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Gastrointestinal and Haemoparasites of *Synodontis clarias* (Linnaeus, 1758) from Lekki Lagoon, Lagos, Nigeria

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ABSTRACT

The present study was undertaken to investigate the diversity and prevalence of the parasites of *Synodontis clarias* (LINNAEUS, 1758) from Lekki Lagoon, Lagos, Nigeria. *S. clarias* (the upside-down red-tailed catfish) is a bottom feeder in its natural habitat feeding as an omnivore. It is one of the rich aquatic fauna of the Lekki Lagoon. A total of one hundred and twenty (120) randomly selected fishes were examined for ectoparasites, gastrointestinal parasites, and haemoparasites. A total of nine hundred and sixty-nine (969) gastrointestinal parasites were recovered from the fishes examined. They are two Caryophyllidae cestodes and a Proteocephalid cestode, belonging to the genus: *Wenyonia*, *Caryophyllaeus*, and *Proteocephalus*. *Balantidium sp* was found in the intestine of two of the fishes examined. The haemoparasite isolated from the infected fishes was *Trypanosoma sp*. The monogenean *Gyrodactylus sp* was also recovered from the skin and gills of some of the fishes examined. The overall prevalence of infection was 54.1% for gastrointestinal helminths and 19.1% for haemoparasites. Prevalence of infection was higher in the males than in the females of *S. clarias*. Histologic examination of infected intestinal tissues showed alterations such as an increase in the connective tissue of the submucosa, stunting of the villi, and loss of intestinal glands.

INTRODUCTION

The fisheries sector contributes immensely to the nutritional security and food of about 200 million Africans, and it also generates income for over 10 million others engaged in fish production, processing, and trade (Miller, 2011). Fish is an affordable source of animal protein with a very long list of dietary and health benefits even over muscle meat (Tessavi *et al*., 2014). Fish consumption and demand are on the increase because fish is cheap, widely acceptable, and has no religious or ethical barrier (Obaroh *et al*., 2013). Fish acts as a vector of some human disease pathogens (Akinsanya *et al*., 2015). Water bodies in Nigeria harbor a variety of fishes, of which 90% are croakers, catfishes, tilapias, threadfins, and clupeids (FDF, 2003).

Environmental change, whether occurring naturally or through human intervention, affects the ecological balance and contexts within which fish parasites breed, develop and cause disease (Patz *et al*., 2000). Parasitic diseases of fish are common around the world and are of particular importance in the tropics (Janovy, 2000). Endoparasitic infections are indicators of water quality because helminths increase in abundance and diversity in polluted waters (Avent-Oldewage, 2001).

Fish parasites have an enormous impact on fish given their negative impact on profitability, they also cause zoonotic diseases in many areas of the world (Murrell and Fried, 2007).

Synodontis clarias (LINNAEUS, 1758) belongs to the family Mochokidae, and the genus Synodontis to which *S. clarias* belong is the most common and of great commercial importance (Reed *et al*., 1967). *S. clarias* is commonly known as the upside-down red-tailed catfish that occurs widely in the freshwater of Northern Africa (Chad, Niger, Senegal, etc) and also other parts of the continent including Nigeria (Adegoroye *et al*., 2019). *S. clarias* is a bottom feeder in its natural habitat feeding as an omnivore (Shinkafi and Ipinjolu, 2001) on insect larvae, plants, mollusks, and detritus. The fish prefers a mixed and varied diet. *S. clarias* prefers to be kept in water which has a pH in the range of 6.5-7.5 and a hardness of 18ºdGH. This catfish is ideally suited to temperatures in the range of 21-24ºC or 69-75°F.

Parasites can cause mechanical damage (fusion of gill lamellae, tissue replacement), physiological damage (cell proliferation, immunomodulation, detrimental behavioral responses, altered growth) and reproductive damage (Iwanowicz, 2011). Parasites affect fish health, growth, and survival (Akinsanya and Kuton, 2016), they also reduce fish yield, aesthetic value, and market value.

Trypanosomes are haemoflagellates having a single free flagellum at the anterior end of their body. The first trypanosome was discovered from the blood of *Salmo trutta* by Valentin (1841). Since then, the parasite has been reported in fishes from different parts of the globe (Shahi *et al*., 2013). Most species of trypanosomes infecting fishes cause pathogenic diseases of considerable medical and economic importance. Symptoms of piscine trypanosomiasis range from mild anemia associated with low levels of parasitaemia to severe pathological changes due to a heavy parasite burden (Islam and Woo, 1991). Leukocytosis, hypoglycemia and hypocholesterolemia are the frequent outcomes of trypanosomiasis (Gupta *et al*., 1983). *Trypanosoma* species are transmitted to fish through a blood-sucking host, usually a species of the leech. However, isopod crustaceans can also be potential vectors of trypanosomiasis in fish (Corrêa *et al*., 2016). Monogeneans are a class of parasitic flatworms that are commonly found on fishes and lower aquatic invertebrates. Most monogeneans are browsers that move about freely on the fish's body surface feeding on mucus and epithelial cells of the skin and gills; however, a few adult monogeneans will remain permanently attached to a single site on the host. Some monogenean species invade the rectal cavity, ureter, body cavity, and even the blood vascular system. Between 4,000 and 5,000 species of monogeneans have been described. They are found on fishes in fresh and saltwater and in a wide range of water temperatures (Reed *et al*., 21012). Gyrodactylids are found on freshwater, marine, and brackish water fishes, they are generally found on the bodies and fins of fish, though they occasionally may occur on the gills.

The study of fish parasites is a necessity as it will enhance the sustenance of fish in their natural environment and also serve as the basis for information on the potential risk of diseases and pathogens involved in fishing and fish farming in Nigeria (Adegoroye *et al*., 2019). This study was designed to investigate the diversity and prevalence of the parasites of *S. clarias* from Lekki Lagoon, Lagos, Nigeria.

MATERIALS AND METHODS

The Study Area:

Lekki lagoon (Fig. 1) supports many species of fish and aquatic plants (Emmanuel and Chukwu, 2010). The lagoon is located in Lagos and Ogun States of Nigeria lies between 6°25'- 6°35'N and 4°00'- 4°13'E (Adesalu and Nwanko, 2009). It covers an area of nearly 247km^2. A

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greater part of the lagoon is shallow (<3.0m), while some areas are up to 6.0m deep (Adesalu, 2007). The Lekki lagoon is part of an intricate system of waterways made up of lagoons and creeks found along the coast of Southwestern Nigeria from the Dahomey border to the Niger Delta (Emmanuel, 2009). It is fed by the Oni River discharging into the North-eastern part, and by the rivers, Oshun and Saga discharging into the North-western parts of the lagoon (Emmanuel and Chukwu, 2010). Lekki lagoon experiences both dry and rainy seasons typical of the southern part of Nigeria (Adesalu and Nwanko, 2009).

The rich fish fauna of the lagoon includes *Heterotis niloticus*, *Gymnarchus niloticus, Clarias gariepinus, Malapierurus electricus, Synodontis clarias, Chysichthys nigrodigitatus, Parachanna obscura; Mormyrus rume, Calabaricus calamoichthys, Tilapia zilli, Tilapia galilae, Hemichromis fasciatus*, and *Sarotherodon melanotheron* (Kusemiju, 1981).

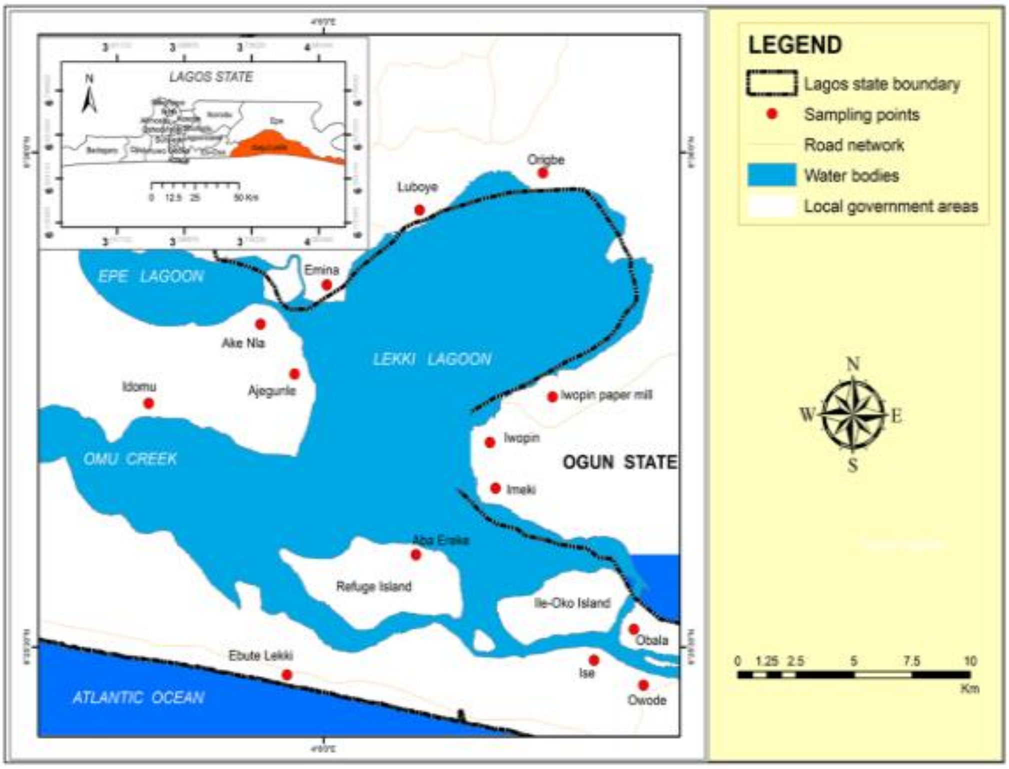

Fig. 1: A Map Showing the Lekki Lagoon, Lagos (Akinsanya *et al*., 2020).

Collection Of Specimens and Morphometrics:

One hundred and twenty specimens of *Synodontis clarias* were purchased alive at Oluwo Market in Epe, Lagos, Nigeria, between November 2020 and April 2021. The total and standard lengths of the fishes were measured in centimeters (cm) using a metre rule (Akinsanya *et al*., 2007), while the weight of the fishes was measured in grams (g) using a digital weighing balance (Ohaus, 5000). A gross examination of the gonads was used to determine the sex of the fishes (Akinsanya and Kuton, 2016).

Blood Collection and Examination for Haemoparasites:

Blood samples were collected from the caudal circulation as described by Kori-Siapere and Ake (2005). before the morphometric was done. Thin blood smears were made from the blood samples collected (Hassan *et al*., 2007). The blood smears were allowed to air dry and fixed in absolute methanol. The smears were then taken to the laboratory for further processing. Slides were stained with a phosphate-buffered Giemsa stain and examined under a 100x objective oil immersion microscope. Images were then captured using a digital camera.

Examination For Ectoparasites:

The skin and the gills of the fishes were screened for ectoparasites. Using forceps and scalpel, monogeneans attached to the skin and gills were scrapped into petri dishes containing normal saline. This was done when the fish specimens were still fresh and wet, so as to prevent the monogeneans from drying up.

Examination Of Fishes for Intestinal Helminth Parasites:

The fishes were dissected, the intestines were removed and placed in Petri dishes containing normal saline. The intestines were carefully slit open to aid the emergence of parasites (Akinsanya, 2015). The collected helminths parasites were counted, recorded, and fixed in 70% alcohol. Parasite identification was done using the keys provided by (Wooland, 1937, Yamaguti, 1959, Ukoli, 1972, and Paperna, 1996). The Prevalence, and Mean intensity was calculated thus:

$$\text{Percentage prevalence} = \frac{\text{Number of infected fish}}{\text{The total number of fish hosts examined}} \times 100$$

$$\text{Mean intensity} = \frac{\text{Total number of parasites recovered}}{\text{The total number of infected fish examined}}$$

Examination Of Fishes for Intestinal Protozoan Parasites:

Saline solution of the intestinal content of the fish was decanted into a sterile bottle, and preserved in the fridge. At the lab, 3 drops of the mixture were placed on a slide, covered with a coverslip, and mounted under a compound microscope for direct observation for protozoans (Auta *et al*., 2019). This was done within 24 hours of sample collection.

Processing of Intestine for Histopathology:

Both infected and uninfected intestines were placed in separate bottles containing Bouin's fluid which was decanted six hours later. 10% phosphate buffer formalin was then added to the specimens to prevent shrinkage, and cell decomposition by bacteria and enzymes. Random selection was made from the preserved tissues, while uninfected tissues were chosen as control. The dehydration of the tissues was then carried out in increasing concentrations of alcohol (70%, 95%) and then twice in absolute alcohol 30 minutes apart. The tissues were then impregnated in molten paraffin wax and allowed to solidify. Sectioning of the tissue was carried out at 4-5µm, and then floated in pre-coated slides and dried. The sections were stained using hematoxylin-eosin stains, washed in tap water, and then dried. The tissues were mounted using DPX mountant and then examined under the microscope (Akinsanya and Hassan, 2012).

Statistical Analysis:

The overall prevalence of gastrointestinal helminth and haemoparasites were calculated. Chi-square was used to calculate the significant difference in the levels of infection between the male and female fishes.

RESULTS

Diversity Of Parasites Of Synodontis Clarias From Lekki Lagoon:

The helminth parasites recovered from the infected fishes are eight cestodes: *Wenyonia virilis* (Wooland, 1923), *Wenyonia acuminata* (Wooland, 1923), *Wenyonia youdeoweii* (Ukoli, 1972), *Wenyonia longicauda* (Wooland, 1937), *Wenyonia synodontis* (Ukoli, 1972), *Wenyonia minuta* (Wooland, 1923), *Proteocephalus spp* (Weinland, 1858), and *Caryophyllaeus spp* (Kulmatycki, 1923). *Balantidium spp*, a protozoan parasite, was also seen in the intestine of two of the infected fish. The only haemoparasite seen in the infected fishes was *Trypanosoma sp.* The monogenean *Gyrodactylus sp* was recovered from the skin and gills of some fishes. (Table 1).

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Table 1: Types of parasites of *Synodontis clarias* from Lekki lagoon

FISH HOST	SITE OF INFECTION	PARASITE	TYPE
Synodontis clarias	Intestine	*Wenyonia virilis*	Cestode
		Wenyonia acuminata	Cestode
		Wenyonia youdeoweii	Cestode
		Wenyonia longicauda	Cestode
		Wenyonia synodontis	Cestode
		Wenyonia minuta	Cestode
		Proteocephalus sp	Cestode
		Caryophyllaeus sp	Cestode
		Balantidium sp	Protozoan
	Blood	*Trypanosoma sp*	Protozoan
	Skin	*Gyrodactylus sp*	Monogenean
	Gills	*Gyrodactylus sp*	Monogenean

Prevalence Of Gastrointestinal Helminths and Haemoparasites in *Synodontis clarias* in Relation to Sex:

Sixty-five fishes were infected from the one hundred and twenty fishes examined, and a total of nine hundred and sixty-nine (969) helminth parasites were recovered. The overall prevalence of gastrointestinal helminth infection was 54.1% (Table 2). Of the 47 male fishes examined, 28 were infected, with a prevalence of 59.5% which is higher than the prevalence of 50.6% observed in the female population of the fish. The mean intensity of infection was 14.9. Only one fish was infected with a gastrointestinal protozoan parasite.

Table 2: Prevalence of gastrointestinal helminths in relation to sex

Sex	Number examined	Number infected	Prevalence (%)	Number of parasites recovered	Mean intensity
Male	47	28	59.5	396	14.1
Female	73	37	50.6	573	15.4
Both sexes	120	65	54.1	969	14.9

$X^2 = 0.2674$, df=1, P>0.05

Twenty-three of the one hundred and twenty fishes examined were infected with haemoparasites (Table 3). Ten of the forty-seven male fishes examined were infected, while thirteen of the seventy-three female fishes examined were infected. There is a higher prevalence of infection in males than females. Sixteen fishes were infected with both gastrointestinal helminths and blood parasites.

Table 3: Prevalence of haemoparasites in relation to sex

Sex	Number examined	Number infected	Prevalence (%)
Male	47	10	21.2
Female	73	13	17.8
Both sexes	120	23	19.1

$X^2 = 0.1497$, df=1, P>0.05

Prevalence of Gastrointestinal Helminth Infection in Relation to Length:

The prevalence of infection was the highest in fishes measuring between 16.0-16.9cm (Table 4). Fishes measuring between 13.0-13.9cm and 15.0-15.9cm had the lowest prevalence of infection. The highest number of parasites was recovered from the fishes measuring between 14.0-14.9cm.

In the male population of the fish examined, the highest prevalence was observed in the fishes measuring between 16.0-16.9cm. Fishes measuring between 12.0-12.9cm and 13.0-13.9cm had the lowest prevalence of infection. A high prevalence of infections was recorded in the longer fishes.

In the females, the highest prevalence of infection was seen in fishes measuring between 12.0-12.9cm. Fishes measuring between 13.0-13.9cm and 15.0-15.9cm had the lowest prevalence of infection. The highest number of parasites was recovered in fishes measuring 14.0-14.9cm.

Table 4: Prevalence of intestinal helminths in relation to the length.

Standard length (cm)	Number examined	Number infected	Prevalence (%)	Worm load	Mean intensity
Both Sexes					
12.0-12.9	11	7	63.6	131	18.7
13.0-13.9	22	10	45.4	217	21.7
14.0-14.9	35	20	57.1	369	18.4
15.0-15.9	33	15	45.4	120	8
16.0-16.9	17	12	70.5	129	10.7
17.0-17.9	2	1	50	3	3
Male					
12.0-12.9	2	1	50	21	21
13.0-13.9	14	7	50	122	17.4
14.0-14.9	13	7	53.8	179	25.5
15.0-15.9	9	6	66.6	42	7
16.0-16.9	9	7	77.7	61	8.7
17.0-17.9	0	-	-	-	-
Female					
12.0-12.9	9	6	66.6	110	18.3
13.0-13.9	8	3	37.5	95	31.6
14.0-14.9	22	13	59.0	190	14.6
15.0-15.9	24	9	37.5	78	8.6
16.0-16.9	8	5	62.5	68	13.6
17.0-17.9	2	1	50	3	3

Prevalence of Gastrointestinal Helminth Infection in Relation to The Weight:

In the fish population examined, the only fish that weighed between 100-109g was infected, hence, the highest prevalence of 100%. Fishes that weighed between 30-39g had a 77.7% prevalence of infection (Table 5). The prevalence of infection was at the lowest in the fishes weighing between 50-59g. In the male fish population, the lowest prevalence of infection was observed in the fishes weighing between 50-59g. Male fishes that weighed between 30-39g, 70-79g, and 100-109g had a prevalence of 100%.

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Among the female fishes, the lowest prevalence of infection was observed in the fishes weighing between 40-49g, while the highest prevalence of infection was seen in the fishes weighing between 80-89g.

Table 5: Prevalence of intestinal helminths in relation to weight.

Weight (g)	Number examined	Number infected	Prevalence (%)	Worm load	Mean intensity
Both Sexes					
30-39	9	7	77.7	158	22.5
40-49	19	9	47.3	207	23
50-59	39	17	43.5	340	20
60-69	35	19	54.2	159	8.3
70-79	11	8	72.7	81	10.1
80-89	5	4	80	23	5.7
90-99	1	0	-	-	-
100-109	1	1	100	1	1
Males					
30-39	2	2	100	50	25
40-49	9	6	66.6	110	18.3
50-59	17	7	41.1	134	19.1
60-69	13	8	61.5	84	10.5
70-79	4	4	100	17	4.25
80-89	0	0	-	-	-
90-99	1	0	-	-	-
100-109	1	1	100	1	1
Females					
30-39	7	5	71.4	108	21.6
40-49	10	3	30	97	32.3
50-59	22	10	45.4	206	20.6
60-69	22	11	50	75	6.8
70-79	7	4	57.1	64	16
80-89	5	4	80	23	5.7
90-99	0	-	-	-	-
100-109	0	0	-	-	-

Histopathological Results:

The results of the histologic analysis of the intestinal tissue sections in *Synodontis clarias* are shown in Fig 3 (A-F). All the parasites were recovered from the intestine. The histologic analysis revealed mild stunting of the villi, thickening of the mucosa, and loss of villous structure.

The normal sections showed normal villi structure, normal mucosa, submucosa, and muscularis. The normal crypt-villous architecture was well preserved (Fig. 3A&B). There was mild stunting of villi and loss of intestinal glands (Fig. 3C), thickening of the muscularis mucosa, and mild presence of detritus within the lumen (Fig. 3D). Inflammation in the connective tissue of the submucosa (Fig. 3E) and a focal area of loss of villous structure (Fig.3F) was also revealed.

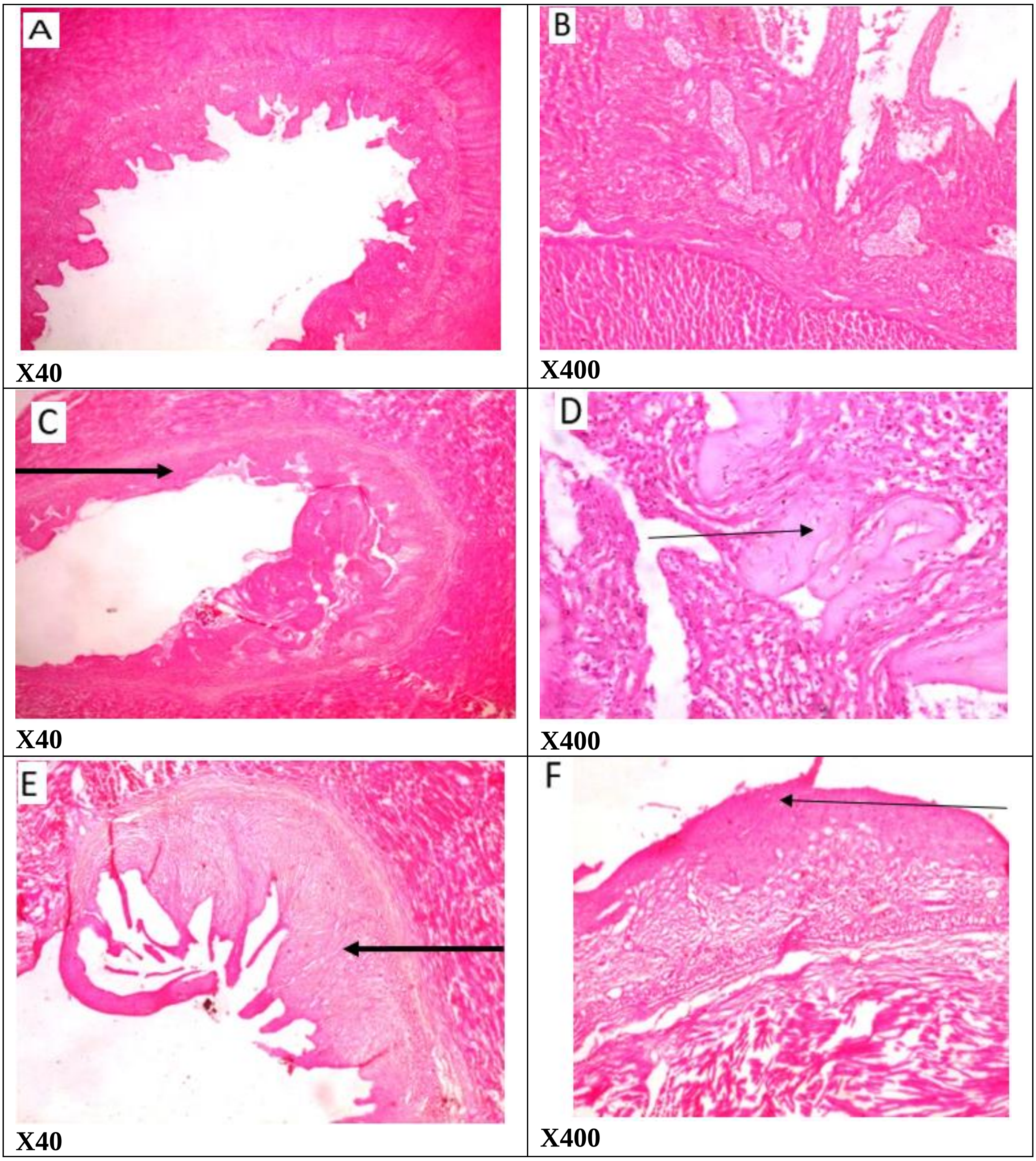

Fig. 3(A-F): Pathological effects of intestinal helminth parasites on *S. clarias*
A and **B**: normal sections, **C**: mild stunting of the villi of the intestinal tissue,
D: thickening of the muscularis mucosa, **E**: inflammation in the connective tissue of the submucosa, **F**: loss of villi structure

DISCUSSION

Eight species of cestodes belonging to the genus: *Wenyonia* (71.62%), *Proteocephalus* (22.19%), and *Caryophyllaeus* (6.19%), and two protozoans: *Balantidium sp* and *Trypanosoma sp* were recovered from the fishes examined in this study, which is in par with the findings of Khali (1971), and Van as and Basson (1984) who reported the occurrence of the *Caryophyllaeidae*, Psudophyllideans, and *Proteocephalidae* from native African fishes. Akinasnya *et al*., (2008), reported *Wenyonia sp* in *Synodontis clarias* from Lekki Lagoon, Lagos, Nigeria. Okemadu (2018) isolated *Wenyonia* *sp* from *S. clarias* from Omanbala River, Otuocha, Anambra State, Nigeria. Adegoroye *et al*., (2019) also reported *Wenyonia sp* from *S. clarias* from Asejire dam, South-West Nigeria. The six *Wenyonia* species considered valid by Schaeffner *et al*., 2011, who provided their re-descriptions were all isolated in the present study with their prevalence as follows: *Wenyonia virilis* (35.40%), *Wenyonia acuminata* (17.23%), *Wenyonia youdeweii* (10.11%), *Wenyonia longicauda* (5.68%), *Wenyonia synodontis* (2.27%), and *Wenyonia minuta* (0.93%). *W. virilis* was the most abundant of the six species recovered.

Hassan *et al*. (2007) reported the haemoparasite *Trypanosoma sp* in *Synodontis clarias* from Lekki Lagoon, Lagos, Nigeria. Sixteen fishes (9 males, 7 females) were infected with both intestinal helminths, and haemoparasites.

The overall prevalence of gastrointestinal helminth infection in the current study was 54.1%. Akinsanya *et al*., 2008 reported a prevalence of intestinal helminth infection in *S. clarias* from the same location as with this current study to be 38.7%. The increase in the prevalence of gastrointestinal helminth parasite infection in *S.clarias* from Lekki Lagoon may be attributed to an increase in pollution arising from human activities around the Lagoon and also the abundance of the intermediate host in the Lagoon. High parasite prevalence in freshwater ecosystems has been associated with pollution in the form of waste dumpsites at these water bodies and the release of effluents and other waste from human activities in industries and abattoirs (Kelly *et al*., 2010).

A higher prevalence (59.5%) of gastrointestinal helminth infection was observed in the male fishes, this is at par with the findings of Akinsanya *et al*., 2008, and Adegoroye *et al*., 2019 who both reported a higher prevalence (37.8% and 86.49% respectively) of intestinal helminth infection in the male *S. clarias*. In contrast, Obaroh *et al*., 2013 reported a higher prevalence (72.50%) of intestinal helminth infection in the female *Synodontis clarias*, this is to attest that parasite infection is independent of the sex of the fish host. In the current study, a higher prevalence (21.2%) of blood parasite infection was seen in the males, which is in divergence with the findings of Hassan *et al*., 2007, who documented a higher prevalence (20.95%) of haemoparasites in the female *S.clarias*.

The highest prevalence of infection was observed in the fishes measuring between 16.0-16.9cm, which agrees with the findings of Akinsanya *et al*., (2008), who documented a higher parasite prevalence among the largest fishes. The highest prevalence of infection was seen in the fishes weighing between 100-109g, although only one fish was examined in that category. Fishes weighing between 80-89g had a prevalence of 80%, while those that weighed between 50-59g had the lowest prevalence (43.5%) of infection, despite having the highest worm load. All intestinal helminth parasites recovered were isolated from the intestine of the fishes, this may be due to the omnivore nature of the fish (Akinsanya *et al*., 2008). The histopathological analysis of the intestinal tissues of the infected fishes showed various pathological conditions such as stunting of villi, loss of intestinal glands, thickening of the mucosa, and loss of villous structure.

Conclusion:

Fish is an important source of high-quality protein, providing about 16% of the animal protein consumed by the world's population. Fish parasites affect the market value of fish, and they cause economic losses in fish farming and production. The results from this present study show that there is an increase in pollution at the Lekki Lagoon due to anthropogenic activities by humans. There is a need for concerted effort to mitigate the effect of pollution and proffer remediations in the aquatic ecosystem.

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