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The Caryophylleadae cestodes, *Wenyonia spp* Woodland, 1923 Bioaccumulates High Quantities of A Specific PCBs Congener in the Fish Host, *Synodontis clarias* (Linnaeus, 1758), with Histopathological Alterations as Biomarker Response

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ABSTRACT

One hundred and fifty samples of *Synodontis clarias* were collected,and subjected to parasitologic examination.They were analyzed from three stations of the sampling site (Epe axis of Lekki Lagoon). Out of the total number of specimens examined from the three stations, 56 (37.33%) were infected. The total infected individuals from the three stations had 30 (20.0%) males and 26 (17.33%) females while the non-infected individuals for all the stations had 64 (42.67%) males and females. Also, in this study, *Synodontis clarias* were infected with two (2) species of parasites the Cestodes (*Wenyonia spp)* and Nematode (*Raphidascaroides spp)* which is common among family Mockokidae. The concentration of Polychlorinated biphenyl in the fish tissue, parasite, sediment and water collected from the sampling site were also analyzed . The PCB congeners 8, 18, 28, 44, 77, 81, 123, 153, 156 detected in the water and sediment sample of all the 209 PCB congeners were also reported. The findings presented in the study showed more of the lower chlorinated PCB congeners in the water sample than in the sediment, *Synodontis clarias* and parasite sample from the three stations in the Epe axis of Lekki Lagoon. The concentration of PCB congeners in the parasite was high in Oribo and Ikosi (549.53 ppb and 569.95ppb) sampling station while it is low in Imode (57.77ppb) station. There was high quantity of PCB 81 found in the parasite but not found in the fish host.The fish samples collected from Oribo had the high concentration of congeners 28, 18, 44, and 52 among other detected, while fish samples collected from station Imode had the high concentration of 44,18,8 and 28 and the fish samples collected from station Ikosi also had the high concentration of PCB 44, 18, 8 and 123 respectively. However, the concentration of PCBs level found in the fish tissue was above W.H.O limits of 200 part per billion (ppb) in Oribo and Ikosi ((607.42ppb and 325.43ppb) sampling station while the concentration was below in Imode (188.61ppb) sampling station and hence the *Synodontis clarias* in Oribo and Ikosi is not safe and edible for consumption.

INTRODUCTION

Persistent organic pollutants can not be degraded easily through biological, chemical and light processes (El- Shahawi *et al.*, 2010). PCBs are a group of synthetic organic chemicals that contain 209 congeneers.

These chemically related compounds vary in their physiochemical properties and toxicity (Beyer *et al.*, 2002). Due to the affinity of PCBs to adsorb to suspended particulate material like sediment and biota and their hydrophobic behaviour, they can be found in nearly all water bodies and in all biota (Walker *et al.*, 1997).The chemicals have being in use to assist man (Erickson *et al.*, 1997). They are also important as a fluid in transformers and capacitors. PCBs was no longer in use in the

United States as a result of their consequences on humans (ASTDR, 2001). Man and animal can be exposed to PCBs with serious effects. The chemicals that have entered into sedimentsare not readily available to organisms that have been exposed to them. (EPA 1994). These chemicals enter into man when foods contaminated with them are eaten. (Fitzgerald *et al.,* 1996). This happened simply because the chemical has been accumulating in the diet of man.

In addition, ingestion of PCBs that have accumulated in fish is a way of introduction of the chemicals in the human surroundings (EPA 2005).

As a result of nondegradable nature of the chemical, they bio-accumulate in the human surroundings (Erickson 1997). The process of biomagnification of PCBs is as a result of higher trophic level organisms having large contaminant within their bodies than.(Danuta *et al.,* 1997). PCBs may enter water bodies and tend to accumulate in the sediments (Ashley and Baker 1999).PCBs are also found in the in the fatty tissues of fish and when consumed by humans may represent a major pathway of exposure (Birmingham *et al.,* 1989).There is a high levels of exposure to PCBs with attendant effects (WHO 1992).

Parasites have a high level role in the ecosystem which are being neglected by scientists (Lafferty *et al.,* 2008). Fish parasites was used as biological indicators with methodologies related to fisheries(McKenzie 2002). Pollution is an added stress to hosts which made the hosts to be vulnerable to parasitic diseases (Arkoosh *et al.,* 1998). There is a relationship between parasitism and pollution which compel the use of parasites to evaluate environmental stressors (Sures, 2006).Parasites also influence the hosts' response. (Sures and Radszuweit 2007).

Fish are specific indicators of different levels of contaminants bioaccumulation depending on habitat or food chain position (Scaps, 2002). Some parasites can not tolerate environmental chemicals while others tend to increase in number in pollutant conditions (Sures, 2004). Parasitic infections in fish is related to the degree of immunity in the hosts (Szefer *et al.,* 1998). Parasites exhibit some pathological consequences on their hosts such as depletion of host energy,behaviours alterations, morphological abnormalities, fecundity reduction, growth retardation and mortalities (Marcogliese, 2004).

There has been several published report on fish parasites as the potential indicators of environmental contaminants (Sures *et al,* 1999). Biomonitoring is a unique field that uses several biological groups such as invertebrates and fish as bioindicators (Rosenberg and Resh, 1993). This research therefore emphasises biological monitoring in lekki lagoon due to anthropogenic activities.

MATERIALS AND METHODS

Epe axis of lekki Lagoon is situated between latitudes 3050'-4010'N and longitudes 5030'-5040'E. There are so many plants and fishes as reported by Akinsanya (2007).Map of the lagoon is shown in Fig 1. Three stations were randomly selected with their geographical locations shown in Table 1.

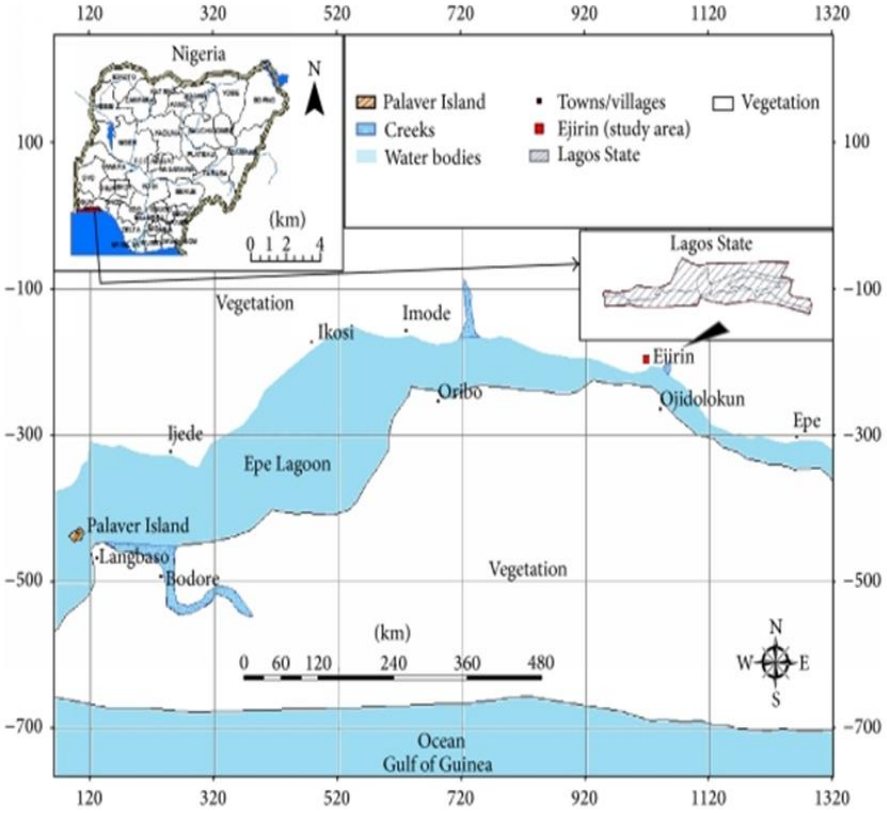


Fig. 1: Map of Epe Lagoon

Table 1: Showing geographical locations of sampling sites

S/N	Latitude	Longitude	Station
1.	6034'50.11"	3059'34.11"	ORIBO
2.	6034'56.17"	3059'26.92"	IKOSI
3.	6034'52.34"	3059'14.32"	IMODE

Collection of Samples:

Specimens of *Synodontis clarias* were randomly collected at the sample locations. These were purchased at Oluwo Market from local fishmongers who are based at the Epe jetty, Lagos, Nigeria. A total of 150 (length ranged from 20 - 36 cm and weight ranged from 88.8 - 220 g) *Synodontis clarias* specimens were collected on six trips over a period of 3 months from July, 2016 to September, 2016. Most of the specimens were purchased while still alive. The sex and maturity of the collected specimens were determined by gross examination of the gonad. The weights of the fish were recorded using a weighing balance (Camry, EK5055), standard lengths and total lengths of the fishes also were recorded using a measuring board.

Collection of water samples:

From the three stations, water samples were collected on one of the field trips. Water samples were collected using a five liters container which was firstly cleaned with the surface water at each site. The collected samples were stored in the refrigerator for further analysis. Samples were collected for analysis of physiochemical parameters.

Water collected from Epe lagoon was used to analyse the following physico-chemical parameters: hydrogen ion concentration (pH), temperature, conductivity, salinity, dissolved oxygen,

total suspended solids and total dissolved solids using standard methods.

Hydrogen Ion Concentration (pH)::

This is simply to measure the hydrogen ion activity in the water .The pH was determined in situ with the aid of a pH meter.

Temperature:

The temperature was measured using a thermometer. It was done by lowering the thermometer so the tip is a few inches below the water surface. The thermometer time came to equilibrium and the values were read off and recorded.

Conductivity:

This is to determine the conductivity of a solution . Water with absolutely no impurities (which is rare) is a poor conductor of electricity. In the real sense, the impurities in water increase its conductivity. The conductivity was measured using the Horiba water quality checker, model U-10. The water sample was put in the sample cup and coupled with the probe, and readings were recorded from the meter.

Salinity:

The salinity was done in-situ with the aid of refractometer. One drop of the water was placed on the prime of the meter of the refractometer and the meter was adjusted to 0% marks and viewed through the eye piece. The daylight plate was closed and the salinity was read on the scale.

Dissolved Oxygen:

The dissolved oxygen level was measured in-situ using a DO meter. The probe was placed in the water sample and the reading was recorded from the meter. The trimetric method was used for the determination of dissolved oxygen demand. The BOD bottle was submerged with the cap in the sample water. The cap was employed and the BOD bottle was filled with water. The BOD bottle was covered while it was still under water. The BOD bottle was removed and it was checked for air bubbles. Immediately 8 drops of alkaline Potassium Iodide azide solution was added. The solution in the bottle was mixed by inverting it several times. The precipitate was then allowed to settle. 1 gram spoon was used to add one level measure of H_2SO_4 powder. The mixture was gently inverted to mix the contents until the reagents totally dissolved.

The titration bottle was filled to 20ml line with the sample and 8 drops of starch indicator solution were added. The sample turned blue, this was then titrated against a standard solution of sodium thiosulphate until the blue coloration disappeared.

$$\text{DO (mg/l)} = \frac{16{,}000 \times M \times V}{\left[\frac{V_2}{V_1}\right][V1-V2]}$$

M = Molarity of Thiosulphate
V = Volume of Thiosulphate used for titration
V_1 = Volume of bottle with stopper in place
V_2 = Volume of aliquot taken for titration

Total Suspended Solids:

A portion of the water sample was measured and filtered using pre-weighed what-man filter paper. The filter paper with the residue was dried for 1 hour at 105^0C in an oven. The filter paper with then residue was then cooled and weighed. The amount of suspended solids was calculated using the formula:

SS = R-F
SS = Suspended Solids
R = Weight of filter paper and residue
F = Weight of the filter paper

Total Dissolved Solids:

One hundred cubic centimeters ($100cm^3$) of the filtered sample was measured. This was transferred into a weighed evaporating dish. This was transferred into an oven maintained at 85^0C and heated into dryness. The evaporating dish with the residue was cooled and weighed.

Total dissolved solids (TDS) were calculated using:

$$\text{Total dissolved solids (mg/l)} = \frac{R-D \times 1000}{\text{Volume of filtered sample}}$$

R = weight of evaporating dish & residue
D = weight of the evaporating dish.

Laboratory Procedures:

Determination of Phosphate:

The surface water Phosphate-phosphorus was determined using the ascorbic acid method. A mixture was prepared by mixing 1% ammonium molybdate in 2M H_2SO_4 and Hydrazine sulphate 0.1% (or$SnCl_2$ and Ascorbic acid immediately before use). The resulting solution PO_4/mg/ml of 4.39 KH_2PO_2 (dried at 110ºC) was dissolved in distilled water. 1ml $CHCl_3$ was added and further diluted to one liter of distilled water.10 to 25ml of the sample was acidified with nitric acid and 25ml of the reagent was added. The absorbance was read off using 780nm.

Determination of Nitrates:

Surface water Nitrate-nitrogen was determined gravimetrically, 20.0ml of the water sample was added to 1ml of fresh prepared 0.3% Sodium salicylate. The mixture was then evaporated in a bath and thereafter left to cool. On cooling, 2ml sulphuric acid was added for 10min, the solution was then washed with 25ml of distilled water into a calorimetric cylinder. 7ml of alkaline reagent (30% NaOH and 60% Rochelle salt) was added. Next, the solution was made up to 50ml by adding distilled water. The yellow colour developed was matched with prepared standards using a calorimeter at 420nm. The nitrate content was recorded in mg/l.

Biochemical Oxygen Demand (BOD):

This is a measure of the amount of oxygen that is removed from water sample due to natural biological assimilation or degradation of organic compounds by the organisms present, especially bacteria. The Biochemical Oxygen Demand for the water samples from the study area was determined to take the difference between the DO content of the samples on the day of sample collection and then 5 days after the samples were collected. The water samples were incubated at 20ºC for five days. Measurement of the 5-day DO was carried out using the same Horiba water checker (Model U-10) used to measure the DO during the sampling period.

Sediment Collection and Analysis:

Sediments were collected with the aid of Van Veen grab at 4^0C in an ice-box and transported to the laboratory. The samples were separated and air dried in a laboratory. It was homogenized and sieved to eliminate particulates of sediments samples which were then digested as follows: 5g of the powdered sediment samples were weighed into a 100 ml beaker. 15ml of the freshly prepared mixture of HNO_3/ H_2O_2 ratio 1:1 were added to each sample and covered with washed glass. It was

allowed to stand for 30 minutes during which the initial reaction subsided. Digestion was carried out on a hot plate whose temperature was allowed to rise gradually until it reached a maximum temperature of 160ºC in a fume cupboard. Heating was continued for about 2 hours, reducing the volume in the beaker to about 2-5 ml. The beaker were allowed to cool while the content was transferred with what man filtration into a 50ml volumetric flask and made up to mark with distilled water (FAO/SIDA, 2003).

Examination and Method of Analysis of Fish Samples:

Collection of Internal Organs of the fish samples:

A total of one hundred and fifty specimens of freshly obtained *Synodontis clarias* from Epe axis of Lekki Lagoon were randomly collected bimonthly during the wet season (July - September) at three different locations along the Epe axis of Lekki Lagoon, Epe Lagos, Nigeria. The fish were immediately preserved in an ice-chest with ice-blocks prior to laboratory analysis. The collected fish samples were arranged on a table. Each fish was slit open using scissor through the urogenital opening. Specific internal organs (Gills, liver, and gastrointestinal tract) were then carefully extracted and placed in Petri dishes filled with 0.09% saline.

Examination of the Gastrointestinal Tract:

Examination of parasites presents within the intestinal tract was carried out using the techniques of Akinsanya *et al*. (2007). The Petri dishes containing the internal organ were examined using a hand lens. Afterward, the intestines were carefully teased open from the anterior to the posterior end (from the rectum through to the esophagus region) to aid parasite emergence. The emergence of the parasite was carefully observed through its movement in the saline solution. The recovered parasites were fixed in 70% alcohol, counted and recorded.

Preservation of Organs and Parasites:

The organs were stored in labelled universal bottles with 0.09% saline, then transported to the laboratory for further analysis

Recovered parasites were fixed in 70% alcohol in differently labeled specimen bottles.

Histological Assessment of Fish Samples:

The selected target organ, the intestines from both infected and uninfected intestines were dissected for histological preparation and processed under standard histological procedure.

Analysis of PCBS:

All chemicals and reagents were of analytical grade and of highest purity possible. LC grade dichloromethane and n-hexane used for the extraction and clean up were obtained from Fisher Scientific. The silica gel used in clean up was supplied by BDH Laboratories. The acetone and anhydrous sodium sulphate used in this study were also obtained from BDH Laboratories. A mixture of 8 PCB congeners (namely PCBs 28, 52, 107, 105, 118, 153, 156 and 180) was obtained from Sigma Aldrich.

Extraction:

Prior to extraction, the fish specimens were dissected and the muscle tissue removed. 10 g of muscle tissue was ground with anhydrous sodium sulphate until completely dry homogenate was obtained (Anyakora *et al*., 2005). Extraction was carried out with dichloromethane in a cold extraction mode (Anyakora *et al*., 2004). After the extraction, the extracting solvent was evaporated using a rotary evaporator and the mass of the extractable fat determined by gravimetry.

Sample Clean Up:

The isolation of PCBs from the lipid matrix was done by solid phase extraction in a normal phase mode. Activated silica gel was loaded into a

glass chromatographic column (20mm, height 400mm) and conditioned with dichloromethane. The extractable fats from the samples were dissolved in 5 ml n-hexane and loaded on to the column and eluted with about 60 ml n-hexane. The effluents were then concentrated using a rotary evaporator and under a gentle stream of pure nitrogen. The samples were thereafter dissolved in 1 ml acetone and ready for GC analysis.

Gas Chromatography:

Analyses were performed with Perkin model 5890 gas chromatograph equipped with Ni 63 electron capture detector. A low polar HP–5 column of 30 m length, 0.32 mm and 0.25 mm film thickness was used. Nitrogen was used as a carrier gas at a flow rate of flow rate 40 ml/s. Data were processed using an HP 3396 integrator. The operating parameters were as follows: injector temperature set at 250 and 300°C for the detector, the oven temperature was programmed at 150°C initially (5 min hold) and increased to 300 at 4°C/min to give the analysis period of 34 min.

Identification and Quantification:

PCB congeners in the fish were identified by retention time match with those of the standards. The standard mixture contains PCBs 28, 52, 107, 105,118, 153, 156 and 180. Hence only these congeners were identified and determined in the fish samples during this study, quantification was done based on area count match with those of known concentration of the standards. Parasitic prevalence and mean intensity were calculated using the formulae according to Ezewanji, *et al.*, (2005) as thus:

$$\text{Prevalence \%} = \frac{\text{Number of fish infected}}{\text{Number of fish examined}} \times 100$$

$$\text{Mean intensity} = \frac{\text{Total number of parasite}}{\text{Number of fish infected}}$$

$$\text{Bio-load} = \frac{\text{Number of collected parasites}}{\text{Number of infected fish}}$$

$$\text{Abundance} = \frac{\text{Number of collected parasites}}{\text{Number of fish examined}}$$

Calculation of Bioaccumulation Factor (BAF):

Bioaccumulation is the increase in concentration of the test substance in or on an organism (specified tissues thereof) relative to the concentration of test substance in the surrounding medium, the biota to soil accumulation factor (BSAF) and bio-concentration factor (BCF) were determined as ratio of PCBs in the fish to that in the soil and water samples as follows:

$$\text{BSAF} = \frac{\text{Concentration of PCBs in animal tissue}}{\text{Concentration of PCBs in soil sample}}$$

$$\text{BCF} = \frac{\text{Concentration of PCBs in animal tissue}}{\text{Concentration of PCBs in water sample}}$$

Statistical Analysis:

Data generated from the investigations was entered into Microsoft excel spread sheet (2013) and later subjected to two-way analysis of variance (ANOVA) (SPSS Version 20 software).

RESULTS

Physiochemical Parameters in three stations at Epe Lagoon Lagos, Nigeria

Table 2 presents the physiochemical parameters of the water sample obtained from the three different stations at the study location. A slight variance in the parameters recorded is

observed within the stations. The mean value recorded for the parameters include: pH of 6.6±0.1, 6.4±0.3, 6.5±0.1, dissolved oxygen; 4.5±0.4, 3.50±0.3, 3.2±0.2 mg/l, total suspended solids; 11±5.5, 7.1±2.6, 9±1.5 g/l, total dissolved solids; 106.3±8.4, 113.9±6.3, 110.1±5.6g/l, conductivity; 152.7±0.5, 172.3±2.6, 193.3±3, µS/cm, salinity; 4±0.5, 5±0.3, 4.5±0.5 ppt, turbidity; 10.3±3.5, 7.7±3.2, and 7.7±2.5 NTU, for the three stations (ORIBO, IMODE, IKOSI) respectively.

Table 2: Showing the Physicochemical Parameters of the Sampling Locations

Parameters	Oribo (mean)	Imode (mean)	Ikosi (mean)	Fepa Limit
Temperature (^{0}C)	26.5±0.5	25.8±0.3	25.2±0.7	< 40
pH	6.6±0.1	6.4±0.3	6.5±0.1	6-9
Dissolved Oxygen (mg/L)	4.5±0.4	3.5±0.2	3.2±0.3	> 5.0
Total Suspended Solids (g/L)	11±5.5	7.1±2.6	9±1.5	NA
Total Dissolved Solids (g/L)	106.3±8.4	113.9±6.3	110.1±5.6	2000
Conductivity (µS/cm)	152.7±0.5	172.3±2.6	193.3±3	NA
Salinity (ppt)	4±0.5	5±0.3	4.5±0.5	NA
Turbidity (NTU)	10.3±3.5	7.7±3.2	7.7±2.5	10

Prevalence of Intestinal Helminth Parasite of *Synodontis clarias* in Lekki Lagoon, Lagos:

Table 3: Shows the prevalence of intestinal helminth parasite of *Synodontis clarias* in Lekki Lagoon, Lagos. Out of the 120 fishes collected, 45 were females and 75 were males; 45 fishes were infected (37.5%) and 75 fishes were not infected (62.5%). The Chi-square ($x^2(3)$) for the distribution is 14.79** p<0.001. Among the sexes, 21 females were infected (46.67%) and 24 were not infected (53.33%), 24 males were infected (32%) and 51 males were not infected (68%). The parasites found in the intestine of the infected fish were cestodes (*Wenyonia spp)* and nematoda (*Raphidascaroides spp)* and are shown in plate 1a to 2b. Plates 1a and 1b show the cephalic and caudal regions of the *Wenyonia spp* found in the infected intestine while plates 2a and 2b show the cepahalic and caudal regions of the *Raphidiaroides spp.*

Table 3: Prevalence of Intestinal Helminth Parasite of *Synodontis clarias* in Lekki Lagoon Lagos

Sex/Infection	Number examined	Infected	Non-Infected
Female	56(37.5%)	26(17.33%)	30(20.00%)
Male	94(62.5%)	30(20.00%)	64(42.67%)
Combined	150(100%)	56(37.33%)	94(62.67%)

Morphometrics and Condition Factor of *Synodontis Clarias* in Lekki Lagoon, Lagos:

Table 4: Shows the morphometrics and condition factor of *Synodontis clarias* in Epe axis of Lekki Lagoon, Lagos. Standard length of mean is 14.34±1.19, p<0.01, with minimum and maximum value of 11.00-20.00 (cm). Total length with mean, 20.35±1.81, p<0.01with minimum and maximum value of 15.00-26.00 (cm). Weight with mean±SD, 64.72±11.47, p<0.01with minimum and maximum value of 28.50-105.50 (g). Liver weight with mean±SD, 1.10±0.48, p<0.01 with minimum and maximum value of 0.30-3.00 (g). Gonad weight with mean±SD, 2.02±3.49, p<0.01, with minimum and maximum value of 0.00-20.00 (g). The number of the parasite with mean±SD, 2.12±4.48, p<0.01with minimum and maximum value of 0.00-20.00. Condition factor with mean±SD, 2.21±0.36, p<0.01with minimum and maximum value of 1.00-3.60.

Table 4: Morphometrics and condition factor of *Synodontis clarias* in Lekki Lagoon, Lagos, Nigeria.

Parameters	N	Mean	SD	Min-Max
Standard length (cm)	150	14.34**	1.19	11.00-20.00
Total length (cm)	150	20.35**	1.81	15.00-26.00
Weight (g)	150	64.72**	11.47	28.50-105.50
Liver weight (g)	150	1.10**	0.48	0.30-3.00
Gonad weight (g)	150	2.02**	3.49	0.00-14.00
No of parasite	150	2.12**	4.48	0.00-20.00
Condition factor	150	2.21**	0.36	1.00-3.60

** Mean significant at level 0.01
*Mean significant at level 0.05

Length-Weight Relationship in *Synodontis Clarias* in Lekki Lagoon, Lagos using Nine Regression Models:

Table 5 shows the correlation coefficients of the linear model (R^2 = 0.453, $p<0.001$, β = 0.675), and the logarithm coefficient (R^2 = 0.470, $p<0.001$, β = 0.688), the quadratic coefficient as (R^2 = 0.465, $p<0.001$, β = 1.620), Cubic coefficient as (R^2 = 0.465, $p<0.001$, β = 1.620), compound coefficient as (R^2 = 0.492, $p<0.001$, β = 2.022), the power model coefficient as (R^2 = 0.517, $p<0.001$, β = 0.721), growth model coefficient as (R^2 = 0.492, $p<0.001$, β = 0.704), the exponential model coefficient as (R^2 = 0.492, $p<0.001$, β = 0.704), and the logistic model coefficient as (R^2 = 0.492, $p<0.001$, β = 0.495). The logistic, exponential and growth models have the same correlation coefficient (R = 0.704, $p<0.001$); and also the quadratic and cubic models correlation coefficient being the same (R = 0.688, $p<0.001$); with the highest being the power model (R = 0.721,$p<0.001$); and the linear model being the least (R = 0.675,$p<0.001$).

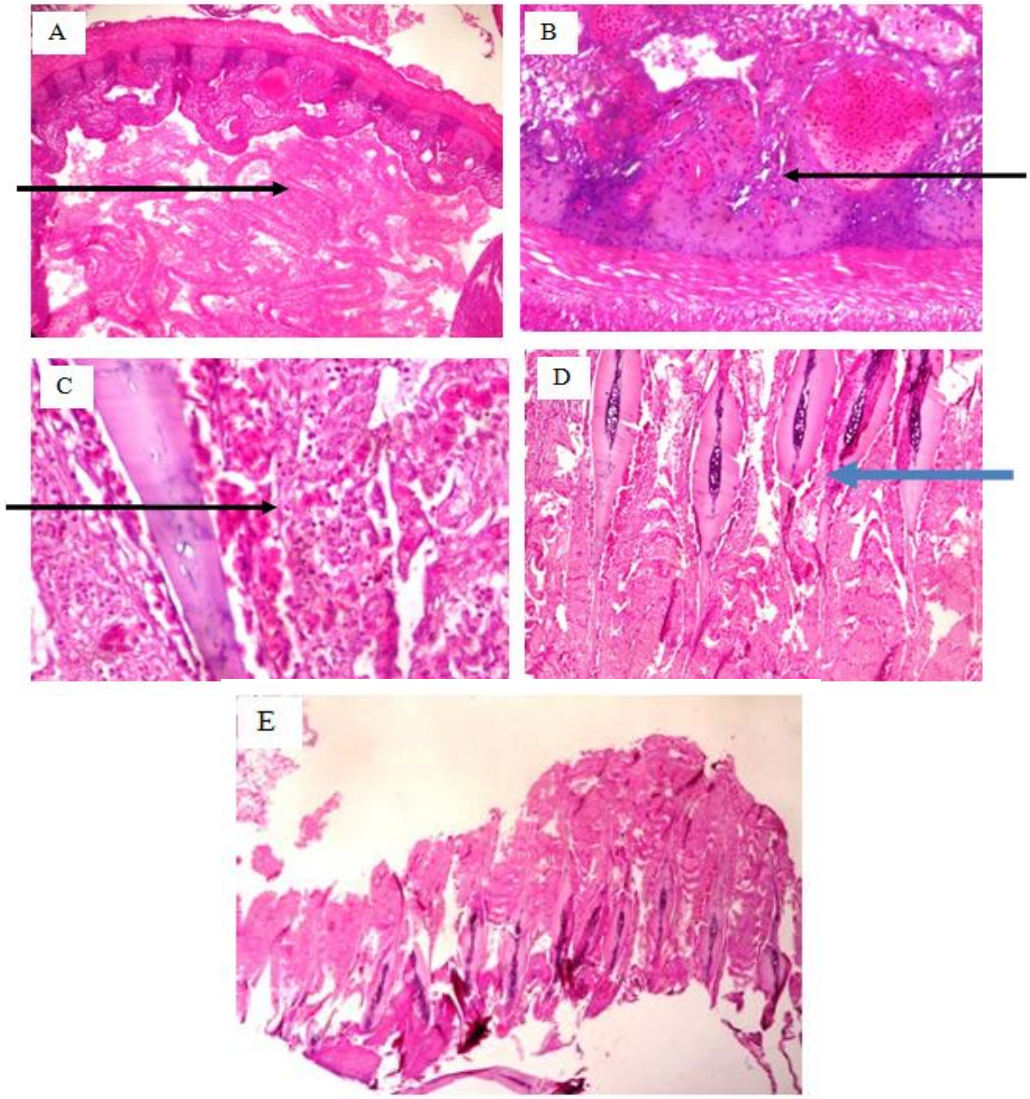
Table 5: Length-Weight relationship in *Synodontis clarias* using nine regression models

Models	R	R^2	B
Linear	0.695**	0.479**	0.695
Logarithm	0.711**	0.502**	0.711
Quadratic	0.731**	0.526**	3.374
Cubic	0.731**	0.526**	3.374
Compound	0.691**	0.473**	1.996
Power	0.714**	0.506**	0.714
Growth	0.691**	0.473**	0.691
Exponential	0.691**	0.473**	0.691
Logistic	0.691**	0.473**	0.501

Histopathological Alterations Showing A Degree of Changes in The Intestines and Gills of S*ynodontis clarias* in Epe Lagoon, Lagos:

The microscopic study of the infected intestine and gill recovered from the fish host revealed different pathological effects. These effects are shown in plate 1.

The infected intestine showed severe congestion of the submucosa . The villi structure and the surface epithelial were moderately preserved while the gill showed vasolidation with blood congestion of primary filament, loss of filaments, curling of filaments and hyperplasia.



PLATES: 1 (A): The villi structure and the surface epithelial were moderately preserved. (B) Photomicrographs of intestinal tissue show severe congestion of the submucosa (black arrow). (C) gill showing vasodilation with blood congestion of primary filament (black arrow). (D) Loss of filaments (blue arrow). (E) Curling of filaments and hyperplasia.

Mean Concentration of PCBS Congeners in the Tissue of *Synodontis clarias* across Stations (PPB):

The analysis of polychlorinated biphenyls in the tissue of *Synodontis clarias* from Epe axis of Lekki Lagoon showed that Between the three stations there was a significant difference (Anova, P>0.05) in the congeners identified, possibly indicating that PCBs availability and concentrations were significantly impacting the aquatic ecosystem. (Table 6). There was no significant difference between congeners in Oribo and Ikosi but revealed that there was a significant difference between congeners in Imode. The trend of mean concentration ranged from 5.02 (PCB 77) to 265.73 (PCB 44) in Oribo, 5.08 (PCB 123) to 71.12 (PCB 44) in Imode and 0.00 (PCB 52) to 32.37 (PCB 18) in Ikosi sampling station.

Table 6: Mean concentration of PCBs congeners in the tissue of *Synodontis clarias* across stations

FISH									
CONGENER	ORIBO			IMODE			IKOSI		
	MEAN (PPB)	SD	MAX	MEAN (PPB)	SD	MAX	MEAN (PPB)	SD	MAX
PCB 8	7.96	11.25	15.91	35.44	49.023	70.00	12.44	8.59	19.00
PCB 18	202.00	264.37	389.30	46.58	56.32	86.00	28.41	32.37	51.00
PCB 28	44.77	63.32	89.55	21.36	22.96	38.00	ND	0.00	0.00
PCB 44	265.73	20.956	280.56	71.12	100.58	142.00	36.54	20.45	51.00
PCB 52	68.22	5.76	72.29	3.36	4.75	7.00	0.00	0.00	0.00
PCB 60	ND	0.00	0.00	ND	0.00	0.00	ND	0.00	0.00
PCB 77	5.02	7.09	10.03	5.68	8.03	11.00	8.38	11.85	17.00
PCB 101	7.99	11.31	15.99	ND	0.00	0.00	ND	0.00	0.00
PCB 123	5.37	7.59	10.73	5.08	7.189	10.00	10.22	0.86	11.00
TOTAL PCBS	343.33			223.42			95.99		

*total pcb refers to the total pcb observed in the fish at that station
concentrations are reported in wet weight($p>0.05$)
*nd (not detected)

Mean Concentration of PCB Congeners in Parasites of S*ynodontis clarias* across Stations (PPB):

Parasites from the fish samples at the three different stations were taken for PCBs analysis and their mean concentration was calculated although the PCBs congeners identified were higher than those in the fish, their values ranged from 0.00-483.20 in Oribo, 7.40 to 20.70 in Imode and 0.00 to 546.30 in Ikosi. (Table 7). However, the concentration of PCBs congener PCB 81 was high at Oribo and Ikosi and is above W.H.O residual limit of 200ppb.

Table 7: Mean concentration of PCBs congeners in parasite of *Synodontis clarias* across three sampling stations

CONGENERS	ORIBO	IMODE	IKOSI
PCB 18	50.70	20.70	21.70
PCB 28	0	7.40	0
PCB 52	15.70	9.30	0
PCB 77	0	8.20	0
PCB 81	483.20	12.20	546.30
TOTAL	549.60	57.80	568.00

*total pcbs refers to the total pcbs observed in the fish at that station
concerntrations are reported in wet weight($p>0.05$)
*nd (not detected)

Mean Concentration of PCB congeners in Sediment Media Across Stations (PPB):

Sediment samples were taken from the three different sampling stations at Epe axis of Lekki lagoon and were taken for analysis, ORIBO means concentration ranges from 0.00 to 371.40, while that of IMODE range from 0.00 to 821.70 and IKOSI from 0.00 to 358.10.This is shown in table 8.

Table 8: Mean concentration of PCBs congeners in sediment across stations

CONGENERS	ORIBO(PPB)	IMODE (PPB)	IKOSI (PPB)
PCB 8	6.10	0	3.2
PCB 18	11.90	8.10	0
PCB 77	14.20	14.70	14.20
PCB 81	371.40	821.70	358.10
PCB 101	0	0	20.10
PCB 123	11.20	10.20	9.80
PCB 153	0	6.00	0
TOTAL	414.90	860.70	405.40

Mean Concentration of PCB Congeners in Water across three Stations (PPB):

Water samples were taken for analysis and across the three stations, Imode had the highest PCBs content with a total of 5.9608, while Oribo and Ikosi had 3.1556 and 3.3071, the reason for Imode high content may be due to the fact that it is just close to fresh water source when contaminants from anthropogenic activities enters the lagoon. (Table 9).

Table 9: Mean concentration of PCBs congeners in water three sampling across stations

CONGENERS	ORIBO(PPB)	IMODE (PPB)	IKOSI (PPB)
PCB 8	0	2.0606	0
PCB 28	0	0.0978	0
PCB 44	1.6656	2.0556	0
PCB 77	1.1008	0.8207	2.0463
PCB 81	0	0	0.0905
PCB 123	0	0	0.6878
PCB 153	0.3892	0	0.4825
PCB 156	0	0.9261	0
TOTAL	3.1556	5.9608	3.3071

Summary Concentration of PCBs:

The summary of total PCBs concentration in fish, parasite, water and sediment are shown in Table 10. In all the three stations, the sediment has the highest PCBs concentration, while the water has the lowest PCBs concentration, indicating that these contaminants sediment at the bottom of water while

Table 10: Total PCBs concentrations in fish, parasite, water and sediment collected in three sampling stations

SITES	FISH (PPB)	PARASITE (PPB)	WATER (PPB)	SEDIMENT (PPB)
ORIBO	607.42	549.53	3.20	414.90
IMODE	188.61	57.77	6.00	860.70
IKOSI	325.43	569.95	3.30	405.50
TOTAL	1121.46	1177.25	12.50	1681.10

Bioconcentration Factor (BCF):

Table 11 shows the bio-concentration factor in the fish and parasite across stations. The Parasite had the highest concentration factor (319.88) while *Synodontis clarias* had a low bio-concentration of 319.88 compared to the parasite. Across the stations, Oribo (361.55) had the highest concentration followed by Ikosi (271.33) while Imode (41.07) had the least concentration.

Table 11: Bio-concentration factor in different stations

SITES	BCF	
	FISH	PARASITE
ORIBO	189.82	171.73
IMODE	31.44	9.63
IKOSI	98.62	172.71
Total	319.88	354.07

Biota-Soil Accumulation Factor (BASF)

Table 12 shows the biota-soil accumulation factor in fish and parasite at the Epe axis of Lekki lagoon. The parasite had the highest accumulation factor of 2.80 while the fish had 2.42 which were slightly low compared to that of the parasite. Across the stations, Oribo (2.72) had the highest accumulation followed Ikosi (2.21) and the lest was IMODE (0.29)

Table 12: Showing biota-soil accumulation factor in different stations

SITES	BSAF	
	FISH	PARASITE
ORIBO	1.40	1.32
IMODE	0.22	0.07
IKOSI	0.80	1.41
TOTAL	2.42	2.80

DISCUSSION

Stress allows the hosts to be susceptible to parasitic diseases which can thereafter be transmitted from one host to another . Environmental stress is an indication of parasitic infections in fishes (Schludermann *et al*., 2003). The reactions of the hosts against the parasites may lead to some pathological reactions (Don-Pedro *et* al., 2004; Falcao *et al*., 2008). Helminthes parasites infections were higher in males 30 (20.00%) than females 26(17.33%). This is similar to the report of (Allumma and Idowu, 2011; Akinsanya *et al*., 2008). The prevalence of (37.5%) recorded in this study in *Synodontis clarias* was lower than 85.2% reported in Zaria (Ashraf, 2005).Condition factor informed of the health status of a fish population (Ighwela, *et al*., 2011). Length and weight parameters of the fishes were taken to relate these to parasitic infections (Sarkar *et al*., 2013). This findings were also made by Abowei and Davies (Abowei and Davies, 2009) (Deekae *et al*., 2010) where negative allometric growth was obtained (b=0.88 and b=2.88) for the studies of *Clarotes laticeps*. The differences in reports could be as a results of fishes from different geographical locations(Akinsanya, 2007). The health statusof fishes is anchored on the condition factor (Marcogliese, 2005). It is concluded that fishes with high weight are in good condition than fishes with less (Falcao *et al*., 2008).

In this study, the fish species were infected with two kinds of parasites the cestodes (*Wenyonia spp)* and nematode (*Raphidascaroides spp)* which is common among the family mockokidae and is in conformity with the report of Ahmed *et al.*, (2012). *Raphidascaroides* is a small ovoviparous nematode that is prevalent in most African freshwater fishes, notably Siluroids.

Histopathological alterations observed is in agreement with the report of (Akinsanya, 2007).Winkaler, *et al.*, (2001) and Tkatcheva, *et al.*, (2004), some morphological changes in gills and intestine may represent adaptive strategies to maintaining physiological functions.The lesions observed indicates that the fishes were affected as a result of

intake of contaminants. In this study the fish gill showed hyperplasia, epithelial lifting, fusion and loss of filaments which can result in difficulty of oxygen, carbon dioxide, acids and ammonia exchanges. The effects can also lead to hindrance in the transfer of ions and water. The intestine of *Synodontis clarias* showed congestion of the submucosa, degeneration of epithelia layer and debris in the lumen. These effects can hinder the digestion and absorption of food materials in the fish which might lead to loss of appetite of the fish leading to decrease in the size of fish or reduction in rate of reproduction or even mortality of the fish thereby leading to species extinction and reduction in economic value of the fish.

Parasitism coupled with pollution could either increase or decrease the prevalence, intensity and load of the parasites and upset host/parasite equilibrium which could lead to diseased condition and mortality of the host.

The PCB congeners 8, 18, 28, 44, 77, 81, 123, 153, 156 detected in the water and sediment sample of all the 209 PCB congener is in line with reports from (Wania and Mackay, 1996) who stated that the concentration of volatile compound is low in tropical areas and higher in temperate or polar regions. Also, it is well known that lower chlorinated PCB can volatilize and are thus more susceptible to atmospheric removal process (Mackay *et al.*, 1992, Fiedler 1998). The findings presented in the study, showed more of the lower chlorinated PCB congeners in the water sample than in the sediment, fish (*Synodontis clarias*) and parasite sample from the three stations in the Epe axis of Lekki Lagoon. Anyasi and Atagana (2013) showed that lower chlorinated PCB congeners tend to be more volatile and soluble in water, while adsorption to organic materials, sediments, and soils tends to increase with chlorination of PCB and organic content of the substrate because of their hydrophobic nature (Passatore *et al*., 2014).High chlorinated PCBs were also detected in *Synodontis clarias* and parasite samples from Epe axis of Lekki Lagoon, having relatively high amount of congeners is an indication that the water body is less contaminated as it contains the high concentration of poly chlorinated biphenyl, which is a toxic form of PCB.

The fish samples collected from Oribo had the high concentration of congeners 28, 18, 44, and 52 among other detected, while fish samples collected from Imode had high concentration of 44,18,8 and 28 and the fish samples collected from Ikosi also had high concentration of PCB 44, 18, 8 and 123 respectively. However, the concentration of PCBs level found in the fish tissue was above W. H. O limits of 200 part per billion (ppb) in Oribo and Ikosi (607.42ppb and 325.43ppb) sampling station while the concentration was below in Imode (188.61ppb) sampling station and hence the *Synodontis clarias* in Oribo and Ikosi is not safe and edible for consumption. The parasite samples collected from the organs of *Synodontis clarias* in ORIBO was analysed and found to be high in PCB 81, 77 and 52 while parasite collected fish samples from IMODE was found to be high in PCB 18, 81 and 77 and parasite collected from fish samples in IKOSI was also analysed and found to be high in PCB 81 and 18 respectively.

The concentration of PCB congeners in the sediment from each of the three stations were also analysed and found to contain high amount of PCB 81, 77 and 8 in samples collected from Oribo, PCB 81, 77 and 123 in Imode and PCB 81, 101 and 77 in Ikosi respectively. Although the major sources of PCB contamination in the Epe axis of Lekki Lagoon is not known, the presence of PCB congeners can be linked to run-off from industrial sites around the environ.

The results from this study demonstrates a persistent problem with polychlorinated biphenyls, leading to high risk in fish species in aquatic ecosystems, and for the human populations living near these regions, concentration of PCBs in *Synodontis clarias* at Epe axis of Lekki lagoon in Oribo and Ikosi is already far above the WHO limits for PCBs in fish, while is at warning limits in Imode sampling station. Biological monitoring of the water and fish meant for consumption should be done regularly. Laws passed on our aquatic environment should be obeyed. The activities at the three sampling stations (Oribo, Imode and Ikosi) should be kept under strict surveillance. However, the study showed a need for continuous pollution assessment study of aquatic organisms and its environment.

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