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Endoparasitic helminths of *Synodontis schall* (Bloch and schneider, 1801, siluriformes, mochokidae) at the confluence of Niger and Benue Rivers, Lokoja, Nigeria

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Abstract
Monthly sampling of catches at the confluence area of Niger and Benue rivers was carried out between March 2014 and February 2015 to determine the occurrence of endohelminth parasites in *Synodontis schall.* A total of 193 hosts were examined and the prevalence of infection was 85.59%. Endohelminth species encountered included 2 digeneans (*Allocreadium ghanensis*, Metacercaria of *Pygidiopsis* spp), 3 cestodes (*Monobothrioides woodlandii*, *Bothriocephalus acheilognathii,* and *Proteocephalus* spp), 3 nematodes (*Procamallanus laevionchus, Rhabdochona* spp*, Spinitectus guntheri,* larval nematodes*)* and 2 acanthocephalans (*Acanthocephalus* spp*, Neoechinorhynchus prolixum*, *acanthella* - the larval stages of acanthocephalans). Among the endohelminth parasites that infected *Synodontis schall Procamallanus laevionchus* recorded highest prevalence of 62.2% while prevalence of other parasites ranged between 1% and 30.6%. Infection of *S. schall* was high between 0-100 gm weight classes and in all the length classes. Multiple infections were observed. 62.7% of the fish hosts harboured between 1 - 20 worms while 19.6% harboured between 21 - 80 worms. The overall worm burden was independent of sex of the fish hosts.

Keywords: Endohelminths, *Synodontis schall*, River Niger, River Benue, confluence, Nigeria

Introduction
Synodontis schall (Bloch and Schneider, 1801) is a species of upside down catfish that is abundant throughout the year at the confluence area of Niger and Benue rivers, Lokoja. It contributes significantly to the economy of the fishers since it is affordable and acceptable to the general populace [1]. *S. schall* grows to a length of at least 400 mm and a weight of more than 1 kg in the natural environment [2].
Parasitic infections are rampant in natural water bodies which may cause a host of pathological debilities in the affected fish [1]. Evidences suggest that parasites can act as severe pathogens, causing direct mortality or rendering the fish more vulnerable to predators while other fish parasites have been reported to be transmissible to man [3].
There is little or no information on the parasites of fish at the confluence area of Niger and Benue rivers. The present study of endohelminth parasites of *S. schall* at the confluence area of Niger and Benue Rivers at Lokoja, Nigeria, provides a basic knowledge on the *S. schall* endohelminth parasites and bridges the existing paucity of information on helminth parasites of fish of the confluence area of Niger and Benue rivers.

Materials and Methods
The study was carried between March 2014 and February 2015.

Study Area
The study area is located around the confluence of the two major rivers in Nigeria, River Niger and River Benue between latitude 7º 45N- latitude 8º 12N and longitude 6º 39E- longitude7º 00E (Fig. 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 savannah 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

Sample Collection, identification and data analysis

Fish were sampled from fishers using a variety of fishing gears (set nets, cast nets, hooks, gill nets, etc) at the 3 localities for 12 months.

Locality 1: Ohono village, along Lokoja - Koton Karfe road, (Niger River).

Locality 2: Mozum village, located on the eastern bank, (Benue River).

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 fish species were identified according to [2, 4]. Examination of fish for parasites followed methods of [5, 6]. Treatment, fixation and preservation of parasites were adapted from [7]. The helminth parasites were identified based on [8-12].

Infection statistics [13] was used for the determination of prevalence, mean intensity and mean abundance. Analysis was done using SPSS version 21.

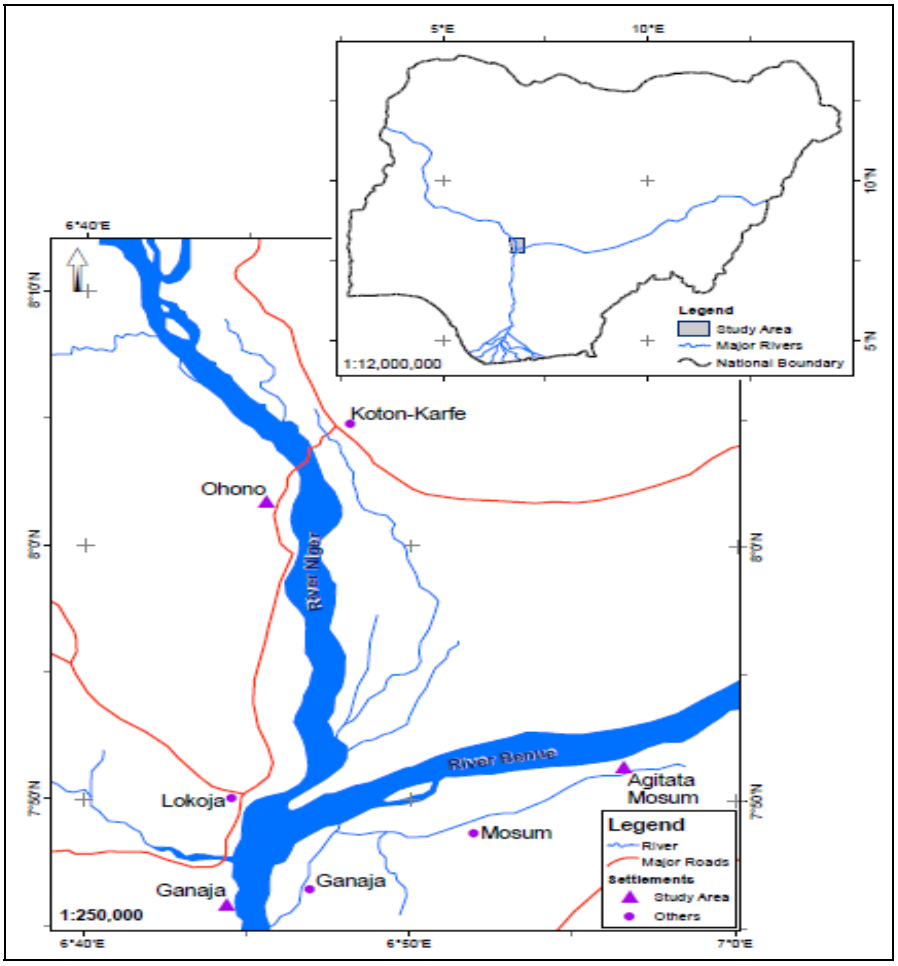

Fig 1: Map of the Study Area.

Results

Out of one hundred and ninety three (193) *S. schall* examined for endohelminth parasites 165 (85.47%) fish hosts were infected while 28 (14.5%) were uninfected with 3260 endohelminth parasites recovered. In River Niger (Locality 1), 77 hosts were examined, 66 (85.71%) hosts were infected and 883 parasites recovered. In River Benue (Locality 2), of the 57 hosts examined, 47 (82.45%) hosts were infected and 1038 helminths recovered while at the confluence (Locality 3), 59 hosts were examined, 52 (88.1%) were infected with a total of 1339 helminths recovered.

Helminth taxa and species encountered were: The digenean trematodes, *Allocreadium ghanensis* and Metacercariae of *Pygidiopsis* spp, the cestodes, *Monobothrioides woodlandii*, *Bothriocephalus acheilognathii, Proteocephalus* spp, the nematodes, *Procamallanus laevionchus, Rhabdochona* spp, *Spinitectus guntheri,* larval nematodes and the acanthocephalans, *Acanthocephalus* spp, *Neoechinorhynchus prolixum* and canthella, (larval stages of acanthocephalans). All helminths were recovered from the intestines except the few larval nematodes which were found in the body cavities and liver of fish.

Nematode parasites infected more fish hosts than other parasite groups. *Procamallanus laevionchus* recorded the highest infection with 120 fish hosts, a prevalence of 62.18%, mean intensity of 16.9±21.4 and mean abundance of 10.51. Infection of other nematode species were as follows; *Spinitectus guntheri,* 49 hosts, prevalence, 25.30%, mean intensity, 9.76±10.2 and mean abundance, 2.48. Larval nematodes, 41 hosts, prevalence, 21.24%, mean intensity, 8.83±20.5 and mean abundance, 1.88. *Rhabdochona* spp. had the least infection among the nematodes. Prevalence of infection recorded by *Monobothrioides woodlandii* and Metacercariae of *Pygidiopsis* spp were 30.59% and 20.21% respectively. The rest were between 1.04% and 3.6% (Table 1).

Similarly, *Procamallanus laevionchus* recorded highest prevalence in 3 localities (Table 2). Apart from *Proteocephalus* spp., *Neoechinorhynchus prolixum* and acanthella, the rest helminths were found across the 3 localities.

Multiple parasitic infections were frequently encountered in this study. 64 (33.2%) *S. schall* were infected by 2 helminth species, 31 (16.1) were infected by 3 species, 8(4.1%) by 4 species while 2 (1%) were infected by 5 species. One fish was infected by 6 species (Fig. 1).

The worm burden (infra-population) showed that 121 fish hosts (62.6%) of sampled *S. schall* harboured between 1 - 20 worms, 24 (12.4%) harboured between 21 - 40 worms, 8 (4.1%) harboured between 41 - 60 worms, 6 (3.1%) harboured between 61 - 80 worms, while 6 (3.1%) harboured 81 worms and above (Fig. 2).

Infection by body weight of *S. schall* showed that *Procamallanus laevionchus* had highest prevalence of 72.7% in 76 – 100 gm weight class. The highest prevalence of 30.0% by *Spinitectus guntheri* and *Rhabdochona* spp was in 26 – 50 gm weight class. Among the cestodes, *Monobothrioides woodlandii* has the highest prevalence of 46% in 51 – 75 gm weight class. *Allocreadium ghanensis* recorded the highest prevalence of 4.5% in 76 – 100 gm weight categories while metacercariae of *Pygidiopsis* spp recorded 22% in 51 – 75 gm weight class (Table 3).

Table 1: Endohelminth infection of *S. schall* at the confluence of Niger and Benue rivers.

Parasites		Host Infected (N = 193)	Parasites Recovered	Prevalence (%)	Mean Intensity± STD	Mean Abundance
Digeneans	*Allocreadium ghanensis*	2	9	1	4.5±2.12	0
	Metacercaria of Pygiopsis spp.	39	183	20.2	4.69±3.96	0.9
Cestodes	*Monobothrioides woodlandii*	59	244	30.6	4.13±5.42	1.3
	Bothriocephalus acheilognathii	7	21	3.6	3±2.58	0.1
	Proteocephalus spp	4	11	2.1	2.75±1.26	0.1
Nematodes	*Procamallanus laevionchus*	120	2028	62.2	16.9±21.45	10.5
	Rhabdochona spp	39	244	20.2	6.26±6.33	1.3
	Spinitectus guntheri	49	478	25.3	9.76±10,29	2.5
	Larval nematodes	41	362	21.2	8.83±20.51	1.9
Acanthocephalans	*Acanthocephalus* spp.	5	8	2.6	1.6±0.55	0
	Neoechinorhynchus prolixum	2	5	1	2.5±2.12	0
	Acanthella(larval acanthocephalan)	4	6	2.1	1.5±0.58	0

Table 2: Endohelminth Infection of *S. schall* at the Three Localities (Niger, Benue and Confluence)

Parasites	Locality 1					Locality 2					Locality 3				
	Host examined N =77					Host Examined N=57					Host examined N=59				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Allocreadium ghanensis	1	6	1.3	6	0.08	1	3	1.75	3.00±0.00	0.05					
Metacercaria of *Pygidiopsis.* spp.	14	53	18.2	3.79±2.94	0.69	11	45	19.3	4.09±3.18	0.79	14	85	24	6.07±5.09	1.44
Monobothrioides woodlandi	26	131	3.77	5.04±6.79	1.7	9	35	15.8	3.89±3.98	0.61	24	78	41	3.25±4.10	1.32
Bothriocephalus acheilognathii	4	6	5.19	1.50±0.58	0.08	1	8	1.75	8.00±0.00	0.14	2	7	3.4	3.50±2.12	0.12
Proteocephalus spp						3	8	5.26	2.67±1.53	0.14	1	3	1.7	3.00±0.00	0.05
Procamallanus laevionchus	48	543	62.4	11.31±15.81	7.05	34	616	59.7	18.12±16.68	10.8	38	869	64	22.87±28.91	14.7
Rhabdochona spp	10	32	13	3.20±2.25	0.42	20	145	35.1	7.25±6.72	2.54	9	67	15	7.44±7.84	1.14
Spinitectus guntheri	2	10	2.6	5.00±0.00	0.13	5	14	8.77	2.80±2.05	0.25	2	3	3.4	1.50±0.71	0.05
Larval nematodes	15	61	19.5	4.07±2.15	0.79	9	54	15.8	6.00±4.24	0.95	17	247	29	14.53±31.28	4.19
Acanthocephalus spp	3	4	3.9	1.33±0.58	0.05	1	2	1.75	2.00±0.00	0.04	1	2	1.7	2.00±0.00	0.03
Neoechinorhynchus prolixum	1	4	1.3	4.00±0.00	0.05						1	1	1.7	1.00±0.00	0.02
Acanthella(larval acanthocephalan)	2	3	2.6	1.50±0.71	0.04						2	3	3.4	1.50±0.71	0.05

KEY: A= Hosts infected, B = Parasites recovered, C= Percentage prevalence, D= Mean intensity (mean±STD), E= Mean abundance

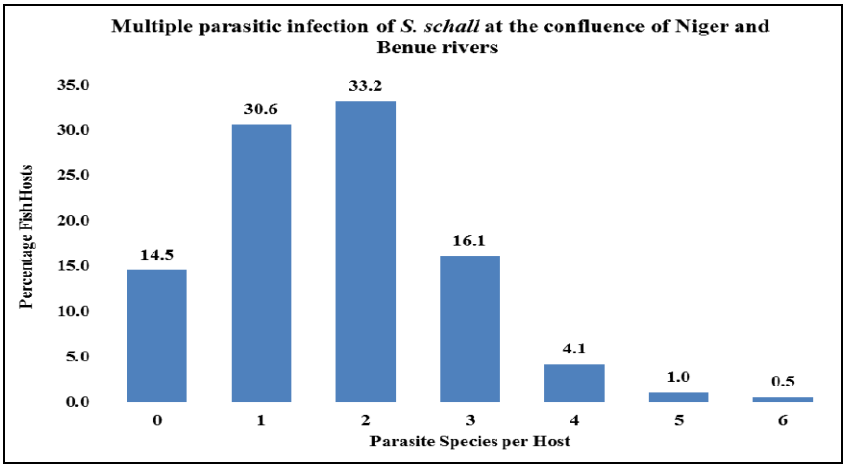

Fig 2: Multiple infection of *S. schall* at the confluence of Niger and Benue rivers.

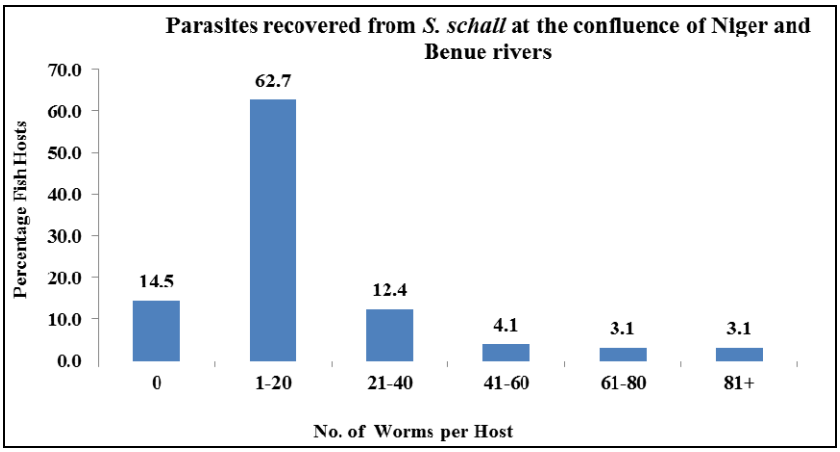

Fig 3: Total number of endohelminths recovered from *S. schall* at the confluence of Niger and Benue rivers.

In the standard length categories, nematode parasites infected more fish in 0 – 20 cm length but with highest prevalence of 100% in 30+ cm length category. Other parasite species infected fish of 0 – 20 cm length categories with highest prevalence of 35% by *Monobothrioides woodlandii* in 11 – 20 cm length though metacercariae of *Pygidiopsis* spp recorded a prevalence of 67% in 20 – 30 cm length category, being the only parasite found in this category (Table 4). Infections were high at 0 – 20 cm length category.

Infections of *S. schall* by sex (Table 5) showed that females had higher infections with *Allocreadium ghanensis*, metacercariae of *Pygidiopsis* spp, *Monobothrioides woodlandii, Bothriocephalus acheilognathii, Rhabdochona* spp, *Spinitectus guntheri*, while males had higher infections with *Procamallanus laevionchus, Acanthocephalus* spp and acanthella. Although females were infected with more parasite species, there was no significant difference in the infection of male and female *S. schall*, $P>0.05$.

Discussion

A rich parasitic fauna involving four helminth taxa and 10 species were found in *S. schall* at the confluence area of Niger and Benue rivers. Most of the helminths were found across the three localities except *Proteocephalus* spp. which were not found in River Niger, *N. prolixum* and acanthella, not in River Benue and *Allocreadium ghanensis* not at the confluence. Nematode parasites occurred with high prevalence while other helminth parasites, though found across the three localities, occurred with low prevalence. This result agrees with the observations of [14] that the number of parasite species a fish host harbours varies widely from one fish to another and from one locality to another. According to [6], the distribution of parasites in fish hosts is almost always aggregated or over dispersed, meaning that most parasites in a population maybe found in a small number of hosts and most potential hosts maybe infected or uninfected.

The overall helminth parasite infection of 85.59% in this study compares well with 85.2% recorded in similar wild population of *Synodontis* species in Zaria dam [15]. Among the helminth parasites, nematodes had the highest infection rate. The high infection rate of nematode parasites in *S. schall* in this research work is in conformity with high infection rates in siluriid fish spp in other freshwater ecosystems in the tropics. Abundant and heavy camallanids infections, up to 20 species or more have been reported in many catfishes in Africa [9, 16, 17, 18]. Prevalence of nematode parasite species up to 85% with a mean of 9 worms per fish was reported in lake Naivasha, Kenya [11]. Larval nematodes found in the body cavities of fish in this study had also been reported in other research findings in freshwater bodies [16, 20, 21]. [16] Reported *Amplicaecum* larvae in the body cavity of various predatory catfishes with prevalence of 10 - 37% and worm burdens of up to 36 worms per fish and noted that piscivorous birds feed on nematode infected fish and when they defecate, the eggs are released in the water, and this in turn infects the fish. Catfishes, particularly the mochokid species are mainly bottom dwellers, feeding on mud, detritus and debris, [2] which may explain the heavy nematode burden observed in this study. In some of the fish hosts examined, the digestive tracts were filled with nematode worms. Some worms were observed coming out through the anal tracts of the fish hosts. Such fish looked emaciated with no market appeal and died earlier than others. Some larval nematodes found in the liver of one fish altered the liver texture which became softer and decomposed easily.

Table 3: Endohelminth infection of *S. schall* by body weight at the confluence of Niger and Benue rivers

Parasites of Synodontis schall	0-25 gm (N=16)					26-50 gm (N=66)					51-75 gm (N=76)					76-100 gm (N=22)					100+ gm (N=13)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Acanthella (larval acanthocephalan)	0	0	0	0	0	2	4	3	0	0	2	2	2.6	0.03	0.03	0	0	0	0	0	0	0	0	0	0
Acanthocephalus spp.	0	0	0	0	0	2	4	3	0	0	2	3	2.6	0.04	0.1	0	0	0	0	0	1	1	7.7	0.1	0.1
Allocreadium. Ghanensis	0	0	0	0	0	0	0	0	0	0	1	6	1.3	0.1	0.1	1	3	4.5	0.1	0.2	0	0	0	0	0
Bothriocephalus acheilognathii	0	0	0	0	0	4	13	6	0	0	2	6	2.6	0.1	0.1	1	2	4.5	0.1	0.1	0	0	0	0	0
Larval nematodes	1	8	6.3	1	0.5	9	43	14	1	1	23	121	30.3	1.6	1.6	8	190	36.4	8.6	8.7	0	0	0	0	0
Metacercaria of *Pygidiopsis* spp	4	9	25	1	0.6	10	60	15	1	1	17	88	22.4	1.2	1.2	4	13	18.2	0.6	0.6	4	13	30.8	1	1
Monobothrioides woodlandii	0	0	0	0	0	18	55	27	1	1	35	157	46.1	2.1	2.1	5	30	22.7	1.4	1.4	1	2	7.7	0.2	0.2

Neoechinorhynchus prolixin	0	0	0	0	0	1	1	2	0	0	1	4	1.3	0.05	0.1	0	0	0	0	0	0	0	0	0	0
Procamallanus laevionchus	10	122	63	8	7.6	41	748	62	11	11	47	855	61.8	11.3	11.3	16	272	72.7	12.4	12.4	6	31	46.2	2.4	2.4
Proteocephalus spp	0	0	0	0	0	2	7	3	0	0	2	4	2.6	0.1	0.1	0	0	0	0	0	0	0	0	0	0
Rhabdochona spp	3	14	19	1	0.9	20	144	30	2	2	10	61	13.2	0.8	0.8	3	18	13.6	0.8	0.8	3	7	23.1	0.5	0.6
Spinitectus guntheri	3	42	19	3	2.6	20	212	30	3	3	18	165	23.7	2.2	2.2	5	49	22.7	2.2	2.2	3	10	23.1	0.8	0.8

Key: A = Number of fish hosts infected, B= Total number of parasites recovered per host, C = Percentage prevalence, D = Mean intensity (Mean±STD), E= Mean abundance of parasite, N= Hosts Examined., gm= grammes

Table 4: Endohelminth infection of *S. schall by* standard length at the confluence of Niger and Benue rivers

Parasites of Synodontis schall	0-10cm (N=28)					11-20cm (N=161)					21-30cm (N=3)					30+cm (N=5)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Allocreadium ghanensis	0	0	0	0	0	2	9	1.2	0	0	0	0	0	0	0	0	0	0	0	0
Acanthella (larval acanthocephalan)	1	2	3.6	0.1	0	3	4	1.9	0	0	0	0	0	0	0	0	0	0	0	0
Acanthocephalus spp.	1	2	3.6	0.1	0	4	6	2.5	0	0	0	0	0	0	0	0	0	0	0	0
Bothriocephalus acheilognathii	0	0	0	0	0	7	21	4.4	0	0	0	0	0	0	0	0	0	0	0	0
Larval nematodes	4	20	14	0.7	1	37	342	23	2	2	0	0	0	0	0	0	0	0	0	0
Metacercaria of *Pygiopsis* spp	7	14	25	0.5	1	30	163	19	1	1	2	6	67	2	2	0	0	0	0	0
Monobothioides woodlandii	2	4	7.1	0.1	0	57	240	35	2	2	0	0	0	0	0	0	0	0	0	0
Neoechinorhynchus prolixum	0	0	0	0	0	2	5	1.2	0	0	0	0	0	0	0	0	0	0	0	0
Procamallanus laevionchus	17	178	61	6.4	6	101	1844	63	11	11	1	3	33	1	1	1	3	100	3	3
Proteocephalus spp	0	0	0	0	0	4	11	2.5	0	0	0	0	0	0	0	0	0	0	0	0
Rhabdochona spp	6	30	21	1.1	1	31	210	19	1	1	1	1	33	0.3	0.3	1	3	100	3	3
Spinitectus guntheri	7	80	25	2.9	3	39	380	24	2	2	2	8	67	2.7	2.7	1	10	100	10	10

Key: A = Number fish hosts infected, B= Total number of parasites recovered, C = Percentage prevalence, D = Mean intensity (mean±STD), E= Mean abundance, N= Hosts Examined, cm= centimeter

Table 5: Endohelminth infection of Male and Female *S. schall* at the confluence of Niger and Benue rivers

Parasite sp	Male					Female				
	Host Examined (N=115)					Host Examined (N= 78)				
	A	B	C	D	E	A	B	C	D	E
Allocreadium ghanensis	1	6	0.87	6.00±0.00	0.05	1	3	1.3	3.00±0.00	0.04
Acanthella (larval acanthocephalan)	3	4	2.61	1.33±0.58	0.03	1	2	1.3	2.00±0.00	0.03
Acanthocephalus spp	4	6	3.48	1.50±0.58	0.05	1	2	1.3	2.00±0.00	0.03
Bothriocephalus acheilognathii	4	6	3.48	1.50±0.58	0.05	3	15	3.9	5.00±3.00	0.19
Larval nematodes	18	116	15.65	6.44±4.55	1.01	23	246	29	10.70±27.21	3.15
Metacercaria of *Pygiopsis* spp	21	104	18.26	4.95±4.02	0.9	18	79	23	4.39±3.96	1.01
Monobothioides woodlandii	34	171	29.57	5.03±6.67	1.49	25	73	32	2.92±2.68	0.94
Procamallanus laevionchus	74	1130	64.35	15.27±21.61	9.83	46	898	59	19.52±21.16	11.5
Proteocephalus spp	3	8	2.61	2.67±1.53	0.07	1	3	1.3	3.00±0.00	0.04
Rhabdochona spp	21	142	18.26	6.76±7.56	1.23	18	102	23	5.67±4.64	1.31
Spinitectus guntheri	27	295	23.48	10.93±12.07	2.57	22	183	28	8.32±7.60	2.35

Key: A = Number fish hosts infected, B= Total number of parasites recovered per host, C = Percentage prevalence, D = Mean intensity (mean±STD), E= Mean abundance, N= Hosts Examined.

Among the other helminth parasites that infected *S. schall*, the cestode, *M. woodlandii* and the digenean trematode, metacercariae of *Pygidiopsis* spp. recorded prevalence of 30.59% and 20.21% respectively. The rest helminths occurred in low prevalence. The fact that *Procamallanus laevionchus* recorded highest prevalence in the three localities showed that it is the dominant helminth of *S. schall* at the confluence area.

The higher prevalence and mean intensity of some parasites recorded in fish of intermediate weight/length classes indicate the increase in parasitism of *S. schall* of intermediate sizes. High prevalence of infection in fish of intermediate weight/length had been reported in several other studies [1, 22, 23, 24, 20, 25, 26]. In similar studies, [27, 28] found higher levels of parasitism in hosts with intermediate lengths and stated that fish acquired the parasites in their youth phase which are eliminated in the fish's adult phase, suggesting the possibility of the development of immunological resistance in adults. [26] found that parasite prevalence increased with host body size only up to 700 mm; larger individuals showed lower prevalence. Such a pattern, they argued could reflect the premature mortality of infected older individuals [29,30,31] or the lower prevalence in larger individuals may be due to the development of immunity with age as stated above.

There was no evidence of the influence of sex on parasitic infection of *S. schall*. Both sexes were equally infected (P>0.05). Similar results were reported by [15, 32, 33]. Multiple infections of fish hosts had also been reported variously in other studies, [34, 35, 33]. The level of multiple infections in this study is an indication of the rich parasitic fauna of fish hosts in Niger and Benue rivers at the confluence.

Conclusion

This study was an effort to contribute to the knowledge of parasitism of tropical freshwater fish hosts. It is hoped that it will elicit interest of fish parasitologists in the area for more information on the factors responsibles for the abundance of parasites in fish of the confluence of rivers Niger and Benue.

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