Original Research Article

IMPACT OF POLUTION ON HAEMATOLOGY AND HISTOLOGYOF JUVENILES OF *Chrysichthys nigrodigitatus* IN OGBESE RIVER, ONDO STATE, NIGERIA

ABSTRACT

The silver catfish *Chrysichthys nigrodigitatus* is of economic importance in sub-sahara Africa. In Ogbese town, and its environs, it constitutes a means of income and food for fisherfolks and community members. Hence, this study was undertaken to assess health status of *Chrysichthys nigrodigitatus* using haematology and histological assessment of the fish specie due to the anthropogenic activities that takes place around the river body. A total 120 live juvenile fish samples of *Chrysichthys nigrodigitatus* were collected around shallow habitats of Ogbese River by the assistance of fisherfolks using fish cage. Some water parameters measurements were taken: temperature, pH, DO, Turbidity and Conductivity. Morphometric measurement: Weight (g) and length (cm) of fish were taken. Haematology and histology of fish gills, liver and intestine were determined. Mean water temperature (27.70±0.18^{o}C), pH (7.36±0.22), DO (6.98±0.15 mg/l), Turbidity (78.50±13.53 NTU) and Conductivity (148.35±27.98) of the river determined respectively. Mean body weight of fish was 148.15 ± 36.53 g, and mean length was 25.64 ± 2.86 cm. The gills, liver and intestines of the fish specie were examined to assess the architecture of the organs. Results of haematology studies of *C. nigrodigitatus* revealed high values in the parameters measured. Red Blood Cell was higher than the White Blood Cell with mean value of (225.63±10.45 $10^3/mm^3$) while Eosinophils recorded lowest parameters with mean value of (1.75 ±0.52 %). Results of histology of gills, liver and intestines showed that the gill filaments were eroded with deformation of the cartilage core and also hyperplasia of the secondary lamellae. The intestines showed atrophy in a mucosal layer**,** hemorrhage and dilation within blood vessels and within serosa of mucosa and for liver, picnotic nucleus were shattered, the hepatocytes were ruptured and there was increased kupffer cell count as a result of exposure to pollutants. The results indicated that pollution level of the environment have significant impact on health status of fish.

KEYWORDS: *Chrysichthys nigrodigitatus*, Ogbese River, Haematology, Histology.

INTRODUCTION

Fish is one of the most important animal protein sources that are widely consumed by all races and classes of people (Abolude and Abdullahi, 2005). It compares favorably with milk, meat, pork and poultry (James, 1984). Fish and fishery products are highly nutritious and are excellent sources of other dietary essentials like vitamins and minerals. Fish fat contains a high proportion of polyunsaturated fatty acids which may help to decrease the incidence of atherosclerosis and heart related diseases (Akande, 2011). Fish also provide an important complement to the predominantly carbohydrate-based diet of many people in Nigeria (Akande, 2011).

The silver catfish *Chrysichthys nigrodigitatus* (Lacepede, 1803) is a highly valued food-fish included among the dominant commercial catches exploited in Ogbese river, Ondo State, Nigeria. It is restricted to the bottom of deep water, omnivorous; consume bivalves, detritus, chironomids, crustaceans and vegetable matter (Bankole *et al*., 2011). This fish can be raised in both fresh and brackish water environments.

Fish health can be adversely affected by temperature changes, habitat deterioration and aquatic pollution (Skouras *et al*., 2003). Hematological parameters are considered an important indicator of fish health status, and provide valuable information to assess the fish welfare (Azevedo *et al*., 2006). Hematology is also used as an indicator of physiological and pathological changes in fish (Chekrabarty and Banerjee 1988, Martins *et al*., 2008). It can be affected by several factors including gonad maturation (Ranzani-Paiva and Godinho, 1985), dissolved oxygen alterations (Ranzani-Paiva *et al*., 2000), gender (Lusková, 1998), spawning and water temperature (Joshi 1982), lotic or lentic environment (Val *et al*., 1985), handling stress and transportation (Gbore *et al*., 2006), fish inflammation (Martins *et al*., 2006), size, feeding and stocking density (Rey Vázquez and Guerrero, 2007), microbial infection and parasitism (Martins *et al*., 2004, Azevedo *et al*., 2006. Jamalzadeh *et al*., 2009).

Ogbese region comprises Ogbese community and some neighboring agrarian settlements that sustain it with agricultural produce. The location of Ogbese in the rain forest zone in South Western Nigeria gives it a natural tendency of wood, timber and food production in the region. The community serves as an economic life wire of Akure North Local Government Area of Ondo State that produces food crops in large quantities. Dispite these economic potentials, the town still remains a remote rural settlement in the State.

Pollution of the rivers examined in this study is mainly through run-off activities from agricultural practices and commercial activities. Many studies have shown that very large quantities of heavy metals are found in run-off associated with the operation of motor vehicles, atmospheric fallout and road surface materials (Harper, 1985). To the environmental scientists, the ultimate concern of trace metal contaminants in receiving water is their toxic impact on aquatic organisms including fish species (Sutherland and Tolosa, 2000). Assessing pollutants in different components of the ecosystem is an important task in preventing risk to natural life and public health. Pollutants entering these receiving waters by way of run-off conveyance systems, indiscriminate dumping of wastes e.t.c, may adversely impact many of the desired uses. The Ogbese community has undergone great economic development in recent years. In fact, it is notably one of the fastest growing, economically important communities in Ondo State and handles a considerable number of micro- industries. The very popular market (Ogbese market) and the timber business coupled with unequalled agricultural practices have drawn people from several cultural backgrounds in the country to make the settlement inter-tribal. This increase in anthropogenic activities surrounding the area has lead to an increase in environmental degradation. These multiple sources make it especially difficult to identify and isolate the risks associated with this contaminated water. Unfortunately, records of water quality parameters are non-existing and no known monitoring fish health due to the water quality have been initiated within the state (Ogunola, et al, 2017).

MATERIALS AND METHODS

Study Area

The study site was Ayede, Ogbese River along Akure-Benin expressway in Ondo State. The area lies between E6^{0}SE8^0 and longitude N4^{0}N6^{0}E. The river has its source from Ayede-Ekiti in Ekiti state and flows through Ogbese in Ondo State to Edo State. The Ogbese community is about 10km east of Akure, the Ondo state capital.

Collection of Water Samples

Water samples were collected using water samplers at 10 cm depth at three points locations from the river body, and parameters were determined using multi- parameter machine for dsissolved oxygen, temperature, turbidity, conductivity, and pH.

Collection of Fish

120 live *Chrysichthys nigrodigitatus* fish samples were collected by the assistance of fisherfolks using fish cage at Ogbese River from May to August, 2018. They were then transported alive in buckets containing water to the Marine Biology Laboratory of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure.

Length-weight Measurement

The weight in grams (g) of each specimen was taken using a digital weighing balance, which was wiped dry between samples. Standard length was measured in centimeters (cm) using a meter ruler.

Condition factor of the fish was assessed to know the state of health being of the fish.

$$K = \frac{100 \text{ X } W}{L^3}$$

K = Condition Factor

W = Body Weight of Fish in gram (g)

L = Standard Length of Fish in centimeters (cm)

3.4 Haematological Analysis

Blood samples were taken from the caudal vein of each fish using a syringe and transferred to 5ml of Ethylene Diamine Tetraacetic Acid (EDTA) bottles. After blood collection in the laboratory, the samples were maintained on ice and sent to the laboratory of Animal Production and Health Technology, Federal University of Technology, Akure for hematological analysis.

The haematological parametres analysed were; Erythrocyte Sedimentation Rate Count (ESR), Packed Cell Volume Count (PCV), Red Blood Cell Count (RBC), Haemoglobin Concentration (Hgb), White Blood Cell Count (WBC), Lymphocyte Count, Neutrophils Count, Monocytes Count, Basophils Count, Eusonophils Count. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) And Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated according to (Houston, 1990).

The Haemoglobin was calculated as: Hb (g/100ml) = Absorbance of test x Concentration of standard Absorbance of Total erythrocyte (RBC)

Red Blood Cell and White Blood Cell counts were calculated thus; = C x D x 4000

Where;

C = dilution factor (20)

D = number of cells counted

$$\text{Hematocrit/ PCV} = \frac{\text{Volume of packed red blood cell X 100}}{\text{Volume of whole blood}}$$

White blood cell (WBC) = %WBC X total WBC + thrombocytes counts

The red cell indices – MCHC, MCH and MCV were derived thus;

$$\text{Mean Cell Hemoglobin Concentration (MCHC)} = \frac{\text{Hemoglobin (g/100ml) X 100}}{\text{PCV(\%)}}$$

$$\text{Mean Corpuscular Haemoglobin (MCH)} = \frac{\text{Hemoglobin (g/100ml)}}{\text{RBC (x10,000rbc/mm}^3\text{)}} \text{ X 100}$$

$$\text{Mean Cell Volume (MCV)} = \frac{\text{PCV X 100}}{\text{RBC (x10,000 rbc/mm}^3\text{)}}$$

3.5 Histological Analysis

The fish were dissected to collect gills, intestines and livers specimens to determine the health status of the fish. specimens were removed and rinsed in distilled water to remove blood stains. Histological Analysis was carried out according to Humason, (1962). The tissues were washed in 0.90 % NaOH to remove the adherence of mucous and blood; and kept on blotting paper to drain the moisture. The samples were fixed in physiological saline solution for 24 hours. Tetra hydrofuron was used as dehydrating and clearing agent. Section of 6µ thickness were selected from respective specimens to observed histology changes by adding haematoxylin and Eosin counter stain. The results were expressed in photomicrograph.

3.6. Statistical Analysis

Data collected were analyzed using one-way ANOVA. Further tests were done using Duncan Multiple Range Test. And test of significance(s) was done at $P > 0.05$.

4.0. Results and Discussion

4.1. Physico-Chemical Parameters of water from River Ogbese

The physicochemical properties of water obtained from River Ogbese are presented in Table 1.

Table 1: Physico-chemical parameters of water from River Ogbese.

Parameters	**Range**		**EPA 2003 Standards and Limits**
DO (mg/l^{-1})	5.80 – 7.99	6.98 ± 0.15	4.00 – 6.50
Turbidity (NTU)	67.00– 97.00	78.50 ± 13.53	50.00 (instantaneous); 25.00 (over 10 days); 10.00 (over a long time).
Temperature (^oC)	26.44 – 30.64	27.70 ± 0.18	$25^0C – 30^0C$
Conductivity (µmhos/cm)	119.0– 178.0	148.35 ± 27.98	50 – 1500 (general range); 150 – 500 (good mixed fisheries)
Ph	6.81-8.12	7.36 ± 0.22	6.50 – 9.00

Length, Weight, Condition Factor (K) and LWR of *Chrysichthys nigrodigitatus*

Length (cm), Weight (g), Length / Weight Relationship and Condition factor (K) of *C. nigrodigitatus* obtained at River Ogbese are shown in (Table 2). The average body weight of *Chrysichthys nigrodigitatus* used was 148.15 ± 36.53g which ranged from 106g – 185g, while the average body length was 25.64 ± 2.86cm ranging between 23cm – 30cm. The condition factor was 0.88. The "b" values of the fish were not equal to 3, hence growth in the individual species was allometric (i.e. b values were less/greater than 3) showing that the rate of increase in body length is not proportional to the rate of increase in body weight.

Table 2: Morphometric Characteristic of *Chrysichthys nigrodigitatus* obtained from River Ogbese

Length / Weight Relationship	Measurement
Length (cm)	25.64 ± 2.09
Weight (g)	148.15 ± 28.56
Condition Factor (K)	0.88
Intercept (a)	2.08
Slope (b)	2.29
Coefficient of determination (r^2)	0.64

Haematological Parameters of *Chrysichthys nigrodigitatus* obtained from River Ogbese

Tables 3 and 4 showed haematology characteristics of the *Chrysichthys nigrodigitatus*. The result showed high values in parameters measured, as compared to standard normal healthy fish haematology in unpolluted environment. Red Blood Cell was higher than the White Blood Cell count with mean value of (225.63±10.45). Eosinophils recorded the lowest count with mean value of (1.75 ±0.52).

Table 3: Haematological Profile of *Chrysichthys nigrodigitatus* from River Ogbese.

Parameters	**MAY**	**JUNE**	**JULY**	**AUGUST**
ESR	3.50±0.71[a]	4.00±0.78[a]	3.75±0.42[a]	4.00±0.00[a]
PCV (%)	24.50±0.71[a]	22.50±0.41[a]	23.50±1.41[a]	24.50±0.28[a]
RBC (µL)	237.00±8.49[a]	218.00±4.24[b]	219.50±9.19[b]	228.00±11.31[c]
WBC (µL)	123.00±7.07[a]	113.50±2.12[b]	115.50±13.44[b]	113.50±10.61[b]
Hb (gdL-1)	8.15±0.21[a]	7.80±0.42[a]	8.00±0.28[a]	8.50±0.21[a]
Lymphocytes	59.00±1.41[a]	50.00±0.00[a]	55.00±1.41[a]	59.50±2.12[a]
Neutrophils	25.00±0.00[a]	34.00±2.83[a]	22.50±2.12[ab]	23.00±4.24 [ab]

Monocytes	12.50±1.41[a]	12.00±2.83[a]	13.50±2.12[a]	13.00±1.41[a]
Basophils	2.00±0.71[a]	2.50±0.91[a]	2.00±0.41[a]	2.50±0.71[a]
Eosinophils	1.50±0.71[a]	1.00±0.71[a]	2.50±0.71[a]	2.00±0.00[a]
MCHC (gdL-1)	33.27±0.09[a]	33.19±0.21[a]	33.19±0.29[a]	33.27±0.16[a]
MCH	3.44±0.03[a]	3.58±0.06[a]	3.56±0.02[a]	3.50±0.10[a]
MCV (pg)	10.34±0.07[a]	10.78±0.11[a]	10.71±0.13[a]	10.75±0.23[a]

Values on the same row with the same superscript alphabet are not significantly different. N = 30

Table 4: Range and Mean Haematological Profile of *Chrysichthys nigrodigitatus* from River Ogbese

Parameter	Range	Mean±SD	SR
ESR (mm)	3.00– 4.00	3.81±0.35	4-10
PCV (%)	23.00-25.00	23.75±0.76	21-26
RBC ($10^3/mm^3$)	213.0– 243.0	225.63±0.45	200-250
WBC ($10^3/mm^3$)	106.0-128.0	116.38±8.19	100-150
Hb (g/100ml)	7.60 – 8.30	8.11 ±0.27	5-10
Lymphocytes	58.00– 61.00	55.88±1.19	64-80
Neutrophils (%)	20.00 -26.00	26.13±2.33	25-30
Monocytes (%)	10.00– 15.00	12.75±1.69	10-20
Basophils (%)	2.00– 3.00	2.25±0.53	2-5
Eosinophils (%)	1.00– 2.00	1.75±0.52	1-2
MCHC (gdL-1)	33.04 – 33.33	33.23±0.13	30-45
MCH (pg)	3.40 – 3.60	3.52±0.07	5-10
MCV (pg)	10.20 – 10. 90	10.65±0.22	10-15

Data are presented as Means ± S.D. ESR =Erythrocyte Sedimentation Rate, PCV =Packed Cell Volume, HB =Haemoglobin, RBC =Red Blood Cell, WBC =White Blood Cell, MCV =Mean Corpuscular Volume, MCHC =Mean Cell Haemoglobin Concentration, MCH =Mean Cell Haemoglobin. S.R = Standard Range (Eisler,1965).

Histology of *Chrysichthys nigrodigitatus*

Results of histology of gills, liver and intestines of *Chrysichthys nigrodigitatus* are given in the plates 1 - 12 below. The gill filaments were eroded with deformation of the cartilage core and also hyperplasia of the secondary lamellae. The intestines showed atrophy in a mucosal layer**,** hemorrhage and dilation within blood vessels and within serosa of mucosa. Liver histology revealed shattered picnotic nucleus, ruptured hepatocytes and increased kupffer cells**.**

Histology of the Gills

PLATE 1: **The gill filaments showed eroded cartilage. Magnification; x 100**

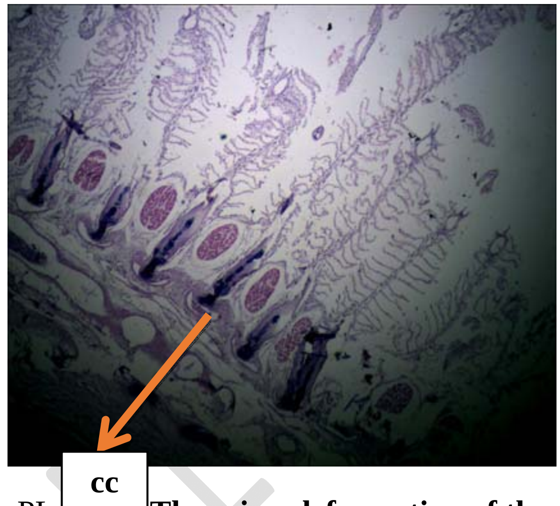


PLATE2: **There is a deformation of the core. Magnification x 100**

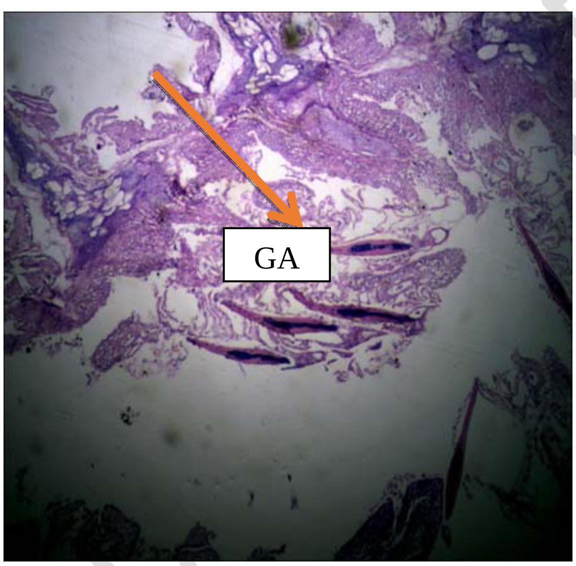


PLATE 3: The gill arch and gill filaments are showing visible signs of lesions

Magnification; x400

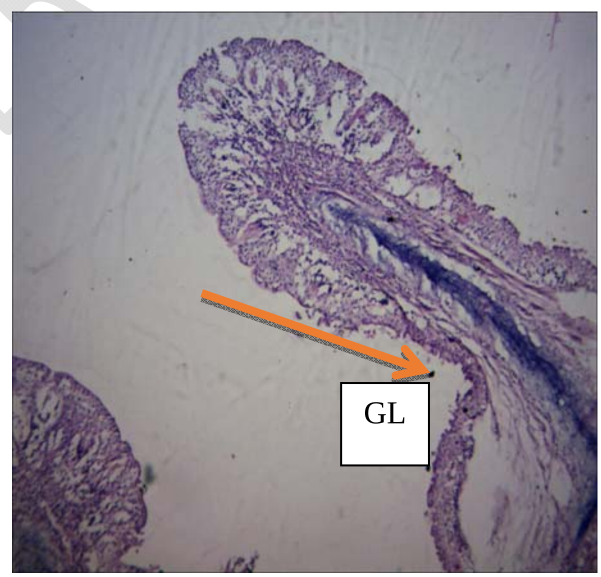


PLATE 4: There is hyperplasia of the eroded secondary lamellae

Magnification; x 400

4.4.2 Histology of the Intestines

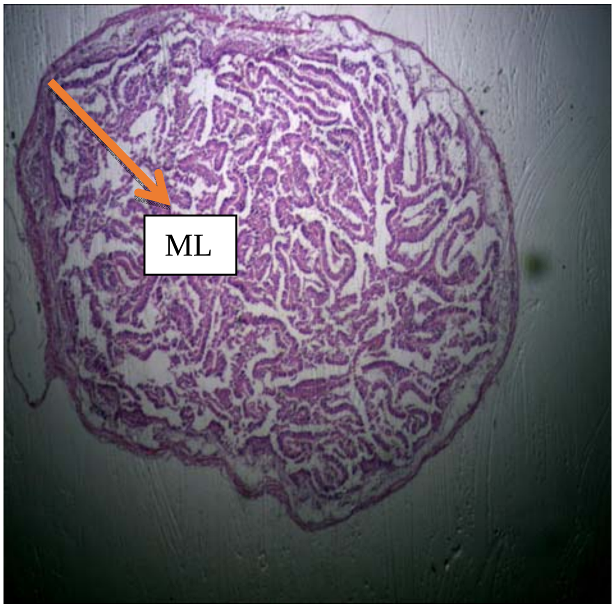


PLATE 5: shows atrophy in a mucosal layer

Magnification; x 100

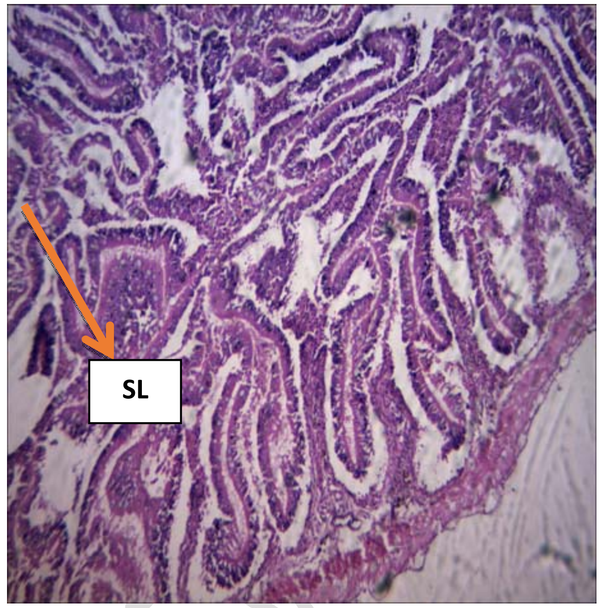


PLATE 6: Intestine shows sign of haemorrhage

Magnification; x 100

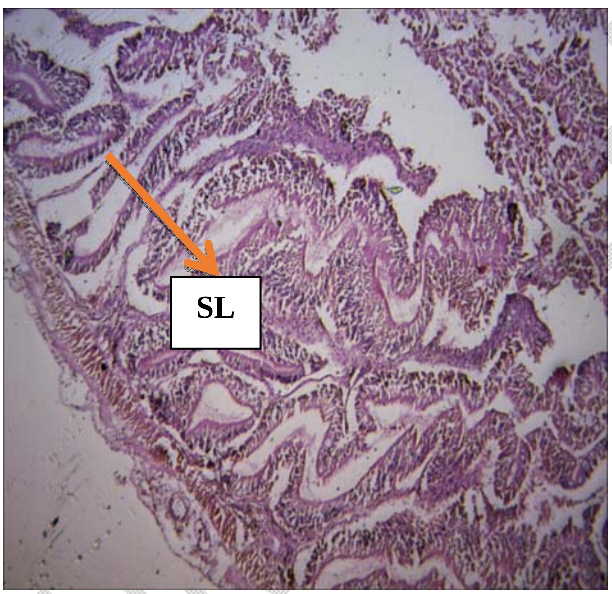


PLATE 7: shows hemorrhage and dilation within blood vessels and within serosa of mucosa.

Magnification; x400

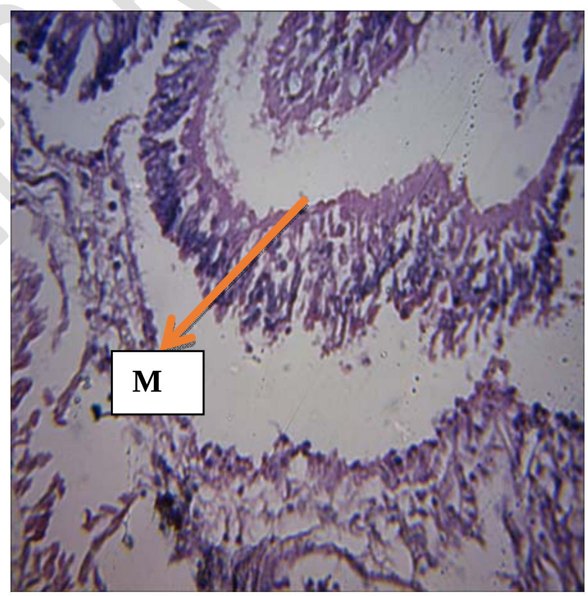
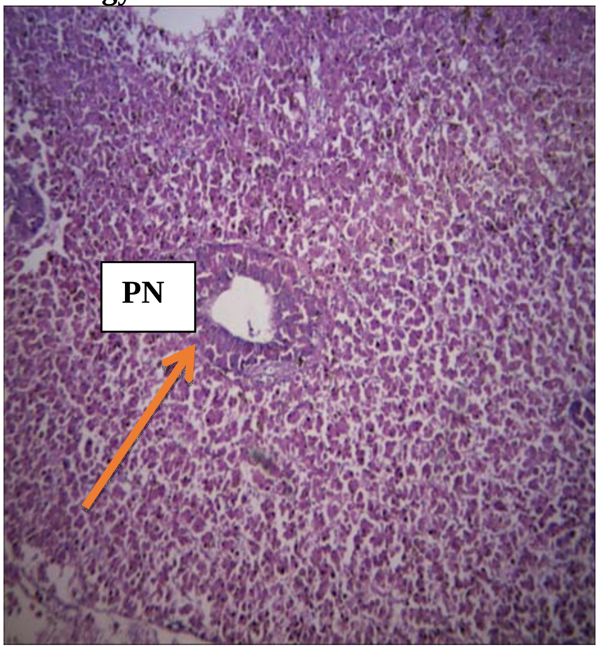


PLATE 8: shows severe degeneration and necrosis of mucosal membrane of intestine

Magnification; x400

Histology of the Livers



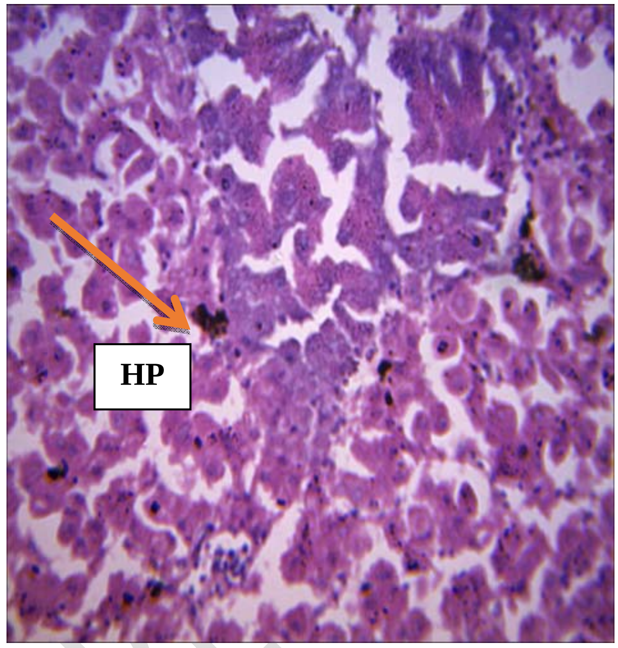
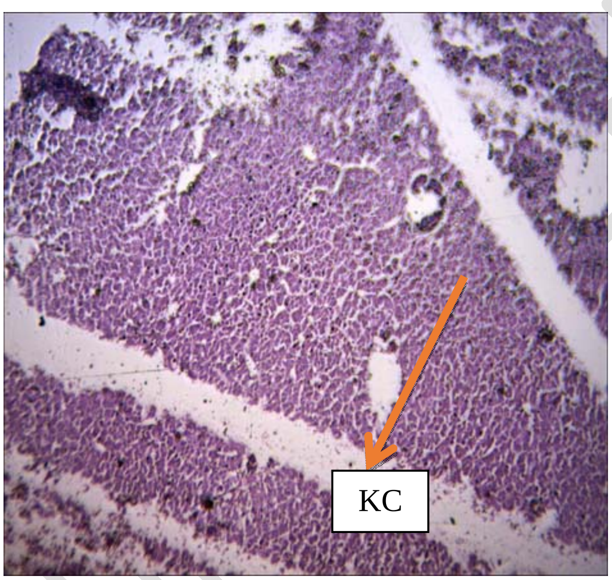


PLATE 9: The picnotic nucleus are shattered **PLATE 10:** The hepatocytes are ruptured
Magnification; x 100 **Magnification; x 100**



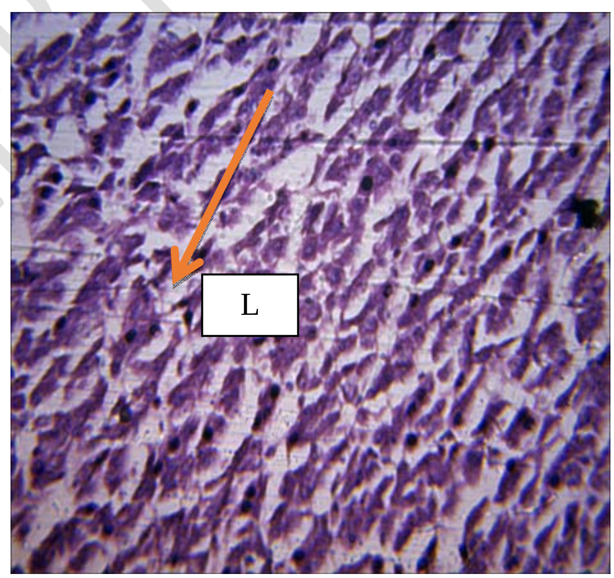


PLATE 11; There is increased kupffer cells **PLATE 12;** Visible lesions seen

Magnification; x400 **Magnification; x400**

GF= Gill Filaments, CC= Cartilage Core, GA= Gill Arch, GL= Gill Lamellae, ML= Mucosa Layer, SL= Serosa Layer, PN= Picnotic Nucleus, KC= Kupffer Cell, L = Lesion

DISCUSSION

Results of physico-chemical parameters of water obtained in this study were within the tolerable range of fish as recommended by WHO (2001 and 2006) except for DO. The result was similar to the reports of Ansa (2004) on the benthic macrofauna of the Andoni flats in the Niger Delta Area of Nigeria, Chindah *et al.*,(1998) on effect of municipal waste discharge on the physico-chemical and phytoplankton in a brackish wetland in Bonny Estuary, and Ladipo *et al.*, (2011) on seasonal variations in physico-chemical properties of water in some selected locations of Lagos Lagoon who opined that waters with little change in physico-chemical parameters are generally more conducive to aquatic life. Most organisms including *C. nigrodigitatus* do not tolerate wide variations in physico-chemical parameters and if such conditions persist, death may occur. High oxygen demand experienced in this study is in line with Adebayo *et al.*, (2007) observation.

Ujjania *et al.,* (2012) opined that condition factor greater or equal to one is good, indicating a good level of feeding, and proper environmental condition. Mean K-values gotten from this study (0.88) were less than one (1), hence revealing that the species fell slightly from being unhealthy. This support the report of Gesto *et al.,* (2017) who worked on the Length-Weight Relationship and Condition factor of *C. gariepinus* and *O. niloticus* of Wudil River, Kano, Nigeria, and obtained condition factor less than one (1). Also feeding intensity, availability of food, fish-size, age, sex, season, stage of maturation, fullness of the gut, degree of muscular development and amount of reserved fat (Gupta and Banerjee, 2015) also have influence on K factor of fish

The observation of absolute Isometric growth (b = 3) in nature is occasional (Bassey and Ricardo, 2003), and deviation from isometric growth is often observed in most aquatic organisms which changes shape as they grow (Thomas *et al.*, 2003). The difference in the length-weight relationship also agrees with the report of Olurin and Aderibigbe (2006) who stated that the differences may be due to sex and developmental stages of fish.

Mean heamotocrit value of *C. nigrodigitatus* was 23.75±0.76% which did not differ considerably from those found by Badawi and Said 1971 and Etim *et al.,* 1999. The Red Blood Cell count had a mean value of $225.63 \times 10^6 mm^3 \pm 10.45 \times 10^6\ mm^3$. The Packed cell volume (PCV) had a mean value of 23.75±0.76%. Heamoglobin concentration had a mean value of 8.11±0.27g/dl. The mean haemoglobin value is low which may be due to the exposure of fish to pollutants resulting in inhibitory effect of those substances on the enzyme system responsible for the synthesis of haemoglobin according to Pamila *et al.*, 1991. The low heamoglobin value obtain in blood assessed from *C. nigrodigitatus* from the water body may also be associated with less active fishes. Similar results were reported by Engel and Davis, (1964) and Rambhaskar and Rao, (1987). Eisler, (1965) suggested that there was a correlation between haemoglobin concentration and the activity of the fish. The more active fishes tend to have higher haemoglobin values than the more sedentary ones. The high erythrocyte number was associated with fast movement, predaceous nature and high activities with streamlined body (Satheeshkumar *et al*., 2011). A fall in hematological parameters count, Hb% and PCV%, in the fishes, due to water pollution, has been reported along with acute anemia (Singh, 1995). According to Singh *et al.,* 2002), the discharge of waste may cause serious problems as they impart odour and can be toxic to aquatic animals. The organic wastes present in Ogbese river seem to cause stress in the fish and as such seem to be responsible for the changes in the hematological parameters. The PCV or haematocrit is an important tool for determining the amount of plasma and corpuscles in the blood (measurement of packed erythrocytes) and is used to determine the oxygen carrying capacity of blood (Larsson *et al*., 1985). Hematocrit or PCV in the present study is low compared to the works of (Joshi *et al*., 2002) and (Banerjee and Banerjee, 1988) have suggested that pollutant exposure decreases the TEC count, Hb content and PCV value due to impaired intestinal absorption of iron.

There were variations in WBC quantity and leukocyte cell proportions (neutrophil, monocyte) in the fish specimens. The implication of this result is that the fish has been able to defend itself from invading pathogens both by cell and antibody-mediated responses (Kumar *et al*., 1999). Similar results were obtained by Sahan and Cengizler, (2002) on carp caught from different regions of Seyhan River. Leukocytosis is directly proportional to severity of stress condition in maturing fish and is a result of direct stimulation of immunological defense due to the presence of pollutants in water bodies. This is in conformity with the report of Saravanan and Harikrishnan *et al.*, (1999) in freshwater fish, *Sarotherodon mossambicus* , when exposed to sublethal concentration of copper and endosulfan and by Nanda, (1997) in respect of *Heteropneustes fossilis* during nickel intoxication. This may be attributed to alteration in blood parameters and direct effects of various pollutants. The lymphocytes are reported to be responsible for immune response (Cazenave *et al*., 2005), while neutrophils are reported to show the greatest sensitivity to change in the environment. Their characterization and identification revealed significance for assessing the changes in the physiological state of fishes

Marked variations like hyperplasia, vacuolation, deformation of cartilage core, bubbling of gill filament, epithelial lifting, lamellar fusion; secondary lamellar damage, shorter secondary lamellae and erosion of secondary lamellae were noticed in the gill tissues of *C. nigrodigitatus* collected from river Ogbese. Similar results were obtained by several works: Fernandes and Mazon, (2003), Simonato *et al.*, (2008), Rajeshkumar *et al.*, (2015), as they revealed alterations like aneurysm, mucous deposition, hypertrophy, fusion of secondary lamellae, ruptured epithelial layer, lifting of primary lamellae, lamellar swelling and necrosis. Through the gills, as the main site of xenobiotic transfer, the toxins are distributed through their bodies accumulating in tissues and organs and may have deleterious effects Vasanthi,*et al*., (2015).

The extent of liver damage observed in the present investigation indicates that chronic exposure always causes impairment to the architecture of the tissue. Since liver is involved in detoxification of pollutants (Lagadic *et al*., 2000), it is susceptible to a greater degree of disruption in its structural organization due to toxic stress. Some distinct changes like rupture of hepatocytes, melanomacrophages, increased Kupffer cell, increased pyknotic nucleus, vacuolation, ruptured nucleus, Blood congestion, cytoplasmatic vacuolation and nucleus disorganization were observed in the liver of fish; revealing environmental status impart on fish species. Macrophage aggregates have been suggested as potentially sensitive histological biomarkers and or immunological biomarker of contaminant exposure (Schmitt *et al*., 2000). Histological changes observed in various studies in liver taken from the fishes exposed to pollutants include increased vacuoles in the cytoplasm, changes in nuclear shapes, focal area of necrosis (death of cells in a localized area), ischemia (blockage of capillary circulation), hepatocellular shrinkage, and regression of hepatocytic microvilli at the bile canaliculi, fatty degeneration and loss of glycogen.(Marchand *et al*., 2012) reported that histopathological changes of fish liver from polluted freshwater system shows structural alterations in hepatic plates or cords, multiple focal areas of cellular alterations leading to a loss of uniform hepatocyte structure, steatosis, cytoplasmic and nuclear alterations (hypertrophic and pyknotic nuclei) of hepatocyte, increase in the size of melanomacrophage centers (MMCs), and focal areas of necrosis. The results from this study also agrees with the result of microscopic examination of liver specimens from Lagos and Ologe Lagoon which were consistent with the findings of Olarinmoye *et al.,* (2009) in which liver of *C. nigrodigitatus* from Lagos lagoon showed several alterations including vacuolar hepatocellular degeneration and hepatic necrosis.

Histology of the Intestine in the study revealed visible sign of lesions. Although, uptake of metals occurs mainly through gills, it may also occur via intestinal epithelium. Histopathological alterations in the intestine of *C. nigrodigitatus* included severe degenerative and necrotic changes in the intestinal mucosa and sub mucosa, atrophy in the muscularis and sub mucosa and aggregations of inflammatory cells in the mucosa and sub mucosa with edema between them. These findings are in agreement with those of Hanna *et al*., (2005), Bashir (2010), Yousafzai *et al*., (2010) and Soufy *et al.,* (2007), who opined that pollutants and contaminants affects gills by epithelial lifting, hyperplasia of epithelial cells and blood congestion within filaments and in liver tissue produced hemolysis between hepatocytes, cytoplasmic degeneration and necrosis. Whereas an aggregation of inflammatory cells, edema in an intestinal mucosal layer and hemorrhage between blood vessels were the main alterations observed in the intestine, the changes seemed to be more pronounced in the liver and gills rather than the intestine.

Conclusion

Human activities including industrialization and agricultural practices contributed immensely in no small measure to the degradation and pollution of aquatic environment which adversely has effects on the water bodies that is a necessity for life. Since water pollution has direct consequences on human well beings, an effective teaching strategy in the formal education sector is essential for aquatic health

Regulation and monitoring, are effective ways of pollution management; therefore, policy makers and stakeholder have to attain agreement on strategies to be adopted in ensuring health aquatic environment. The need to enact legislation to regulate various types of pollution as well as to mitigate the adverse effects of pollution.

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