A TWO FISH SPECIES STUDY OF THE PARASITIC HELMINTH FAUNA OF *Synodontis filamentosus* (BOULENGER, 1901) AND *Calamoichthys calabaricus* (SMITH, 1865) FROM LEKKI LAGOON, LAGOS, NIGERIA

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ABSTRACT

The parasitic helminth fauna of a fish *Synodontis filamentosus* and *Calamoichthys calabaricus* was investigated. A total of 100 specimens from each of the fish species (n= 200) was examined. The female specimens of *S. filamentosus* had a prevalence of 46% while the male specimens had a lower prevalence of 37.2%. No infection was recorded in the fish species *C calabaricus*. There was no single parasitic infection in all the specimens examined. The worm burden was high in *S. filamentosus* with male specimens recording ninety five helminths while the female specimens recorded two hundred and seventeen helminths in both single and mixed infections (single infection was 2% while multiple infections was 98%). The overall prevalence of parasitic infections in the two fish species is 42%. The length range for *S filamentosus* was 6.0 - 13.5cm while for *C calamoichthys* the length range was 21.5 – 34.0cm. The Caryophyllidea cestode, *Wenyonia sp and a* nematode*, Raphidascaroides sp* were recovered from the intestine of *Synodontis filamentosus*. The length range were 10.0cm and 28.0cm for *S. filamentosus* and *C. calamoichthys* respectively while the weight range for the two fish species was 37.0g and 32.0g respectively. Condition factor range was 2.07 – 5.93 and 0.07 – 0.23 in *S. filamentosus* and *C. calamoichthys* respectively. Infection was more pronounced in the juveniles of *Synodontis filamentosus* and less pronounced in the adults .

Keywords; *Synodontis, Calabaricus,Wenyonia* , helminth

INTRODUCTION

Fishes are a diverse group of animals serving as one of the best sources of animal protein to human. They are harvested in bulk in Nigeria and are of great economic importance representing the key organisms in aquaculture. Aquaculture is defined as the rearing of fish in artificial or natural bodies of water by manipulation of the environment with the aim of increasing production beyond the natural limit (Ugwumba *et al.,* 2003).

Water bodies in Nigeria harbor a variety of fish species that serve as food and an economic resource to the country. Some of the most important species that account for 90% of Nigeria's fishery includes croaker, catfishes, tilapias, threadfins and the clupeids (FDF, 2004).

An appreciable proportion of the Nigerian population live close to creeks, rivers and lakes, and their main means of occupation is fishing. When parasites infect fishes, they show emaciation, anaemia, discolouration of the skin and susceptibility to secondary infections.

According to the Food and Agriculture Organization, (FAO, (1997), fish is an important source of high quality protein, providing about 16% of the animal protein consumed by the world's population. In Nigeria, fish provides 40% of the dietary intake of animal protein of the average Nigerian. Aside from being a source of protein for livestock, fish plays an important role medicinally as it replenishes the human body with vitamins A and D; calcium, phosphorus and lysine; sulphur and amino acids (Ohen *et al.,* 2007).

Fish is very important in the diet in tropical Africa and different parts of the world in that it has higher biological value in terms of high protein retention, assimilation, low cholesterol content, and safety. Sikiru *et al.* (2009) observed that fisheries production has steadily shifted away from developed countries to developing countries. FAO (1995) reported that fish production in Nigeria has failed to meet domestic demand . This has led to the existence of a demand-supply gap of at least 0.7 million metric tons with import making up the short fall.

Widespread homestead and small scale fish production can substantially solve the demand-supply gap in the country. Efforts made to improve fish production in the country must be anchored on analysis of fish production (Kudi *et al.,* 2009).

Synodontis filamentosus and *Calamoichthys calabaricus* are important delicacies for inhabitants along the shores of the West Africa freshwater. The genus *Synodontis* belong to the group of fishes which are members of the mochokidae family found in Africa. *Synodontis species* occurs only in Africa and, apart from those species present in River Nile, they are restricted to water systems within the tropics (Willoughby, 1974).

Synodontis filamentosus is a species that is native to the Sudan, it occurs at the mouth of the White Nile River. It is particularly wide-spread in Africa, and occurs also in the Chad, Volta and Niger River basins. It is particularly common in the Bénoué branch of the Niger (Paugy and Roberts, 1992). It has a variable body colour pattern, depending on where it was collected. Small spots, larger irregular dots, and several other variations are seen on this catfish with a purple-grey ground. They have a very long adipose fin which aids identification while possessing a higher body weight than some other species, reaching a size of 20 to 25 centimeters, depending on where they are collected. They are found in soft water; tolerate a pH within the range of 7 and a temperature range of 75 to 79°C (Skelton, 1993). They are generally classified as omnivores or predators feeding mainly on aquatic insects, fishes and higher plants debris (Micah, 1973). They have also been found to feed on terrestrial insects, molluscs and fruits.

Calamoichthys calabaricus or the Reed fish is a species of water fish in the Bichir family. It is native to West Africa, with its natural habitat stretching from Nigeria to The Congo and it is the only member of the genus. It has a maximum total length of 90 cm (36 inches), lives in slow-moving, brackish or fresh water; and warm water within a temperature of 22 to 28 °C. It can breathe atmospheric air using a pair of lungs; this makes it able to survive in water with low dissolved oxygen content and to survive out of water for brief spells (Froese *et al.*, 2004).

*C. calabaricus*is is a nocturnal creature that feeds on annelid worms, crustaceans and insects at night. Despite its nocturnal life style, *C . calabaricus* sometimes comes outside during the day to predate on bloodworms or nightrawlers for larger fish. Some of them have affinity to stay close to the water surface where they will be safe from predatory fishes (Rainer *et al.*, 2004).

C . calabaricus are peaceful and inquisitive. Due to their peaceful nature, they undergo threats from other fishes despite their large size when competing in the water body for space and food . These two fish species are harvested for sale and subsequent consumption in Nigeria.The increasing demand for freshwater fish species by the growing population in developing countries and the growing fish culture in Nigeria make it imperative to screen for the incidence of infection in these freshwater fish species. Relatively few workers have documented information on the parasitofauna of other relatives of *S filamentosus*. Khalil (1971) and Van *et al.* (1984) reported the existence of over 40 species of adult tapeworms in African catfish. The objective of this study is to identify the parasitic helminth fauna of *Synodontis filamentosus* and *Calamoichthys calabaricus* to determine the location of the intestinal parasites in the fish hosts and to determine the influence of the sex of the fish on the susceptibility to parasitic infections.

MATERIALS AND METHODS

Description of Study Area

Lekki lagoon supports a major fishery in Nigeria. The Lekki lagoon located in Lagos State Nigeria lies between longitudes $4^{0}00'$ and $4^{0}15'$ E and between latitudes $6^{0}25'$ and $6^{0}37'$ N, has a surface area of about 247 km^2 with a maximum depth of 6.4m. A large portion of the lagoon is shallow and less than 3.0 m deep.

The Lekki lagoon is part of an intricate system of waterways made up of lagoons and creeks that are found along the coast of South-Western Nigeria from the Dahomey border to the Niger Deltas stretching over a distance of about 200km. It is fed by the River Oni discharging to the North-Eastern and the Rivers Oshun and Saga discharging into the North-Western parts of the lagoon.

The vegetation around the lagoon is characterized by shrub and raphia palms, *Raphiasudanica,* and oil palms *Elaeisguineensis.* Floating grass occur on the periphery of the lagoon while coconut palms *Cocos nucifera* are widespread in the surrounding villages. The lagoon which experiences both dry and rainy seasons typical of the Southern part of Nigeria supports a major fishery in Nigeria. Fig. 1 shows the map of Lekki Lagoon, Lagos, Nigeria.

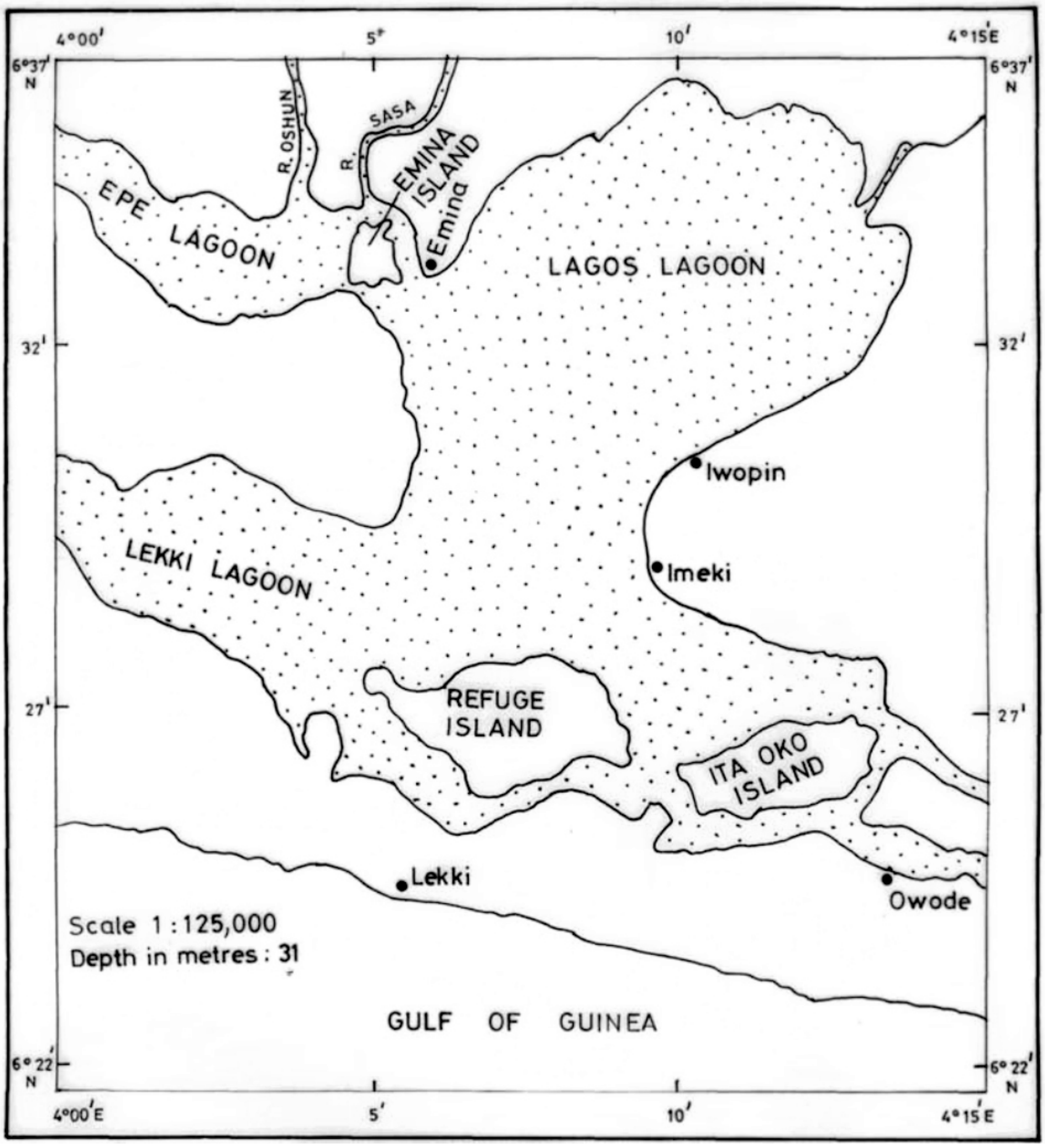

Fig. 1: A Map Showing the Lekki Lagoon, Lagos

FIELD PROCEDURES

Collection and Examination of Specimens for Parasites

From December 2010 to June 2011, one hundred fresh specimens, each of *S. filamentosus* and *C. calabaricus* were purchased at Oluwo Market, Epe, Lagos, Nigeria. The fishes were opened from the mouth laterally and the alimentary canals were removed and cut into different parts such as the stomach, small intestine and large intestine. This was done in a Petri dish with normal saline for parasite recovery. The intestines were carefully slit open to aid the emergence of parasites. The wriggling movements of the worms during emergence enhanced its recognition.The parasitologic examination of the specimens were done immediately on the field to prevent autolysis of the host intestine. They were subsequently processed for parasitic examination.

Morphological Parameters of the Fish Species

The total length of each fish was taken on the spot from the tip of the snout (with the mouth closed) to the extended tip of the caudal fin while the standard length was obtained by subtracting the length of the caudal fin from the total length. This was done using a transparent ruler and recorded to the nearest 0.5 centimeter (cm). After draining excess water from the mouth and blot drying, the weight (w) of the same fish was obtained to the nearest 0.1g using a Standard loading Denward balance. Sex determination of the fish species was done by visual examination of the anal opening. The presence of an intromittent organ on the ventral side, just before the anal fin is indicative for a male species while the absence of the intromittent organ indicates a female species. This was consequently confirmed by the presence or absence of testis or ovaries during dissection.

Processing of Parasites Recovered

The guts were removed, washed in saline and the parasites recovered were fixed and preserved in 70% alcohol. They were counted, recorded and the identifications of the parasites were carried out at the Natural History Museum, Parasitic worm Division, United Kingdom.

Condition Factor of the Fish Species

The mathematical parameters of the relationship between the length and the weight of fish furnish further information on the weight variation of individuals in relation to their length (condition factor, K). This factor estimates the general well-being of the fish (Ikpeoha *et al.*, 2007). It is the ratio weight of the whole fish to the cube of its standard length and it is influenced by age, sex, season and maturity stages of the fish. Specimens of a given length exhibiting higher weight are said to be in better condition.

RESULTS

Overall Prevalence of Helminth Infection

Out of a total of 200 fish specimens examined, 42 (21%) were infected with different helminth parasites (Table 1). The worm burden was high in *S. filamentosus* with three hundred and twelve (312) helminth parasites recovered in both single and mixed infections. A maximum of fourteen helminths were recovered from a specimen while average worm load (intensity) was seven (7).

The prevalence of helminth parasites in *Synodontis filamentosus* was higher in female fish (46%) than in males (38%) . However, there was no significant difference in prevalence of infection in both sexes. ($p>0.05$; Table 2).

A monozoic cestode (*Wenyonia* species) belonging to the family Caryophyllaedae and a nematode *Raphidascaroides sp* were recovered from the intestine of *Synodontis filamentosus* while there was no infection in *Calabaricus calamoichthys.*

Table 1: Overall Helminth Parasites in Both *Synodontis filamentous* and *Calamoichthys calabaricus*.

Sample organisms	Number examined	Number infected	Prevalence (%)	Total number of parasites recovered	Mean Intensity
Synodontis filamentosus	100	42	42	312	7
Calamoichthys Calabaricus	100	0	0	0	0
Total	**200**	**42**	**21**	**312**	**7**

Table 2: Prevalence of Gastrointestinal Helminthes Infections in Relation to Sex of *Synodontis filamentosus*

Sex	Number examined	Number infected	Prevalence (%)	Total parasites recovered	Mean Intensity
Male	43	16	37	95	6
Female	57	26	46	217	8

$\chi^2 \alpha$ **(1)** =3.841: χ^{2*}=0.87, (p> 0.05)
(χ^{2*} = calculated Chi-Square)

Prevalence of Helminth Infection in Relation to Length and Body Weight of the Fish hosts.

Synodontis filamentosus comprised of three age groups – juveniles, sub-adults and adults which are classified on the basis of their standard length ranges. Minimum length (Standard length) examined was 6.0 cm while maximum length examined was 13.5 cm. Parasitic infection was not limited to any of the groups but was more pronounced in juveniles while the sub-adult recorded the lowest prevalence of infection as shown in Table 3. The table shows that among the males the prevalence of helminthes infection decreased with increase in length.Among the females, the prevalence patterns decreased from the juveniles to subadult and then rose among the adults. In both sexes, the prevalence decreased from maximum of 63% to a 36% among the sub-adult and then rose to a prevalence of 39% among the adult..

The minimum weight of *S. filamentosus* examined was 10 g while maximum weight was 68 g. The smallest weight group recorded the highest rate of infection. The females also recorded the highest prevalence in all weight groups but Chi-Square (x^2) analysis revealed that there was no significant difference (p>0.05) between prevalence and weight. Thus, prevalence of infection in *S. filamentosus* was independent of weight. Maximum weight examined for *Calamoichthys calabaricus* was 48 g while the minimum weight was 10 g. Table 4 shows the vivid picture of gastrointestinal helminth infections in relation to body weight in *S. filamentosus*.

Table 3: Prevalence of Gastrointestinal Helminthes Infections in *Synodontis filamentosus* in Relation to Standard Length of the Fish

Standard Length (cm)	Number Examined	No. Infected	Prevalence (%)	Worm Load	Mean Intensity
Male					
[illegible]	13	8	62	57	7
8.0 - 10.9	11	3	27	29	10
11.0 - 13.9	19	4	21	25	6
Female					
5.0 – 7.9	3	2	67	18	9
8.0 - 10.9	22	9	41	63	7
11.0 - 13.9	32	16	50	120	8
Both Sexes					
5.0 – 7.9	16	10	63	75	8
8.0 - 10.9	33	12	36	92	8
11.0 - 13.9	51	20	39	145	7

$x^2\alpha\ (2) = 7.815 : x^{2*} = 0.65$, $(p > 0.05)$

Table 4: Prevalence of Gastrointestinal Helminthes Infections in *Synodontis filamentosus* in Relation to their Body Weight.

Weight (g)	Number Examined	No. Infected	Prevalence (%)	Worm Load	Mean Intensity
Male					
10 – 29	24	11	46	86	8
30 – 49	6	0	0	0	0
50 – 69	13	4	31	25	6
Female					
10 – 29	16	10	62	67	7
30 – 49	23	5	22	42	8
50 – 69	18	12	67	92	8
Both Sexes					
10 – 29	40	21	53	153	7
30 – 49	29	5	17	42	8
50 – 69	31	16	52	117	7

$x^2\alpha\ (2) = 7.815 : x^{2*} = 0.07$, $(p > 0.05)$

CONDITION FACTOR

Length and Weight Measurement of *Synodontis filamentosus* and *Calamoichthys calabaricus*.

Randomly-selected specimens were measured to obtain their length and weight parameters. The lengths were 10.0cm and 28.0cm for *Synodontis filamentosus* and *Calamoichthys calabaricus* respectively. The weight for *Synodontis filamentosus* was 37.0g while that of *Calamoichthys calabaricus* was 32.0g. The length and weight of samples of these two fishes showed positive correlation (r). The value of r for *Synodontis filamentosus* was 0.95 as shown in Fig. 2 while Fig. 3 shows length-weight relationship of *Calamoichthys calabaricus* examined. r was equal to 0.82, depicting a direct correlation between length and weight measured from the study.

Condition Factor in Relation to Length of the Fish Hosts

The condition factor (K) range was 2.07 – 5.93 and 0.07 – 0.23 in *Synodontis filamentosus* and *Calamoichthys calabaricus* respectively. The mean condition factor for *Synodontis filamentosus* was 3.37 while a mean value of 0.15 for K was recorded in *Calamoichthys calabaricus*. The correlation coefficient between condition factor (K) and standard length were analyzed. Both organisms yielded negative or indirect perfect correlation (r = -0.71: r = 0.66) This is shown in Figs. 4 and 5.

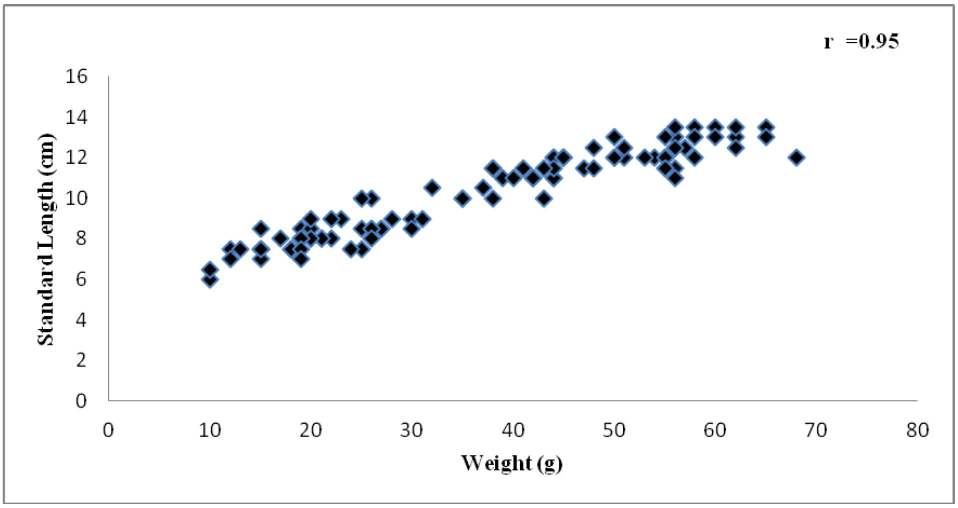

Fig.2: Relationship between Standard Length and Weight of *Synodontis filamentosus.*

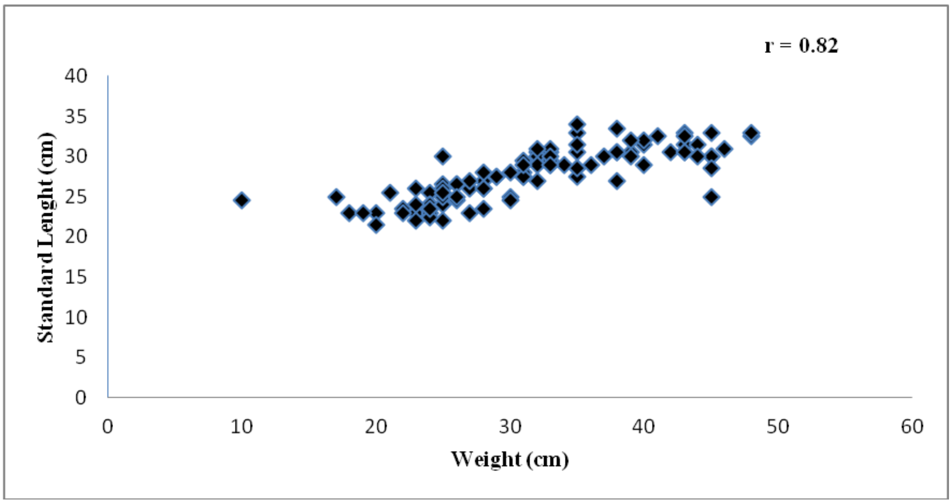

Fig. 3: Relationship between Standard Length and Weight of *Calamoichthys calabaricus.*

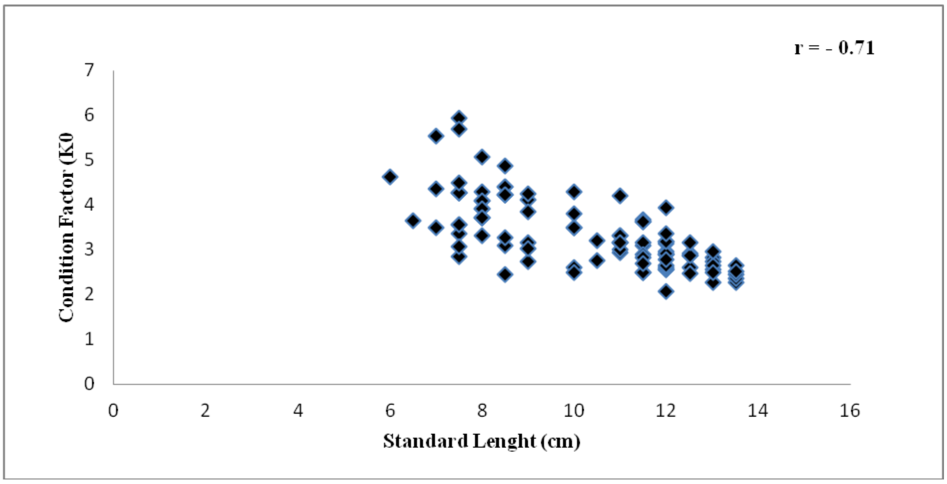

Fig. 4: Relationship Between Condition Factor and Standard Length of *Synodontis filamentosus.*

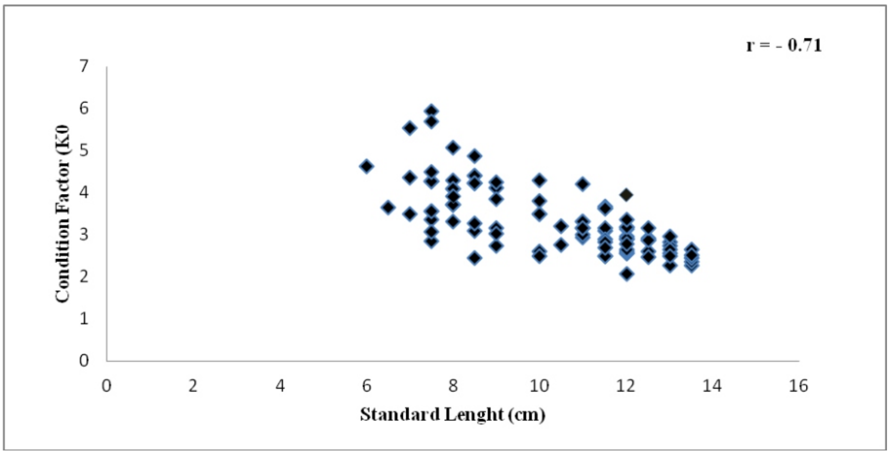

Fig 5: Relationship Between Condition Factor and Standard Length of *Calamoichthys calabaricus.*

Condition Factor in Relation to Weight

Synodontis filamentosus has a K value of - 0.50 showing an indirect perfect correlation coefficient while the r value for *Calamoichthys calabaricus is* - 0.15, showing strong negativity of weight with condition factor. Figs. 6 and 7 illustrate the relationship between condition factor and weight of the fish hosts.

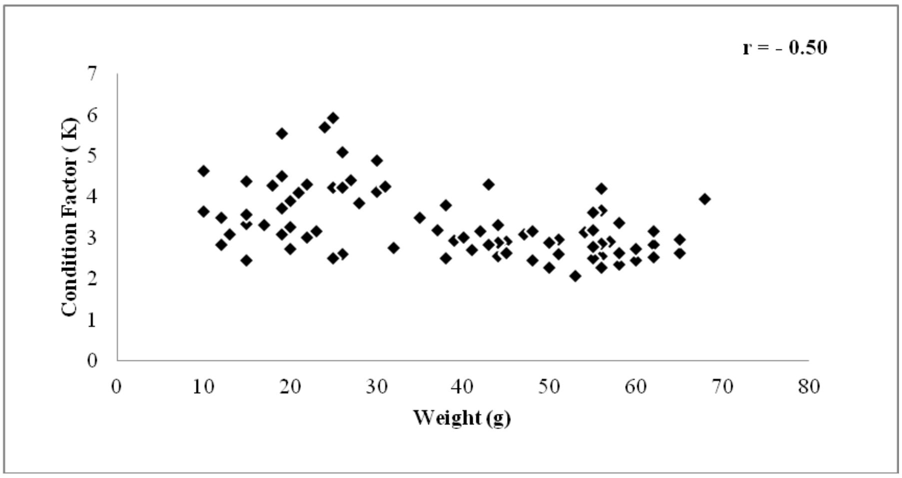

Fig. 6: Relationship Between Condition Factor and Weight of *Synodontis Filamentosus.*

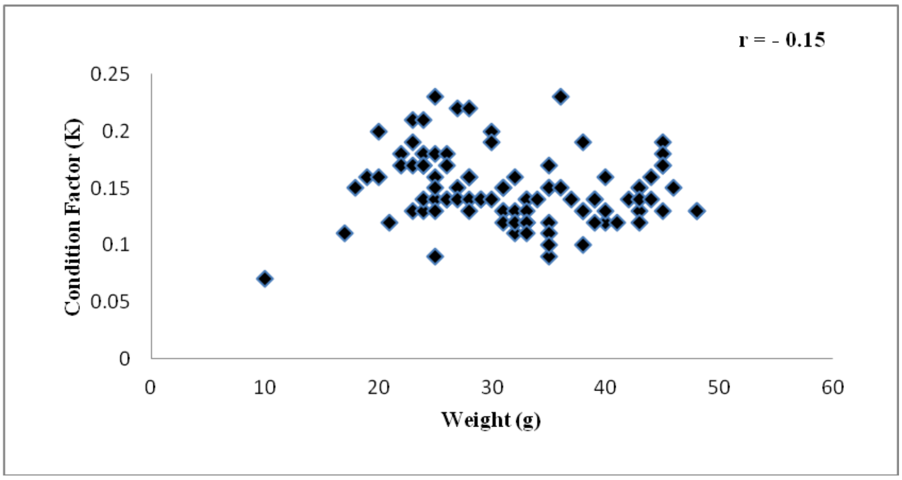

Fig 7 : Relationship Between Condition Factor and Weight of *Calamoichthy scalabaricus*

DISCUSSION

The overall prevalence of the helminth parasites (42%) recorded in this study among *Synodontis filamentosus* was lower than a prevalence of 85.2% reported in Zaria for *Synodontis species* by Auta *et al.*(1999). This may be due to ecological differences between the habitats. Williams and Jones (2004) opined that parasitism varies from one aquatic ecosystem to the other and that it influences by the interplay of mixed biotic and abiotic factors. It is also worthy that infection rates vary from one region to another and that a number of factors like availability of intermediate host, susceptibility of a definitive host, amongst others, determine to a large extent the rate of infection.

Stomach content analysis revealed that mollusks, crustaceans, copepods and insects formed part of the diet of *S. filamentosus* in Lekki Lagoon. These dietary items could have served as intermediate hosts of various parasites like the nematodes whose life cycle in fresh water fishes involves invertebrate host especially crustaceans and aquatic insects. Paperna (1996) implicated worms and copepods as invertebrate intermediate hosts of several species of nematodes and cestodes.The high number of parasites found in the intestines of fish samples could also be associated with the fact that most digestion activities take place in the intestine resulting in the release of parasite ova/cysts in food particles while presence of absorbable food materials in the lumen of the gut allows for the establishment of helminth parasites (Onyedineke, *et al.,* 2010). Akinsanya (2007 a, and b) and Akinsanya 2007 (c and d) have reported several species of helminths recovered from some species of fishes.

Lagler *et al.* (1979) and Torres *et al.* (1977) reported that an increase in size is a reflection of increase in length which is considered a measure of age, hence the fish hosts were grouped into juveniles, sub- adults and the adults. The results from the study showed that the juvenile stages of *Synodontis filamentosus* were highly parasitized. This might be attributed to low level of immunity in smaller - sized fish and the small number of the juvenile age group examined. This is in line with the observation by Obano (2006, 2010), and Oniye *et al.* (2004) but in contrast with the observations by Ayanda, (2008) and Reed *et al.* (1967) whose works recorded more infection rates in large-sized fishes.

There were variations in parasitic infection among the sexes and weight classes of *S. filamentosus* studied but statistics revealed that the degree of helminth infection was independent of these parameters. Higher prevalence in either the males or females may simply be by chance and there might be no reason to believe that one sex should have more parasitic infection than the other. A study by Onyeideike *et al.* (2010) on *S. eupterus*, *S. clarias*, *Chrysichthys nigrodigitatus* and *Clarias kingsleye* which are related species of *S. filamentosus* shows that there is no specific trend in parasite prevalence in relation to weight classes.

In this study, two major groups of parasites were encountered, cestode and nematode. The Caryophylaedae cestodes (*Wenyonia sp.*) reported in this study is common in Nigeria freshwater fishes. It has been reported by Ukoli (1969), Ugwuzor (1987), Okaka (1991) and Akinsanya (2007b) The other helminth recovered was a nematode., *Raphidascaroides sp.* Multiple infections with helminth parasites in *Synodontis* species inhabiting Nigeria inland water was reported by Owolabi (2008).

There was no parasites observed in *C. calabaricus.* Their quiescent and inactive nature could make competition for food low and hence, a possibility of low or no parasitic manifestation. Chubbs (1982) however suggested the possibility of antibody complement secretion into the intestine in the mucus by fishes; a physiological action that might also prevent the establishment of parasites in the gut of *C. calabaricus*. It could be a case of coincidence owing to the randomness and number of samples examined within a particular time frame.

The length-weight relationship of *S. filamentosus* and *C. calabaricus* specimens collected at the Lekki Lagoon, Lagos were determined to ascertain the wellbeing of the fishes. The condition factor obtained shows that the fishes were thriving fairly well in the Lagoon.The good condition of *C. calabaricus* in Lekki Lagoon could have probably been responsible for the zero prevalence recorded. Oswald *et al.* (1992) reported that fish species in good environmental conditions are rarely susceptible to the attack of fish diseases (Owolabi, 2008).

The availability of certain classes of nutrient and their different sites of absorption and digestion plays a distinct role in knowing the parasite and its distribution in the gut. Carbohydrates, especially glucose and other monosaccharides have been considered to be a major limiting factor in the survival and growth of tapeworm and acanthocephalans. (Hickman *et al.* ,2008)
Unlike bacteria and viruses that cause great mortalities and could wipe out whole populations of fish, helminth parasites generally cause chronic damage which may be tolerated by fish. However, they are significant enough to retard fish growth, cause tissue disruption, reduce fish numbers by death and more importantly, reduce their market value.

Although, the pathological effect of these worms in the fish was not observed, the prevalence obtained 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, the aquaculture development of the species may have to depend on the collection of fingerlings and or parent brood stocks from the wild. Considering the suggestion made by Oniye *et al.* (2004) on the protection of siluriforms such as *Clarias gariepinus*, the incorporation of anti – helminthic therapy into the diets of *S. filamentosus* and even to the uninfected *C. calamoichthys* may prevent infestation, thus providing a better aquaculture condition and proffered solutions to some of the problems of fish farmers. It can also be recommended that since parasitic infection affect the palatability and aesthetic value of fish conditions that favour parasite infestation should be eliminated by establishing some standard degree of surveillance and periodic checks for parasite in our culture tanks. Further studies are still essential to establish the extent of pollution as a result of environmental changes, whether natural or man-made and to proffer probable natural control of the helminth parasites in Lekki Lagoon.

REFERENCES

Akinsanya, B., Hassan, A. A., and Otubanjo O. A. 2007a. A comparative study of the parasitic helminth fauna of *Gymnarchus niloticus* (Gymnarchidae) and *Heterotisniloticus* (Osteoglossidae) from Lekki Lagoon, Lagos, Nigeria .*Pakistan Journal of Biological Science* 10(3):427-32.

Akinsanya, B. 2007b. Histopathological study on the parasitised visceral organs of some fishes of Lekki Lagoon, Lagos, Nigeria. *Life Science Journal* 4(3): 70-76.

Akinsanya, B., Otubanjo, O.A., and Ibidapo C.A. 2007c. Helminth Bioload of *Chrysichthys nigrodigitatus*(Lacepede, 1802) from Lekki Lagoon Lagos, Nigeria *Turkish Journal of Fisheries and Aquatic Sciences* 7: 83-87.

Akinsanya, .B.,Otubanjo O. A., and Hassan A. A. 2007d. Helminth Parasites of *Malapterurus electricus* (Malapteruridae) from Lekki Lagoon, Lagos, Nigeria. *Journal of American Science* 3(3): 1-6.

Anna, R. 2003. Cestodes of the Antarctic fishes.*Polish Polar Research.* 24 (3-4): 261–276.

Auta, J., Oniye, S.J., and Adakole, J.A. 1999. The helminth parasites of the gastro-intestinal tracts of *Synodontis*species in Zaria, Nigeria, Zuma. *Journal of Pure and Applied Science* 2 (2): 47 – 53.

Ayanda, O. I. 2008. Comparative study on the Parasitic Infection between the different Age Groups of *Clariasgariepinus* from Asa Dam, North-central, Nigeria, *African Journal of Environmental Science and Technology* 2(11) : 404-406.

Bloch, B. L., and Sudha, M. 2005. Redescription of *Procamallanus mathurai* (Pande, Bhatia and Rai, 1963 - Camallanidae: Nematoda). *Boletínchileno de parasitología*, 54: 3-4.

Chubb, J. C. 1982. Seasonal occurrence of helminthes in freshwater fishes. Part IV. Adult Cestoda, Nematoda and Acanthocephala. *Advanced Parasitology* 20: 1-22.

Edema, C.U., Okaka, C.E., Oboh, I.P., and Okogub, B.O 2008. A Preliminary Study of Parasitic Infections of Some Fishes from Okhuo River, Benin City, Nigeria. *International Journal of Biomedical and Health Sciences* 4(3): 107-112.

FAO. 1995. Code of conduct for responsible fisheries. FAO, Rome.

FAO 1997. The State of Fish: Aquaculture. Food and Agriculture Organization, Rome.

FDF 2003. *Fisheries development sub-sector*. Paper presented at presidential forum, Abuja: 1-11.

Federal Department of Fisheries 2004. Fisheries Statistics of Nigeria. 45pp.

Hickman, C.P., Roberts, L.S., Larson, A., I'Anson, H., and Eisenhour, D.J. 2008. Integrated Principles of Zoology (14th Edition), McGraw Hill and Company. pp: 289-311, 384-400.

Hassan, A.A., Akinsanya B., and Adegbaju W.A. 2007. Haemoparasites of *Clarias gariepinus* and *Synodontis clarias* from Lekki lagoon, Lagos Nigeria. *Journal of American Science* 3 (3): 61-67.

Jackson, J.A., and Tinsley, R.C. 2002. Representatives of *Batrachocamallanus ng* (Nematoda: Procamallaninae) from *Xenopus* spp. (Anura: Pipidae): Geographical Distribution, Host Range and Evolutionary Relationships, *Systematic Parasitology* 31: 159-188.

Khalil, L. F. 1971. *Checklist of the helminth prasites of African feshwater fihes.* Common wealth Agricultural Bureaux. Farnham Royal, Slaugh. England. 80pp

Kudi, T.M., Bako, F.P., and Atala, T.K. 2008. Economics of fish production in Kaduna State, Nigeria. *ARPN Journal of Agriculture and Biological Science* 3: 17-21.

Kusemiju, K. 1981. The hydrobiology and fishes of Lekki Lagoon. *Nigerian Journal of Natural Sciences,* 3(1-2): 35-146 In: Helminth Parasites of *Clarias gariepinus* (Clariidae) in Lekki Lagoon, Lagos. Akinsanya *et al.* (2006), *Nigeria.Rev.bio. Trop.* 54 (1): 93 – 99.

Lagler, K. F., Bardach JE, Miller RR 1979. Ichthyology. John Wiley, New York. In: Comparative study on the Parasitic Infection between the different Age Groups of *Clarias gariepinus* from Asa Dam, North-central, Nigeria, Ayanda, O. I. 2008. *African Journal of Environmental Science and Technology* 2 (11): 404-406.

Maizels, R.M., and Yazdanbakhsh, M. 2003. Immune Regulation by Helminth Parasites: Cellular and Molecular Mechanism. *National Review of Immunology* 3(9): 733-744.

Micha J.C. 1973. Etude des populations piscoles de pubangui et tentative de selection et d' adaptation de quelques especes a l'etang de piscecuture. Center Technique Forestiere Tropical, Nogent 1961.

Obano E.E., Ezeri G.N., and Aniyie U.K. 2010. Studies on the parasitic infections in fishes in Ovia river at Ikoro, Ovia South-West Local Government Area of Edo State, Nigeria, *Bioscience Research Communications* 22 (30): 137-143.

Obano, E.E., and Odiko A.E. 2004. Parasitic fauna of freshwater fish from Ogba River, Benin City, Nigeria.*Nigerian Journal of Applied Science* 22: 322-324.

Obano, E.E. and Okaka, C.E 2007. Helminth parasites infections in fishes of Ogba River, Benin City, Edo state Nigeria *African scientist* 8(2).

Okaka, C. E. 1999. A survey into the helminth parasites of fishes of Asa River and its Dam at Ilorin, Nigeria. *Journal of Experimental and Applied Biology* 3: 12-18

Onyedineke, N. E., Obi, U., Ofoegbu, P.U., and Ukogo, I. 2010. Helminth Parasites of some freshwater fish from River Niger at Illushi, Edo State, *Nigeria.Journal of American Science* 6 (3):16-21.

Osward, E., and Hulse, J.H. 1992. Fish quarantine and Fish disease in South East Asia. Report of Workshop held in Jarkata, Indonesia. Coordinating Programme (Philippines) and International Development Resource Centre Centre, Canada. 5pp.

Otubanjo, O.A. 2007. *Elements of Parasitology*. Panaf Publishing, Inc. pp: 20-25.

Owolabi,O.D. 2008. Endoparasitic Helminths of the Upside -Down Cat Fish, *Synodontis Membranaceus* (Geoffrey Saint Hilarie) In Jebba, Nigeria. *International Journal of Zoological Research* 4(3): 181-188.

Ohene-Adjei, S., Teather, R.M., Ivan, M. *and* Forster, R.J. 2007. Postinoculation protozoan establishment and association patterns of methanogenic archaea in the ovine rumen. *Appl. Environ. Microbiol.* 73, 4609–4618.

Paperna, I. 1996. Parasite infections and disease of fishes in Africa, F.A.O., C.I.F.A Technical paper, 31: 220pp.

Patrlcio, T., and Eileen, R., Walter, G., and Aldo, M. 1991. Gastrointestinal Helminths of Fish Eating Birds from Chiloe Island, Chile.*Journal of Wildlife Diseases* 27(1):178-179.

Paugy, D. and T. R. Roberts, 1992. Mochokidae. p. 500-563. In C. Levêque, D. Paugy, and G.G. Teugels (eds.) Faune des poissons d'eaux douces et saumâtres d'Afrique de l'Ouest Tome 2. Coll. Faune Tropicale n° 28. Musée Royal de l'Afrique Centrale, Tervuren, Belgique and O.R.S.T.O.M., Paris, France, 902.

Rainer, E., and Pauly, D. 2004. *Erpertoichthy scalabaricus.* Fish Base.

Reed, W., Burchan, J., Hopson, A.J., Jennes, J., and Yaro, I. 1967. Fisheries of Northern Nigeria.M.A.N.R. 22pp.

Rehulkova, Eva B., Vlastimi G., and Milan 2005. Two Remarkable Nematodes from the African Reed Fish *Erpetiochthyscalabaricus*. *Helminthologia* 42(3) : 149-153.

Reed W, Burchan J., Hopson A.J. , Jennes J. and Yaro I 1967. *Fish and fisheries of Northern Nigeria.*_Publ. M.A.N.R. 22p.

Sikiru, B.O., Omobolanle, B.O., Ayorinde, B.J.O., and Adegoke, O.O. 2009. Improving *Clarias*productivity towards achievibg food security in Ijebu-Ode, Ogun State, Nigeria.*Advanced Biological Research* 3: 24-28.

Skelton, P. H., 1993. A complete guide to the freshwater fishes of Southern Africa. Southern Book Publishers 388pp.

Tacon, A. G. 2001. Aquatic feeds and nutrition: minimizing environmental impacts of shrimp feeds. *The Global Aquaculture Advocate* 4 (6): 34-35.

Torres, P.B., Contreras, L., Figuerga, R., Franjola, H., Gonzaleh, R, and Martin, R., 1977. Research on Pseudophyllidea from the South of Chile, In: Preliminary investigation on infection by Plerocercoids of *Diphyllobotrium sp.* in *Salmogairdnerii* from Calatquenlake, Chile. *Boletin Chileno de Parasitologi.* 32: 73-80.

Ugwumba, A.O., and Ugwumba, A.A. 2003. Aquaculture option and the future of fish supply in Nigeria. *The Zoologist.* 2: 96-122.

Ugwuzor, G.N. 1987. A survey of helminth parasites of fish in Imo River. *Nigerian Journal of Applied Fisheries and Hydrobiology* 2: 25-30.

Ukoli, F. M. A 1969. Preliminary report on the helmithic infections in the River Niger at Shagunu (near kainji) In: *Proc. Accra symp.* Man – Made lake (Ed Obeng, E. E). Accra, Ghana. University Press for Ghana Academy of Sciences. pp: 269 – 283.

Van As, J.G. & Basson, L., 1984. Checklist of freshwater fish parasites from southern Africa. *S. Afr. J. Wildl.* 14: 49–61.

Vermont Fish & Wildlife Department 2004. Cestodes (Tape worms).Vermont Agency of Natural Resources, 1pp.

Volknandt, W., and Zimmermann, H. 2006. Acetylchdine, ATP, and Proteoglycan are Common toSynaptic vesides isolated from the electric organs of electric eel and electric catfish. *Journal of Neurochemistry* 47(5):1449 – 1462.21.

Wen, X. L., Pin, N.,Gui, T. W., and Wei, J. Y. 2009. Communities of gastrointestinal helminths of fish in historically connected habitats: habitat fragmentation effect in a carnivorous catfish *Pelteobagrus fulvidraco* from seven lakes in flood plain of the Yangtze River, China. *Parasites and Vectors*, 2 (22): 1756-3305 (http://www.parasitesandvectors.com/content/2/1/22).

Williams H, Jones A. 2004. Parasitic worms of Fish, Taylor and Francis, Bristol, UK. 593pp

Willoughby, N. G. 1974. The ecology of Synodontis (Pisces: Siluroides) in Lake Kainji, Niger, Nigeria. *Ph.D. thesis*, University of Southampton. 288pp.

Woodland, W. N. F. 2007. On some remarkable new Monticellia-like and other Cestodes from Sudanese siluroids. *Quart J. of Microsc. Sci.* 69(4): 703 – 729.