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Effects of Parasitism on Morphmetric Indices of *Oreochromis niloticus* (Linné, 1757) in a Tropical Reservoir

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Abstract
Morphometric indices and parasitic infestation of Oreochromis niloticus (Linné, 1757) in Oba Reservoir were investigated between 2016 and 2018 using standard methods. Growth in total length and weight were higher in females than males, which could be traced to parental care in the fish species. Season had no effect on the growth and quantity captured. Growths of the fish were positively allometric. The correlation coefficient (r^2) values in the two years (2016/2017, 2017/2018) for male (0.984 and 0.956), female (0.966 and 0.950) and combined sexes (0.961 and 0.959), were close to unity and showed that at least 95% of the data collated on length and body weight were able to fit into the regression line. Abundance and condition factor of the fish species were not related to seasons. The condition factor showed that, male lived a more robust life than the female. The helminthes parasites retrieved from the enteron comprised of two Acanthocephala Neoechinorhynchus rutili (Mueller, 1780), and Acanthocentius tilapiae and the metacercaria of a trematode Clinostomum tilapiae (Leidy, 1856). No parasite was found in the stomach, C. tilapiae were found in the buccal cavity; while acanthocephalans were found in the intestine. Prevalence of parasitic infestation values obtained in the two years was higher in females (23.40%) than in males (19.15%) and was higher in the dry seasons of the two years than the rainy seasons. Parasitaemia was observed not to have any significant effect on the total length and body weight of O. niloticus in Oba Reservoir.

Keywords: Enteroparasites, Infestation, Intensity, Morphometric, *Oreochromis niloticus*.

Introduction
Nile tilapia (Oreochromis niloticus), is a predominantly cultured species worldwide and the most widely cultured freshwater fish in tropical and subtropical countries (Fasakin et al., 2005). The attributes that make Nile's Tilapia so suitable for fish farming, are its resistance against harsh conditions, ease of breeding, rapid growth rate, ability to efficiently convert organic and domestic wastes into high quality protein, and good taste (Pena-Mendoza et al., 2005). Due to their economic importance, Tilapias have become prominent in freshwater aquaculture in many regions of the world and are among the most studied groups of fish in African waters (Adesulu and Sydenham, 2007).

Olurin and Aderibigbe (2006) reported the value of regression co-efficient obtained for the length-body weight relationship for male *O. niloticus* as 3.14, while that for female was 2.90 and for the combined sexes 3.10. Condition Factor (CF) calculated by weight/body length has been used to compare growth conditions of fish. It provides information on the wellbeing of a fish and is usually influenced by the fish, sex, season, maturity stage (Anyanwu et al., 2007). A high condition factor above 1.0 reflects good environmental quality; while a low condition factor reflects poor environmental quality (Fawole and Adewoye, 2004). In Fisheries science, the condition factor is used in order to compare the "condition", "fatness', or wellbeing of fish. It is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal, 1978). Condition factor is also a useful index for the monitoring of feeding intensity, age, and growth rates in fish (Oni et al., 1983). It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of an aquatic ecosystem in which fish live. The condition factor computed for male Oreochromis niloticus by Olurin and Aderibigbe (2006) was 1.14, while female was 1.08 and for the combined sexes 1.11, which suggests that the specimens were healthy. Faced with a supply constraint of proteinous food, attention has now been drawn to aquaculture as a means to combat protein malnutrition in developing countries.
Different parasites have a variety of intermediate host and often depend on trophic interactions for transmission; hence parasites within a vertebrate host may be excellent indicators of food-web

structure and biodiversity (Marcogliese and Cone, 1997). Parasites are ubiquitous, primarily surviving in a dynamic equilibrium with their host(s) they are most often overlooked in fish health assessments. Changes in the environment, (both anthropogenic and environmental) can alter parasite/host equilibrium leading to disease and mortality in fish. 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. Ashade et al., (2013) found *Clinostomum marginatum, Bothriocephalus sp., Camallanus sp., Capillaria sp., Eustrongylides sp.* and *Contracaecum sp.* parasitizing *O. niloticus*; Nematode parasites were found in the intestines of the fish host, and it was also observed that adult fishes have more susceptibility to parasitic infections than juveniles. The emanating need to culture fishes for protein consumption for the rapidly growing populations in Nigeria have made it mandatory to intensify studies on the parasite fauna of the African freshwater fishes and examine the roles of parasitic infestation and infection on the biology of the fish.

Materials and Methods

The study area was Oba Reservoir in Ogbomoso North Local Government Area of Oyo State, Nigeria. The area is characterized by annual dry season months of October to March and raining season months of April to September. The vegetation of the shoreline is dense with submerged macrophytes which decompose in the raining season. The substratum of the reservoir is mainly mud and sand.

Samples were collected monthly from catches of local fishermen using traps, gill nets, and cast nets in the reservoir. Collection was done from November 2016 to October 2018, between 06:00 and 08:00 am. Water from the reservoir was added to the samples at the point of collection before being transported to the research laboratory in the Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria for further investigations. The first year, November 2016 to October 2017, referred to as 2016/2017, 166 specimens (90 males; 76 females); the second year, November 2017 to October 2018, called 2017/2018, 162 specimens (96 males; 66 females) were studied.

Identification of specimen was done using the most distinctive characteristic of the family which is the possession of only a single pair of nostrils distinguished by the characteristic alternating dark and light band on the caudal fin (tail) as reported by Adesulu and Sydenham (2007). The sexes were identified by examining the papillae; there are two orifices (openings) in the papillae of female and one in male, (Adesulu and Sydenham, 2007). They were further confirmed after dissection with the presence of testes (in male) and ovaries (in female).

Morphometric Parameters:

The Length – weight relationship (LWR): The weight of each specimen was measured using a top loading spring balance (model PN 1200) to the nearest 0.1 g after draining excess water with a pile of filter paper, while total length (TL) was measured in centimeter (cm) using a measuring board. The LWR was estimated according to Froese (2006). The relationship between total length and body weight was done by linear regression, (Hossain et al., 2006). For each species, the length - weight regression equation was determined and the parameters 'a' (regression constant), 'b' (regression coefficient) and 'R' (correlation coefficient) were estimated, using the SPSS version 15 for Windows.

The mean of total lengths and weights of samples for each and combined sexes in 2016/2017 were compared with those of 2017/2018 for significance at 95% confidence level. This test was also repeated to find the difference between male and female in each year.

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 were tested for significance at $p < 0.05$.

The condition factor K: The Condition factor was calculated according to Tesch (1971).

Where

K = Condition factor
W = Total weight (g) and
L = Total Length (cm)

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.

Examination for parasites: Euthanasia was carried out by physical method; Cervical dislocation with the two hands, or cervical transection using a knife inserted caudal to the skull, to sever the spinal cord

and cervical vertebrae followed by pithing. Examination of fish for parasites, handling and processing were done using standard procedure of Moravec (2004). Cestodes and nematode parasites recovered were stained using the procedure of Khalil (1991). Fixative used was formalin acetic acid (FAA). Cestodes were stained using acetocarmine; nematodes were stained with Horen's trichome stain; while acanthocephalans were preserved in weak Erlich's haematoxylin solution overnight and dehydrated, cleared in methyl-salicylate and mounted on a slide in Canada balsam.

Statistical analyses: Significant differences of parasitic infestation were tested using Kolmogorov-Smirnov K-S test at 95% level of confidence using SPSS version 15.0 for Windows. Difference between the means of body weight and total length of infested and uninfested fish specimens were carried out using t-test (2-tailed) at 95% level of confidence with SPSS version 15.0 for Windows. Regression analysis was carried out on the length-weights of infested and uninfested fish specimens as described by Hossain et al., (2006). The correlation coefficients r2 of good fit for infested and uninfested fishes were determined using MS-Excel package.

Results

A total of 376 *O. niloticus* comprising 184 and 192 specimens were caught in the first and second year of study respectively. However, of the fishes caught, males were in the majority – 57.18% - in the two years of investigation.

Length distribution: The mean total lengths for males for the period of study ranged from 15.87+0.47 cm to 23.93+0.97 cm with a yearly mean of 18.76+0.73 cm in 2016/2017. It ranged from 16.00+0.41 cm and 16.00+0.33 cm to 21.40+0.20 cm with a yearly mean of 18.08+0.47 cm in 2017/2018.

The mean for the two years was 18.42+0.52 cm. There was no significant difference ($p > 0.05$) in the means of total length of males between 2016/2017 and 2017/2018. Seasonal effect on the total length in male: The mean total length in 2016/2017 rainy season was 18.65+0.72 cm while dry season was 17.33+1.16 cm with no significant difference between seasons at $p = 0.05$. In 2017/2018, the rainy season TL value was 17.43+0.45 cm while the dry season was 20.63+1.34 cm and the difference in seasons was not significant ($p > 0.05$).

Total length distribution for females: The monthly distribution of the mean total lengths for females for the period of study ranged from 17.97+1.90 cm to 25.43+1.41 cm with a yearly mean of 22.11+0.60 cm in 2016/2017. It ranged from 18.05+0.47 cm to 23.30+2.70 cm with a yearly mean of 20.00+0.41 cm in 2017/2018. The mean for the two years was 21.06+0.57 cm.
There was no significant ($p > 0.05$) difference in the means of total length of females between 2016/2017 and 2017/2018. There was significant ($p = 0.05$) difference between the means of total length of males and females in the two years $p = 0.042$.

Seasonal effect on total length of female: The mean of TL value in rainy season of 2016/2017 was 21.26+0.62 cm while the dry season value was 24.53+0.64 cm. In 2017/2018 rainy season, the value was 20.01+0.60 cm while the value for dry season was 20.31+0.59 cm and the difference was not significant ($p > 0.05$).

Mean weights in males: The mean body weights for males of *O. niloticus* in 2016/2017 ranged from 88.00+5.30 g for a total length of 15.87+ 0.47 cm to 260.33+27.24 g, lengths 23.93+0.97 cm with a yearly mean of 142.52+16.01 g, length 18.76+ 0.73 cm. In 2017/2018, the mean ranged from 91.00+3.00 g, length 16.00+0.41 cm to 181.50+3.50 g length 21.40+0.20 cm, yearly mean of 121.01+9.58 g, length 18.08+0.47 cm.

The mean weight for the two years was 134.62+3.04 g. There was no significant ($p = 0.261$) difference in the mean weights of males in 2016/2017 and 2017/2018. Mean weights in females: The mean body weights for females ranged from 121.67 + 47.02 g, length 17.97+1.90 cm to 316.00+43.29 g, lengths 25.43+1.41 cm with a yearly mean of 204.75 + 15.28 g length 22.11 + 0.60 cm in 2016/2017. In 2017/2018, it ranged from 107.25 + 8.10 g, length 18.05 + 0.47 cm to 246.50 + 61.50 g, lengths 23.30 + 2.70 cm and a yearly mean of 149.77 + 11.95 g, length 20.00+0.41 cm. There was significant difference in the mean weights of females in 2016/2017 and 2017/2018; P value was 0.010. The mean weight for the two years was 179.24 + 7.16g.

There was significant (p = 0.010) difference in the mean weights of males and females in 2016/2017. There was no significant (p = 0.074) difference in the mean weights of males and females in 2017/2018.

The length – weight relationship: The length – weight relationship as examined using regression analyses showed a positive linear relationship. They all exhibited a positive allometric growth because the regression coefficient 'b' was greater than 3 in the males, females, and combined sexes of the two years (Table 1). The correlation coefficient (R) values of all the length weight relationships were close to unity (1). They showed good fit to the line of regression meaning good relationship exists between length and weight of fish during the period of investigation.

Table 1. Length-Weight Regression Relationships in *Oreochromis niloticus* of Oba Reservoir

Year	Sex	N	a	b	Regression Equation	R	Type of Growth
2016/2017	Male	99	-1.873	3.184	LogW = 0-1.873 + 3.184 log L	0.984	Positive Allometric
	Female	85	-1.845	3.133	LogW = -1.845 + 3.133 log L	0.966	Positive Allometric
	Combined	184	-1.861	3.155	LogW = -1.861 + 3.155 log L	0.961	Positive Allometric
2017/2018	Male	116	-2.028	3.266	LogW = -2.028 + 3.266 log L	0.956	Positive Allometric
	Female	76	-1.953	3.206	LogW = -1.953 + 3.206 log L	0.950	Positive Allometric
	Combined	192	-1.986	3.229	LogW = -1.986 + 3.229 log L	0.959	Positive Allometric
2016/2017 and 2017/2018	Combined	376	-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.

Fish abundance: The monthly abundance of *O. niloticus* was showed that in 2016/2017, the fish were more abundant in the months of November and December, January, March, June, July and October. In 2017/2018, they were more abundant in November, December, June, and July. They had a monthly mean body weight of 183.87+12.82 (g) in 2016/2017 and 133.71+9.23 (g) in 2017/2018. The mean weight for the year 2016/2017 was significantly (p = 0.04) different from the mean weight of 2017/2018.

Condition factor: The minimum value of 1.90+0.37% was recorded in October while the maximum of 2.24+0.83% was recorded in July with a yearly mean of 2.07+0.03% for 2016/2017. In 2017/2018, a minimum of 1.81+0.09 % was recorded in March and a maximum of 2.32+0.11% in September with a yearly mean condition factor value of 2.02+0.05%. There was no significant (p = 0.341) difference in the mean values of the condition factors of 2016/2017 and 2017/2018 in males.

In females, a minimum value of 1.56+0.54% was recorded in December while a maximum of 2.20+0.38% was recorded in June and a yearly mean of 1.87+0.06% for 2016/2017. In 2017/2018, a minimum of 1.47+0.08% was recorded in September and a maximum of 2.08+0.06% in December with a mean value of 1.84+0.05% for the year. There was no significant (p = 0.668) difference between the mean values of the condition factors of 2016/2017 (0.54+0.05%) and 2017/2018 (0.73+0.12%) in females. There was significant (p = 0.005) difference in the mean values of the condition factors of males (2.07+0.03%) and females (1.87+0.06%) in year 2016/2017. There was significant difference (p = 0.02) in the mean values of the condition factors of males (2.02+0.05%) and females (1.84+0.05%) in year 2017/2018.

Condition factor for combined sexes: There was no significant difference (p = 0.05) in the mean condition factor values between the rainy and dry seasons for O niloticus in the two years of study, though the values obtained for the dry season was higher than values obtained for rainy season. There was no significant (p = 0.073) difference in

the mean condition factor values between year 2016/2017 and 2017/2018 for combined sexes. The mean condition factor in the months of the two years for combined sexes was shown in Figure 1; it showed that the fish thrived better in 2016/2017 than 2017/2018 in all the months except in the month of December.

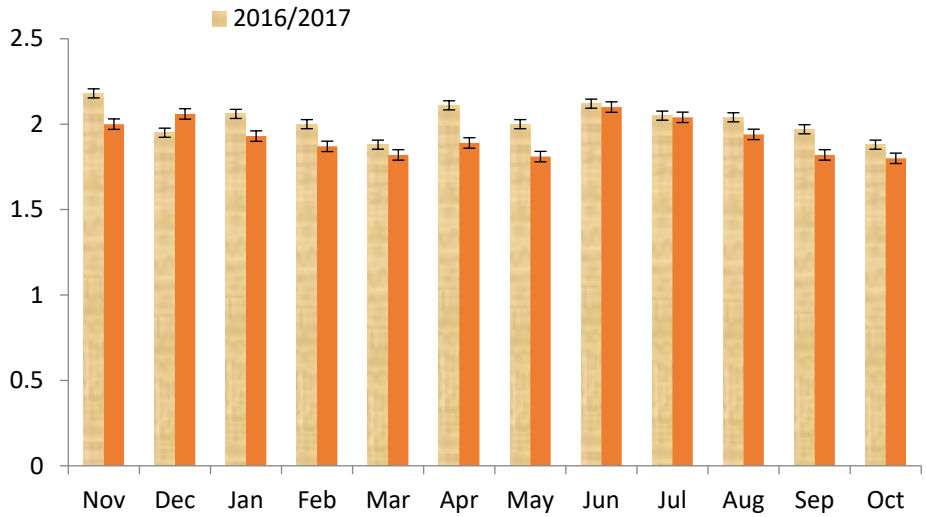


Figure 1: Monthly condition factors for combined sexes of *Oreochromis niloticus* in Oba Reservoir 2016/2017 and 2017/2018.

Parasite species diversity and distribution in the enteron of *O. niloticus* in Oba Reservoir: The intestinal helminth parasites recovered were comprised of two Acanthocephalan; *Neoechinorhynchus rutili* (Mueller, 1780), *Acanthocentius tilapiae* and the metacercaria of a Trematode; *Clinestomum tilapiae* (Leidy, 1856). The metacercariae were found in the buccal cavity while the two acanthocephalans were found in the intestine, nothing was found in the stomach.

Prevalence of parasitic infestation in male and female *O. niloticus* in the two years of study: The prevalence of infestation in males in the two years of study was 17.82% while in females it was 21.01%. The yearly values were shown in Table 2.

Table 2: Prevalence of Parasitic Infestation in Male and Female *Oreochromis niloticus* in the Two Years of Study.

	2016/2017						2017/2018					
	Male	Prev. (%)	Female	Prev. .(%)	Total-comb	Prev. (%)	Male	Prev. (%)	Female	Prev. (%)	Total Comb.	Prev. (%)
Infested	24	13.04	54	29.35	78	42.39	43	22.40	25	13.02	68	35.42
Within Sex		24.24		63.53				37.07		32.90		
Uninfested	160	86.96	31	16.84	106	57.61	149	77.60	51	26.56	124	64.58
Within Sex	75	75.76		36.47			73	62.93		67.11		
Total	99		85		184	100	116		76		192	100

Prev. = Prevalence; Comb. = Combined sex.

Seasonal level of parasitaemia for each species in *O. niloticus* in the two years of study:

The Seasonal level of parasitaemia for each parasite species in *O. niloticus* in the seasons of each year is shown in Table 3.

Seasonal level of parasitic prevalence in *O. niloticus* in the two years of study: The parasitic prevalence values for 2016/2017 were 32.61% (60) in the dry season and 9.78% (18) in the rainy season. In 2017/2018, it was 21.88% (42) in the dry season and 13.54% (26) in the rainy season.

Significant test between levels of parasitaemia in rainy and dry seasons: A KS test at p=0.05 between the means of numbers of parasites in rainy (32.33+4.18) and dry (71.00+18.36) seasons in 2016/2017 was significant. A test at p=0.05 between the means of the numbers of parasites in rainy (20.67+8.67) and dry (104.00+21.94) seasons in 2017/2018 was significant.

Table 3: Seasonal Level of Parasitaemia for Each Species of Parasite in *Oreochromis niloticus* in the Two Years of Study

Season	MALE Rainy				Dry				FEMALE Rainy				Dry			
	B. cavity		Intestine		B. cavity		Intestine		B. cavity		Intestine		B. cavity		Intestine	
Parasites spp.	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP
2016/2017																
N.rutili	0	0	0-10	32	0	0	0-8	27	0	0	0-5	5	0	0	0-13	39
C. tilapiae	0-10	21	0	0	0-10	24	0	0	0-15	15	0	0	0-9	18	0	0
A. tilapiae	0	0	0-8	15	0	0	0-11	68	0	0	0-4	7	0	0	0-11	37
Total		21		47		24		95		15		12		8		76
			68				119				27				94	
						187		+		121	=	308				
2017/2018																
N.rutili	0	0	0-7	11	0	0	0-5	13	0	0	0-10	27	0	0	0-16	91
C. tilapiae	0	0	0	0	0-11	22	0	0	0-8	12	0	0	0-12	44	0	0
A. tilapiae	0	0	0-2	2	0	0	0-15	50	0	0	0-7	10	0	0	0-12	92
Total		0		13		22		63		12		37		44		183
	13				85				49				227			
							98	+	276	=	374					

B. = Buccal; R. =Range; TNP = Total number of parasites; R. = Range.

Relationship of parasitaemia and total length: In 2016/2017, a 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* (18.07+0.65 cm) and uninfested males (17.94+0.37 cm) was not significant. In infested (20.61+0.47 cm) females and uninfested females (18.67+0.45 cm) it was also not significant.
In 2017/2018, the test between infested male (18.87+0.81 cm) and uninfested male (19.96+0.89 cm) was not significant and the test between infested female (21.50+0.87 cm) and uninfested females (23.16+0.74 cm) was not significant.

Relationship of parasitaemia and total length: In 2016/2017, a 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* (18.07+0.65 cm) and uninfested males (17.94+0.37 cm) was not significant. In infested (20.61+0.47 cm) females and uninfested females (18.67+0.45 cm) it was also not significant.
In 2017/2018, the test between infested male (18.87+0.81 cm) and uninfested male (19.96+0.89 cm) was not significant and the test between infested female (21.50+0.87 cm) and uninfested females (23.16+0.74 cm) was not significant.
Relationship of parasitaemia and body weight: In 2016/2017, a 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 2017/2018, a 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* (145.69+18.02 g) and uninfested males (165.68+19.01 g) was not significant. In infested females (193.57+21.24 g) and uninfested female (230.33+22.60 g) it was also not significant.

Influence of parasitaemia on length – weight relationship: In uninfested male of 2016/2017, R2 value was 0.970, in infested male it was 0.930; in uninfested female it was 0.932, in infested female it was 0.926. In 2017/2018, the R2 value of uninfested male was 0.932, infested male was 0.909; in uninfested female, it was 0.926, in infested female it was 0.713.

Discussion

Size distribution and population: The mean total length of male *O. niloticus* ranged from 15.87 ± 0.47 cm to 23.93 ± 0.97 cm in the two years of study. The mean total length (TL) obtained for the male was 18.42 ± 0.52 cm for the two years and there was no significant difference (p=0.05) in the means of the two years, which indicated that the rate of growth in length in males in the two years was about uniform. This trend was also observed in females, the mean TL obtained for females in the two years was 21.06 ± 0.57 cm. This result showed that females had a higher TL growth than males, this was confirmed with a statistical inference which showed a significant difference between the mean values of the male and female at p = 0.042 in the two years. The combined sex had a TL of 20.83 ± 0.49 cm in 2016/2017; and

20.00 ± 1.13 cm in 2017/2018. The reason why the female attained a higher TL than male in Oba reservoir 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, Ogun State, Nigeria.

However, the mean TL value obtained for male and female *O. niloticus* was higher than those values reported by Olurin and Aderibigbe, (2006), Obasohan et al., (2012) in Ijebu-ode and Ekpoma, Edo State Nigeria respectively. 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. Ajala and Fawole (2015) reported that although the fish was found to be an omnivore, its preferred diets were food from plant sources. In a turbid aquatic system as observed in the reservoir, light penetration will be reduced, limiting the phytoplankton organisms to be abundant in the photic zones. This gives the pelagic fish species that could survive in the turbid water abundant food supply. Another reason could be the turbid nature of the water which could be an advantage by offering some protection (reduction in visibility) to the fish from potential predators.

It was observed that season had no effect on the growth of total length in male and female *O. niloticus* and quantity captured. In this study, the season might not have had an effect on the TL of the fish species but it had on the sex of fish harvested. In the rainy and dry seasons, males were in the majority of the fish harvested. The two seasons were periods of high reproductive activities when the fish species spawn and care for the young; the scarcity of the females at this period may be due to their role in the reproductive process. *O. niloticus* is a maternal mouth brooder, the female sex during the period of spawning and caring for the young, remains in the nest in the pond bottom, does not forage for food, and is safe from been caught by the fisherman's net and traps; while the male on the other hand easily enter the traps while searching for food and other sex mates This result agreed with the findings of Offem et al.(2007) and Olele (2010) all of whom were of the opinion that more males were harvested in the two seasons.

The mean weight of male was 134.62+13.04 g in the two years, female was 179.24+13.16 g. This showed that female *O. niloticus* had more weight than male in Oba reservoir. The reason for this could be traced to the weight of the eggs and feeding habits of the female. The mean of the combined sex body weight was 183.87+12.82 g in 2016/2017 and 143.29+27.83 g in 2017/2018. Obasohan et al. (2012) reported that the body weight of *O. niloticus* in Ekpoma ranged between 61.9 – 112.7 g and 82.12 ± 17.37 g (mean); Mortuza and Al-Misned (2013) reported a weight that ranged from 14.8 - 430 g for male, 13.1 - 402 g for female, and 13.1 - 430 g for combined sex. The discrepancies in the values of TL and body weight reported from various water bodies was caused by feeding, which is dependent on available resources and reproductive phenomena (Oni et al., 1983).

Length-Weight Relationship: The regression coefficient 'b' recorded in 2016/2017 and 2017/2018 for male, female and combined sex specimens were greater than 3 (Table 1). This indicated that the growth of the fish 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 value 'b' then becomes greater than 3 as the fish becomes fatter, or when the value is lower than 3, the fish is slimmer (Ibrahim, 1984). This result conformed to the work of Mortuza and Al-Misned, (2013) who reported positive allometric growth for *O. niloticus* in Riyadh, Saudi Arabia; Yem, et al. (2007) also reported positive allometric growth in Hermichromis niloticus from Kainji Lake, Nigeria.

The correlation coefficient (R) values for male, female and combined sexes in 2016/2017 and 2017/2018 were close to unity (1) (Table 1). The values showed 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 of *O. niloticus* in the two years of study. This also showed that the fish species probably thrived well in the reservoir in the two years.

Abundance of *O. niloticus* in Oba Reservoir: The fish was more abundant in 2016/2017 than 2017/2018; this was supported by the significant difference in means of the two years. The result also showed that the abundance of the fish species in Oba Reservoir was not related to seasons because they were found to be abundant in months belonging to both rainy and dry seasons. This was supported by the tests (p=0.05) which was found not to be significant between the two seasons for combined sexes in the two years. It was also observed that the fish thrived better in 2016/2017 than in 2017/2018; this was supported by the student t - test that showed that the mean weight for the year 2016/2017 was significantly (p = 0.004) different from the mean of 2017/2018.

Condition factor: The condition factor ('k') monthly mean value in male was significantly higher than the values obtained for the females in both study years; and ranged from 1.81 ± 0.09% (March 2018) to 2.32 ± 0.11% (September 2018); while in females it ranged from 1.47 ± 0.08% (September 2018) to 2.20 ± 0.38% (June 2017). It was observed that the difference in the mean 'k' value of male (2.07 ± 0.03%) and females (1.87 ± ¬ ¬ ¬ 0.06%) was significant at p = 0.05 in 2016/2017, while in 2017/2018, the difference between male (2.02 ± 0.05%) and female (1.84 ± 0.05%) 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 not be unconnected to the heavy investment of the female sex in reproduction.

The result showed that the living condition of the fish in the two years was stable. However, they thrived better in 2016/2017 than in 2017/2018 (Figure 1). 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; while Dan-Kishiya (2013) reported a 'k' value of 1.93% in male and 1.87% for female from lower Usama Reservoir Abuja, 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. Kumolu-Johnson and Ndimele (2011) obtained a 'k' value range 0.91 % to 8.46% from Ologe Lagoon in Lagos, and Ibrahim et al. (2012) recorded a mean of 1.98 ± 0.35% in Kotangora Reservoir, Niger State.

The condition factor of the fish was not significantly influenced by seasons and did not follow any regular pattern. However, the dry season values 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. 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) in Shanawan drainage canal in Egypt. 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; which indicated that condition factor was not influenced by fish size. All the values obtained for the size groups were higher than one. This was an indication that fish specimens of all size groups lived a robust life and the quality of water in the reservoir probably supported the growth of *O. niloticus*.

Distribution of parasites in the enteron of *O. niloticus* in Oba reservoir: The stomach of *O. niloticus* in Oba reservoir could not be colonized by any parasites, maybe as a result of the acidic medium that exist in the stomach of the fish species and/or none availability of nutrients required by the parasites. The metacercaria of C. tilapiae found in the buccal cavity may be as a result of their physiological demand for oxygen and the location provided easy accessibility. 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* collected from the Department of wildlife and fisheries managements fish farm, University of Ibadan; Ochieng et al. (2012) reported that the parasites (C. tilapiae) were mostly found attached to tissues behind the buccal cavity in *O. niloticus* from small water bodies in Eldoret, Kenya, they further indicated that females had a higher intensity than males.

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; Morenikeji and Adepeju (2009) also reported the presence of C. tilapiae in

the mouth and body cavity of *O. niloticus* and S. galilaeus from Agodi fish farm in Ibadan, Western Nigeria; Eissa et al.(2011) also reported 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* from Kafr El-sheikh governorate fish farms in Egypt.

Prevalence and intensities of parasitic infestation in regard to sex of the host fish: The prevalence of parasitic infestation in *O. niloticus* did not follow any particular pattern. In 2016/2017, prevalence in male was smaller than prevalence in females; while in 2017/2018 prevalence was higher in males (Table 2). However, when the values obtained in the two years were pooled together prevalence was higher in females than in males. The buccal cavity of the fish was infested by C. tilapiae only and the intensity was higher in females than males in the two years. This result was in agreement with the findings of Ochieng et al. (2012) who reported a higher intensity of C. tilapiae in female *O. niloticus* than male. This trend of higher parasitic intensities in females than males was also observed in N. rutili in *O. niloticus*, while intensity of A. tilapiae on the other hand was marginally higher in males than in females. The higher infestation recorded in females may be due to the physiological state of the female; most gravid females could have reduced resistance to infection and infestation by parasites. These results conform to the report of Morenikeji and Adepeju (2009) who also reported higher parasitic infection in female than male.

Seasonal influence on parasitic infestation of *O. niloticus* in Oba reservoir: Seasonally, prevalence of parasitic infestation in *O. niloticus* was higher in the dry seasons of the two years than the rainy seasons (Table 3). This may be due to eutrophication in the rainy season. Eutrophication, normally leads to algae bloom towards the peak of rainy season, which results in an increase in productivity, species variety and population of the parasite's intermediate hosts, which are aquatic invertebrates mostly fresh water crustaceans (Lafferty and Kuris, 1999). This may result in the infestation or infection of fishes that fed on them in the rainy season, thus probably bringing the maturity of the parasites in the fish towards the dry season, depending on the life cycle of individual parasite. Another factor may be a drop in water level in the dry season exposing the invertebrates to their fish predators. Piscivorous birds are the definitive hosts for many of the metacercariae found in fish, and bird migration is the greatest contributing factor for dispersal of metacercarial infection (Hoffman, 1999). Generally, N. rutili and A. tilapiae infesting the intestine of *O. niloticus* in Oba reservoir had a higher intensity in the dry season than the rainy season, while C. tilapiae infesting the buccal cavity was higher in the rainy season than the dry season.

The knowledge of the life cycle explains why C. tilapiae infesting the buccal cavity was higher in the rainy season than the dry season. The parasite uses two intermediate hosts' fresh water snails and Tilapia before getting to the final definitive host (Ochieng et al., 2012). The final host of the parasite is piscivorous birds like Herons and Egrets (Olurin et al., 2012). The eggs of the parasites are passed out with the faeces of the bird into the water when the birds come to the water body to feed (on the fish) mostly in the dry season when water level is low. The eggs hatch in the water and the miracidium larvae that emerge invade the foot of the snail and encyst in the connective tissues of the freshwater snail forming the metacercaria. In the rainy season, when food is abundant the snails forage for food and in the process gets eaten by the fish and the fish gets infested; the more infected snail eaten, the more the parasitic load on the fish. The cyst formed in the fish may die off if the life cycle is not completed by predation on the fish by birds, the final host (Adeyemo and Agbede, 2008). The fish gets caught by the birds mostly in the dry season when the water level is low and the birds come to the water body to feed. This may reduce the quantity of infested fish caught in the water body hence low prevalence and intensity.

However, Olurin et al. (2012) ascribed the depauperate nature of helminthes in their study of helminthes parasite in S. galilaeus and T. zillii to the flow of water; they reported that the period of collection of specimen from river Oshun coincided with the rainy season characterized by rising water levels and increased flow. Martinez-Aquino et al. (2009) were also of the opinion that high water flow of the collecting site was the main factor determining the depauperate helminthes assemblages in fish farm from Cuzalapa hydrological system in Mexico. Moreover the molluscan intermediate hosts of parasites might have been swept away by the tide as rainfall increases, Morenikeji and Adepeju (2009).

Effect of parasitic infestation on total length, body weight and length weight relationship:

Parasitaemia was observed not to have any effect on the total length of *O. niloticus* in Oba Reservoir. The influence of parasitic infestation on body weight of *O. niloticus* generally in the studied years in Oba reservoir was not significant, this result was in consonance with the result of Olurin et al. (2012) who also reported that there was no relationship between parasitic burden and size of fish in their study of helminthes parasites of S. galilaeus and T. zillii from Oshun River, South-West Nigeria. However, the influence was observed to be significant between the means of the body weight of infested female and uninfested females. This influence on the body weight was further confirmed from the regression coefficient value of 0.713, obtained from the regression of the total length and body weight of infested females of 2017/2018. This value was the lowest of all values obtained from the regressions in male and female of the two years. It was also observed that the r2 values of the length-weight regression of all infested specimens in both sexes were of lesser values than in uninfested. This showed 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 2017/2018.

Conclusion

The amount of *O. niloticus* captured was not affected by seasons, it had no effect on its total length growth, and female had a higher total length than males. The fish exhibited positive allometric growth with the correlation coefficient greater than 94% in males, females, and combined sexes of the two years of investigation. Abundance and condition factor of the fish were not influenced by seasons, males lived better (high 'k' values) than females and the fish species generally thrived better in 2016/2017 than 2017/2018.There was no observable sequence between the condition factor and the fish size.

Species diversity of parasites in *O. niloticus* was few, only three species were recorded, one in the mouth cavity and two in the intestine, none was found in the stomach. Intensity of the parasites was observed to be higher in the dry season than the rainy season. The parasitic infestation was found to have reduced the weight of the infested fish specimens.

It is recommended that continuous monitoring of causes of parasitic infestation and infection are carried out, because of its adverse effect on reproductive capability of the fish species, which may result in depletion of the fish population in the aquatic environment.

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