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Endoparasitic Helminths of the Upside-Down Catfish, Synodontis Membranaceus (Geoffroy Saint Hilarie) in Jebba Lake, Nigeria

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Abstract: The endoparasitic helminths of the gastrointestinal tracts of mochokid upside-down catfish, *Synodontis membranaceus* (Geoffroy Saint Hilarie, 1809) caught from Jebba Lake, Nigeria with gill nets of various mesh sizes were examined for 24 months (April 2002-March 2004). Out of 1,208 fish specimens examined, 438 (36.25%) were infected with 1,321 helminth parasites, comprising two nematodes (*Procamallanus laevionchus* and *Cucullanus* species) and a cestode (*Polyonchobothrium* species). Parasite population data showed that nematodes had higher prevalence (27.81%) and mean intensity (03.29) than cestode (prevalence: 08.44%; mean intensity: 02.09). The prevalence of endoparasites was highest in the intestine, while the oesophagus recorded the lowest. Multiple infections and isolation of parasites from the liver and gall bladder are reported for the first time in *Synodontis* species. There was no significant difference ($p>0.05$) between the infestation of male and female specimens. However, the relationship between host size and parasite burden showed that fish below 20 cm SL were free from infection, while infection increased from 27.68% in fish between 20-27 cm SL to a significantly higher ($p<0.05$) value (67.61%) in fish above 27 cm SL. Infestation of endoparasites was more prevalent ($p<0.05$) in the dry season than in the rainy season. The implications of these results on the management and culture of *Synodontis membranaceus* are discussed.

Key words: *Synodontis membranaceus*, endoparasites, gastrointestinal tracts, Jebba Lake, Nigeria

INTRODUCTION

The mochokid upside-down catfish, *Synodontis membranaceus* is endemic to Africa (Teugels, 1996) and it is one of the most important commercial fish species in the artisanal fisheries of Jebba Lake. It is very common throughout the year and fishermen seek *S. membranaceus* because among other *Synodontis* species, it attains the biggest size and therefore attract a relatively higher price either fresh or smoke-dried. *S. membranaceus* are potentially suitable for culture (Owolabi, 2005) but up to now, no information exists on their culture. However, they are popular aquarium species (Otubusin, 1986; Teugels, 1996) as they exhibit the habit of swimming up side down. Ecological field studies on the biology and management of *S. membranaceus* have been carried out, but mainly restricted to feeding and reproduction in River Nile at Khartoum (Bishai and Abu-Gideiri, 1965), sex ratio and fecundity in River Niger, Nigeria prior impoundment (Imevbore, 1970), orientation and swimming (Willoughby, 1974) and other aspects of the biology of the fish in Jebba Lake (Owolabi, 2005). Much information exists on the parasites of tropical freshwater fish species; however, studies on the parasitofauna of *S. membranaceus* in tropical freshwater systems are scanty. Woodland (1923) reported the incidence of a cestode, *Wenyonia acumunata* in *S. membranaceus* from River Nile in Sudan, while in Imo River Nigeria. Although, Auta *et al.* (1999) reported four endoparasitic helminths comprising *Procamallanus*, *Proteocephalus*, *Heterakis* and *Wenyonia* species in the gastrointestinal tracts of some species of *Synodontis* in Zaria dam, Nigeria, this did not include that of

S. membranaceus. However, relatively few other workers have documented information on the parasitofauna of other relatives of *S. membranaceus*. Moravec and Rehulka (1987) observed a cosmocercid nematode, *Railletnema synodontisi* in the intestine of *S. eupterus* in aquarium, while Araoye (2005) reported the incidence of philometrid nematode in the alimentary tract of *S. schall* from Asa Lake, Ilorin, Nigeria. Helminthofauna infections in fish have been reported to have marked relationship with sex (Ezenwaji and Ilozumba, 1992; Saliu, 1998; Auta *et al*., 1999; Araoye, 2005) and size (Diamant, 1989; Oniye and Aken'Ova, 2002; Oniye *et al*., 2002) of the host. Equally important factor that influence the dynamic of parasitic infection in fish is season (Shotter, 1977; Geets and Ollevier, 1996; Oniye and Aken'Ova, 2002; Araoye, 2005). The influence of size, sex and season on the parasitic infection in the species is yet to be documented, hence stalling a better understanding of the population biology of the parasite and its host in Jebba Lake.

Fish parasites are important because they affect fish production particularly under culture systems, by decreasing their yield, aesthetic value, marketability, palatability and reproductive potential (Ibrahim *et al*., 2001; Oniye *et al*., 2004) and if left uncurtailed, may lead to mass mortality of fish, or in some cases, infection of man and other animals that feed on fish. They are therefore studied with a view to understanding their population biology and elucidate their life cycles in order to develop an efficient approach of controlling them. In view of the commercial importance of *S. membranaceus* and its aquacultural potential, the study of its parasites under natural conditions become imperative as it will not ouly enhance the sustenance of the fish in Jebba lake; but also forms the basis for information on the potential risk of diseases and pathogens expected during the aquacultural development of the species. This is more so as there are no hatchery bred *Synodontis* species in Nigeria (Owolabi, 2005) and parent brood stocks, like most cultivated species in Africa, would have to be collected from the wild; in order to develop artificial breeding programme for the species.

This study is therefore aimed at providing information on the helminth parasites of this species and to determine the effects of size, sex and season on the parasitic helminths of the species in Jebba Lake, Nigeria.

MATERIALS AND METHODS

Jebba Lake (9° 10' to 9° 55' N and 4° 30' to 5° 00' E) was formed in August 1983 as an impoundment in the valley of River Niger. It extended from the dam-site at Jebba to southern tip of Kainji dam. The lake is therefore unique as the first and the only man-made lake in Nigeria that has a direct inflow from another man-made lake located upstream to it. It is bounded by Kwara State on the west and Niger State on the east. The lake has a surface area of 303×10^6 m^2, length of 100 km, maximum depth of 33.0; maximum width of 10.0 km and maximum volume of $1,000\times10^6$ m^3 (Adeniji, 1991). One sampling station each was selected from each of the three zones (basins) i.e., Dam-site from the Southern basin (maximum depth: 23.0 m), Old Gbajibo from middle basin (maximum depth: 27.0 m) and Faku from the Northern basin (maximum depth: 33.0 m).

Specimens of *S. membranaceus* (n = 1,208) were caught bi-monthly for a 24 month period (April 2002-March 2004) using gill nets of various mesh sizes ranging from 5.08 to 10.16 cm. The specimens were identified using the meristic features provided by Willoughby (1974). The total length, standard length and body weight were measured using standard procedure described by King (1996). The sex was determined by examination of genital pore and dissection to expose the gonads. For the survey of parasites, fish organs were dissected and each section of the digestive tracts (mouth, oesophagus, stomach, intestine and rectum) were removed and kept separately in petridishes containing normal physiological saline. Each organ was then slit longitudinally and examined under a dissecting microscope for parasites. The liver, gonads and muscle were also examined. Parasites

obtained were counted, placed in physiological saline overnight in the refrigerator to enable them to stretch and relax, after which they were fixed in 5% formalin for preservation (Oniye *et al*., 2004). Parasites were identified using the identification keys provided by Yamaguti (1959, 1961), Soulsby (1982), Williams and Jones (1994) and Paperna (1996). Some of the preserved parasites were sent to fish parasitology laboratory, Department of Biological Sciences, Ahmadu Bello University, Zaria and aquatic pathobiology laboratory, National Institute for Freshwater Fisheries Research (NIFFR), Kainji, Nigeria for confirmation. Terminology of infection statistics (prevalence and mean intensity) as described by Bush *et al*. (1997) was employed in the analysis of parasite data. Each specimen was grouped into different size categories based on the number of growth rings examined on the opercula bones (Owolabi, 2005). The data were analysed using Z and Chi-square statistics, with H_0: $p = 0.05$ to examine the relationship existing, if any, between parasite burden and each of seasons, sex and size of host.

RESULTS

Of the 1,208 fish specimens examined, 438 (36.25%) were infected with 1,321 helminth parasites, comprising two nematodes (*Procamallanus laevionchus* and *Cucullanus* species) and a cestode (*Polyonchobothrium* species). The overall prevalence of infection (Table 1) showed that nematodes (27.81%) were common than cestodes (8.44%) with *P. laevionchus* being the most common. Table 2 shows that *P. laevionchus* parasitised the liver, stomach, intestine and the rectum. *Cucullanus* species occurred in the intestine, rectum and muscle while *Polyonchobothrium* species was found in the oesophagus, liver, intestine and gall bladder. The prevalence of endoparasites was highest in the intestine (19.37%) and accounted for 56.62% of the total number of parasites recovered from the 438 infected specimens. This was followed by rectum (8.61%) constituting 27.55% of parasites recovered, while the lowest occurred in the oesophagus (0.58%) and accounted for 1.21% of total

Table 1: Parasite spectrum, their overall prevalence and mean intensity in *S. membranaceus* (n = 1,208) from Jebba Lake, Nigeria

Taxa	Parasite species	No. of fish infected	Total No. of parasites recovered	Prevalence* (%)	Mean** intensity
Nematoda	*Procamallanus laevionchus*	192	612	15.89	3.19
	Cncullanus species	144	496	11.92	3.44
	Total	336	1108	27.81	3.29
	Cestoda *Polyonchobothrium* species	102	213	8.44	2.09
	Overall total	438	1321	36.25	3.02

*No. of host infected divided by number examined expressed as percentage, **Mean number of parasites per infected host

Table 2: Parasite and mean intensity of helminth parasites in relation to sites of infection in *S. membranaceus* (n = 1,208) from Jebba Lake, Nigeria

Taxa	Site of infection	No. of fish infected	Total No. of parasites recovered	Prevalence** (%)	Mean*** intensity
Procamallanus laevionchus	Liver	5	12 (0.91)*	0.41	2.40
	Stomach	28	64 (4.85)	2.32	2.29
	Intestine	105	365 (27.63)	8.69	3.48
	Rectum	54	171 (12.94)	4.47	3.17
Cncullanus species	Intestine	80	266 (20.14)	6.62	3.32
	Rectum	50	193 (14.61)	4.14	3.86
	Muscle	14	37 (2.80)	1.16	2.64
Polyonchobothrium species	Oesophagus	7	16 (1.21)	0.58	2.29
	Liver	9	20 (1.51)	0.75	2.22
	Intestine	49	117 (8.86)	4.06	2.39
	Gall bladder	37	60 (4.45)	3.06	1.62

*No. of parasites recovered from each site divided by the total number of parasites recovered from all sites expressed as percentage, **No. of host infected divided by number examined expressed as percentage, ***Mean number of parasites per infected host

Table 3: Sites simultaneously infected by helminth parasites in *S. membranaceus* from Jebba Lake, Nigeria

Parasite species	Simultaneously infected sites	No. of fish infected	No. of observation	Simultaneously infected (%)
Procamallanus laevionchus	Liver, stomach and intestine	4	192	2.08
	Stomach and rectum	2	192	1.04
Cncullanus species	Intestine and rectum	6	144	4.17
	Intestine and muscle	2	144	1.39
	Liver and intestine	3	102	2.94
Polyonchobothrium	Liver and species gall bladder	1	102	0.98

Table 4: Sexual variation in the prevalence and mean intensity of endoparasitic helminth infection in *S. membranaceus* from Jebba Lake, Nigeria

Sex	No. of fish examined	No. of fish infected	Total No. of parasites recovered	Prevalence (%)	Mean intensity
Male	601	218	653	36.27	2.99
Female	607	220	668	36.24	3.04

Z = 0.0108, p>0.05

Table 5: Size variation in the prevalence and mean intensity of endoparasitic helminth infection in *S. membranaceus* from Jebba Lake, Nigeria

Size group (SL, cm)*	No. of fish examined	No. of fish infected	Total No. of parasites recovered	Prevalence (%)	Mean intensity
12-19	221	0	0	0.00	0.00
20-27	542	150	268	27.68	1.79
28-35	374	240	873	64.17	3.64
36-43	71	48	180	67.61	3.75

*SL: Standard length, χ^2: 341.547, p<0.05

Table 6: Seasonal variation in the prevalence and mean intensity of endoparasitic helminth infection in *S. membranaceus* from Jebba Lake, Nigeria

Season	No. of fish examined	No. of fish infected	Total No. of parasites recovered	Prevalence (%)	Mean intensity
Rainy (April-October)	808	257	578	31.81	2.25
Dry (Nov.-March)	400	181	743	45.25	4.11

Z = -4.4701, p<0.05

parasites recovered. The Table 2 also shows that the rectum had the highest mean intensity (3.50) with the intestine ranking second (3.19) and muscle ranking third (2.64). The oesophagus, liver and stomach had a mean intensity of 2.29 each while the lowest intensity (1.62) was recorded in the gall bladder.

The intestine and the rectum were simultaneously more infected by nematodes than any other combination of sites; while simultaneous infection by cestodes was more in liver and intestine (Table 3). However, eight cases of mixed infections were observed, with three each occurring between *P. laevionchus* and *Cucullanus* species and *P. laevionchus* and *Polyonchobothrium* species; while two cases occurred between *Cucullanus* species and *Polyonchobothrium* species. There was no significant difference (p>0.05) in the degree of mixed infections. Higher prevalence of infection (36.27%) and lower mean intensity (2.99) were recorded in male fish than in the female (36.24 and 3.04%, respectively). Statistical analysis, however, revealed lack of significant difference (Z = 0.0108, p>0.05) in the prevalence and intensity of infection (Table 4). Table 5 shows that size of fish had remarkable relationship with susceptibility to helminth parasite infection. Fish with standard length (SL) ranging from 36-43 cm had the highest prevalence (67.61%) and mean intensity (3.75) and this was closely followed by fish in the length range 28-35 cm SL; while those in 20-27 cm SL had the least prevalence (27.68%) and mean intensity (3.64). Parasites were not recovered from fish between 12 and 19 cm SL. The prevalence of the parasites and their mean intensity were significantly higher (Z = -4.4701, p<0.05) in the dry season (April-October) than in the rainy season (November-March) (Table 6).

DISCUSSION

The overall incidence of the helminth parasites (36.25%) was generally low compared with 85.2% recorded in wild populations of related *Synodontis* species in Zaria dam (Auta *et al*., 1999). This may be due to ecological differences between the habitats. Williams and Jones (1994) opined that parasitism varies from one aquatic ecosystem to the other and this is influenced by the interplay of mixed biotic and abiotic factors. Fish species in good environmental conditions are rarely susceptible to the attack of fish diseases (Oswald and Hulse, 1992). The good condition of *S. membranaceus* in Jebba Lake as reflected by their high condition factor (Owolabi, 2005) could have probably be responsible for the low incidence of parasitic infection. The higher prevalence of nematodes (27.81%) than cestodes (8.44%) showed that nematodes were the commonest infection of this species in Jebba Lake. Stomach contents analysis revealed that insects (adult and larvae), worms, crustaceans (copepods), gastropods and detritus formed part of the diet of *S. membranaceus* in Jebba Lake (Owolabi, 2005). Any of these dietary items could have served as intermediate hosts of various parasites since the life cycle of nematodes in freshwater fishes involves invertebrate hosts especially crustaceans and aquatic insects. Paperna (1996) implicated worms and copepods as invertebrate intermediate hosts of several species of nematodes and cestodes. However, it is evident from the total nnmber of nematodes recovered that its intermediate hosts seemed to be more common in the environment, thus justifying the higher prevalence of nematode infection. Auta *et al*. (1999) made a similar observation in the population of *Synodontis* species from Zaria dam, Nigeria. Although, *P. laevionchus* had the highest prevalence rate with *Cucullanus* species ranking second, the mean nnmber of parasites per host was higher for *Cucullanus* species; indicating that, though greater nnmber of *P. laevionchus* was recovered it parasitized relatively smaller nnmber of hosts than *Cucullanus* species.

The three helminth parasites observed in this study have been reported infesting feral mochokid catfishes in Nigerian iuland waters and other water bodies in Africa (Ukoli, 1969; Onyia, 1970). These parasites were either found to be parasitic in the stomach, intestine or rectum of their hosts. This, therefore, appears to be the first report of the isolation of parasites from the liver and gall bladder of *Synodontis* species. The highest prevalence and mean intensity of parasites in the intestine and rectum respectively imply that these microhabitats are more preferred. This could be due to the favourable condition and the attendant abundance of food (nutrients) supply in these sites, from which the parasites stand to profit, thus enhancing their survival. Nematodes are generally equipped with alimentary canal and could freely roam around any area of the canal to graze on digested or semi-digested food. Somerville (1963 fide Holmes, 1973) stated that each species of nematode tend to be located about the region of greatest food abundance as a normal frequency distribution. In cestodes, on the other hand, the lack of alimentary system and the obligatory dependence on end products of food digestion of the host usually absorbed through the body surfaces; could probably account for their preference for the intestine. The diffusion of glucose from the liver, since it is known for glucose metabolism, may have attracted parasites to this organ. Therefore, migration of parasites with food could be a possible explanation for their presence in any organ of their host.

The endoparasites encountered in *S. membranaceus* from Jebba Lake and their related species have been implicated as causative agents of various debilities in several fish species in tropical freshwaters. *Polyonchobothrium clariae*, a cestode, has been reported to cause inflammation of gut mucosa and the penetration of its bothrinm into the gall bladder initiates the formation of nodules in its hosts (Paperna, 1996). Injuries associated with points of attachment of these endoparasites may also serve as entry points for secondary infection with opportunistic bacteria and fungi, thereby compromising the health status of their hosts. Rohde (1984) asserted that mass infection of parasites could negatively influence the host condition and growth. In terms of management therefore, these

endoparasites are very important as their presence in the muscle may result in skin undulation leading to consumer resistance against the fish. Heavy infection of the liver may lead to breakdown of metabolic activities, thereby weakening the fish and ultimately resulting in mortality. The lack of significant difference in the prevalence and mean intensity of infection in both male and female *S. membranaceus* (Table 4) suggests that both sexes were equally susceptible to infection by helminth parasites irrespective of the physiological differences that may exist between the sexes. Owolabi (2005, 2007) observed that though the relative importance of dietary composition of both sexes varied, the qualitative composition of the diets was similar. This may have been responsible for the equal exposure of both sexes to the same level of risk of acquiring the infection while feeding. Auta *et al.* (1999) and Araoye (2005) made similar observation in the infection of *Synodontis* species by endoparasitic helminths.

The significantly higher prevalence and intensity of infection in the larger fish specimens (Table 5) suggests that as the fish grow, the parasite load increased probably due to the change in the fish's dietary habit with size. Owolabi (2005, 2007) had earlier reported that *S. membranaceus* switched from detritivorous (filter) mode of feeding in the juveniles (12-19 cm SL) to active reliance or predation on bigger-sized food organisms such as copepods, insects and gastropods, which constituted the most important diet for fish in the intermediate size (20-27 cm SL), sub-adult (28-35 cm SL) and adult (36-43 cm SL), respectively. These food items consumed by each size group (above 19 cm SL) may have contained infective larval stages of the endoparasites. The lack of infective larval stages of the parasites in diets of the juveniles (12-19 cm SL) may explain why they were not infected. These observations conform to those reported in *Siganus* species (Amin, 1985; Diamant, 1989) and *Hyperopisus bebe occidentalis* (Oniye and Aken'Ova, 2002; Oniye *et al.*, 2002). However, the observation contradicts those reported in other relatives of *S. membranaceus* from Zaria dam (Auta *et al.*, 1999), where size did not have marked influence on the degree to which fish were infected and from Asa Lake, Ilorin (Araoye, 2005) where infestation was significantly higher ($p<0.05$) in smaller fish specimens than in the larger ones. The higher feeding activity of *S. membranaceus* noticed in the dry season in a bid to building more fat stores in preparation for breeding in the raining (wet) season (Owolabi, 2005, 2007) may have accounted for the high prevalence and intensity of parasitic infection in the dry season than in the rains. These seasonal changes in intensity and infestation pattern of the helminth parasites may also be associated directly with the reduction in water level of the lake noticed during the dry season (Owolabi, 2005), thus enhancing much higher contact between the host and infective stages of the parasites than in the rainy season. The intensity and prevalence of parasites in tropical fish population in relation to season have been reported by Shotter (1977), Oniye and Aken'Ova (2002), Oniye *et al.* (2002) and Araoye (2005). Although, multiple infections with helminth parasites has not been reported in any *Synodontis* species occurring in Nigerian iuland waters, the one observed in this study is not strange as such phenomenon has been observed in other shell and fin fishes in Nigeria (Ezenwaji and Ilozumba, 1992; Sowemimo and Asaolu, 2004).

Although, no apparent pathological effect was observed on the fish, the generally low incidence of helminth infection is however enough to cause a serious havoc with far reaching consequences in any culture systems; where high biomass of fish species over a limiting space enhances a closer contact between the parasites and the host. Until there are hatchery bred *Synodontis* species in Nigeria, which hitherto are unavailable, the aquaculture development of the species may have to depend on the collection of fingerlings and or parent broodstocks from the wild. Therefore care must be taken in stocking any culture system with stocks from the wild during the dry season. The incorporation of antihelminthic therapy into the diets of *S. membranaceus* as suggested for other siluriforms (catfishes) such as *Clarias gariepinus* (Oniye *et al.*, 2004) may prevent infestation, thus providing a better aquaculture condition and proffered solutions to some of the problems of fish farmers.

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