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Survey of parasitic fauna of some fishes from Osun river, Osun state, southwestern, Nigeria

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Abstract

This study survey the parasitic fauna of some fishes collected from Osun river, Osun State Southwestern Nigeria with aims of evaluating the prevalence, intensity, pattern and distribution of parasites among the collected fishes. A total of 258 fish specimens consisting of 9 species belonging to 7 families were procured by fishermen between March and August, 2021 with the use of cast net. Fish samples were examined, dissected and parasites were removed, identified and counted by employing standard techniques in parasitology. A total of 49 out of 258 collected fishes were infected with ten different parasites with an overall prevalence of 22.9%. The recovered parasites include four cestodes (30%), two digenetic trematode (23.23%), one monogenean, (1.01%), one acanthocephalan (8.08%), one secernetean (32.32%) and one nematode (5.05%). Generally, parasitic prevalence was not size dependent and the female fishes were observed to be more parasitized than male ($p>0.05$). The mean intensity and abundance of parasites were higher in the stomach and intestine than the gills. Fish parasitism is one of the major problems facing fish production and could be sustained with high degree of pollution as indicated in this study. Hence pollution control and regular examination of the water bodies should be advocated to prevent low fish performance and production.

Keywords: Osun river, prevalence, intensity, Osun state

Introduction

More than a billion of people around the world depend primarily on fish as their ultimate source of animal protein especially in low-income food deficit countries like Africa, and in coastal and riverine areas (Adou *et al.*, 2017) [2]. The demand for the fish and fishery products however become increasing not only because of its affordability as source of animal protein but also because of its numerous health benefits (Tammy, 2002; Wang and Lu, 2015; Adou *et al.*, 2017) [2, 61, 67]. Several factors over time have contributed to the decrease in quality and quantity of fish and fishery products in the wild around the globe. One of the factors which have become a menace is the pollution. Aquatic degradation which daily increase as a result of pollution arising from effluent discharges in agricultural practices or farm lands, industries, sewages and run offs from construction and mining activities has not only negatively impacted freshwater qualities but has also physiologically impair aquatic biota and their community structure respectively (Yusuf *et al.*, 2017; Fakolujo *et al.*, 2018; Akinkuolie *et al.* 2021; Akinbadewa *et al.*, 2021) [68, 18, 4, 3]. Aquatic organism especially fish has been extensively used as bio-indicator in pollution studies due to their bioaccumulation potentials (Goater *et al.*, 2013; Le *et al.*, 2014; Sures *et al.*, 2017; Olofinko *et al.*, 2018) [21, 59, 42]. Effects of these various pollutants on fishes have also been well documented in literatures (Ashauer, *et al.*, 2013; Rosi-marshall *et al.*, 2015; Schnigger *et al.*, 2016; Saaristo *et al.*, 2018; Sundin *et al.*, 2019; Wang *et al.*, 2020; Hader *et al.*, 2021) [8, 53, 67, 54, 58]. Most of these effects result in the breaking down of the fish immune system which allows for the proliferation of their body system by parasites. Fish parasitization depending on the intensity level may cause disease, severe pathological alterations in visceral organs, poor fish quality, reduced growth, poor spawning and eventually mortality a factor for serious economic loss in fisheries

(Amaechi, 2014; Gophen, 2016; Atalabi *et al.*, 2018) [6, 23, 9]. Several studies on parasites of freshwater fishes have been documented across the globe (Ohaeri 2012; Keremah and Inko-Teriah, 2013; Baidoo *et al.*, 2015; Adou *et al.*, 2017; Sures *et al.*, 2017; Atalabi *et al.*, 2018; Akinsanya *et al.*, 2020; Nur *et al.*, 2020) [2, 59, 9, 40, 29, 11, 5, 38]. Osun River is one of the major rivers in Southwestern, Nigeria. Fishing activities across this river due to increasing fish demands and other health benefits is actively persistent. However, the river is currently experiencing heavy pollution as a result of gold mining activities across the state. This pollution is evident in the persistent turbidity of the water body over the past five years which was not the case prior. This study therefore assessed the prevalence, intensity, pattern and distribution of parasites in fishes from Osun River as a result of continuous pollution of the water body.

Materials and Methods

Study Area

A portion of Osun River around Owode-Osogbo located in Osun State, Nigeria was used for this study. The River which has its source from Igede-Ekiti flows its main course about 270 km southwards through Osun state and Central Yorubaland in South Western Nigeria into the Lagos Lagoon and the Atlantic Gulf of Guinea where its mouth (Anifowose and Oyeboade, 2019) [7]. The study area is characterized with fisheries, and various agricultural and commercial activities. Activities of artisanal miners which utilize the river upstream for the washing of their mining equipment, as well as those of the gold ores through a process known as panning was also observed.

3.2 Fish Specimen Collection

Fish specimens were collected monthly from the study area with the help of a fisherman using cast netting method for 6 months between March and August, 2021. The collected fishes were transported in an ice-chest from the study area to the Parasitology Laboratory, Department of Zoology, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. In the laboratory, the fishes were identified using Identification keys prepared by Adesulu and Sydenham (2007) [1] and Paugy *et al.* (2003 and 2009) [1]. The morphometric of the fish specimens were documented and examination and identification of parasites followed.

Fish Parasites Examination and Identification

The fish specimens were observed for both ecto and endo parasitic infections according to the method of Onana and Asaolu (2018) [43]. The external body surfaces such as scales, gills, fins body and mouth of each the fish specimens were examined for the presence of ectoparasites with the use of hand lens. The ectoparasites which firmly attached to the gills and scales were dislodged using forceps and a pair of scissors in a petri-dish containing 0.9% physiological saline. The different helminths recovered were counted and transferred to a labeled bottle with the Fish ID number and fixed for one hour in formaldehyde. The recovered parasites were later preserved in Teflon tube containing 70% alcohol. The fish were dissected ventrally in longitudinal manner enabling the sex determination of the fish through sexual feature observation. The gut of the fish was then cut into stomach and intestine and was placed in a separate petri dish containing 0.9% saline where both were slit open and the contents expressed into the saline solution. Each organ was then

examined under a dissecting microscope on a black surface background so as to make the parasites more visible. The recovered helminths from the stomach and intestine of the examined fishes were transferred from saline to acetic acid in a clean petri dish to get them stretched and were then preserved in 70% ethanol in separate specimen bottles. All the recovered parasites were counted and recorded. Permanent whole mounts of the recovered parasites were prepared on clean glass slide. The digenean trematode larvae recovered were stained in delafield's Haematoxyl in, counter stained in Eosin and mounted on glass slides using Canada balsam (Palm, 2004) [47]. Nematodes recovered were removed from 70% alcohol, cleared in lactophenol without staining and edges of the slips were sealed with glycerol (Onana and Asaolu, 2018) [43]. The cestodes parasites were stained with acetic carmine, dehydrated in alcohol cleared with eugenol and mounted in Canada balsam (Palm, 2004) [47]. Acanthocephala recovered were transferred to a petri dish containing distilled water until the proboscis everted prior to fixation. The parasite was then dehydrated in a graduated ethanol series and transferred to 100% glycerine according to Reiman (1988). The helminths were identified to species level using identification guides prepared by Paperna (1996) [48], and Pariselle and Euzet, (2009) [49].

Data Analyses

Standard parasitological parameters determined were prevalence, intensity and mean intensity according to Bush *et al.* (1997) [15]. The prevalence and mean intensity of infection with respect to the sex, size and alimentary system of the fish was determined using chi-square with statistical significance determined at $P < 0.05$. Shannon-Weiner diversity index and Evenness index were used to determine the diversity of the parasite species.

Results

Fish Composition and Parasitic Prevalence

Two hundred and fifty-eight (258) fish specimens consisting of nine (9) species belonging to seven (7) families: Alestidae, Cyprinidae, Hepsetidae, Mormyridae, Cichlidae, Claridae and Channidae were collected from the study area (Table 1). Forty nine of the collected fishes were infected with a total load of ninety-nine parasites. Ten parasitic species were found to infect nine (9) fish species from the study area. *Barbus bynni occidentalis*, *Labeo parvus*, and *Parachanna obscura* were each infected with one parasite while the other fishes were infected with two or more parasite species (Table 1). Among the fishes, *Mormyrus rume* had the highest parasitic prevalence of 42.85% while the least parasitic prevalence (10.24%) was recorded in *Brycinus macrolepidotus* (Table 1).

Recovered Fish Parasites Checklist

Ten different parasites which belong to the class: Cestoda, Trematoda, Monogenea, Acanthocephala, Secernatea and Nematoda were recovered from the infected fishes (Table 2). The parasites include, four cestodes, two digenetic trematode, one monogenean, one acanthocephalan, one secernetean, and one nematode (Table 2). All the infected fishes were infected with one or more parasites. *Procamallanus laeviconchus* and *Clinostomum tilapiae* were the parasites that heavily parasitized the fish specimens with 32 and 15 loads of parasite respectively, whereas, *Gyrodactylus* Spp had the least load (1) of infection (Table 2). Four (4) fish species were infected by *Procamallanus laeviconchus* and was closely followed by

Clinostomum tilapiae which infected three (3) fish species (Table 2).

Prevalence and Mean Intensity of Parasite Infection

As shown in table 3, the prevalence and mean intensity of parasite infection analyses among the examined fishes revealed that generally, *Barbus bynni occidentalis* infected by *Procamallanus laeiviconchus* had the highest prevalence (30.77%) closely followed by *Momyrus rume* infected by *Spinitectus mormyri* with a prevalence of 28.57%. *Brycinus macrolepidotus* infected by *Polyonchobothrium clarias* had the least parasitic prevalence (3.15%). However, the overall prevalence analysis showed that *Brycinus macrolepidotus* infected by *Polyonchobothrium clarias* had the highest overall parasitic prevalence (3.88%). Highest mean intensity were recorded in *M. rume* (3.0 ± 1.15), *Hepsetus odoe* (3.0 ± 1.71), and *Clarias gariepinus* (3.0 ± 0.56) which were respectively infected with *Procamallanus laeiviconchus*, *Lytocestus marcuseni* and *Clinostomum tilapiae*.

Prevalence and Intensity of Infection in Relation to the Size of the Fish in the Study Area

The prevalence of parasitic infection among the different fish host grouped into 3 different size ranges as shown in table 4 revealed that the highest prevalence of parasitic infection (100%) among the 11-20 cm size group was recorded among specimens of *M. rume* infected by *Gyrodactylus* sp. and *Spinitectus mormyrii* while the lowest prevalence (12%) was reported among the specimens of *Brycinus macrolepidotus* infected by *Procamallanus laeiviconchus*. Among the 21-30 cm size groupings, specimens of *Clarias gariepinus* infected by *Ligula intestinalis* had the highest parasitic prevalence of 50% while specimens of *Brycinus macrolepidotus* infected by *Procamallanus laeiviconchus* and *Polyonchobothrium clarias* has the least parasitic prevalence of 11.32%. *Sarotherodon galilaeus* infected with *Clinotomum tilapiae* had the highest prevalence (100%) among the 31 – 40 cm size group, while the least prevalence (8.16%) was observed among the specimens of *Brycinus macrolepidotus* infected by *Polyonchobothrium clarias*. There were no significant difference ($p > 0.05$) in the prevalence of fish parasitic infection across the different size group of the fish host ($P = 0.999$; $F = 3.402$).

Mean intensity of parasitic infection calculated by fish host is shown in table 4. In the 11 – 20 cm size, the mean intensity of parasitic infection was recorded among the specimens of *Parachanna obscura* and *Brycinus macrolepidotus* infected with *Ligula intestinalis* and *Procamallanus laeiviconchus* respectively while the specimens of *Barbus bynni occidentalis* infected with *procamallanus laeiviconchus* had the least mean of intensity (0.5). Members of the family Cichlidae (*Oreochromis niloticus* and *Sarotherodon galilaeus*) infected with *Euclinostomum heterostomum* and *Acanthogyrus tilapiae* respectively were observed to have the highest (4) and the least (0.33) mean intensity of parasitic infection among the 21 – 30 cm size group. The parasitic infection mean intensity among the 31 – 40 size group was highest in the specimens of *Momyrus rume* infected with *Procamallanus laeiviconchus* while specimens of *Clarias gariepinus* infected with *Proteocephalus* sp had the least mean intensity of parasitic infection (0.25).

Sexual variation in the intensity and prevalence of fish parasite in different fish species

Generally, among the different fish species, females were more infected with parasites than the males (Table 5). However, in order of prevalence, male specimens of *Momyrus rume* had the highest prevalence of parasitic infection (60%) closely followed by female specimens of *Sarotherodon galilaeus* (Table 5). The least prevalence of parasitic infection by sex was observed among the female specimens of *Parachanna obscura* (0.33%). There was no significant difference in the prevalence of the parasitic infection in relation to the sex of the fish species (Table 5).

Prevalence of Infection in Relation to Site of Parasite Infestation on the Fish

The parasites were recovered from three major sites (gills, stomach and intestine) in the fishes examined (Table 6). Generally higher numbers of parasite (77.78 %) were recovered from the alimentary tract (stomach (50) and intestine (27)) of the examined fishes. In the gills, the prevalence analysis showed that *Oreochromis niloticus* infected with *Euclinostomum heterostomum* had the highest prevalence of infection (18.18%) while the gills of *Sarotherodon galilaeus* infected with *Clinostomum tilapiae* had the least prevalence (7.69%) (Table 6). Out of the three parasites that were recovered from the stomach, *Polyonchobothrium clarias* had the highest prevalence (30.77%) in *Barbus bynni occidentalis* and the lowest prevalence (3.15%) in *Brycinus macrolepidotus* (Table 6). Among the parasites that were recovered from the intestine of the examined fishes, *Ligula intestinalis* which infested *Parachanna obscura* had the highest prevalence (22.22%) while the intestine of *Clarias gariepinus* infected by *Proteocephalus* sp. had the least level of parasitic prevalence (3.70%) (Table 6).

Fish Parasite Species Richness in the Study Area

The summary of parasite species richness and prevalence of infected fish in relation to endo-ecto parasite and monoxenous and heteroxenous parasite species is shown in Table 7. Five parasitic species were each reported to be monoxenous and heteroxenous parasites in this study. Eight of the recovered parasites were endoparasitic at their site of infection while three were ecto-parasitic. Among the parasitic species, *Clinostomum tilapiae* was the only parasite species which was reported at ecto and endo site of infection. The diversity indices calculated showed that monoxenous ($p > 0.05$) and endo parasite ($p < 0.05$) parasites species were more diverse and richer than the heteroxenous and ecto-parasite species respectively, however the parasitic species among heteroxenous parasites were found to be evenly distributed (Table 7).

Discussion

The prevalence, pattern and distribution of parasite in 258 fishes in 7 families of 9 fish species from Osun River, Owode-Osoybo, was evaluated in this study. The fishes from different families were represented at the three trophic levels i.e. herbivore, omnivorous and piscivorous species because of their variety of food items ranging from generalists to specialist due to their differing body sizes (Bonato *et al.*, 2017; Froese and Pauly, 2019)^[14, 20].

Parasitic fauna survey of the collected fishes from the Osun River in this study revealed an overall prevalence of 22.9%. This was lower compared to the findings of Vincent *et al.* (2014)^[65] and Simon-Oke, (2016)^[56] on parasitic studies of

fishes collected from Warri (32.9%) and Eleyeile Reservoir (57.34%) respectively. However, the findings of this study was higher than the total prevalence of 19.17% and 13.6% reported by Oniye *et al.* (2004) [44] and Ugwuzor (1987) [63] respectively in different fish species collected from Zaria and Imo-River respectively. The difference in the overall prevalence reported in this study compared to those reported by the authors could be attributed to pollutants, food availability, parasite complex life cycle, and anthropogenic activities effect on the different water bodies where the researches were carried out. Studies have shown that water pollution affects parasitism either positively or negatively. According to Oso *et al.* (2017) [46], when hosts (fish) of parasites are stressed as a result of natural and anthropogenic stressors, it reduces their ability to resist parasitic infections, therefore parasitism will increase. Akinsanya *et al.* (2020) [5] also reported the destruction of plankton community through conventional fishing and other anthropogenic activities as a promoter of food competition which could contribute to either high or low prevalence of parasitic infection. Sosanya (2002) [57] and Oso *et al.* (2017) [46] have documented high positive correlation between pollution and prevalence rate of parasite in fish. The complex life cycle of some parasite with transmission through prey-predator interaction has also been attributed to low or high parasitism level in fish. Infection levels in fish species is dynamic due to the difference in environment characteristic (Val, 2019) [64]. The influence of these characteristics determines the influence of parasitism on fish communities. In this study, the recovered parasites are Cestoda (30%), Trematoda (23.23%), Monogenea (1.01%), Acanthocephala (8.08%), Secernetea (32.32%) and Nematoda (5.05%). The high presence of Secernetea represented by *Procamallanus laeiviconchus* during the period of study agreed with the findings of Okoye *et al.* (2014) [41], Uchechukwu (2015) [62] and Oso (2017) [46] who reported high prevalence (42.9%, 40.4%, 96% respectively) of *Procamallanus laeiviconchus* in fishes from Maiduguri, homestead pond in Enugu and River Ogun respectively. The high parasitic infestation of *Procamallanus laeiviconchus* on the hosts in this study could be due to the diet of the host, life span, migration, habitat and size of the host. Two omnivore's feeders, a planktonic feeder and a piscivorous feeder were parasitized by these helminthes. These fishes feed on wide choices of food through different stages of growth. At juvenile stage, omnivorous feeders feed on insect larvae, small crustaceans and fry of other fishes while planktonic feeders feed on varieties of phyto and zoo plankton (Osho, 2017; Neves *et al.*, 2020) [45, 36]. The piscivores on the other hand feeds on aquatic birds, fishes, frogs and tadpoles (Oben *et al.*, 2015) [39]. However, many of these foods are largely transport host since they act as the intermediate host for the parasite.

At certain stage in the lifecycle of a parasite, some parasites are more dependent on a particular characteristic of host fish because of their evolutionary strategies (Bellay *et al.*, 2013) [12]. This may also be due to the variation observed in age or size group of the different fish species examined in this study. Several authors have reported increase in parasitic infection with increase in age and fish size (Poulin, 2000; El nagger and Reda, 2003; Munoz and Cribb, 2005; Morrand, 2015) [51, 16, 33, 32]. However, in this study, the level of parasitic infection was not size dependent. Susceptibility of smaller fishes to parasitism in the study area could be attributed to the vulnerability of these fishes to changing environmental

conditions, (variations in temperature, pH and dissolved oxygen) which reduced their immunity. Smaller fishes, which also serve as intermediate hosts for most parasites, are easily preyed on by bigger fishes in the aquatic food web, are known to be subjected to fluctuating eco-physiological conditions in the littoral zones where they inhabit before moving to the open water ecosystem (Takemoto and Pavenelli, 2000) [18]. Increase in host size was reported to positively correlate with high abundance of parasite in environment (Osho, 2017) [45]. Fishes with bigger size has more chance of acquiring parasites with time, and this could be attributed longer time of exposure (Biu *et al.*, 2014) [13]. These could be the reason for high level of parasitization in some bigger fishes compare to the smaller size in this study.

The findings of this study showed that females were generally more infected than males. Five female fish species were infected out of the nine fish species examined. There was however no significant difference ($p < 0.05$) with respect to sex in the infection rate. This finding corroborates the findings of Hasan *et al.* (2010) and Osho (2017) [45] that discovered higher rate of infection in female *P. obscura*, though not significantly, than the male specimens from Lekki Lagoon and Ogun River respectively. However, significantly lower infection rate has been reported in female *O. niloticus* and *P. obscura* than males from lower Cross river system and Lake Alau, Maiduguri, Nigeria respectively. The difference in the incidence of infestation between sex may be due differential feeding either by quality and quantity of food eaten or as a result of degrees of resistance and infection (Emere, 2000). Osho (2017) [45] also attributed the main reason for differences in parasitic prevalence with sex to be physiological.

Seventy-seven (77.78%) out of 99 recovered worms were from the alimentary tract of the infected fishes. The recovery of such higher number of parasites from the stomach and intestine of the fishes could be due to the important activities of the site. Most of the digestive activities take place in the stomach and intestine of an organism where the parasite ova/cyst can be released from the food particles into the body. The conduciveness of the physical environment of the gut, and the ready availability of food nutrients could also contribute to the abundance of the recovered parasites from the organs. Nkwenguilila and Mwita (2004) [37], Simon-Oke (2016) [56] and Ibronke and Morenikeji (2018) [28] earlier reported that nutrient availability and gut environment were the factors that will most likely limit the distribution of parasites in different sections of the alimentary canal. Some fish specimens had multiple of infections which could be attributed to the nature of the environment that supports the survival and presence of such parasites thereby exposing the host to series of infection with many of them.

The high species diversity of parasite (1.99) and evenness distribution of parasites in the infected fishes as reported in this study could be attributed to anthropogenic and natural factor. One of the factors documented to contribute to the variability of parasite species in an environment is environmental changes. Change in the environment as a result of anthropogenic activities and natural factors promotes or hinders certain stages of development in the life cycle of each parasite species. Hirawa *et al.* (2010) reported that differences in water temperature may potentially affect hos susceptibility and parasite growth. The activities of free living larval at certain developmental stages of some parasites species are temperature dependent (Oso *et al.*, 2017) [46]. Water column mixing as a result of wind pattern coupled with rainfall can

increase the chance of fish host ingesting preys that are intermediate hosts (Pech *et al.*, 2010) [50]. Higher percentage (73%) of the infected fishes was endoparasitic infection. The Shannon-Weiner index of the endo-ecto parasite was also higher (1.74) in endo parasitic infection. Hosts' diet has been implicated as one of the important source of endo parasitic infections (Goncalves *et al.*, 2016, Hoshino *et al.*, 2016; Baia *et al.*, 2018; Negereiros *et al.*, 2019; Ferreira *et al.*, 2019) [27, 10, 19]. Most of the endo parasite complete their life cycles

when ingested by their definitive hosts especially endo helminths and therefore they depend on prey-predator interactions (Baia *et al.*, 2018) [10]. In this study, the carnivorous fish with diets based on invertebrates and fish and omnivorous fish diets containing only invertebrates had higher richness (1.74) of endoparasitic infection than the herbivores and planktivorous fish. The finding of this study showed that omnivorous diet was a factor that determines the accumulation of endo parasites through predation.

Table 1: Fish Checklist from the Study Area and their Parasitic Prevalence

Fish Family	Fish Host	Parasite species Recovered	Number of fish examined	Number of fish Infected	Prevalence (%)
Alestidae	<i>Brycinus macrolepidotus</i> Valenciennes, 1850	<i>Procamallanus laeiviconchus</i> <i>Polyonchobothrium clarias</i>	127	13	10.24
Cyprinidae	<i>Barbus bynni occidentalis</i> Boulenger, 1911	<i>Procamallanus laeiviconchus</i>	13	4	30.77
	<i>Labeo parvus</i> Boulenger, 1902	<i>Lytocestus marcuseni</i>	12	2	16.67
Hepsetidae	<i>Hepsetus odoe</i> Bloch, 1794	<i>Procamallanus laeiviconchus</i> <i>Proteocephalus</i> sp <i>Lytocestus marcuseni</i>	15	5	33.33
Mormyridae	<i>Mormyrus rume</i> Linnaeus, 1758	<i>Procamallanus laeiviconchus</i> <i>Spinitectus mormyri</i> <i>Gyrodactylus</i> Spp	7	3	42.85
Cichlidae	<i>Sarotherodon galilaeus</i> Linnaeus, 1758	<i>Acanthogyrus tilapiae</i> <i>Clinostomum tilapiae</i>	26	8	30.77
	<i>Oreochromis niloticus</i> Linnaeus, 1758	<i>Clinostomum tilapiae</i> <i>Euclinostomum heterostomum</i> <i>Acanthogyrus tilapiae</i>	22	5	22.72
Clariidae	<i>Clarias gariepinus</i> Burchell, 1822	<i>Ligula intestinalis</i> <i>Polyonchobothrium clarias</i> <i>Proteocephalus</i> Spp <i>Clinostomium tilapiae</i>	27	7	25.93
Channidae	<i>Parachanna obscura</i> Gunther, 1861	<i>Ligula intestinalis</i>	9	2	22.22

Table 2: Checklist of Fish Parasite Recovered from the Fish Host in the Study Area

Class	Parasite Species	Fish Host	No Recovered	Class Percentage
Cestoda	<i>Ligula intestinalis</i>	<i>Clarias gariepinus</i>	3	30.30
		<i>Parachanna obscura</i>	5	
	<i>Lytocestus marcuseni</i>	<i>Hepsetus odoe</i>	3	
		<i>Labeo senegaliensis</i>	2	
	<i>Polyonchobothrium clarias</i>	<i>Brycinus macrolepidotus</i>	5	
		<i>Clarias gariepinus</i>	9	
		<i>Proteocephalus</i> Spp	2	
Trematoda	<i>Clinostomum tilapiae</i>	<i>Sarotherodon galilaeus</i>	5	23.23
		<i>Oreochromis niloticus</i>	7	
		<i>Clarias gariepinus</i>	3	
	<i>Euclinostomum heterostomum</i>	<i>Oreochromis niloticus</i>	8	
Monogenea	<i>Gyrodactylus</i> Spp	<i>Mormyrus rume</i>	1	1.01
Acanthocephala	<i>Acanthogyrus tilapiae</i>	<i>Sarotherodon galilaeus</i>	6	8.08
		<i>Oreochromis niloticus</i>	2	
Secernetea	<i>Procamallanus laeiviconchus</i>	<i>Brycinus macrolepidotus</i>	16	32.32
		<i>Barbus bynni occidentalis</i>	6	
		<i>Hepsetus odoe</i>	7	
		<i>Mormyrus rume</i>	3	
Nematoda	<i>Spinitectus mormyri</i>	<i>Mormyrus rume</i>	5	5.05

Table 3: Prevalence and Mean Intensity of Fish Parasite Recovered from the Fish Host in the Study Area

Parasite Species	Fish Host	Number Examined	Number Infected	No Recovered	Prevalence (%)	Overall Prevalence	Mean Intensity
<i>Procamallanus laeiviconchus</i>	<i>Brycinus macrolepidotus</i>	127	10	16	7.87	3.88	1.6±0.46
	<i>Barbus bynni occidentalis</i>	13	4	6	30.77	1.55	1.5±0.1
	<i>Hepsetus odoe</i>	15	4	7	26.67	1.55	1.75±0.31
	<i>Mormyrus rume</i>	7	1	3	14.29	0.78	3.0±1.15
<i>Polyonchobothrium clarias</i>	<i>Brycinus macrolepidotus</i>	127	4	5	3.15	1.55	1.25±0.60
	<i>Clarias gariepinus</i>	27	7	9	25.93	2.71	1.29±0.01
<i>Proteocephalus</i> sp	<i>Hepsetus odoe</i>	15	2	2	13.33	0.78	1.0
	<i>Clarias gariepinus</i>	27	1	1	3.7	0.39	1.0
<i>Lytocestus marcuseni</i>	<i>Hepsetus odoe</i>	15	1	3	6.67	0.39	3.0±1.71
	<i>Labeo senegaliensis</i>	12	2	2	16.67	0.78	1.0
<i>Spinitectus mormyri</i>	<i>Mormyrus rume</i>	7	2	5	28.57	0.78	2.5±0.83
<i>Acanthogyrus tilapiae</i>	<i>Sarotherodon galilaeus</i>	26	3	6	11.54	1.16	2.0±0.42
	<i>Oreochromis niloticus</i>	22	1	2	4.55	0.39	2.0
<i>Clinostomum tilapiae</i>	<i>Sarotherodon galilaeus</i>	26	2	5	7.69	0.78	2.5±1.17
	<i>Oreochromis niloticus</i>	22	3	7	13.64	1.16	2.33±0.92
	<i>Clarias gariepinus</i>	27	1	3	3.70	0.39	3.0±0.56
<i>Euclinostomum heterostomum</i>	<i>Oreochromis niloticus</i>	22	4	8	18.18	1.55	2.0
<i>Ligula intestinalis</i>	<i>Clarias gariepinus</i>	27	3	3	11.11	1.16	1.0
	<i>Parachanna obscura</i>	9	2	5	22.22	0.78	2.5
<i>Gyrodactylus</i> sp	<i>Mormyrus rume</i>	7	1	1	14.29	0.39	1.0

Table 4: Prevalence and Mean Intensity of Parasitic Infection in Relation to Fish Standard Length

Fish Host	Size Range (cm)	Parasite Species	NE	NI	I	P (%)	MI
<i>Brycinus macrolepidotus</i>	11 – 20	<i>Procamallanus laeiviconchus</i>	25	3	6	12	2
	21 – 30	<i>Procamallanus laeiviconchus</i> <i>Polyonchobothrium clarias</i>	53	6	6 5	11.32	1 0.83
	31 – 40	<i>Polyonchobothrium clarias</i>	49	4	4	8.16	1
<i>Barbus bynni occidentalis</i>	11 – 20	<i>Procamallanus laeiviconchus</i>	2	1	1	50	0.5
	21 – 30	<i>Procamallanus laeiviconchus</i>	6	1	1	16.67	1
	31 – 40	<i>Procamallanus laeiviconchus</i>	5	2	4	40	2
<i>Hepsetus odoe</i>	11 – 20	<i>Lytocestus marcuseni</i>	7	1	1	14.29	1
	21 – 30	<i>Lytocestus marcuseni</i> <i>Procamallanus laeiviconchus</i> <i>Proteocephalus</i> Spp	6	3	3 3	50	0.67 1 1
	31 – 40	<i>Procamallanus laeiviconchus</i> <i>Lytocestus marcuseni</i>	2	1	2 1	50	2 1
<i>Labeo parvus</i>	11 – 20	<i>Lytocestus marcuseni</i>	8	1	1	12.5	1
	21 – 30	<i>Lytocestus marcuseni</i>	4	1	1	25	1
	31 – 40		0	0	0	0	0
<i>Mormyrus rume</i>	11 – 20	<i>Gyrodactylus</i> Spp <i>Spinitectus mormyri</i>	1	1	1 1	100	1 1
	21 – 30	<i>Spinitectus mormyri</i>	3	1	3	33.33	3
	31 – 40	<i>Procamallanus laeiviconchus</i>	3	1	4	33.33	4
<i>Sarotherodon galilaeus</i>	11 – 20	<i>Clinostomum tilapiae</i>	14	3	3	21.43	1
	21 – 30	<i>Clinostomum tilapiae</i> <i>Acanthogyrus tilapiae</i>	10	3	2 1	30	0.67 0.33
	31 – 40	<i>Clinostomum tilapiae</i>	2	2	2	100	1
<i>Oreochromis niloticus</i>	11 – 20	<i>Clinostomum tilapiae</i> <i>Euclinostomum heterostomum</i>	17	4	7 4	23.53	1.75 1
	21 – 30	<i>Euclinostomum heterostomum</i> <i>Acanthogyrus tilapiae</i>	4	1	4 2	25	4 2
	31 – 40		0	0	0	0	0
<i>Clarias gariepinus</i>	11 – 20	<i>Polyonchobothrium clarias</i>	14	2	3	14.29	1.5
	21 – 30	<i>Ligula intestinalis</i> <i>Polyonchobothrium clarias</i>	2	1	1 3	50	1 3
	31 – 40	<i>Polyonchobothrium clarias</i> <i>Proteocephalus</i> Spp <i>Ligula intestinalis</i>	11	4	6 1 2	36.36	1.5 0.25 0.5
<i>Parachanna obscura</i>	11 – 20	<i>Ligula intestinalis</i>	5	1	2	20	2
	21 – 30	<i>Ligula intestinalis</i>	4	1	3	25	3
	31 – 40		0	0	0	0	0

NE – Number of Fish Examined; NI – Number of Fish Infected; I – Number of Parasite Recovered; PI – Prevalence; MI – Mean Intensity

Table 5: Prevalence of Parasitic Infection in Relation to Sex

Fish Host	Sex	Number of fish examined	Number of fish Infected	Prevalence (%)	Chi-Square	P-value
<i>Brycinus macrolepidotus</i>	Male	59	4	6.78	1.4238	0.2313
	Female	68	9	13.24		
<i>Barbus bynni occidentalis</i>	Male	9	3	33.33	0.0903	0.7638
	Female	4	1	25		
<i>Hepsetus odoe</i>	Male	3	1	33.33	0.4167	0.5186
	Female	12	2	16.67		
<i>Labeo senegaliensis</i>	Male	5	2	40	3.360	0.067
	Female	7	0	0		
<i>Mormyrus rume</i>	Male	5	3	60	2.100	0.1473
	Female	2	0	0		
<i>Sarotherodon galilaeus</i>	Male	16	3	18.75	2.8212	0.0930
	Female	10	5	50		
<i>Oreochromis niloticus</i>	Male	8	1	12.5	0.7487	0.3869
	Female	14	4	33.33		
<i>Clarias gariepinus</i>	Male	7	2	28.57	0.0340	0.8530
	Female	20	5	25		
<i>Parachanna obscura</i>	Male	6	1	16.67	0.3214	0.5708
	Female	3	1	0.33		

Table 6: Site, Prevalence and Mean Intensity of Fish Parasite Infection

Parasite Species	Fish Host	Location	Number Examined	Number Infected	No Recovered	Prevalence	Mean intensity (%)
<i>Procamallanus laeiviconchus</i>	<i>Brycinus macrolepidotus</i>	Stomach	127	10	16	7.87	1.6
	<i>Barbus bynni occidentalis</i>	Stomach	13	4	6	30.77	1.5
	<i>Hepsetus odoe</i>	Stomach	15	4	7	26.67	1.75
	<i>Mormyrus rume</i>	Stomach	7	1	3	14.29	3.0
<i>Polyonchobothrium clarias</i>	<i>Brycinus macrolepidotus</i>	Stomach	127	4	5	3.15	1.25
	<i>Clarias gariepinus</i>	Stomach	27	7	9	25.93	1.29
<i>Proteocephalus Spp</i>	<i>Hepsetus odoe</i>	Intestine	15	2	2	13.33	1.0
	<i>Clarias gariepinus</i>	Intestine	27	1	1	3.7	1.0
<i>Lytocestus marcuseni</i>	<i>Hepsetus odoe</i>	Intestine	15	1	3	6.67	3.0
	<i>Labeo senegaliensis</i>	Intestine	12	2	2	16.67	1.0
<i>Spinitectus mormyri</i>	<i>Mormyrus rume</i>	Stomach	7	2	5	28.57	2.5
<i>Acanthogyryus tilapiae</i>	<i>Sarotherodon galilaeus</i>	Intestine	26	3	6	11.54	2.0
	<i>Oreochromis niloticus</i>	Intestine	22	1	2	4.55	2.0
<i>Clinostomum tilapiae</i>	<i>Sarotherodon galilaeus</i>	Gills	26	2	5	7.69	2.5
	<i>Oreochromis niloticus</i>	Gills	22	3	7	13.64	2.33
	<i>Clarias gariepinus</i>	Intestine	27	1	3	3.70	3.0
<i>Euclinostomum heterostomum</i>	<i>Oreochromis niloticus</i>	Gills	22	4	8	18.18	2.0
<i>Ligula intestinalis</i>	<i>Clarias gariepinus</i>	Intestine	27	3	3	11.11	1.0
	<i>Parachanna obscura</i>	Intestine	9	2	5	22.22	2.5
<i>Gyrodactylus Spp</i>	<i>Mormyrus rume</i>	Gills	7	1	1	14.29	1.0

Table 7: Species Richness, Prevalence of Infected Fish, Ecto-Endo, Monoxenous and Heteroxenous Parasite Species in the study Area

Parasite Species	I	Pi	Ecto-parasite	Endo-Parasite	Monoxenous	Heteroxenous
<i>Ligula intestinalis</i>	8	2	-	+	+	-
<i>Lytocestus marcuseni</i>	5	2	-	+	+	-
<i>Polyonchobothrium clarias</i>	14	2	-	+	+	-
<i>Proteocephalus Spp</i>	3	2	-	+	-	+
<i>Clinostomum tilapiae</i>	15	3	+	+	-	+
<i>Euclinostomum heterostomum</i>	8	1	+	-	-	+
<i>Gyrodactylus Spp</i>	1	1	+	-	+	-
<i>Acanthogyryus tilapiae</i>	8	2	-	+	-	+
<i>Procamallanus laeiviconchus</i>	32	4	-	+	+	-
<i>Spinitectus mormyri</i>	5	1	-	+	-	+
Total	99	20	3	8	5	5
Diversity Index						
Shannon – Weiner (H ⁰)	0.77	2.21	0.54	1.74	1.04	0.95
Evenness	0.33	0.96	0.49	0.89	0.59	0.59
P-value, F-value (α=0.05)	P=0.01, F= 7.7485		P = 0.05, F = 4.5510		P = 0.489, F = 0.5244	

Conclusion and Recommendations

This study came to conclusion that Osun River is heavily

polluted due to series of anthropogenic activities going on in the river and this is affecting the production, species richness

and the quality of the fish in the river. Government should intervene and ensure regular examination and pollution control of the water body.

Declaration of conflicting interest

The authors declare that they have not conflict of interest

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