laevionchus	2	4	6	0	0	0	0	0	0	0	1	43	13	5.4	5.4	5	50	17	1.7	1.7
R congolensis	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	4	6.7	0.1	0.1
Spinitectus guntheri	4	52	11	1	1	3	33	33.3	3.7	3.7	2	59	25	7.4	7.4	4	12	13	0.4	0.4
Oxyuris equi	8	30	23	1	1	0	0	0	0	0	2	60	25	7.5	7.5	5	37	17	1.2	1.2
C. microcephalum	1	5	3	0	0	0	0	0	0	0	0	0	0	0	0	6	22	20	0.7	0.7
Larval nematode	1	16	2.9	16	0.4	0	0	0	0	0	0	0	0	0	0	1	20	3.3	20	.7
Strongylides sp.	3	18	8.6	6	0.5	0	0	0	0	0	1	1	5.9	1	0.06	1	26	3.3	26	.87
Acanthocephalus sp.	12	37	34	1	1	4	18	44.4	2	2	2	5	25	0.6	0.6	12	64	40	2.1	2.1
N. prolixum	7	19	20	1	1	2	7	22.2	0.8	0.8	0	0	0	0	0	5	19	17	0.6	0.6
Acanthella sp.	6	8	17	0	0	1	2	11.1	0.2	0.2	0	0	0	0	0	6	10	20	0.3	0.3

A = Number of fish hosts infected, B= Total number of parasites recovered per host, C = Percentage prevalence, D = Mean intensity of parasite, E= Abundance of parasite, N= Number of fish hosts.

gill irritation, displayed by flashing, rubbing, rapid breathing and excessive mucus secretion in gills although some of the fish examined were infected with many trichodinids with mucus secretion in their gills, acceptable for the market. The four species of cestode parasites recovered occurred in very low prevalence and were not significance ($p > 0.01$). The significantly higher prevalence and mean intensity of some parasites recorded in fish of large weight classes (51 to 100 g and above) examined indicated the increase in parasitism with increase in size which is also related to age. Several studies affirmed positive correlations between host age/size and increase in parasitism (Betterton, 1974; Madhavi and Rukmini, 1991; Chandler et al*.,* 1995; Brickle et al*.,* 2003). Generally, standard length in fish is directly related to age (Shotter, 1973) and fish body size. Poulin (2000) argued that older fish have longer time to accumulate parasites than younger ones and may provide more internal and external space for parasite establishment and therefore tend to have heavier worm burdens because they eat more parasitized prey and offer larger surface area for skin-attaching parasites. Muňoz and Cribb (2005) argued that this pattern might be explained by the combination of resources, time and prey. In general, large hosts have more space, more flux of energy (that is, food) and microhabitats for parasites than small hosts. Higher prevalence and mean intensities of acanthocephalans *in S. guntheri* were recorded in fish of intermediate standard lengths. High prevalence of infection in fish of intermediate standard length had also been reported in several other studies (Hanek and Fenando, 1978 a, b; Fernandez, 1985; Obiekezie et al*.,* 1987; Valtonen et al*.,* 1990, Chapman et al., 2000; Owolabi, 2005, 2007). This could result from changes in dietary habits due to age or due to immunological resistance in adults.

There was no evidence of the influence of sex on parasitic infection of *S. batensoda*. Both sexes were equally and significantly ($p < 0.05$) infected. Similar results were reported by Auta et al*.* (1999), Araoye (2005) and Owolabi (2008). Multiple infections of fish hosts had also been reported in several other studies (Ezenwaji and Ilozumba,

Table 7. Parasitic infection of *S. batensoda* by standard length at the River Niger-Benue confluence.

Parasites	1 – 10 cm (N = 3)					11 – 20 cm (N = 67)					21 cm+ (N = 14)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Trichodinids	0	0	0	0	0	8	382	12	0.12 ± 0.3	570	3	15	21.4	1.07 ± 2.56	107.1
A. ghanensis	0	0	0	0	0	1	2	1.5	0.01 ± 0.1	2.99	0	0	0.0	0	0.0
Met. of *P. genata*	0	0	0	0	0	12	94	17.9	0.18 ± 0.4	140	2	8	14.3	0.57 ± 1.65	57.1
M. woodlandi	0	0	0	0	0	2	3	3.0	0.03 ± 0.2	4.48	0	0	0.0	0	0.0
B. acheilognathii	0	0	0	0	0	2	3	3.0	0.03 ± 0.2	4.48	0	0	0.0	0	0.0
Caryophyleus sp	0	0	0	0	0	3	4	4.5	0.04 ± 0.2	5.97	0	0	0.0	0	0.0
P. largoproglotis	0	0	0	0	0	1	1	1.5	0.01 ± 0.1	1.49	0	0	0.0	0	0.0
P. laevionchus	0	0	0	0	0	7	93	10.4	0.10 ± 0.03	139	1	4	7.1	0.29 ± 1.07	28.6
R. congolensis	0	0	0	0	0	2	4	3.0	0.03 ± 0.2	5.97	1	2	7.1	0.14 ± 0.53	14.3
S. guntheri	1	1	33.3	0.33 ± 0.6	33.3	10	148	14.9	0.15 ± 0.4	221	2	7	14.3	0.5 ± 1.29	50.0
O. equi	0	0	0	0	0.0	15	127	22.7	0.23 ± 0.4	192	0	0	0.0	0	0.0
Strongylides sp	0	0	0	0	0.0	4	19	6.0	0.06 ± 0.2	28.4	1	26	7.1	1.86 ± 6.95	185.7
C. microcephalum	0	0	0	0	0.0	4	21	6.0	0.06 ± 0.2	31.3	3	6	21.4	0.43 ± 0.85	42.9
Larval nematodes	0	0	0	0	0.0	2	35	3.0	0.057 ± 0.2	52.2	0	0	0.0	0	0.0
Acanthocephalus sp	2	7	66.7	2.33 ± 3.2	233.3	27	112	40.3	0.40 ± 0.5	167	1	5	7.1	0.36 ± 1.34	35.7
N. prolixum	1	1	33.3	0.33 ± 0.6	33.3	12	43	17.9	0.18 ± 0.4	64.2	1	1	7.1	0.070 ± 0.27	7.1
Acanthella sp	0	0	0	0	0.0	11	17	16.4	0.16 ± 0.4	25.4	2	3	14.3	0.21 ± 0.58	21.4

A = Number fish hosts infected, B= Total number of parasites recovered per host, C = Percentage prevalence, D = Mean intensity of parasite, E= Abundance of parasite, N- Number of fish hosts.

Table 8. Parasitic infection of Male and Female *S. batensoda* in River Niger-Benue at the Confluence.

Parasite	Male (N = 47)					Female (N = 37)				
	A	B	C	D	E	A	B	C	D	E
Trichodinids	6	183	12.77	305 ± 45.97	3.89	5	214	13.51	42.80 ± 48.39	5.78
A. ghanensis	0	0	0	0	0.00	1	2	2.70	0.05 ± 0.32	5.41
Met. of *P. genata*	6	67	12.77	11.17 ± 7.31	1.43	8	35	21.62	4.38 ± 4.72	0.95
M. woodlandi	2	3	4.255	0.06 ± 0.32	0.63	0	0	0.00	0	0.00
B. acheilognathii	1	2	2.128	0.04 ± 0.29	0.42	0	0	0	0	0
Caryophyleus sp	1	2	2.128	0.04 ± 0.29	0.42	2	2	5.41	0.05 ± 0.23	0.54
P. largoproglotis	0	0	0	0	0.00	1	1	2.70	0.03 ± 0.16	0.27
P. laevionchus	4	12	8.51	3.0 ± 1.83	0.25	4	85	10.81	21.25 ± 18.68	2.3
R. congolensis	3	6	6.383	0.13 ± 0.49	1.27	0	0	0.00	0	0.00
S. guntheri	8	87	17.02	1.85 ± 7.40	0.18	5	69	13.51	1.87 ± 8.49	0.18

Table 8. Contd.

O. equi	7	35	14.89	5.00 ± 3.87	0.74	8	92	21.62	11.50 ± 17.05	2.49
Strongylides sp	3	10	6.383	0.21 ± 0.98	0.21	2	35	5.41	0.95 ± 4.48	0‘94
C. microcephalum	3	11	6.38	3.67 ± 1.536	0.23	4	16	10.81	4.00 ± 2.83	0.43
Larval nematodes	1	15	2.128	0.32 ± 2.19	0.32	1	20	2.70	0.54 ± 3.28	0.54
Acanthocephalus sp	18	64	38.3	3.56 ± 2.53	1.36	12	60	32.43	5.00 ± 4.95	1.62
N. prolixum	8	22	17.02	2.75 ± 1.75	0.47	6	23	16.22	3.83 ± 3.43	0.62
Acanthella sp	6	8	12.77	1.33 ± 0.52	0.17	7	12	18.92	1.71 ± 0.76	0.32

A = Number fish hosts infected; B = total number of parasites recovered per host; C = percentage prevalence; D = mean intensity of parasite; E= abundance of parasite; N= number of fish hosts.

1992; Sowemimo and Asaolu, 2004; Owolabi, 2008). The level of multiple infections in this study was an indication of the rich parasitic fauna of the Niger and Benue Rivers at the confluence. This study was an effort to contribute to the knowledge of parasitism of tropical fish hosts and to bridge the gap of the general perception that there is a lack of adequate information on the parasitic fauna of tropical fish as opined by Kennedy (1995), and Choudhury and Dick (2000).

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