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Prevalence and seasonality of parasites of fish in Agulu Lake, Southeast, Nigeria

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A study was undertaken to assess the prevalence, mean intensity, abundance and seasonality of parasites of fish in a natural, freshwater, tropical lake, southeast Nigeria. A total of 1191 fish specimen belonging to four families (*Cichlidae, Bagridae, Hepsetidae* and *Channidae*), seven genera and nine species were collected from the lake and examined for parasites. Eleven (11) species of parasites comprising metacercariae of three digenetic trematodes, one cestode, five nematodes and two acanthocephalans were isolated. *Clinostomoides* sp. showed the highest range of sites of infection, and the operculum carried significantly more worm burden (F = 196.843, d.f. = 5, p = 0.000) than other sites infected by this parasite. Prevalence ranged from 0.7% in *Clinostomum tilapiae* infection of *T. zillii* to 71.7% in *Neochinorhynchus* sp.2 infection of *Hepsetidae fasciatus* with an overall prevalence of 59.5%. Mean intensity ranged from 1.0 ± 0.0 in *Clinostomoides* sp. and *Proteocephalus* sp. infection of *P. obscura* and *Anemone occidentalis*, respectively, to 76.5 ± 29.7 in *Neoechinorhynchus* sp. 2 infection of *H. fasciatus. Neoechinorhynchus* sp. 2 infection also had the highest mean abundance (54.90 ± 2.74) while the lowest was recorded in the *Clinostomoides* sp. infection of *H. fasciatus*. Patterns of infection were significantly different in the prevalence and abundance of *Clinostomoides sp*; C*amallanus* sp.3 and *Neoechinorhynchus* sp.1 while mean intensity was comparable in all cases.

Key words: Natural lake, freshwater, fish parasites, worm burden.

INTRODUCTION

Fish has a remarkable impact on the lives of many individuals and communities in almost all continents of the world, primarily as a major source of relatively cheap and affordable essential animal protein. Fish interacts with the various levels of food chain and influence the structures of lakes, streams and estuaries since, they are usually restricted to particular modes of life related to their food sources and reproductive requirements (Ashade et al., 2013). The ever-increasing cost of beef leaves fish as the most feasible option in resolving protein shortage. Fish oil contains omega-3-essential fatty acids necessary for the proper functioning of the brain, heart and immune system (Hohn, 1999). It forms the main source of income for these communities, especially for the hinterland areas. Fishing and fish processing provide job opportunities for individuals and groups of people. Sport fishing is a major source of recreation.

The role of freshwater fish in transmitting parasites to humans had been known for a long time. Fish parasites and diseases remain some of the most important problems confronting the fishery biologist (Ravichandran

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et al., 2007). Fish may serve as parentenic/ intermediate or definitive hosts of parasites that are harmful to man and animals. Zoonotic diseases that result from the ingestion of raw or under cooked fish include opisthor-chiasis, diphyllobothriasis, clonorchiasis, gnathosomiasis and anisakiasis (Ko, 1995).

Fish production in Nigeria as other developing countries, is strengthened by the availability of extensive inland water systems made up of streams, rivers and lakes which support a large number of fish species, many of which are of economic importance. To fully develop and manage these diverse and rich fish resources in these inland water bodies, there is need for adequate knowledge of parasites that infect them with a view to adopting preventive and control measures to improve fish yield. This study therefore aimed to address the dearth of information on the parasitofauna of fish in many water bodies in Nigeria and other developing countries.

MATERIALS AND METHODS

The study area

Agulu lake is a natural lake found in Agulu, southeast Nigeria. The lake is located between latitude 6°07' and 6°09'N and longitude 7°01' and 7°03'E. The climate of the area shows two distinct seasons namely, rainy season (April - September/October) and dry season (October/November - March). The mean annual rainfall is 215 cm, while the water surface temperature ranges from 24 - 34°C. The vegetation is made up of riparian shrubs, sedges and grasses since the lake lies within the tropical rainforest region.

Collection of specimens

Various species and sizes of fish in the lake were collected with the aid of cast nets, beach sieve and gill nets with mesh sizes ranging from 25 - 75 mm (or (1" - 3") as well as local traps. The fish samples collected were immediately examined for ectoparasites with the help of hand lens and then transported to the Parasitology and Biomedical Research laboratory, University of Nigeria, Nsukka (UNN) in ice medium for further examination for parasites. As soft internal details of parasites are lost rapidly, often within minutes following the death of the host (Upton, 2003), the unused specimens were deep-frozen until they were needed for use. This ensured that all the fish specimens remained in good state till they were examined. The fish species were identified using the key of Olaosebikan and Raji (1998) as well as Leveque et al. (1992) and Teugels et al. (1992).

Sex determination

The sexes of the fish were determined using one or more of three methods or procedures: i) The abdomen of each fish specimen was pressed for the extrusion of whitish milt (for males) or eggs (for females). This approach was used if the fish was in ripe or running stage; ii) the fish was dissected for the presence or absence of testes or ovaries. Presence of testes signified maleness, while the presence of ovaries indicated that the fish was a female; iii) the gonads were excised and examined under the microscope for immature eggs or milt and conclusion made as in (i) above. However, where the sex was difficult to identify by these three methods, the fish was categorized as immature or juvenile.

Examination of fish for parasites

The external body surface (scales, gills, fins, opercula and eye) of freshly caught fish specimens were examined for ecto-parasites with the aid of a hand lens, microscope and the unaided eye. The ecto-parasites associated with gills, skin, scales, fins, etc, were collected by cutting these structures and placing them in a dish of 0.25% aqueous formalin (that is, 0.25 ml formalin and 99.75 ml distilled water) for 30 min. The mixture was shaken briskly to dislodge relaxed worms, and the particles in suspension were allowed to settle for 15-30 min. Using a dissecting microscope, the parasites were pipetted into alcohol-formalin-acetic acid (AFA) according to their taxonomic categories, fixed for 1 h and preserved in 70% alcohol (Upton, 2003). The gut was cut into oesophagus, stomach, small intestine, large intestine and rectum and examined for endo-parasites using clean implements to avoid transfer of parasites from one site to another. Special note was taken of any damage to tissues/organs of the host by recovered parasites. The sorted specimens were preserved in 4% formaldehyde.

Treatment, fixation and preservation of parasites

The treatment, fixation and preservation of parasites followed the procedure employed by Ash and Orihel (1991). Trematodes, cestodes and acanthocephalans were shaken in normal (physiological) saline to clear mucus and other host debris. The parasites were shaken in cold 4% formaldehyde until they died. They were then fixed in FAA (5% formal - 90% alcohol - 15% glacial acetic acid) for 2 h prior to staining. The parasites were stained in acetocarmine solution and mounted on permanent slides using Canada Balsam.

Live nematodes were killed by pouring steaming 70% alcohol on them in Petri dishes and preserved in cold 70% ethanol to which 2% glycerine had been added. Leeches and arthropods were cleared in lactophenol and fixed in 10% buffered formalin and 70% ethanol, respectively. Both the leeches and arthropods were preserved in 70% ethanol. Treatment of micro-parasites also followed the procedure of Ash and Orihel (1991). Blood smears and tissue smears from scrapings of the various organs were made on glass slides, allowed to air-dry, fixed in 95% methyl alcohol for 5 min, and stained in Giemsa for 20 min. Smears were examined at x400 under oil emersion.

Identification of parasites

The identification of parasites collected relied on (i) the comparison of distinctive body shapes and the morphological features of the collected specimen and those described in literature; (ii) a key to identification modified from Frimeth (1994) for identification of the major taxa of adult parasites of fish. After identification, the parasites were fixed, photographed/micro-photographed or preserved in 70% alcohol.

Statistical analysis

Parasites recovered were analyzed using the infection statistics of Bush et al. (1997). Comparative analysis of parasite prevalence, mean intensity and abundance with respect to sex, size, seasons and parasite habitat(s) were carried out using chi-squared test, student t-test, ANOVA, or correlations as the case may be.

RESULTS

Parasite spectrum of fish species examined

A total of 1191 fish specimen belonging to four families

Table 1. Parasite species composition, Prevalence, Mean intensity, Abundance and site of infection in Fish from Agulu Lake.

Parasite class	Parasite species	Host fish species	Site of infection	N. E	N. I.	P. L.	Prev. (%)	M.I.± SD	MA.± SD
Trematoda/ Digenea	*Clinostomoides* sp. (metacercariae)	*T. zillii*	Skin/fin/Opercula/ l. jaw	585	79	221	13.5	2.8.±3.13	0.38 ±1.49
		H. fasciatus	Skin / l.jaw	138	1	2	0.7	2.0.± 0.0	0.01 ± 0.17
		P. obscura	Int.body wall	2	1	1	50.0	1.0.± 0.0	0.50 ± 0.71
		P- Value					S	0.817 (NS)	O.000 (S)
		Sub-total		725	80	224	11.0	2.8 ± 3.10	0.19 ± 1.06
	Clinostomum tilapiae (metacerc.)	*T. zillii*	Gill	585	4	6	0.7	1.5.± 0.58	0.01± 0.13
		C. guntheri	Gill	58	1	2	1.7	2.0.± 0.0	0.03 ± 0.26
		P-Value					NS	0.495 (NS)	0.587 (NS)
		Sub-total		643	5	8	7.8	1.6±0.55	0.01 ± 0.11
	Clinostomum sp. (metacercariae)	*T. zillii*	Int. body wall	585	9	10	1.54	1.1.±0.33	0.02 ± 0.14
Cestoda	*Proteocephalus* sp.	*A. occidentalis*	Intestine	13	1	1	7.70	1.0 ± 0.0	0.08 ±0.28
Nematoda	*Camallanus* sp.1	*C. auratus*	Stomach	46	8	60	17.4	7.5 ± 6.41	1.30 ± 3.83
	Camallanus sp.2	*C. guntheri*	Intestine	58	1	4	1.7	4.0 ± 0.0	0.07± 0.53
	Camallanus sp.3	*C. auratus*	Intestine	46	4	13	8.70	3.3 ± 2.63	0.28 ± 1.15
		H. fasciatus	Intestine	138	95	833	68.8	8.8. ± 9.21	6.04 ± 8.65
		P-Value					S	0.237 (NS)	0.000 (S)
		Sub-total		184	99	846	53.8	8.5 ± 9.10	0.71 ± 3.52
	*Oxyuroid (*Adult*)*	*H. odoe*	Intestine	7	2	7	28.6	3.5 ± 3.54	1.00 ± 2.24
	Spironoura sp.	*T. zillii*	Intestine	585	14	16	2.39	1.1 ± 0.53	0.03 ± 0.19
Acanthocephalan	*Neoechinorhynchus* sp.1	*T. mariae*	Intestine	268	66	187	24.6	2.8 ± 2.57	0.70 ±1.76
		T. zillii	Intestine	585	315	1350	53.9	4.3. ± 4.98	2.31 ± 4.23
		T. guineensis	Intestine	74	10	24	13.5	2.4.± 1.35	0.32 ± 0.95
		P-Value					S	0.037 (S)	0.000 (S)
		Sub-total		927	391	1561	42.2	4.0 ± 4.63	1.31 ± 3.25
	Neoechinorhynchus sp.2	*H. fasciatus*	Duodenum	138	99	7572	71.7	76.5.± 29.72	54.87±2.74

NE, Number examined; NI, number infected; P.L, par; Prev, prevalence; S, significant; NS, not significant.

(*Cichlidae,Bagridae, Hepsetidae* and *Channidae*), seven genera and nine species were collected from the lake and examined for parasites. Eleven (11) species of parasites comprising metacercariae of three digenetic trematodes, one cestode, five nematodes and two acanthocephalans (Table 1). The trematodes were *Clinostomum tilapiae, Clinostomoides* sp. and *Clinostomum* sp., the cestode was *Proteocephalus* sp., the nematodes were *Camallanus* sp. 1, *Camallanus* sp. 2, *Camallanus* sp.3, *Oxyuroid* sp. and *Spironoura* sp. while the acanthocephalans were two species of *Neoechinorhynchus. Clinostomum tilapiae* was collected from the gills, *Clinostomum* sp. from the skin, fins, opercula, lower jaw and/or gills

Clinostomum sp. from the epithelial membrane, *Camallanus* sp. 2 and sp. 3, *Oxyuroid* sp., *Spironoura* sp., *Proteocephalus sp* and *Neoechinorhynchus* sp. from the intestine and *Camallanus* sp. 1 from the stomach. *Clinostomoides* sp. showed the highest (5) range of sites of infection, and the operculum carried significantly more worm burden (F = 196.843, d.f. = 5, p = 0.000) than other sites infected by this parasite.

In terms of host preferences all trematode species, a nematode species (*Spironoura sp*) and an acanthocephalan (*Neoechinorhynchus* sp. 1) were collected from *Tilapia spp* and at least one other fish species.

All the fish species were infected by at least one parasite species, *Tilapia zillii* being the most preferred host (habouring five different parasite species), and *Parachanna obscura Anemone occidentalis* and *Hepsetidae odoe*, the least, each habouring one parasite species. *Camallanus* species were distributed in different hosts, C*amallanus* sp. 1 parasitizing *Chrysichthys auratus, Camallanus* sp. 2 *Chromidotilapia guntheri* and *Camallanus* sp. 3 *C. auratus* and *Hemichromis fasciatus* (Table 1).

Table 1 also shows the summary of prevalence, mean intensity and abundance of each parasite in each of the nine fish species investigated. Prevalence ranged from 0.7% in *Clinostomm tilapiae* infection of *T. zillii* to 71.7% in *Neochinorhynchus* sp.2 infection of *H. fasciatus* with an overall prevalence of 59.5%. Mean intensity ranged from 1.0 ± 0.0 in *Clinostomoides* sp. and *Proteocephalus* sp. Infection of *P. obscura* and *A. occidentalis*, respectively to 76.5 ± 29.7 in *Neoechinorhynchus* sp. 2 infection of *H. fasciatus. Neoechinorhynchus* sp. 2 infection also had the highest mean abundance (54.90 ± 2.74) while the lowest was recorded in the *Clinostomoides* sp. infection of *H. fasciatus*. Patterns of infection was significantly different in the prevalence and abundance of *Clinostomoides sp*; C*amallanus* sp.3 and *Neoechinorhynchus* sp.1 while mean intensity was comparable in all cases.

Seasonal distribution of Infection

Table 2 presents the monthly distribution of different fish parasites. Out of the 11 parasites encountered, two (*Clinostomoides* sp. and *Neoechinorhynchus* sp.1) occurred in all the 12 months of study, while *Proteocephalus* sp. and *Camallanus* sp.2 occurred only in one month. The number of parasite species was least in June and July when only 3 parasites were encountered and highest in December and April when seven species were encountered.

Considering the four species that occurred in at least 10 months, prevalence and intensity of *Clinostomoides* sp. varied more considerably than others, rising and falling in a manner that depicts no clear seasonal trends. In contrast, those of *Camallanus* sp. 3 attained a peak in October, decreased to a minimum in December and rose gradually to a higher plateau from February till end of study in May. *Neoechinorhynchus* sp.1 and sp.2 maintained a near constant level from start till end of study while prevalence was at a higher level than intensity in *Neoechinorhy.*

Variation in infection according to host sex

Table 3 presents the distribution of infection patterns by sex of fish hosts namely males, females and in sexually immature fish. All parasites were recovered from male, female and sexually immature fish except *C. tilapiae* that did not occur in sexually immature fish. Generally, there was significant difference in prevalence among the sex groups for all parasite species. There was no significant difference in mean intensity and abundance of all parasites species except *Camallanus* sp.3 and *Neoechinorhynchus* sp.2 which showed significant difference in mean intensity (F = 3.896, d.f.= 2, P= 0.05) and abundance (F =3.214, d.f. =2, P=0.05), respectively, among the sex groups. In this group, the males were most abundantly infected (8.02 ± 25.80), followed by the females (6.65 ± 22.54) and the immature (2.62 ± 14.90) by *Neoechinorhynchus* sp.2 but, the females were more abundantly infected than the males and immature groups by *Camallanus* sp.3.

DISCUSSION

A recovery of eleven species of parasites from nine fish species collected from a relatively small natural lake is a clear indication of a high species diversity characteristic of productive lentic water bodies (Choudhury and Dick, 2000). However, the large number of parasite species and the heavy worm burden as expressed by mean intensity and abundance of some species (on the one hand) supports the hypothesis of high productivity in the lake while also showing the level of risk faced by fish species in the lake. Similar rich parasite species communities in tropical fresh waters have been described (Vidal-Martinez and Kennedy, 2000; Karvonen and Valtonen, 2004). Several of these studies suggest that such parasite burden in an ecosystem poses high risk of infection to both fish and man especially when fish serve as intermediate host of human parasites or where fish is a co- host of zoonotic parasites.

T. zillii was infected with the highest number of species (5) of parasites and sometimes *Clinostomum sp* and *Neoechinorhynchus* sp.1 infected one host and *Clinostomoides* sp. and *Neoechinorhynchus* sp.1 another. In line with the hypothesis of Wisniewski (1958) that parasites communities within an ecosystem are characterized by parasite of the numerically dominant host, this situation would be expected. Schmidt and

Table 2. Monthly distribution of Parasites of Fish in Agulu Lake, Nigeria.

Parasite	Month												
	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	TOTAL
Clinostomoides sp.	+17	+13	+5	+8	+13	+35	+13	+6	+29	+24	+10	+52	12(225)
Clinostomum tilapiae	+2	-	-	+1	-	-	+2	+3	-	-	-	-	4(8)
Clinostomum sp.	-	-		-	-	-	+3	-	-	-	+1	+6	3(10)
Proteocephalus sp.	-	-	-	-	-	+1	-	-	-	-	-	-	1(1)
*Camallanus sp*1	-	-	-	-	+10	-	-	-	+19	+25	+3	+3	5 (60)
*Camallanus sp*2	-	-	-	-	-	-	-	-	-	-	+4	-	1(4)
*Camallanus sp*3	-	+24	+17	+58	+29	+68	+64	+64	+69	+183	+148	+122	11(846)
Oxyuroid	-	-	-	-	+1	-	+6	-	-	-	-	-	2(7)
Spironoura sp.	-		+1	+1	-	+1	-	+2	+11	-	-	-	5(16)
*Neoechinorhynchus sp*1	+55	+70	+141	+77	+56	+138	+116	+85	+107	+227	+315	+174	12(1561)
*Neoechinorhynchus sp*2	-	-	+421	+(386)	+316	+390	+576	+1097	+1062	+1438	+492	+1394	10(7572)
Total	3(74)	3(107)	5(584)	6(531)	6(425)	6(633)	7(780)	6(1257)	6(1297)	5(1897)	7(973)	61751	66(10,309)

+, Present; -, absent.

Roberts (1989) explained that this situation probably arises because the degree of locating a host by any given parasite population increases with increasing numerical value of the host. The infection of *Tilapia mariae* (second most dominant host species) and *P. obscura* by only one parasite species however is incongruous with this hypothesis but may suggest a degree of resistance against parasitic infection. While the findings of this investigation have no concrete evidence to substantiate probable refraction by *T. mariae*, it is well established that this is a major factor that determines degree of host- parasite compatibility (Schmidt and Roberts, 1989).

The presence of *C.d metacercariae* on the gills, skin and opercula of the host have previously been reported (Khalil, 1971) but, its presence in the body cavity of *P. obscura* may be considered accidental. This is the first record of the parasite in the body cavity of *P. obscura* It may have been swallowed with the prey of this host as was suggested for *Posthodiplostomum minimum* in Bluegill (*Lepomis macrochirus)* (Steinauer and Font, 2003). *C. metacercariae* reported in this study has also been described (Oluorin and Somorin, 2006; Musa et al*;* 2007).

The dominance of nematode species in this study is in agreement with similar findings in River Ose in south western Nigeria. The higher incidence of *Camallanus* sp.3 in *H. fasciatus* than *Chrysiclthys auratus* could be explained in terms of dietary variations. *H. fasciatus* being largely piscivorous feed on smaller fish which are probable paratenic/transport host (Ekpo, 1982; Oribhabor and Ogbeibu, 2012) since copepods are the intermediate host for this parasite as against *C. auratus* which is omnivorous as this study reveals. Moreover, *H. fasciatus* are more common than *C. auratus* in the lake and have higher degree of being accessed by the parasite in line with Schmidt and Roberts (1989). The overall prevalence (59.53%) is relatively high. This is characteristic of lentic waters which restrict the fish hosts within its confines, thereby increasing the parasite-host contact and providing ideal conditions for increased rate of transmission. However, lower prevalence have been reported (Watson and Dick, 1979; Leong and Holmes, 1981; Ibiwoye et al., 1997) in similar water bodies. The overall mean intensity (14.54) and abundance (8.66) reflect the contribution of one species *(Neoechinorhynchus* sp. 2) which was concentrated in one site within one species.

The findings show that prevalence, mean intensity and abundance of 4 most frequent parasite species (*Clinostomoides sp, Camallanus sp*3 *Neoechinorhynchus sp*1 and *Neoechinorhynchus sp*2) were higher in drier months of November to April than wet months of May to October. Similar seasonal variations have been reported from (Ezenwaji and Ilozumba, 1992; Ibiwoye et al. 1997; Ibiwoye et al 2004). These reports explained that increasing transmis-

Table 3. Prevalence, Mean intensity and Abundance of Parasites of male, female and immature Fish from Agulu Lake, Nigeria.

Parasite species	Sex	N. E.	N.I.	P.L.	P (%)	M.I ±.SD	M.A. ±SD
Clinostomum tilapiae	M	551	3	6	0.5	2.0 ±0.0	0.01 ± 0.15
	F	366	2	2	0.5	1.0 ±0.0	0.01 ± 0.07
	I	274	0	0	0	0.0	0.0
P-value						-	0.383 (NS)
Total		1191	5	8	0.4	1.6 ±0.55	0.007 ± 0.11
Clinostomoides sp.	M	551	33	83	6.0	2.5 ±1.54	0.15 ± 0.70
	F	366	31	84	8.5	2.7 ±2.27	0.23 ± 1.00
	I	274	16	57	5.8	3.6 ±5.86	0.21 ± 1.61
P-value						0.535 (NS)	0.511 (NS)
Total		1191	80	224	6.7	2.8 ±3.10	0.19 ± 1.06
Clinostomum sp.	M	551	5	5	0.9	1.2 ±0.45	0.01 ± 0.12
	F	366	4	4	1.1	0.8 ±0.50	0.01 ± 0.09
	I	274	1	1	0.4	1.0 ±0.0	0.004 ± 0.06
P-value						0.410 (NS)	0.618 (NS)
Total		1191	10	10	0.8	1.0 ±0.47	0.008 ± 0.03
*Camallanus sp*1	M	551	3	21	0.5	7.0 ±6.93	0.04 ± 0.66
	F	366	3	14	0.5	4.7 ±4.04	0.04 ± 0.52
	I	274	2	25	0.7	12.5 ±9.19	0.09 ± 1.20
P-value						0.471 (NS)	0.619 (NS)
Total		1191	8	60	0.7	7.5 ±6.41	0.05 ± 0.79
*Camallanus sp*3	M	551	54	425	9.8	7.9 ±10.12	0.77 ± 3.92
	F	366	36	361	9.8	10.0 ±8.23	0.99 ± 3.93
	I	274	9	60	3.3	6.7 ±4.80	0.22 ± 1.45
P-value						0.446 (NS)	0.021 (S)
Total		1191	99	846	8.3	8.5 ±0.91	0.71 ± 3.52
Spironoura sp.	M	551	8	10	1.5	1.3 ±0.71	0.02 ± 0.17
	F	366	4	4	1.1	1.0 ±0.0	0.01 ± 0.10
	I	274	2	2	0.7	1.0 ±0.0	0.01 ± 0.09
P-value						0.721 (NS)	0.508 (NS)
Total		1191	14	16	1.2	1.1 ±0.53	0.01 ± 0.14
*Neoechinorhynchus sp*1	M	551	167	658	30.3	3.9 ±3.91	1.19 ± 2.81
	F	366	111	538	30.3	4.8 ±6.63	1.47 ± 4.27
	I	274	113	365	41.2	3.2 ±2.74	1.33 ± 2.37
P-value						0.032 (S)	0.456 (NS)
Total		1191	391	1561	32.8	4.0 ±4.63	1.31 ± 3.25
*Neoechinorhynchus sp*2	M	551	56	4419	10.2	78.9 ±31.02	8.02 ± 25.80
	F	366	34	2434	9.3	71.6 ±28.81	6.65 ± 22.54
	I	274	9	719	3.3	79.9 ±25.04	2.62 ± 14.90
P-value						0.498 (NS)	0.006 (S)
Total		1191	99	7572	8.3	76.5 ±29.72	6.36 ± 22.78

NE, Number examined; NI, number infected; P.L, par; M, male; F, female; I, immature; S, significant; NS, not significant.

sion is probably due to higher evapo-transpiration rate leading to reduced water volume, habitat contraction and higher host and parasite densities. Consequently, more contact is made between the host and the parasite and as has been explained, this is a major factor in parasite transmission.

In view of the above, we recommend constant surveillance of fish-borne parasites and their epidemiological distribution in developing countries such as Nigeria. This is more so because literacy level and awareness of basic

hygiene and methods of limiting the spread of these parasites are low. Fish parasites could be as a result of density of stocking, poor condition of farming, lack of proper husbandry and stress (Ashade et al., 2013; George, 2002).

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