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EFFECTS OF WATER LIMNOLOGY AND ENTEROPARASITIC INFESTATION ON MORPHOMETRICS OF *OREOCHROMIS NILOTICUS* (LINNE, 1757) (CICHLIDAE) IN A TROPICAL RESERVOIR

Ajala Olasunmibo Olumuyiwa
Ladoke Akintola University of Technology, Ogbomoso, Oyo State, **NIGERIA**

Fawole O. Olatunde
Ladoke Akintola University of Technology, Ogbomoso, Oyo State, **NIGERIA**

ABSTRACT

Water quality and enteroparasitic infestation are factors that affect the productivity of fish aquaculture. American Public Health Association's methods were used to determine Limnological characteristics of water while morphometric and enteroparasitological studies of *Oreochromis niloticus* were done using standard methods. Temperature of water in the reservoir was detected to be declining in value when compared with previously acquired data as a result of climate change. The water was turbid and *O. niloticus* was found to thrive well in the turbid water as indicated by the abundance and condition factor values obtained in the two years of study. Values of investigated limnological characteristics were within acceptable standards for fish aquaculture. The growth pattern of the fish in the reservoir was positively allometric. Gastro - intestinal helminth parasites recovered were comprised of two Acanthocephalan (*Neoechinorhynchus rutili*, *Acanthocentius tilapiae*) and the metacercaria of a Trematode, (*Clinestomum tilapiae)*. Infestation by enteroparasites was found to affect the correlation coefficient of length - weight relationship in infested fishes, though the difference in length and weight was not significant (p = 0.05) from those of uninfested fishes.

Keywords: *Oreochromis niloticus*, Morphometry, Limnology, Enteroparasite.

INTRODUCTION

Oba reservoir is situated in Ogbomoso, Oyo state, Nigeria. It sustains a thriving artisanal fisheries industry and serves as a source of domestic water for a population of 198,859 in Ogbomoso North, and 100,379 in Ogbomoso South, (National Population Commission, 2010). Continuous, intermittent anthropological intervention of the environment in an aquatic habitat has made study of limnology and the biology of fish a continuous phenomenon. Seasonal variation in the quantity and quality of water runoffs and tributaries that supplies the reservoir may alter the physical and chemical constituent of the water in a reservoir (Novotny 2012) and invariably affect the health of the fish (Abowei and George, 2009). Global warming and climate change could contribute to the alteration of the quantity and quality of runoffs and tributaries (Abler *et al*., 2002). These re-occurring events made the study of limnology of water bodies and the biology of freshwater fish species dynamic, to detect any change from previously acquired data.

Oreochromis niloticus (also called Nile Tilapia) belong to the family Cichlidae; eleven genera of this family occur in the inland waters of Nigeria (Adesulu and Sydenham, 2007). The eleven genera are *Tilapia, Sarotherodon, Oreochromis, Haplochromis, Hemichromis, Pelmatochromis, Chromidotilapia, Pelvicatochromis, Thysia, Gobiocichla* and *Tylochromis*. Ajala and Fawole (2015) reported *O. niloticus* to be primarily an herbivore but generally an omnivore, and that the feeding on food items of animal origin may be supplementary; they suggested that the choice of food could determine enteroparasite species diversity and

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intensity. Morenikeji and Adepeju (2009) reported *O. niloticus* as having the highest level of infection out of the six Cichlids studied in Eleyele reservoir in Ibadan, Nigeria. Fishes that are infested or infected with parasites are susceptible to stunted growth, low protein content, and low reproductive abilities, since the parasites mostly feed on already digested food, blood, body fluids, and tissues (Akinsanya and Otubanjo, 2006). This study examined some aspects of the limnology of water together with the enteroparasites of *O. niloticus* and the possible effects they could have on some Morphometric indices of the fish in Oba reservoir.

METHODOLOGY

Study Area

The study area was Oba reservoir, it lies between Latitude 8° 3" N to 8° 12" N and Longitude 4° 6" E to 4° 12" E in Ogbomoso North local government area of Oyo state, Nigeria. It was impounded in 1964 and the tributaries are Idekun, Eeguno, Akanbi - Kemolowo, Omoogun, and Yakun streams.

Limnology

Physico-Chemical Parameter Determination

Description of sampling method: Sub surface water samples were collected by lowering the sample bottles by hand to a depth of about 25 cm, and the sample bottle securely cocked inside the water after it is filled. Water samples were taken from the reservoir, twice a month from November 1st 2011 to October 30th 2013. The physical parameters investigated were Temperature, Hydrogen ion concentration (pH), Electrical conductivity and Turbidity and were determined by the procedures of American Public Health Association, (APHA) (1992). The chemical parameters were dissolved Oxygen (DO), biochemical Oxygen demand (BOD), Nitrates, and Phosphates and were also determined by the procedures of APHA (1992) except in the determination of Nitrate contents where the procedure of Agbozu (2001) was used.

Procedure for collection of Fish Specimens

Samples of the fish specimens were collected monthly from catches of local fishermen using traps, gill nets, and cast nets in the reservoir. A total of 308 specimens were studied during the two year period. Collection was done between 06:00 - 08:00 am. Water from the reservoir was added to the samples at the point of collection before being transported to the laboratory in the Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria for further investigations.

Fish Species Identification

Possession of a single pair of nostrils, and the characteristic alternating dark and light band on the caudal fin of *O. niloticus* were used for its identification (Adesulu and Sydenham, 2007). The sexes were identified by examining the papillae; there are two orifices in the papillae of female and one in male (Adesulu and Sydenham, 2007). The sexes were further confirmed after dissection with the presence of testes and ovaries.

Seasonal Studies

Rainy season was taken as the months of February to end of September and Dry season, between the months of October and ending of January.

Morphometric Study

The Length – Weight Relationship (LWR)

The weight of each specimen was measured using a top loading spring balance (model PN1200) to the nearest 0.1g after draining excess water with a pile of filter paper. Total lengths (TL) were measured in centimeter (cm) using a measuring board, total lengths were used because no evidence of cannibalism was observed during the pre-data and data collection periods.

The LWR was estimated by using the equation: $W = a L^{b}$
This was transformed into logarithm in the form of $\text{Log } W = \text{Log } a + b \text{ Log } L$. (Froese, 2006). The relationship between total length and body weight was done by linear regression (Hossain *et al.,* 2006). The length - weight regression equation was determined and the parameters 'a' (regression constant), 'b' (regression coefficient) and 'R' (correlation coefficient) were estimated. The means of total lengths and weights of samples for the sexes in the two years were compared for significance at 95% confidence level. This test was also repeated to find the difference between male and female in each year.

Monthly Abundance

The monthly mean abundance for the combined sexes of the fish was determined by finding the means of the body weight of males and females in each month (Okogwu, 2011).
The means of the body weight of specimens collected in rainy and dry seasons for males, females, and combined sex were tested for significance at $p < 0.05$. The means of the body weight of specimens collected in the two years for males, females, and combined sex were tested for significance at $p < 0.05$.

The Condition Factor K

The Condition factor was calculated based on Tesch (1971) as $K=100W/L^{3}$

Test for significance between the means of the K values of males in rainy and dry seasons in each year, and between the means in the two years of study were done at 95% confidence level, this was also repeated for females and combined sexes.
All statistical analyses were carried out using the SPSS (version 15.0 for Windows).

Enteroparasites

Examination and Identification of Parasites

Examination of fish for parasites, handling and processing followed standard procedure by Maravec (2004). Parasites were examined from the buccal cavity, stomach and the intestines. Parasites retrieved were identified using information provided by Juan and Windsor (2006); Edoh *et al*., (2008).

Processing of Recovered Parasites

Cestodes and nematode parasites recovered were stained using the procedure of Khalil (1991). Fixative used was Formalin acetic acid (FAA).

Statistical Analysis

Significant differences of parasitic infestation were tested using a non parametric (Npar.) statistical method, -Kolmogorov-Smirnov-Z test -, (KSZ) at 95 % level of confidence.
Significant difference between the means of body weight; total length; of infested and uninfested fish specimens were done using the student t test (2-tailed) at 95 % level of confidence. All statistical analysis were done using SPSS version 15.0 for Windows.

RESULTS

Physico-Chemical Characteristic Values in the Years of Study

The mean values of the physico-chemical characteristics in the two years of study in Oba reservoir was shown in Table 1.

Seasonal Mean Values of Physico-Chemical Characteristics of Water from Oba Reservoir

The mean values of physico-chemical characteristics of water in seasons of the two years of study in Oba Reservoir was shown in Table 2.

Table 1: The means of the physico-chemical characteristics in the years of study in Oba reservoir

PARAMETERS	2011/2012	2012/2013	P = 0.05 Values	REGULATORY LIMITS N.I.S. (2007)	W.H.O.(2011)
Temperature (^{0}C)	27.37±0.03	27.36±0.03	0.830	Ambient	Ambient
pH	6.97±0.15	7.15±0.13	0.368	6.5 – 8.5	6.5 – 8.5
Electrical Conductivity (µScm^{-1})	144.25±8.11	129.95±4.38	0.139	100-250	100-250
Turbidity (NTU)	5.17±0.16	5.16±0.15	0.937	5	5
Dissolved Oxygen (mgL^{-1})	5.81±0.16	6.01±0.25	0.522	5-10	5-10
B. O. D. (mgL^{-1})	3.60±0.09	3.39±0.15	0.252	<5.0	<5.0
Nitrates (mgL^{-1})	1.32±0.06	1.33±0.10	0.955	-	<10
Phosphates (mgL^{-1})	0.08±0.01	0.09±0.01	0.525	<0.10	<0.10

D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand. NTU = Nephelometric Turbidity Units.

Table 2: Seasonal mean values of physico-chemical characteristics of water from Oba reservoir

	2011/2012 SEASONS			**2012/2013** SEASONS		
PARAMETERS	Rainy	Dry	P = 0.05value	Rainy	Dry	P =0.05value
Temperature (^{0}C)	27.33±0.02	27.45±0.06	0.032	27.33±0.03	27.43±0.06	0.093
pH	7.17±0.17	6.58±0.15	0.048	7.33±0.11	6.80±0.25	0.045
E. C. (µScm^{-1})	134.83±8.25	177.88±4.41	0.001	126.24±4.97	136.65±8.75	0.289
Turbidity (NTU)	5.01±0.16	5.79±0.11	0.020	5.11±0.19	5.25±0.30	0.689
D. O. (mgL^{-1})	6.08±0.17	5.28±0.11	0.011	6.23±0.27	5.57±0.51	0.233
B. O. D. (mgL^{-1})	3.46±0.11	3.89±0.06	0.020	3.24±0.16	3.70±0.28	0.149
Nitrates (mgL^{-1})	1.38±0.06	1.19±0.13	0.169	1.45±0.10	1.07±0.17	0.062
Phosphates (mgL^{-1})	0.09±0.01	0.07±0.02	0.318	0.09±0.01	0.08±0.02	0.869

E. C. = Electrical Conductivity; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand. NTU = Nephelometric Turbidity Units.

Morphometry

Length – Weight Relationship

The length – weight regression showed a linear relationship exhibiting a positive allometric growth. The correlation coefficient (R) values of all the length weight relationships had a minimum of 0.950, Table 3.

There was no significant difference (p = 0.05) in the means of total length of males in 2011/2012 and 2012/2013 so also in female, and there was no significance between the mean total lengths of males and females in the two years. Seasonally, there was no significance (p = 0.05) in means of total length of rainy and dry seasons. There was no significant difference in the mean weights of males in 2011/2012 and 2012/2013, however there was significant difference in the mean weights of females. Also there was significant difference in the mean weights of males and females in 2011/2012, but no difference in 2012/2013. Generally, the body weight of female fish was significantly higher than that of male in the two years of investigation while the fish had more weights in the dry seasons of the two years than the rainy seasons in the two sexes, except in males of 20112012 (Table 4).

Monthly Abundance

The monthly abundance of *O. niloticus* was shown in Figure 1. They had a monthly mean body weight of 183.87+12.82 (g) in 2011/2012 and 133.71+9.23 (g) in 2012/2013. The mean weight for the year 2011/2012 was higher and significantly different from the mean of 2012/2013 with a P value of 0.004.

Table 3 Regression indices of length-weight relationships of *Oreochromis niloticus* in Oba reservoir

Year	Sex	N	Total Length (cm) Min.	Max.	Body Weight (g) Min.	Max.	a	b	Regression Equation	R	Type of Growth
2011/2012	Male	82	15.87	23.93	88.00	260.33	-1.873	3.184	LogW = -1.873 + 3.184 log L	0.984	Positive Allometric
	Female	70	17.97	25.43	121.67	316.00	-1.845	3.133	LogW = -1.845 + 3.133 log L	0.966	Positive Allometric
	Combined	152	15.87	25.43	88.00	316.00	-1.861	3.155	LogW = -1.861 + 3.155 log L	0.961	Positive Allometric
2012/2013	Male	84	16.00	21.40	91.00	181.50	-2.028	3.266	LogW = -2.028 + 3.266 log L	0.956	Positive Allometric
	Female	72	18.05	23.30	107.25	246.50	-1.953	3.206	LogW = -1.953 + 3.206 log L	0.950	Positive Allometric
	Combined	156	16.00	23.30	91.00	246.50	-1.986	3.229	LogW = -1.986 + 3.229 log L	0.959	Positive Allometric
Two years	Combined	308	15.87	25.43	88.00	316.00	-1.997	3.304	LogW = -1.997 + 3.304 log L	0.961	Positive Allometric

N = Total number of Fish; a = Intercept; b = Regression coefficient; R = Correlation coefficient.

Table 4 Seasonal difference in the mean values of abundance and condition factor of *Oreochromis niloticus* in Oba Reservoir.

ABUNDANCE				CONDITION FACTOR			
Sex and Year	Means in Seasons (g)	'P' value	Inference at p=0.05	Sex and Year	Means in Seasons	'P' value	Inference at p=0.05
Males 2011/2012	Rain- 137.83+15.77 Dry- 115.77+24.83	0.699	Not significant	Males 2011/2012	Rain- 2.06+0.04 Dry- 2.16+0.04	0.705	Not significant
Males 2012/2013	Rain- 108.66+10.25 Dry- 175.94+31.65	0.064	Not significant	Males 2012/2013	Rain- 2.03+0.07 Dry- 1.95+0.05	0.580	Not significant
Females 2011/2012	Rain- 183.66+14.55 Dry- 266.56+24.78	0.016	Significant	Females 2011/2012	Rain- 1.90+0.07 Dry- 1.80+0.12	0.465	Not significant
Females 2012/2013	Rain- 147.24+17.37 Dry- 165.63+13.96	0.780	Not significant	Females 2012/2013	Rain- 1.79+0.06 Dry- 1.96+0.07	0.161	Not significant
Combined sexes. Rain 2011/2012	167.15+13.42	0.060	Not	Rain 2011/2012	1.99+0.03	0.691	Not

Dry	2011/2012	215.01±28.35		significant	Dry	2011/2012	2.06±0.07		significant
Rain	2012/2013	125.37±11.75	0.216	Not	Rain	2012/2013	1.91±0.04	0.600	Not
Dry	2012/2013	170.62±21.60		significant	Dry	2012/2013.	1.97±0.04		significant.

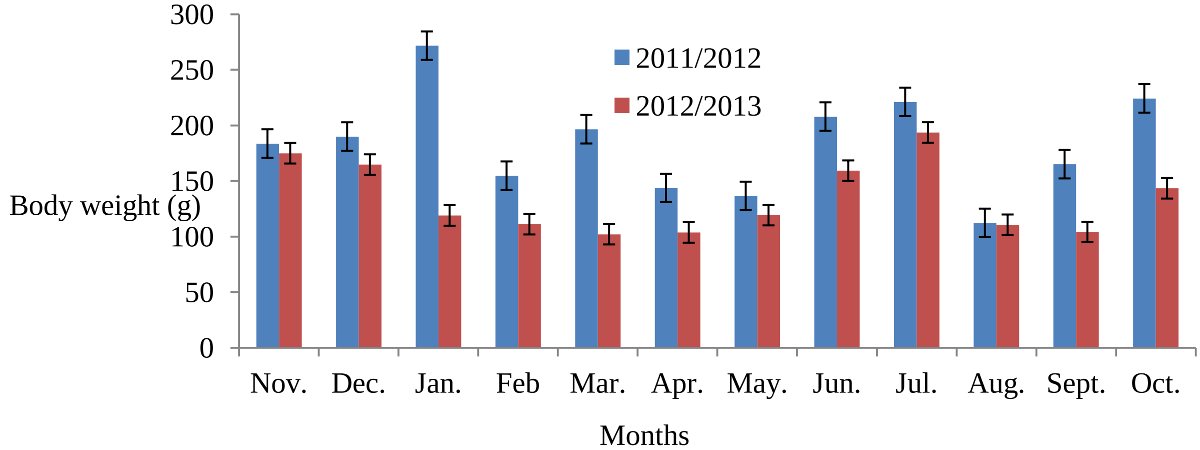

Figure 1. Variation in monthly abundance of *Oreochromis niloticus* for the years 2011/2012 and 2012/2013 in Oba reservoir.
Error bars represents standard error of means.

Condition Factor for Combined Sexes

There was no significant difference (p=0.05) in the mean condition factor values between year 2011/2012 and 2012/2013 for combined sexes; P value of 0.073. Figure 2 showed the mean condition factor for the two years. Table 4 showed the condition factors in the seasons of the two years of study.

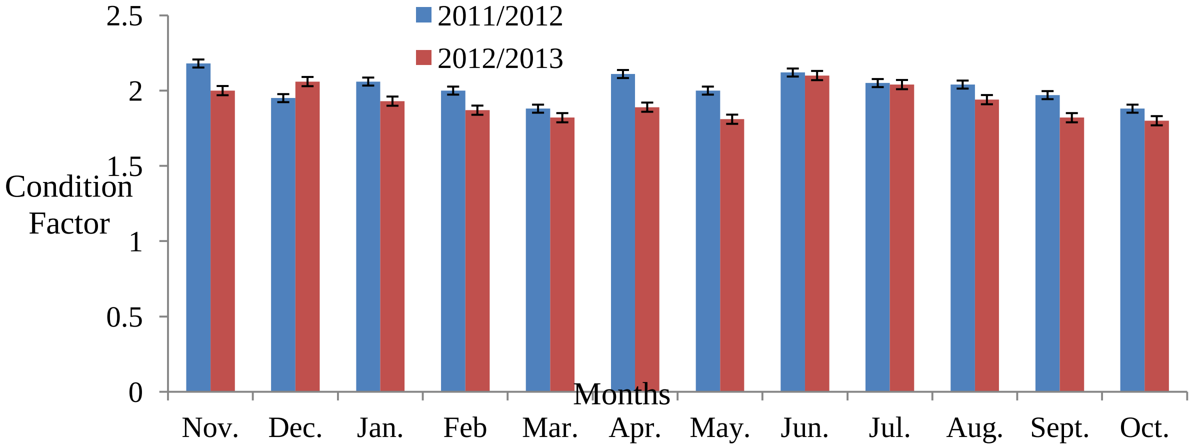

Figure 2. Monthly Condition factors for combined sexes of *Oreochromis niloticus* in Oba reservoir 2011/2012 and 2012/2013.
Error bars represents standard error of means.

Enteroparasites

Parasite Species Diversity and Distribution in the Enteron of *O. niloticus*

The gastro - intestinal helminth parasites recovered were comprised of two Acanthocephalans (*Neoechinorhynchus rutili*, *Acanthocentius tilapiae*) and the metacercaria of a Trematode, (*Clinestomum tilapiae*). The metacercariae were found in the buccal cavity while the two acanthocephalans were found in the intestine, nothing was found in the stomach.

Relationship of Parasitemia and Body Weight

In 2011/2012, the student t test carried out to find the significant difference (at p =0.05) between the means of the body weight of infested males in *O. niloticus* (118.30±12.27 g) and uninfested (116.91±7.17 g) was not significant. Whereas in uninfested females (168.78±12.43 g) and infested (116.63±7.16 g) it was significant.

In 2012/2013, the test between the means of the body weight of infested males in *O. niloticus* (145.69±18.02 g) and uninfested (165.68±19.01 g) was not significant. In infested females (193.57±21.24 g) and uninfested (230.33±22.60 g) it was also not significant.

Relationship of Parasitemia and Total Length

In 2011/2012, the student t test carried out to find the significant difference (at p =0.05) between the means of the total length of infested males in *O. niloticus* and uninfested was not significant. In infested females and uninfested it was also not significant.
In 2012/2013, the test between infested male and uninfested was not significant and the test between infested female and uninfested was also not significant.

Influence of Parasitemia on Length – Weight Relationship

In uninfested male of 2011/2012, R value was 0.970, infested 0.930; in uninfested female it was 0.932, in infested it was 0.926. In uninfested male of 2012/2013, R value was 0.932, in infested it was 0.909; in uninfested female it was 0.926, in infested it was 0.713.

DISCUSSION

Limnological investigation showed that the temperature of water in Oba reservoir showed a gradual decline in values, probably affected over the years with climate change. Fawole (2000) reported a mean value of 27.90±2.3 ^oC, Ajala and Fawole (2012) reported 27.67±0.20 ^oC in Oba reservoir. These values were higher than what were recorded in the two years of current study (Table 1). The long rainy months of February to September during the period of investigation as against previously known months of April to September, could be responsible for this decline in value. Temperature is a very important and sensitive parameter in the metabolism of living things, Pisces been poikilothermic animals, depend on environmental temperature for their metabolic activities and if the declining continues, could result in a significant effect on some biological activities of resident organisms. The progressive decline might be an indication of climate change and a shift in the direction of a cold clime. The values obtained agree with the range of 25 ^oC – 35 ^oC suggested as the temperature of natural inland waters, Alabaster and Lloyd (1980).

The monthly mean values recorded for Hydrogen ion concentration (pH) showed a significant differences (p = 0.05) in the means of pH values between rainy and dry seasons in the two years, with the rainy season values higher than the dry season (Table 2). The pH value recorded in the dry seasons of the study period was acidic and this could be caused by acid rain run-offs and increased animal waste water discharges into the reservoir. Seasonal variations in pH have also been reported in some inland rivers in Nigeria by Abowei and George (2009). Fawole (2000) reported a range of 7.09 - 7.42 and a mean value of 7.24±0.17 (alkaline range) as the pH of water in Oba reservoir. All the values recorded in this study, fell

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within acceptable standard of Nigerian Industrial Standard (NIS) (2007) and WHO (2011). They were indicative of good water quality for fish habitation.

Turbidity values recorded showed no significant difference in the mean values of the two years, which indicated that the turbidity values of the water during the period of study though slightly high were fairly stable, and may be indigenous to the habitat. Fish and aquatic life that are native to streams, rivers, and reservoirs may have evolved over time to adapt to varying levels of background water clarity peculiar to their habitat. Generally the turbidity of the water during the period of study though not statistically different from the desirable limit (5 NTU); was slightly above the desired limit an indication that the cumulative effects of anthropological activities around the reservoir had finally started to have effect on the quality of the water in the reservoir.

The dissolved Oxygen (DO) values recorded (Table 1) varied with the submission of Fawole (2000) who reported a lower value (4.37±1.14 mg/l) of DO in Oba reservoir. The variation observed could be attributed to increase in the volume of rainfall which resulted in flooding experienced in various parts of Nigeria during the period of investigation. Another reason may be a reduction in micro and macro organisms or/and an increase in phytoplankton bloom in the reservoir. The value obtained, agreed with the report of Abowei *et al.*, (2010) that dissolved oxygen concentration of 5.0 mg/L and above is desirable for fish survival. Oxygen concentration in water is controlled by four factors: Photosynthesis, respiration, exchanges at the air-water interface and the supply of water to the water body or pond Erez *et al.*, (1990). Seasonally, the DO values in the rainy seasons were higher than the values recorded in the dry seasons, the seasonal difference was significant ($p = 0.05$) in 2011/2012, but was not significant in 2012/2013. Seasonal variations observed in DO content with higher values in rainy season could be due to increased aeration because of rainfall; as a result of inflow of fresh water from feeder streams and as a result of reduced resident time of polluted waters.

The Biochemical Oxygen demand (BOD) seasonal values obtained in the dry season were higher than the values obtained in the rainy seasons, the seasonal difference was significant ($p = 0.05$) in 2011/2012, but was not significant in 2012/2013. The values followed the same pattern as recorded in Turbidity, EC, and DO values, which suggest the possibility of high quantity of biodegradable organic matter being deposited by the runoffs and accumulating towards the end of the rainy season (Table 2). This made the oxygen demand to increase in the dry season and the quantity was more in 2011/2012 than 2012/2013. However there was no significant difference ($p = 0.05$) in the mean values of the BOD between the two years which indicated a probable stability in the BOD values throughout the study period. Water bodies with BOD levels between 1.0 and 2.0 mg/L were considered clean; 3.0 mg/L fairly clean; 5.0 mg/L doubtful and 10.0 mg/L definitely bad and polluted Chinda (1991).

The seasonal values recorded for Nitrates showed rainy season to be higher than dry season with no significant difference in the two years. The nitrate ion (NO_3^-) is the common form of Nitrogen found in natural waters; it may be biochemically reduced to nitrite (NO_2^-), usually under anaerobic conditions. The nitrite ion is rapidly oxidized to nitrate as oxygen becomes available, which explains the increase in the rainy season months (Table 2) which also correspond with the seasonal increase in DO values. This result is in agreement with the submission of Phiri *et al.*, (2005) who recorded a higher value of nitrates during the rainy season than the dry season in the rivers of urban areas in Malawi. However, the seasonal variation and values of nitrate observed, is in disagreement with Adeyemo *et al.*, (2008) who worked in Ibadan metropolis Western Nigeria. They recorded higher levels of nitrate in the

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dry season and concluded that nitrates are usually built up during dry seasons and that high levels of nitrates are only observed during early rainy seasons. They further suggested that initial rains flush out deposited nitrate from near-surface soils and nitrate level reduces drastically as rainy season progresses. The values obtained in 2011/2012 (1.32$\pm$0.06 mg/l) did not significantly differ ($p = 0.05$) from that of 2012/2013 (1.33$\pm$0.10 mg/l). Natural levels of nitrate in surface waters seldom exceed 0.1 mg/l as NO_3^-, but waters influenced by human activity normally contain up to 5 mg/l as NO_3^- with levels over 5 mg/l as NO_3^- indicating pollution by animal or human waste or fertilizer runoff; while nitrate-nitrite concentrations of 0.2 mg/l or greater encourage eutrophication Eidson (1993). Moderate eutrophication is very good for an aquaculture in that it increases the dissolved oxygen values and increases the biomass of the producers in the ecosystem. The nitrate values of water in the reservoir were within acceptable standard.

The seasonal values recorded for Phosphates showed rainy season to be higher than dry season with no significant difference in the two years. Land use around riverine areas in Nigeria is predominantly for farmland and could be a possible explanation for the high levels of phosphate from run-off during rainy seasons as observed in this study. This result is in agreement with the findings of Adeyemo *et al*., (2008) who worked on physico – chemical parameters of waters in Ibadan metropolis. Phosphate is considered to be the most significant among the nutrients responsible for eutrophication of lakes, as it is the primary initiating factor. Phosphate will stimulate the growth of phytoplankton and aquatic plants which provide food for fish, though its excessive increase may result in algal mats, decaying algal clumps, odors and discoloration of the water which with interference with recreational and aesthetic water uses. Dead macrophytes and phytoplankton that settles to the bottom of a water body, stimulating microbial breakdown processes that require oxygen. Eventually, dissolved oxygen will be depleted. Hence phosphate values require regular monitoring. There was no significant difference ($p = 0.05$) in the mean values for the two years of study, which indicated a stable value during the study period. Results of the Limnological parameters investigated were found to fall within the acceptable limit, these made the water in Oba reservoir adequate for aquaculture.

The mean total length (TL) obtained for the male showed no significant difference ($p=0.05$) in the two years, which indicated uniformity of growth in length in males. This trend was also observed in females. However result showed that females had a higher TL growth than males, this was confirmed with a statistical inference which was significant between the mean values of the male and female at ($p = 0.05$) in the two years. The reason why the female attained a higher TL than male could be traced to parental care in the fish species. *O. niloticus* exhibit uniparental care in which the female stayed behind in the safe environment of the nest to care for the brood, while the male forage for food and further mate partners and in the process probably get caught; thereby reducing their chances of attaining full growth. This result is in agreement with the findings of Olurin and Aderibigbe (2006) who reported higher TL value for female than male *O. niloticus* in Ijebu-ode, Nigeria.

The mean TL value obtained for male and female *O. niloticus* was higher than those values reported by Olurin and Aderibigbe (2006) in Ijebu-ode, south west of Nigeria. This was an indication that the fish probably thrived better in Oba reservoir, maybe as a result of adequate water quality for its survival, or low demand from fish consumers, thereby giving the fish opportunity to grow. It was reported by Ajala and Fawole (2015) that although the fish was found to be an omnivore, its preferred diets were food from plant sources. In a turbid aquatic system as reported in the reservoir, light penetration will be reduced, limiting the phytoplanktons to be abundant in the photic zone; the high concentration of the phytoplankton organisms will increase the dissolved Oxygen supply in the photic area, thereby giving the pelagic fish species that could survive the high turbidity, abundant food and Oxygen supply. Another reason could be the turbid water, offering some protection by reducing its visibility to potential predators.

The length – weight regression indicated that the growth of *O. niloticus* in Oba reservoir in the two years were positively allometric; it showed that the fish species were increasing in weight faster than they were increasing in length, as the values of 'b' increases, the size of the fish also increases because the fish usually grows proportionately in all directions. The correlation coefficient (R) values for male, female, and combined sexes in the two years were shown in Table 3; these values were close to one. This meant that at least 95% of the data collated on length and body weight of *O. niloticus* from Oba reservoir were able to fit into the regression line and could be used to explain the positive allometric relationship that existed in the fish. The results indicated good correlation between length and weight of male, female, and combined sexes in the two years of study. It also showed that the fish species probably thrived well in the reservoir in the two years.

The abundance of *O. niloticus* was calculated based on the body weight of the fish species and it was observed that *O. niloticus* was more abundant in 2011/2012 than 2012/2013 (figure 1); this was confirmed by the means which were significantly different (p=0.05). The abundance of the fish species in Oba reservoir was not related to seasons and sex, it was abundant in the two seasons of the two years of investigation (Table 4). This was supported by the significant difference tests (p=0.05) between the two seasons of combined sexes in the two years that were found not to be significant. It was also observed that the fish thrived better in 2011/2012 than 2012/2013; the student t test that showed the mean weight for the year 2011/2012 was significantly different from the mean of 2012/2013 with a P value of 0.004.

The mean abundance of the female species in rainy season of the two years was observed to be lower in value to those of dry seasons (Table 4). This may be as a result of weight loss during the spawning period (rainy season) and care for the young (maternal mouth brooder) during which the females do not feed. Apart from the reproductive aspect, there was higher value of abundance in both sexes in the dry season, a period when the turbidity values in the reservoir were recorded to be higher than the rainy seasons. It was also observed that the combined sex abundance values in dry season was also higher than rainy seasons of the two years with the value of 2011/2012 (Turbidity of 5.79 NTU) higher than 2012/2013 (Turbidity of 5.11 NTU). The abundance of *O. niloticus* in habitats with low water transparency may reflect a relationship between the fish and another variable that is correlated to water transparency. However, it is also possible that the lower transparency provides some additional protection from its predators. This showed that *O. niloticus* may likely thrive better in slightly high turbid environment (either rainy or dry season) giving them a competitive advantage among ichthyofauna species. This result was in agreement with that of Bwanika *et al*., (2006) who reported that in both seasons, *O. niloticus* abundance was higher where water transparency was lower.

It was observed that the difference in the mean condition factor 'K' value of males and females was significant at p=0.05 in 2011/2012, while in 2012/2013, the difference between male and female was also significant. It was thus evident that in the two years of study, the male thrives better or lives a more robust life than the female. The low 'K' value recorded for females may be connected to the heavy investment of the female sex in reproduction. A test of significant difference between the means of K values of the two years in both male and female were not significant. Also the test of significant difference between the combined sex of the two years (p=0.05) was not significant (Table 4) an indication that the living condition in the two years was stable. However, result showed that the fish thrived better in 2011/2012 than 2012/2013 (figure 2). Also, the turbidity value in 2011/2012 was higher than 2012/2013, and the fish thrived better at slightly high turbidity. This was supported by the differences reported in the results of dissolved Oxygen values in the rainy and dry seasons of 2012/2013 that were higher than those of 2011/2012; and also the BOD values in 2012/2013 that were lesser than the values in 2011/2012. This means physiologically, the fish may probably be better adapted to a turbid environment.

The results obtained for the condition factors in this study was in agreement with those of Olurin and Aderibigbe (2006) who reported a mean 'K' value 1.14 (male) and 1.08 (female) for juveniles reared in earthen pond in Ijebu – ode, Nigeria. Generally, the values obtained in the period of study (1.44% - 2.32%) were similar to what was obtained in other tropical water bodies in Nigeria. The condition factors of the fish species were found not to be influenced by seasons. The result of test of significance between seasons was not significant (p=0.05) in the two years, and the mean values of the seasons for the sexes did not follow any regular pattern. The combined sexes 'K' values in rainy and dry seasons of the two years did not show any significance (p=0.05), but the dry season values recorded in the two years were higher than rainy season. This may be as a result of the raised turbidity level in the dry season in which the species was noted to thrive better, and this was demonstrated with the 'K' value in dry season of 2011/2012 (2.02 ± 0.07%) where the highest turbidity values were recorded. A number of factors has been suggested to affect the 'K' value of fish, this included sex, seasons, environmental conditions, stress, and availability of food Olurin and Aderibigbe (2006). Variation in condition factor with seasons and pollution has also been documented by Khallaf *et al.,* (2003). Generally, the 'K' values obtained for the two sexes in the two seasons of the two years of study showed *O. niloticus* as having lived a robust life and the water condition in Oba reservoir supported its growth. There was no observe-able sequence in the 'K' values obtained for the total length size distribution; all the values obtained for the size groups were higher than one. This was an indication that fish specimens of all size groups live a robust life and the quality of water in the reservoir probably supported the growth of *O. niloticus*.

The stomach of *O. niloticus* in Oba reservoir could not be colonized by any parasites, maybe as a result of the acidic medium in the stomach of the fish species and/or none availability of nutrients required by the parasites. Metacercaria of *Clinostomum tilapiae* (Trematode) were found in the buccal cavity, maybe as a result of easy accessibility to Oxygen; while the acanthocephalans (*Neoechinorhynchus rutili*. and *Acanthocentius tilapiae*) were found in the intestine. This result agreed with Adeyemo and Agbede (2008) who reported the presence of the cyst of the metacercariae of *C. tilapiae* in the skin and pharyngeal region of *O. niloticus*; Olurin and. Somorin (2006) also reported the presence of *N. rutili* and the metacercariae of *C. tilapiae* in *Tilapia mariae* from Owa stream in Ijebu-Ode South West Nigeria. The presence of the Nematodes (*Procamallanus laevionchus, Paracamallanus cyathopharynx),* the Cestode (*Polyonchobothrium sp*.) and the Acanthocephalan, *Acanthocentius tilapiae* in the hybrid and monosex of *O. niloticus* was also reported by Eissa *et al*., (2011).

Parasitemia was observed not to have any effect on the total length of the fish host irrespective of sex. This was an indication that in Oba reservoir, parasitic infestation of *O.*

niloticus might not have had an effect on the growth of its length. The influence of parasitic infestation on body weight of *O. niloticus* in Oba reservoir was also not significant. This result was in consonance with the result of Olurin *et al*., (2012) who reported that there was no relationship between parasite burden and size of fish in their study of helminthes parasites of *S. galilaeus* and *T. zilli* from Oshun River, South-West Nigeria. However, in 2011/2012 the influence was observed to be significant between the means of the body weight of infested (116.63$\pm$7.16) and uninfested females (168.78$\pm$12.43). This influence on the body weight was further confirmed from the regression coefficient (R) value (Table 3) obtained from infested females of 2012/2013 which was the lowest of all values obtained from the regressions in male and female of the two years. It was also observed that the R values of the length-weight regression of all infested specimens in both sexes were less than in uninfested, an indication that a factor was working against the correlation of the length and weight of the infested fish, and this factor was probably parasitic infestation. This probably indicated that the infestation of *O. niloticus* by parasites in Oba reservoir had a negative effect on the weight of the female fish and was more pronounced in 2012/2013.

CONCLUSIONS

The values obtained for limnological parameters of water in Oba reservoir fell within acceptable limits and these made the water in the reservoir adequate for aquaculture. The temperature of the water in the reservoir was detected to be declining in value because of the effects of climate change. *Oreochromis niloticus* had the capacity to thrive well in slightly turbid water as evidenced by the abundance and condition factor values obtained in the two years of study. The growth pattern of the fish was positively allometric and infestation by enteroparasites was found to affect the correlation coefficient of length - weight relationship in infested fishes though the difference in length and weight of infested fishes was not significant from those of uninfested fishes ($p = 0.05$).

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