GASTROINTESTINAL PARASITES OF FISH AS BIO-INDICATORS OF THE ECOLOGY OF CHANCHAGA RIVER, MINNA, NIGER STATE

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ABSTRACT

Fish parasites are of particular interest in relation not only to fish health but also in the understanding of ecological problems. A study of the gastrointestinal parasites of fish as bio-indicators of heavy metal pollution in Chanchaga River was carried out from May-August, 2014. A total of 100 specimens were sampled which comprises of 4 species; Tilapia zilli, Auchenoglanisoccidentalis, Clariasgariepinus and Mormyrusrume (25 samples each). The intestinal contents of the samples were analyzed, parasites found were the Nematodes, 52.00% and mean intensity of 57.03, Cestodes, 28.00%with 4.14 mean intensity and some unidentified species of insects and Copepods were 12.00% and a mean intensity of 7.85. The concentration of the metals (Fe, Zn, Cu, Cr&Mn) were determined using Atomic Absorption Spectrophotometer (AAS). Result showed no significant ($P>0.05$) difference in the heavy metal accumulation in the muscle of both the infected fishes and the uninfected ones, but there was a significant ($P<0.05$) difference in the metal concentration in the intestines amongst the fish species for Cu in T. zilli(0.83±0.01mg/g) and in A. occidentalis(0.02±0.01 mg/g). Among the species sampled for heavy metal in fish muscle M. rumehad the lowest mean concentration (0.27±0.01 mg/g) while C. gariepinushad the highest (0.45±0.03 mg/g). This study has established the presence of gastrointestinal parasites in fish from Chanchaga River and also presence of heavy metal though in low quantity in the fish from the River thereby indicating that the river is slightly polluted.

Keywords: Fish parasites, Heavy metals, Gastrointestinal and Chanchaga River

INTRODUCTION

It is estimated that the population of the world is likely to increase from 6 billion to 8 billion in a short while, already at 7 billion, the escalating demand for animal protein will continue to increase. Animal protein contains essential amino acids which are important for well balanced nutritious diet. In order to meet the demand of the populace people are involved in large scale breeding of warm blooded animals close to human populations which poses serious problems associated with public health issues. There are also increased risks of disease outbreaks through the interspecies transmission of zoonotic disease to humans (e.g. avian influenza virus in birds)[1].

Pollution is the release of pollutants into the environment which results in unfavourable changes; therefore water could be polluted thereby affecting the organism found in the water body and ultimately organisms that depends on them. Most water pollution is caused by human activities such as dumping of industrial wastes such as heavy metals and pesticides runoffs from farms etc. Human activities release heavy metals into the atmosphere where they are transported across boundaries[2]. This results in water pollution through the deposition of heavy metals in environments far from the source of emission (Adams[3]). There are different types of pollutants including oxygen depleting materials, toxic metals, toxic gases, pesticides, fertilizers, heavy metals and toxic organics (Broeget al[4]; Chatlopodyayet al[5]).These heavy metals are chemical elements that are metallic in nature with a considerably high density and are toxic or lethal at low concentration. They comprise of Iron (Fe), Lead (Pb), Cadmium (Cd), Arsenic (As), Thallium (Tl), Chromium (Cr), Mercury (Hg), and Chromium (Cr). They are innate constituents of the Earth crust. They are indestructible; to a small degree they enter the body through water, air and food. Some trace elements like zinc, manganese and copper are vital to sustain metabolism in the body, though a high amount can result in poisoning. Heavy metals are toxic because they have a tendency to bioaccumulate. Heavy metals are treated with special care and great importance due to their highly toxic effect on fish and fish are known to have tendency for storing significant amounts of heavy metals in their tissues[6,7,8] thereby constituting health hazard to humans consuming these fishes.

The primary source of metal pollution in water bodies is runoffs from roads containing a compound mixture of possible pollutants. An increase in the sediments and concentrations of heavy metals in water was reported by Maltbyet al[9] pinpointing cadmium, chromium, lead and zinc as main metal pollutants from highway runoff. These metals are components of brake linings, tires and fuel[9]. The pollution of the water bodies with heavy metals is a very complicated and unsatisfactory problem, the metals may expose aquatic organisms such as fish to untold danger and they present a grave health challenge to man as well, as a result the careful management of pollutants is paramount [10].

The need to preserve the animal protein sourced from our various water bodies has spored the need to monitor the ecology of our various water bodies and the effect of human activities on it and also to proffer solutions to the problems. Reliable technologies for the detection of pollutants and policies and regulations for managing the aquatic environments are not readily in place or are expensive in relation to the technologies and are time consuming. The use of fish parasites however is one of the cheapest and most reliable ways of monitoring environmental disturbances in the aquatic ecosystem [11]. Fish parasites with complex life cycles are used as bio indicators for monitoring environmental disturbance in aquatic ecosystems. Some species of parasites or the entire parasite community serves as indicators for pollution. Relatively higher amount of heavy metals were discovered in tissues of endoparasite than in their host fish [12,13], for instance, the average concentration of cadmium and lead in Monobothriumwagneri in the intestine of tench (Tincatinca) were several times higher than in the host muscle [14,15].

Bioaccumulation increases the amount of chemicals in organism overtime, compared to the environment. Compounds accumulate in organisms whenever they are taken up and are stored more rapidly than they are broken down or passed out. They have negative effects on human health such as high blood pressure, renal dysfunction, skin irritation and ulceration, anemia, gingivitis etc.

The relative abundance of endoparasites and ectoparasites of fish in a particular aquatic ecosystem can be used as an indicator of environmental stress such as heavy metal pollution [16]. Fish are usually infested with several parasites species in the digestive tract, gills and other tissues. Understanding of these parasites is vital not only to learning about the health of the fish but also to judge the quality of the environment[7]. In aquatic ecosystem, the use of parasites as indicators of pollution has been confirmed to be most appropriate owing to their ability to bioconcentrate [17,18,19].

MATERIALS AND METHODS

Study Area

The study was carried out in Chanchaga River in Minna as a case study. Minna is located in the North Central geopolitical zone of Nigeria, located on latitude 9°36′ north and longitude 6°34′east. It covers a land area of 88 square kilometers with an estimated human population of 348, 788 (FDF Bulletin[20]). The area has a tropical climatic condition with mean annual temperature, relative humidity and rainfall of 20-30°C, 61% and 1334 cm respectively. The climate presents two separate seasons: raining season between May and October and dry season between November and April each year. The vegetation is a typical Guinea Savannah type consisting majorly of grassland with scattered trees.

River Chanchaga is located in southern part of Niger State. The River is about 215.61km in length, it takes it source from Mutundaya in Shiroro Local Government Area and flows southward through Zhalape, Shakwata, Shakwatu, Numbupi, Bali, Shaukikafuta, Shagna, TungaWaya, Kadna, Chanchaga, Korokpan, Kakaki, Shiri, Tadagona, Manmagi, Tswadan, Emiworogi, TwataDinkoso, Kenchi, Tsantsaga, Badeggi, Emijiko, Tswatagi, Shidisaba, Ndakwudu, Ekwuti and terminates at Gedege were it joins River Niger.

It lies between the interception of latitudes 8°43′N to 9°40′N and longitudes 6°12′E to 6°47′E of the equator. It is a municipal river with many tributaries including River Guduko, River Gorax, River Gbako and Tagwai dam. There are many anthropogenic activities going on in the river, which include gold mining, sand dredging, bathing, washing, farming, irrigation activities, indiscriminate defecation, fishing, etc. Fishing in the area is dominated by artisanal fishermen that use manually operated wooden (dug out) canoes. River Chanchaga is used by the Niger State Water Board, as the main distribution channel of water to Minna and its environs as shown in Figure 1.

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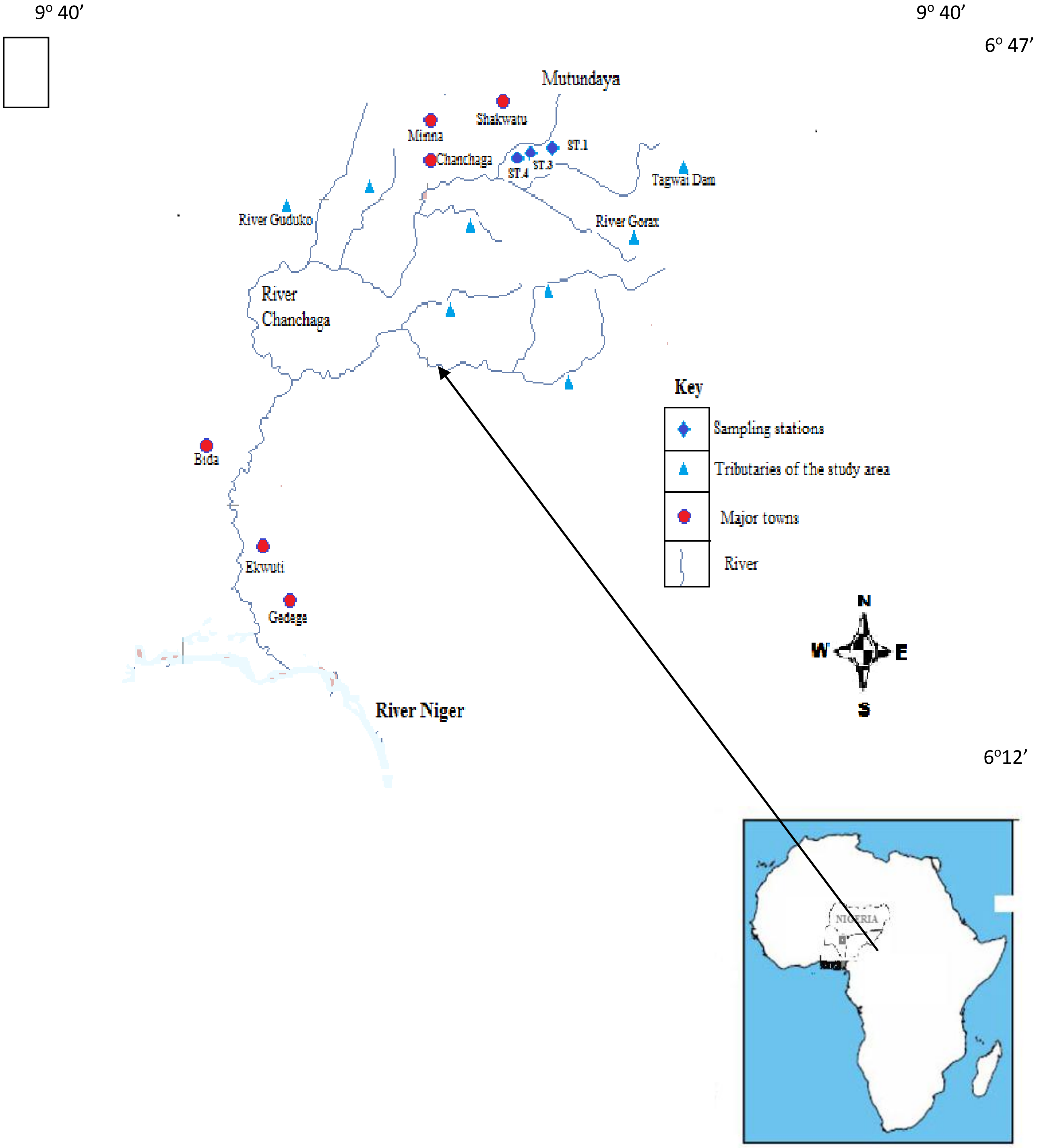

Fig. 1:RiverChanchaga (Source: FDF, 2004}

Sample Size

A total of four species of fish were sampled with twenty five of each species examined. The species sampled were Tilapia zilli, Mommyrusrume, Clariasgariepinus, Synodontisnigarata. A total of 100 fishes were examined.

Sample Collection

Freshly caught fish were collected from the River twice a month between the months of May and August 2014. The fish samples were taken to the laboratory in plastic containers for examination.

Sample Analysis

The fish samples were dissected and the intestine, kidney and liver were deposited in a petri dish containing normal saline. The intestine was dissected in order for the parasites to emerge and the intestinal content was also viewed under the microscope for microscopic intestinal parasites. The parasites seen were counted manually under the microscope. The method described by Sures[21] was used.

The heavy metal analysis was done using air/acetylene flame Atomic Absorption Spectrophotometer (AAS) according to Beavenet al[22] to check for heavy metals. The samples were tested for Copper (Cu), Lead (Pb), Iron (Fe), Zinc (Zn), Manganese (Mn), Chromium (Cr).

Data Analysis

Parasites prevalence and mean intensity was measured and calculated as defined by Margolis et al[23]. ANOVA was used to check for significant difference between the level of heavy metal concentration in the fish parasites and the fish tissue.

RESULTS

Results showed that four species of fish were sampled which includes Tilapia zilli 3(12.00%), Clariasgariepinus7(28.00%) while 12(48.00%) and 3(12.00%) are for Auchenoglanisoccidentalisand Momyrusrume respectively out of 25 each sampled. Some families of parasites encountered are Nematoda which includes Contracecumspecies 2(8.00%) with a M.I of 11.60 and Cammallanusspecies 1(4.00%) with a M.I of 8.33% for Tilapia zilli, Auchenoglanisoccidentalis and Momyrusrume had Contracecumspecies with 12(48.00%) with M.I of 12.50 and 3(12.00%) with M.I of 8.30 respectively. There was no record of Camallanusspecies in both samples. In Clariasgariepinus, Contracecumspecies was 5(20.00%) with a M.I of 12.80 and Camallanusspecies 2(8.00%) and M.I of 3.50.

The trematodeParamphistomatidae was recorded in both Tilapia zilliand Momyrusrume with both having the same number positive with the parasite 1(50.00%) but different M.I; Tilapia had an M.I of 3.70 while Momyrus had 1.00. No Trematode was encountered in Clariasand Auchenoglanis. While the family Cestoda, Diphyllobothridae was recorded only in Auchenoglaniswith 7 and an M.I of 4.14.

Some unidentified species were observed in all the samples; Tilapia had 3(27.27%) and M.I of 3.30, Clariashad 4(36.36%) and M.I of 1.25, Momyrus had 3(27.27%) and M.I of 2.30 while Auchenoglanis had the lowest with 1(9.09%) and M.I of 1.00.

The result showed that out of the four fish species sampled in the course of the study Tilapia zilli and Mormyrusrume had the least number of infected fishes while Auchenoglanisoccidentalis had the highest number of infected fishes. Statistically, there was no significant (P0.05) difference with respect to prevalence of parasites in that a significantly high amount of parasite was not observed in all the fish species sampled (Table 1).

Table I. Prevalence of Parasites in Fish Species Sampled in Chanchaga River, Minna.

		Nematode							Trematode		Cestode			
		Contr.spp	Cama.spp		Eustr.spp				Paramphi.		Diphyllo.		Unidentified spp	
Fish spp	No.	No.+ve(%)	No.+ve(%)	M.I	No.+ve (%)	M.I	No.+ve(%)	M.I	No.+ve(%)	M.I	No.+ve(%)	M.I	No.+ve(%)	M.I
T.zilli	25	3(12.00)	2(8.00)	11.60	1(4.00)	8.33	-	-	1(4.00)	3.70	-	-	3(12.00)	3.30
C. gaeripinus	25	7(28.00)	5(20.00)	12.80	2(8.00)	3.50	-	-	-	-	-	-	5(20.00)	1.25
M. rume	25	3(12.00)	3(12.00)	8.30	-	-	-	-	1(4.00)	1.00	-	-	3(12.00)	2.30
A. occidentalis	25	12(48.00)	12(48.00)	12.50	-	-	-	-	-	-	7(28.00)	4.14	1(1.00)	1.00

Spp – species, Contr.- Contracecum, Cama.-Camallanus,Eustr.- Eustrongylides, Paramphi.- Paramphistomatidae, Diphyllo.- Diphyllobothriidae.

M.I- Mean Intensity, No.+ve- number positive in percentage, No.- number.

Heavy Metal Concentrations in Fish Muscle of Fish from Chanchaga River

Fish samples infected with parasites and those uninfected were analyzed for heavy-metals, result showed five metals encountered in the course of the study including; Manganese (Mn), Chromium (Cr) Iron (Fe), Copper (Cu). Mean ± SD of the heavy-metal analysis showed Fe in infected fish had 0.37±0.07 while uninfected had 0.41±0.01, Cu had 0.01±0.00 in infected and 0.01±0.00, Zn recorded 0.18±0.02 for infected and 0.15±0.01 in uninfected, 0.02±0.01 and 0.01±0.01 was observed in infected and uninfected for Cr, Mn had 0.03±0.01 for infected and 0.01±0.00 for uninfected in Tilapia zilli. While there was no record for Cu in both infected and uninfected in Clariasgaeripinus, Fe had 0.45±0.03 for infected and 0.47±0.01 for uninfected, a similarity was observed between the infected and uninfected of Zn in Tilapia and that of Clarias(0.18±0.01 for infected and 0.15±0.01 for uninfected). Mn and Cr recorded 0.03±0.01 in infected, 0.04±0.01 in uninfected and 0.02±0.01 f0r infected and 0.02±0.00 for uninfected respectively. Similarly, Cu was also not recorded in Auchenoglanisoccidentalis, however, there were records for the other metals; Zn 0.13±0.06 in infected and 0.10±0.00 for uninfected, Mn had 0.01±0.00 for uninfected and 0.04±0.03 in infected while Cr recorded 0.02±0.00 for infected and uninfected and Fe had 0.39±0.02 and 0.41±0.01 for infected and uninfected. In Mormyrusrume however, Mn and Cr had the same value for both infected and uninfected fish (0.01±0.00), Fe on the other hand had 0.27±0.01 for infected and uninfected had 0.28±0.01 while uninfected for Cu had 0.01±0.00 none was recorded in infected fish samples.

The result showed five metals were analyzed and Fe had the highest concentrations in all the fish species and was closely followed by Zn while Cu had the least concentration. Statistically no significant (P>0.05) difference with respect to concentration of metals found in infected and uninfected fish samples (Table 2).

Table II: Mean ± SD of Heavy Metal Concentrations in Fish Muscle of Fish from Chanchaga River.

FISH SAMPLE	Fe	Cu	Zn	Mn	Cr
Tilapia zilli					
Infected	0.37±0.07[a]	0.01±0.00[a]	0.18±0.02[a]	0.03±0.01[a]	0.02±0.01[a]
Uninfected	0.41±0.01[a]	0.01±0.00[a]	0.15±0.01[a]	0.01±0.00[a]	0.01±0.01[a]
Clariasgariepinus					
Infected	0.45±0.03[a]	0	0.18±0.01[a]	0.03±0.01[a]	0.02±0.01[a]
Uninfected	0.47±0.01[a]	0	0.15±0.01[a]	0.04±0.01[a]	0.02±0.00[a]
Auchenoglanisoccidentalis					
Infected	0.39±0.02[a]	0	0.13±0.06[a]	0.04±0.03[a]	0.02±0.00[a]
uninfected	0.41±0.01[a]	0	0.10±0.00[a]	0.01±0.00[a]	0.02±0.00[a]
Mommyrusrume					
Infected	0.27±0.01[a]	0	0.17±0.06[a]	0.01±0.00[a]	0.01±0.00[a]
Uninfected	0.28±0.01[a]	0.01±0.00[a]	0.10±0.00[a]	0.01±0.00[a]	0.01±0.00[a]

Heavy Metal Accumulation in Fish Intestines in Relation to the Parasites in Fish from Chanchaga River

The result of the heavy-metal analysis of fish intestine showed five metals recorded in the course of the study, they include Iron (Fe), Copper (Cu), Zinc (Zn), Chromium (Cr) and Manganese (Mn). The mean ± SD of the heavy-metal analysis showed in Mormyrusrume, Zn had 0.01±0.00, 0.09±0.06 for Mn, Cu recorded 0.10±0.00, Cr had 0.01±0.00 and 0.50±0.04 for Fe. The concentration of Cu in Auchenoglanisoccidentalis was 0.02±0.01, while Fe had 0.39±0.10, Cr 0.01±0.00, Mn and Zn had 0.09±0.06 and 0.01±0.00 respectively. Fe had 0.29±0.03, Cr had 0.01±0.00, Cu had 0.83±0.01, Zn recorded 0.01±0.01 and Mn had 0.02 ±0.02 in Clariasgariepinus, while in Tilapia zilli Cu had 0.77±0.04, Cr had 0.02±0.01, Zn had 0.04±0.06, Mn 0.27±0.06 and Fe had 0.51±0.12.

The result showed five metals were recorded in the analysis and Cu was observed in high concentration in Tilapia and Clariaswhile Fe was recorded in high concentration in all the fish species. Zn had the lowest concentration. Statistically, there was a significant ($P<0.05$) difference was recorded in the mean concentration of metals in the different fish species with respect to the different superscript of the mean ± SD value of the metal concentration (Table 3).

Table III: Mean ± SD of Heavy Metal Accumulation in Fish Intestines in Relation to the Parasites in Fish from Chanchaga River.

FISH SAMPLE (fish intestine)	Fe	Cu	Zn	Mn	Cr
T.zilli	0.51 ± 0.12^{b}	0.77 ± 0.04^{ab}	0.04 ± 0.06^{a}	0.27 ± 0.06^{c}	0.02 ± 0.01^{b}
C.gariepinus	0.29 ± 0.03^{a}	0.83 ± 0.01^{ab}	0.01 ± 0.00^{a}	0.02 ± 0.01^{a}	0.01 ± 0.00^{a}
A. occidentalis	0.39 ± 0.1^{ab}	0.02 ± 0.01^{a}	0.01 ± 0.01^{a}	0.02 ± 0.02^{a}	0.01 ± 0.00^{a}
M.rume	0.50 ± 0.04^{b}	0.10 ± 0.00^{b}	0.01 ± 0.00^{a}	0.09 ± 0.06^{b}	0.01 ± 0.00^{a}

DISCUSSION

Parasites are generally found in all freshwater fishes but their prevalence and intensity depends on factors of parasite species, their biology, host, its feeding habits, physical factors, hygiene of the water body, and presence of intermediate hosts where necessary (Chandra[24]; Martinez-Aquino and Anguillar-Anguillar[25]; Doreen et al[26]; Shukerovaet al[27]; Hussainet al[28]).

The result obtained in this study showed that parasites are not limited to a particular species of fish, particularly nematodes which was observed in all the species sampled. However the overall parasite prevalence recorded in this study was low. This is similar to the findings of Akinsanyaet al[29] who worked on Synodontisclarias from Lekki Lagoon Lagos and encountered two Cestodes species and one Nematode species, the difference in the number of cestode encountered in this study maybe due to the low amount of copepods and mollusks which are intermediate host of larval stages of cestode in Chanchaga River and the high amount of nematode recorded maybe due to their association with fishes that feeds more on mud and detritus. It is also in agreement with Thielenet al[30] who worked on two species of fish Sarotherodongalilaeus and Tilapia zillii from River Oshun, south-west Nigeria and recorded one Trematode and one acanthocephalan.

The highest parasite prevalence was recorded for nematode, which is in agreement with the submissions of Vesilindet al[31] who worked on Oreochromisnilaticus, Clariasgariepinusand Cyprinuscarpiofrom Lake Lugo (Hayke), northeast Ethiopia and recorded three nematodes Cammallanusspp, Contracecumspp and Eustrongylidesspp, two Cestode and One Trematode. This may be due to the fact that most nematodes are found living in rock, soil, freshwater and marine water, mud, debris, animal waste, decaying sludge and leaf litter. However the high nematode prevalence recorded in this study is low when compared to the work of Vidal – Martinez et al[32] who worked on two species of fish Parachannaobscuraand Parachanna Africana from Orogodo River in Delta state, he reported a higher prevalence of nematode this may be due to the fact that River Orogodo is subject to organic pollution load arising from effluent discharge from abattoirs located along the banks of the river. It is also low when compared with the result of Sures[33]who worked on three species of fish Capoetaantalyensis, Aphaniusmentoand Pseudophoxinusbattalgil in Turkey reported encountering three nematode species in the course of the study.

The result of the heavy metal analysis of this study is similar to that of Joseph et al[34] who worked on Tilapia, Synodontis, Clarias and Oreochromisfrom the River

Benue in Vinikilang Adamawa state who recorded high Fe concentrations in all the four species of fish and varying concentration of Zn in high concentration but not uniformly in the fish species. He attributed the presence of these metals in the fish samples to indiscriminate application of fertilizers and pesticides in neighboring farms along the bank of the river. The understanding of heavy-metal concentrations in fish is vital as regards to conservation of nature and consumption of the fish.

Generally, heavy-metal concentrations in tissues of freshwater fish differs in various studies (Chattopadhyayet al[5]; Poulin and Morand[35]), this might be due to difference in metal accumulation and the chemical composition of the water from where the fish are gotten, environmental needs, digestion, feeding pattern of the fish sampled and the time the study was carried out.

The heavy-metal analysis of the muscle of fish sampled showed a high Fe concentration in all the fish species, while Cu had the lowest concentration the highest value was recorded in Clariasgaeripenus, 0.47±0.01 in fact for all the metals analyzed Clarias had a high mean concentration value except for Copper which was not observed at all.

It was followed by Auchenoglanisoccidentalis which similarly had no record of copper also and a high concentration of Fe and the other metals. Momyrusrumehad the least mean concentration value for all the metals. This however agrees with the findings of Ezekiel et al[36] who worked on Catfish (Chrysichthysnigrodigitatus) in that he recorded a higher concentration of Fe 0.371±0.489, this may be due to the similarities in the metal uptake of the two fish in that they are both bottom feeders. Comparing the result obtained for heavy-metal concentration in both infected and uninfected muscle of the different fish species sampled it was observed that there was no significant difference in their metal bioaccumulation statistically this may be as a result of lack of protein necessary for the bonding of the heavy-metal with the muscle.

Heavy-metals have an affinity for tissues such as liver, gills and intestine mainly because they are sites where absorption of heavy metals takes place (Mathis and Cummings[37]). The highest metal concentration in the intestine in relation to fish parasites was recorded by Cu with 0.83±0.01 in Clariasgariepenusthis corresponds with the submissions of Zelikaet al[38] who recorded a high Cu value in European Catfish (Silurisglanis) 0.50mg kg^{-1} from a pond in Croatia the value for Cu in this study is higher than that obtained in the findings of Zelikaet al[38] maybe because of the difference in water bodies.

The result obtained in this study does not correspond with that of Brázováet al[39] who worked on perches (Percafluviatilis) and two of its common parasites, Acanthocephaluslucii and Proteocephaluspercae, from Ružín, water reservoir in Slovakia and recorded an average concentration of each heavy metals in all fish samples decreased in the order zinc > copper > manganese > mercury > arsenic > chromium > cadmium> nickel > lead. Zinc was discovered to be the main element, while in the case of this study Iron was found to be the dominant element uniformly among the different species of fish. There were cases of zinc been higher than iron in some species but it was not uniformly high through all the species sampled.

The gold mining and other anthropogenic activities (e.g. fertilizer wash offs from farms along the bank of the river and waste disposal both industrial and household) at the downstream of the Chanchaga River may be responsible for the presence of these heavy metals in the water.

According to Bala[40] the discharged of untreated pharmaceutical waste into the river pollutes it with heavy metals particularly Zn and Fe and this corresponds with the findings of this study. The heavy metal analysis from this study shows the presence of heavy metals in the fish sampled and the state of pollution of the Chanchaga River. Findings from this study shows the role of parasite as a heavy metal sink for its fish host in that higher concentration of metals were found in the parasites than in the fish host

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