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Studies on aspects of morphometry and enteroparasitic infestation of *Sarotherodon galilaeus* (Linnaeus, 1758) (Cichlidae) in Oba reservoir, Ogbomoso, Nigeria

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Abstract
Oba reservoir lies between Latitude 08° 3' N to 08° 12' N and Longitude 004° 6' E to 004° 12' E in Ogbomoso, Oyo state, Nigeria. Investigations were carried out between November 2011 and October 2013. Studies on Morphometry and enteroparasites of *Sarotherodon galilaeus* (Linnaeus, 1758) were done using standard methods. Investigations revealed the fish had a negative allometric growth and female had a higher length and weight, and were better distributed in the reservoir than males. Condition factor values revealed that the fish lived a robust life in the reservoir. Parasites recovered from the enteron were *Neoechinorhynchus rutili, Acanthocentius tilapiae, Clinostomum tilapiae*, *Procamallanus laevionchus* and *Paracamallanus cyathopharynx*; no parasite was found in the stomach. Enteroparasitic infestation was higher in females than in males and there was no relationship between parasite burden and fish size. Generally, enteroparasitic infestation had an effect on the length – weight relationship of the fish.

Keywords: *Sarotherodon galilaeus,* morphometry, prevalence, Intensity, enteroparasite.

1. Introduction

Fish production is very important in order to meet the proteinous need of the fastly growing population of Nigeria; it is relatively inexpensive when compared with other sources of animal protein such as cattle, pig, and poultry, whose productions are very expensive due to low technology and poor pasture-lands [1]. Continuous intermittent anthropological intervention of the environment in an aquatic habitat, coupled with 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 [2] and may invariably affect the wellbeing of the fish as a whole [3]. It has been reported that global warming and climate change could contribute to the alteration of the quantity and quality of the runoffs and tributaries [4]. 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. They constitute the basis for the development of a successful fisheries management programme on fish capture and culture [5] and are also critical components in any aquatic ecological system [6].

St Peter's fish (*Sarotherodon galilaeus*) is a dominant, endemic, and economically important tropical fresh water fish species, which belongs to the Cichlidae family. *S. galilaeus* has been known to occur at 9 °C; occasionally form schools; adults prefer open waters but juveniles and breeding adults are found inshore [7]. They are often associated with beds of submerged vegetation in Sudd lakes; feed on algae and fine organic debris; lacks marked sexual dichromatism when sexually active; forms temporary pair bonds [8]. Pair-formation exists and is dissolved as soon as the eggs are in the parental mouth, mouth brooding is reportedly biparental [9, 8] gave a short description of *S. galilaeus* as having dorsal spines (total): 15 - 17; dorsalsoft rays (total): 12-13; anal spines: 3; anal soft rays: 9 - 11; vertebrae: 28 - 30. diagnosis: 21-25 rakers on lower limb of first arch; length of lower pharyngeal jaw < 43.5% of head length; 29-32 scales in lateral line series; head length 32.5-39% of standard length; toothed area of lower pharyngeal jaw broad > 2-3 times in keel length.

Fish morphometric has been in the hot-spot of ichthyological studies for many decades, but the initial steps date back to the time of Galileo Galilei [10]. The scientific basis for Morphometry in fishes, and especially the mathematical way that weight relates to length, was set by Fulton, in 1906, who for the first time introduced fisheries science into 'allometry' [10]. In Fisheries science, the condition factor is used in order to compare the "condition", "fatness´, or well-being of fish. It is based on the hypothesis that heavier fish of a particular length are in a better physiological condition [11]. Condition factor is also a useful index for the monitoring of feeding intensity, age, and growth rates in fish [12]. In Nigeria, many investigations had been carried out on the Morphometry of *S. galilaeus* in different water bodies, these include the works of [13] that showed Length – Weight relationship (LWR) had significant correlation, the growth exponent (b) was isometric and condition factor (k) of the fish species for each year was higher than one; [14] showed that the curvilinear relationship between length and weight were significant; [15] showed that class ranged from 22 – 33 cm total length (TL) (250.0 - 814.0 g total body weight), exponent 'b' and 'a' of the length-weight relationship were 2.755 (R^2 =0.943) and 0.0137 respectively, signifying a negative allometric growth pattern, the condition factor was found not to be size dependent, ranged from 2.049 – 2.510 g/cm^3.

Parasite infections/infestations in fish causes production and economic losses through direct fish mortality, reduction in fish growth, fecundity and stamina, increase in the susceptibility of fish to diseases and predation [16, 17] were of the opinion that difference in infestation rate and sites of infestation in *S. galilaeus* population might be due to their diets [18], were also of the opinion that diets might influence infection in *S. galilaeus* population, and reported that fishes from natural reservoir that were heavily parasitized fed on detritus, benthos, and plankton which transmit parasites, while fishes at fish farm (low level of parasitemia) were fed with artificial feeds. This could also explain why most of the parasitic helminthes of fishes in the wild were found to be harbored in the gut while most of the domesticated tilapiae parasites were found to be more in the body cavity [19]. reported that 32.6% (prevalence) of *S. galilaeus* studied had parasitic infection, from which two Helminth species were recorded: a trematode, *Clinostomum tilapiae* (metacercariae), and an adult acanthocephalan, *Neoechinorhynchus rutili*.

This study examined the species diversity and intensity of the enteroparasites of *S galilaeus* and its effect on some Morphometric indices of *Sarotherodon galilaeus* in Oba reservoir.

2. Materials and Methods

2.1. Study area

The study area was Oba reservoir in Ogbomoso North local government area of Oyo state, Nigeria. Oba reservoir was impounded in 1964 and the tributaries are Idekun, Eeguno, Akanbi - Kemolowo, Omoogun, and Yakun streams.

2.2. 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. Collection was done from November 2011 to October 2013 between 06:00 - 08:00 am. All fish specimens were still alive as at the time of collection. 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.

2.3. Fish species identification

Identification was done using the most distinctive characteristic of the family – possession of only a single pair of nostrils, with its rounded profile, a plain tail with no band, bar or spot – [20]. The sexes were identified by examining the papillae; there are two orifices (openings) in the papillae of female and one in male [20]. The sexes were further confirmed after dissection with the presence of testes (in male) and ovaries (in female)

2.4. 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.

2.5. Morphometric study

2.5.1 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

$\text{Log } W = \text{Log } a + b \text{ Log } L$

Where W = Total weight (g)

L = Total length (cm)

a = intercept

b = regression coefficient. [10].

The relationship between total length and body weight was done by linear regression, [21]. The length - weight regression equation was determined and the parameters 'a' (regression constant), 'b' (regression coefficient) and 'R^2' (correlation coefficient) were estimated. The means of total lengths and weights of samples for the sexes (male, female, and combined sex) in 2011/2012 were compared with those of 2012/2013 for significance at 95% confidence level.

This test was also repeated to find the difference between male and female in each year.

2.5.2. 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 [22].

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 years 2011/2012 and 2012/2013 (for males, females and combined sex) were tested for significance at $p < 0.05$.

2.5.3. The condition factor K

The Condition factor was calculated as:

$K=100W/L^3$

Where K = Condition Factor

W = Total body weight (g)

L = Total Length (cm) [23].

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).

2.6. Enteroparasites

2.6.1 Examination for parasites

Examination of fish for parasites, handling and processing followed standard procedure by [24]. The body of each fish was examined for abnormalities (if any), and placed on a dissecting board. The buccal cavity was washed with little amount of distilled water and a fine brush into a labeled test tube after which the body cavity was opened ventrally with the aid of a knife. The mesentery and connective tissues, connecting loops of the gut and the liver were cut and the organs separated. The gut was then placed in a large Petri dish, stretched out and cut into two regions i.e. the stomach and the intestine. Each section was then placed in a separate labeled dish. The separated gastro-intestinal tract sections were opened longitudinally to expose the inner surface which was washed with very little quantity of distilled water into labeled test tubes. Each labeled test tube containing the residue from the mouth, stomach, and intestine was then examined. A drop of the residue was placed on the slide, and observed under various magnifications of the light microscope for the parasites, this was repeated until the entire residue has been examined.

2.6.2 Identification of parasite

The recognition of the parasites was enhanced by their wriggling movement on emergence. Parasites found were counted, labeled with the serial number of the fish and placed in physiological saline water overnight to allow them stretch and relax; they were then fixed and stained for identification to species level. Fish specimens found with parasite were given separate serial numbers to differentiate them from those without parasites. Parasites retrieved were identified using information provided by [25-27].

2.6.3 Processing of recovered parasites

Cestodes and nematode parasites recovered were stained using the procedure of [28]. Fixative used was Formalin acetic acid (FAA). Cestodes were stained using Acetocarmine; Nematodes were stained with Horen's trichome stain; while Acanthocephalans were stored in weak Erlich's haematoxylin solution overnight and dehydrated, cleared in methyl-salicylate and mounted on a slide in Canada balsam.

2.6.4 Statistical analysis

Infection and infestation of host by parasites were not normally distributed; as such, 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.

3. Result

3.1 Morphometric

3.1.1. Length – weight relationship

A total of 314 fish specimens were studied during the two year period. The first year, November 2011 to October 2012, 158 specimens; the second year, November 2012 to October 2013, 156 specimens were investigated. The total length (cm) and body weight (g) ranges together with the Length – weight regression indices of intercept (a), regression coefficient, (b) and correlation coefficient (R) were shown in Table 1. The length – weight regression showed a linear relationship and they all exhibited a negative allometric growth because the regression coefficient 'b' is less than 3 in the males, females and combined sexes of the two years of study.

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 establishing good relationship between length and weight.

There was no significant difference ($p=0.05$) between the mean total length of males in the two years ($P = 0.18$) and no significance was observed in females of the two years ($P = 0.117$). There was no significance between the mean total lengths of males and females in the two years. Seasonally, there was no significance in the means of the total length in the two years of study for both sexes. The body weight of female fish was significantly higher than that of male in the two years of investigation. This observation was also repeated in seasons with the weight of female fish been significantly higher in the rainy than the dry season of the two years.

3.1.2. Length – frequency distribution.

The length – frequency distribution (Figure 1) showed a bimodal size distribution and indicated that a wide range of sizes were caught during the sampling months. Nine class distributions were recorded at 2.0 cm interval; it spread from class starting from 12.00 cm to class ending at 29.90 cm. Males were limited to below 27.90 cm, while females were represented in all the classes.

Table 1: Regression indices of length-weight relationships of *Sarotherodon galilaeus* 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	76	14.72 26.50	126.60 323.50	0.725	1.230	Log W = 0.725 + 1.230 log L	0.928	Negative Allometric
	Female	82	15.65 27.33	144.00 386.00	0.803	1.20	Log W = 0.803 + 1.20 log L	0.953	Negative Allometric
	Combined	158	14.72 27.33	126.60 386.00	0.758	1.216	Log W = 0.758 + 1.216 log L	0.944	Negative Allometric
2012/2013	Male	76	13.40 20.70	163.50 287.33	0.856	1.151	Log W = 0.856 + 1.151 log L	0.898	Negative Allometric
	Female	80	13.33 26.00	198.33 383.75	1.014	1.112	Log W = 1.014 + 1.112 log L	0.926	Negative Allometric
	Combined	156	13.33 26.00	163.50 383.75	0.921	1.127	Log W = 0.921 + 1.127 log L	0.903	Negative Allometric
2011/2012 and 2012/2013	Combined	314	13.33 27.33	126.60 386.00	0.918	1.511	Log W = 0.918 + 1.511 log L	0.861	Negative Allometric

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

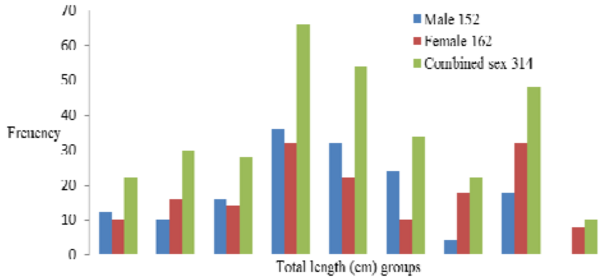

Figure 1. Length - Frequency distribution of *Sarotherodon galilaeus* in Oba Reservoir

3.1.3. Abundance

The monthly abundance of *S. galilaeus* showed a yearly mean of 250.38±19.53 g in 2011/2012 and 259.18±11.59 g in 2012/2013. There was no significant difference between the means of abundance of the two years; the P value was 0.702. The seasonal values and test for significance in males, females, and combined sexes for the two years of study were shown in Table 2. Seasonal variations had no effect on abundance.

3.1.4. Condition Factor

There was a significant difference (p=0.05) between the mean values of the condition factors of 2011/2012 and 2012/2013 for the two sexes, in males, P value was 0.001 and 0.004 in females. The condition factor was higher in females than males in the two years of investigation.

Generally, the monthly condition factors showed that the robustness of life of the fish species was better in 2012/2013 than in 2011/2012 (Figure 2). There was a remarkable progressive decrease in the mean condition factor values as the total length increases (Figure 3).

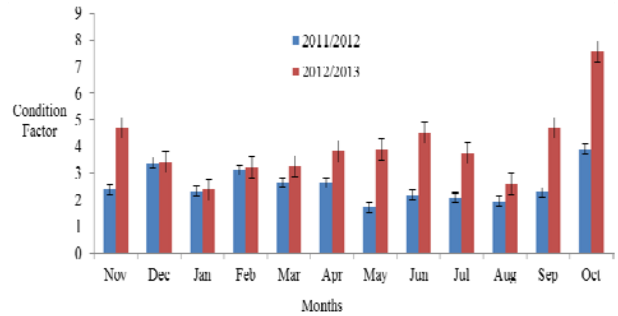

Figure 2 Monthly mean Condition factors for combined sexes of *Sarotherodon galilaeus* in Oba reservoir in the two years of study.
Error bars represents standard error of means.

Table 2: Seasonal difference in the mean values of abundance and condition factor of *Sarotherodon galilaeus* 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 252.71±15.26 Dry 227.56±13.53	0.108	Not significant	**Males** 2011/2012	Rain- 2.33±0.14 Dry- 2.52±0.16	0.118	Not significant
Males 2012/2013	Rain- 251.15±8.79 Dry- 190.21±27.54	0.302	Not significant	**Males** 2012/2013	Rain-3.58±0.18 Dry- 3.54±0.34	0.536	Not significant
Females 2011/2012	Rain- 291.32±30.71 Dry- 232.75±8.04	0.117	Not significant	**Females** 2011/2012	Rain-2.32±0.17 Dry- 2.76±0.37	0.070	Not significant
Females 2012/2013	Rain- 292.26±15.00 Dry- 246.40±38.55	0.282	Not significant	**Females** 2012/2013	Rain-3.99±0.39 Dry- 3.66±0.66	0.456	Not significant
Combined sexes. Rain in 2011/2012 Dry in 2011/2012 Rain in 2012/2013 Dry in 2012/2013.	272.60±23.35 230.71±9.62 273.06±12.17 214.99±19.98	0.133 0.064	Not significant Not significant	**Combined sexes**. Rain 2011/2012 Dry 2011/2012 Rain 2012/2013 Dry 2012/2013	2.35±0.16 2.72±0.34 3.73±0.25 3.61±0.49	0.281 0.800	Not significant Not significant.

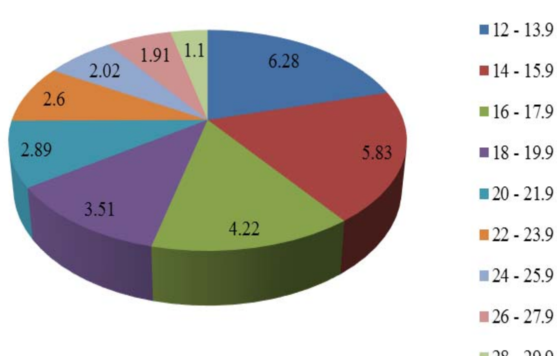

Figure 3 Condition factor of Total lenght groups for combined sexes of *Sarotherodongalilaeus* in Oba reservoir.

3.2. Enteroparasites

3.2.1 Different parasites recovered in the stomach and intestine of *Sarotherodon galilaeus* and their distribution

Intestinal parasites recovered were comprised of two Acanthocephalans; *Neoechinorhynchus rutili* (Mueller, 1780), *Acanthocentius tilapiae*) the metacercariae of a Trematode *Clinestomum tilapiae* (Leidy, 1856) and two nematodes; *Procamallanus laevionchus* (Wedl, 1862) and *Paracamallanus cyathopharynx* (Baylis, 1923). The metacercariae were found in the buccal cavity while the two acanthocephalans and the two nematodes were found in the intestine, nothing was found in the stomach.

3.2.2 Intensities of the parasite species in the enteron.

The intensities of the five parasites were shown in Table 3.

Table 3: Intensities of parasite species in the enteron of *Sarotherodon galilaeus* in Oba Reservoir.

	2011/2012				2012/2013			
	Male		Female		Male		Female	
Parasite Species	**B.C.**	**Int.**	**B.C.**	**Int.**	**B.C.**	**Int.**	**B.C.**	**Int.**
Neoechinorhynchus rutili	0	7.5±0.64	0	9.23±0.58	0	4.1±0.32	0	4.67±0.47
Clinestomum tilapiae	9.1±1.04	0	8±0.73	0	4.±0.51	0	5.5±0.61	0
Acanthocentius tilapiae	0	4.4±0.91	0	7±0.48	0	4.4±0.53	0	5.67±0.46
Procamallanus Laevionchus	0	1.25±0.06	0	1.8±0.05	0	1.5±0.04	0	1.4±0.06
Paracamallanus Cyathopharynx	0	2.6±0.08	0	3.14±0.72	0	1.67±0.04	0	2.67±0.08

B.C. = Buccal Cavity; Int. = Intestine.

3.2.3 Prevalence of parasitic infestation in *S. galilaeus* in sex and seasons of each year

Prevalence were 17.72%, 13.92% for females and males respectively in 2011/2012 and 13.92%; 16.67% respectively in 2012/2013. Prevalence of parasites was found to vary with seasons.

3.2.4 Relationship of parasitemia and body weight

Significant tests (KSZ tests at p = 0.05) of means between body weights of infested and uninfested fish (both sexes) in the two years were not significant.

3.2.5 Relationship of parasitemia and total length

Significant tests (KSZ tests at p = 0.05) of means between total lengths of infested and uninfested fish (both sexes) in the two years were not significant.

3.2.6 Parasitemia of the parasite species in relation to sex and seasons

Significant tests (KSZ tests at p = 0.05) of means of intensities of parasites between male and female fish in each of the two years were not significant. However intensities of the various parasites were found to be sex and season dependent Table 4.

Table 4: Seasonal level of parasitemia for each species of parasite recovered in *S. galilaeus* from Oba reservoir.

2011/2012.	**Male**								**Female**							
Season	**Rainy**				**Dry**				**Rainy**				**Dry**			
	Buccal cavity		Intestine		Buccal cavity		Intestine		Buccal cavity		Intestine		Buccal cavity		Intestine	
Parasites	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP	R.	TNP
N. rutili	0	0	0-5	21	0	0	0-7	20	0	0	0-8	25	0	0	0-6	17
C. tilapiae	0-6	12	0	0	0	0	0	0	0-10	27	0	0	0-7	17	0	0
A. tilapiae	0	0	0-3	4	0	0	0-11	18	0	0	0-10	29	0	0	0-5	5
P. laevionchus	0	0	0-1	2	0	0	0-2	4	0	0	0-1	2	0	0	0-2	5
P. cyathopharynx	0	0	0-2	7	0	0	0-5	11	0	0	0-4	7	0	0	0-5	9
	12		34		0		53		27		63		17		36	
	46				53				90				53			
	99 +								143 = 242							
2012/2013																
N. rutili	0	0	0-8	8	0	0	0-10	22	0	0	0-15	79	0	0	0-11	41
C. tilapiae	0-16	40	0	0	0-8	42	0	0	0-15	35	0	0	0-11	21	0	0
A. tilapiae	0	0	0-5	5	0	0	0-6	17	0	0	0-12	24	0	0	0-13	39
P. laevionchus	0	0	0-1	2	0	0	0-2	3	0	0	0-1	2	0	0	0-3	7
P. cyathopharynx	0	0	0-2	4	0	0	0-4	9	0	0	0-4	9	0	0	0-5	13
Total	40		19		42		51		35		114		21		100	
	59				93				149				121			
	152 +								270 = 422							

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

3.2.7 Parasitemia and length – weight regression of infested and uninfested fish:

In uninfested male of 2011/2012, R^2 value was 0.939, in infested it was 0.882; while uninfested female was 0.946 and infested 0.865. In 2012/2013, R^2 value of uninfested male was 0.918, infested 0.812; while uninfested female was 0.843 and infested 0.794.

4. Discussion

The growth in length in the fish showed that no significant difference was observed between sexes, seasons, and in the two years. These indicated that the growth during the two years in male and female fish in the reservoir were relatively uniform. The result also showed that female *S. galilaeus* were significant (p=0.05) heavier than their male counterpart. The difference may be as a result of the gonad weight which was heavier in female than in male, it may also be as a result of differential feeding habit [29]. However reported that male *S. galilaeus* from lower Niger River were slightly heavier than female [30]. Reported that the weight of *S. galilaeus* Oyan dam, Ogun state Nigeria varied between 219.82±31.47 and 231.37±109.22 g and female were heavier than male.

The length-weight regression gave a positively linear relationship between the length and weight. The regression coefficient 'b' values recorded in the two years were lower than 3, (Table 1). This showed that the growth of *S. galilaeus* in Oba reservoir were negatively allometric. This means, the fish species growth was increasing faster in length than they were increasing in weight [10]. The results obtained in this study agrees with those obtained by [14] who reported 'b' values of 1.3037 for males and 1.503 for females of *S. galilaeus* from Onah Lake in Delta state, Nigeria; [31] reported a 'b' value of 2.519 for combined sexes of *S. galilaeus* from Ologe lagoon in Lagos, [30] reported 2.7017 for males and

2.6727 for females.

The result of the correlation coefficient (R) values obtained, showed that only 92.8% and 95.3% of the data collated for length and weight of male and female fish in 2011/2012 and 89.8% and 92.6% for male and female in 2012/2013 were fit to the line of regression. The remaining percentages to meet up the 100% mark were caused as a result of factors against the correlation of the length and weight relationship. These factors could be from limnological parameters of the water, food availability, feeding habits of the fish, parasitological infections, or infestations of the fish and so on. The correlation coefficient (R) values obtained were however close to unity (1) which showed that the results had a good fit to the line of regression plotted and the values of length and weight were correlated. Similar values were reported by various authors, [14] reported an R value of 0.80 for male and 0.820 for females; [31] reported 0.76 for combined sex; [30] reported very low values of 0.065 for males and 0.646 for females, and [32] reported 0.620 value for combined sexes in Jankara dam, Kano State.

The length frequency distributions showed that a wide range of sizes of the fish specimens were harvested in the two years of study. Females were represented in all the classes while the males were limited to 27.90 cm and females had a higher TL growth than males (Figure 1). This result agreed with the submissions of [30] and [32]; both reported that female *S. galilaeus* were longer than male.

The abundance was calculated based on the body weight of harvested specimens. Season had no effect on the abundance of *S. galilaeus* (Table 2), though the abundance was high in the dry and rainy months; however, the values recorded in the rainy seasons were higher than the dry seasons. Females also had a higher abundance than males in rainy and dry seasons of the two years, though the differences in means were not significant. The reason for this could be adduced to more food that was available (brought by inflow of fresh water runoffs) in the rainy season for fishes to feed on, the long months of rainy season (8 months) recorded during this investigation was also an added advantage for the fish to gain weight. The fish as a bi-parental mouth brooder, the male, and female do no feed while incubating the eggs and taking care of the Frys. Incessant spawning would have probably depleted the body weight of the fish species as the rainy month progresses; this would have led to the low values recorded in the dry season. The dry season months when they had time to feed was short, and by the time the food conversion into body mass took place, rainy season had probably sets in. Availability of food, feeding habits, and changing environmental conditions may be factors that could probably alter this trend. This finding was in agreement with [30] who reported a significant difference in the weight of female and male *S. galilaeus*, with the mean/weight of females recorded greater than that of males.

There were significant differences (p=0.05) in the means of the condition factor ('k') values between 2011/2012 and 2012/2013 in both sexes and the values were higher in females than in males. This result showed that the females lived a more robust life than the males. Condition factors in the months of year 2012/2013 were higher than those of 2011/2012 (Figure 2); this was supported by the differences reported in the means of the two years in males and females. This was an indication that the fish lived a more robust life in 2012/2013 than 2011/2012 and that the quality of water in the reservoir in 2012/2013 was probably better than in 2011/2012.

The least recorded 'k' value for both sexes was higher than 1 which also indicated that the fishes were in good condition during the period of investigation, and the high 'k' values observed indicated that the characteristics of water in Oba reservoir during the period of study supported growth. This result was in agreement with [29] who reported a range of 3.19 to 4.94 for *S. galilaeus*; [31] reported a 'k' factor of 8.46 for *S. galilaeus*; [13] reported a value greater than 1 for S. *melanotheron* in Ologe lagoon; [15] recorded a mean of 2.388 g/ cm^3 for *S. galilaeus* from Ogun estuary; [30] recorded a range of 2.16 ± 0.29 to 2.39 ± 0.44.

Seasonal variation was found not to have any effect on the robustness of living of both sexes in Oba reservoir because they lived a robust life across all seasons. It was however observed that the 'k' values were progressively decreasing as the TL size groups in combined sexes of the two years were increasing. This may be due to the parental investment in reproduction and caring for the young exhibited by both sexes of *S. galilaeus*. Hence, as they grow to sexual maturity the 'k' value reduces.

The buccal cavity where there was high intensity of *C. tilapiae* (Table 3) is a region well supplied with blood capillaries which provide nutrients that the parasites feed on either through passive, active, or facilitated diffusion. Other species of the genus *Clinostomum,* like *C. cutaneum* were known to reside in the skin tissues of Cichlids, their presence in cyst form in the buccal cavity may be as a result of their affinity for oxygen and blood. According to [33] Clinostomatid metacercariae had predilection for the mesenteries' of blood capillaries in the buccal cavity; this explained the high prevalence and abundance in the buccal cavity [34]. in their findings reported that the infection of *C. tilapiae* was very high in infected *Hemichromis fasciatus*. *C. tilapiae* is known to use cichlids as intermediate host while the definitive hosts are piscivorous birds [19].

The intensity of *A. tilapiae* in the intestine was not as high as that of *C. tilapiae* in the buccal cavity in both males and females of the two years and its restriction to the intestine may be attributed to the abundance of food supply in the gut; its proboscis also serve as an organ of attachment to the gut wall [35] were of the opinion that predatory fish species harbor a greater diversity and abundance of larval helminth than herbivorous and planktivorous species. Hence the feeding pattern of *S. galilaeus* is an important factor in their infestation with parasites [17] reported that *S. galilaeus* fed on ten different types of food items in Oba reservoir, it was found to be primarily a carnivore feeding aquatic invertebrates, but when food of animal source became scarce, it could also feed on food items from plant sources, it was therefore generally classified as an omnivore.

Fresh water fishes are the definitive host of *N. rutili* while the Ostracod (*Cypria turneri*) which the fish feed on is the intermediate host. All acanthocephalan have an indirect life cycle that requires at least one intermediate host [36]. Piscine acanthocephalans have aquatic insects and crustaceans (amphipods, isopods, copepods, and ostracods) as their foremost intermediate hosts [36, 17] reported that *S. galilaeus* fed on food items of animal origin like insects and copepods which may be the source its infestation.

The prevalence was observed to be higher in females than in males in the two years of study (Table 4), however, statistical test showed that there was no significant difference (K.S.) at P = 0.05 in the means of parasitemia of male and female *S. galilaeus* [34] and [19] also observed that there was no difference between parasite intensity and sex in the parasitic infestation of *C. guntheri*, *T. mariae* and *H. fasciatus* in Owa stream and in *S. galilaeus* and *T. zilli* from Oshun river respectively. While [37] reported that male *O. niloticus* were more infested with *C. tilapiae* than female in Kenya [35] were of the opinion that these inconsistent results could be attributed to studies failing to control two important confounding variables, study effort and the influence of phylogenetic relationship among fish species. However in Oba reservoir, during the period of this study, female *S. galilaeus* were more infested with parasites than male but there was no difference in the degree of parasitemia or intensity between the sexes.

The tests of significant difference between the means of the total length of infested and uninfested *S. galilaeus* in both sexes of the two years were not significant. This showed that parasitemia had no effect on the total length of *S. galilaeus* in Oba reservoir [38] were of the opinion that the larger the fish, the lower the infestation, they adduced decrease in the prevalence of infection in the larger fish to increase in mortality of infested fish, increase in the built up humoral and non-specific immunity against the parasite; they opined that as the small size fish survives the infection, it grows to occupy new niches and acquire better microhabitat against parasitic infestation [19] worked on helminth parasites of *S. galilaeus* and *Tilapia zilli,* they reported that there was no relationship between parasite burden and fish size (length and weight).

Result showed that there was no significant difference (p=0.05) between the weights of infested and uninfested fish of both sex in Oba reservoir; which probably indicated that the body weight of infested fish was not affected by the parasitic infestation [37] reported that the condition factor of the fish was not affected in any way by the infestation of *O. niloticus* by *C. tilapiae.* However, [39] were of the opinion that clinostomids infection can have several effects on fish, among them been reduced growth, offset weight loss and prominent exophthalmia. *C. tilapiae* had the highest intensity of infestation, and [37] were of the opinion that the position to which the parasite decides to attach is majorly determined by availability of resources it requires for optimum survival. This means the parasites may probably be competing with the host fish species for essential nutrients that are common to the two of them such as dissolved Oxygen [40] observed that adult trematode may not attack host organs by implanting in the tissues, but only affix to well-situated sites where all required nutrients may be acquired with ease.

The regression results showed that parasitic infestation of *S. galilaeus* in Oba reservoir had some little effects on the length weight relationship. The correlation coefficient (R^2) value obtained for uninfested and infested male and female of the two years were high showing that the relationship had a good fit to the line of regression. However, a comparison of the R^2 values of infested fish with uninfested fish showed that lower values were recorded for the infested specimens in both sexes. This is an indication that although there was no significant difference in the student t tests carried out on the length and weight of infested and uninfested fish specimens harvested, the low R^2 values obtained for infested fishes of both sex in the length – weight regression showed a difference. The difference of 5.7%, 8.1% of the data collated for male and female length and weight of infested and uninfested fish in 2011/2012 and 10.6% and 4.9% respectively for male and female fish could not fit into the regression line as a result of some factors affecting either index. Based on the findings of [37, 38 and 39], the enteroparasites probably had an effect on the weight or length of the fish and were responsible for the low values of R^2 obtained in infested fish specimens harvested. This effect, when pronounced or eliminated may affect all Morphometric and reproductive factors whose final values are derived from data generated from length and weight of the fish such as: the growth pattern, abundance, condition factor, gonado-somatic and hepato-somatic indices, relative fecundity (and others) of the fish in the reservoir.

5. Conclusion

It was concluded that *Sarotherodon galilaeus* had a negative allometric growth pattern and thrives well in Oba reservoir. The condition factor values of both sex declines as the body size increases because of their investment in spawning. Females had a higher growth in length and weight and were better distributed in the reservoir than male. The fish was more abundant in the rainy than the dry season. Enteroparasitic infestation was higher in females than in males while metacercariae of *Clinostomum tilapiae* found in the buccal cavity had the highest intensity of infestation. Generally, enteroparasitic infestation was found to have an effect on the length – weight relationship of the fish.

6. Reference

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