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Diets and enteroparasitic infestation in *Sarotherodon galilaeus* (Linnaeus, 1758) (Cichlidae) in Oba reservoir Ogbomoso, Nigeria

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Abstract
Oba reservoir lies between Latitude 8° 3" N to 8° 12" N and Longitude 4° 6" E to 4° 12" E in Ogbomoso, Oyo state, Nigeria. Investigations were carried out between November 2011 and October 2013. Studies on morphometric, food, and feeding habits and enteroparasites of *Sarotherodon galilaeus* (Linnaeus, 1758) were done using standard methods. Ten types of food items were exploited by adults *S. galilaeus* while immature exploited six. In immature, insect parts had the highest frequency of occurrence (92.31 %), while in matured diets, Copepods were highest (78.21 %). The fish species was generally observed to be omnivores, but were primarily carnivores. Parasites recovered from the enteron were *Neoechinorhynchus rutili, Acanthocentius tilapia, Clinostomum tilapia*, *Procamallanus laevionchus* and *Paracamallanus cyathopharynx*; no parasite was found in the stomach. Parasitic prevalence was season and sex dependent, intensity was season dependent, and there was no relationship between parasite burden and fish size.

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

1. Introduction
Cichlidae are native of Africa but have been introduced to other countries, they are among the commercially exploited fishes for human consumption especially in African lakes [1]. The word Tilapia formerly refers to three genera of Cichlids – *Tilapia, Sarotherodon, and Oreochromis* -. In 1972, the genus *Tilapia* was separated into two genera based on their reproductive behavior, they are the genus *Tilapia* (the species that brood their young or eggs on the substratum otherwise known as substrate brooders, substrate spawners or guarsers; they have few gill-rakers usually 12 or less on the lower part of the first gill arch) and the genus *Sarotherodon* which was at that time considered to consist of all the mouth breeding Tilapias, all of which have large number of gill-rakers (usually 13 or more on the lower part of first gill arch). In 1983, the genus *Sarotherodon* was again separated into two genera, *Sarotherodon* which includes all the paternal and biparental mouth brooders and *Oreochromis,* the maternal mouth brooders [2]. Tilapia production is growing exponentially with the global output standing at 2.5 million tons annually, and has therefore, been dubbed as the twenty-first century's most culture - able fish [3, 4].
The study of the food and feeding habits of freshwater fish species is a subject of continuous research, because it plays a fundamental integral part in the development of a successful fisheries management programme on fish capture and culture [5, 6]. Diet compositions are important in community ecology because the use of resources by organisms has a major influence on population interactions within a community [7]. Knowledge on the natural food of fish in its habitat is important in order to be aware of its nutritional needs and interaction with other organisms [8].
Many parasites possess complex life cycles, they are indicative of many different aspects of their host's biology, such as host diet, migration, recruitment, population distinctness and phylogeny [9]. 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 [10]. Some parasites have been discovered to have zoonotic potential in mammalian host including man thereby making them of public health importance [11]. Fishborne zoonotic trematodes (FZT) are transmitted to humans as metacercariae that have encysted in fish [12]. They are an emerging problem and there is now a

consensus that, in addition to wild-caught fish, fish produced in aquaculture produces a major food safety risk especially in Southeast Asia where aquaculture is important economically [13]. Recent global health assessments have identified FZT as among the most important (and neglected) parasitic zoonotic diseases [12, 14].
This study will use diet indices such as frequency of occurrence, numerical methods/percentage composition by numbers and stomach fullness as described by [15, 16] to evaluate the stomach content; identify and quantify the resource that the species uses, and provide information on those selected from the choice available in the environment. It will also investigate how feeding might have influenced enteroparasitic species diversity, prevalence, and intensity in the fish species.

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 species were purchased monthly from catches of local fishermen. Fish specimens used for morphometric and parasitology studies were purchased from catches of local fishermen using traps, gill nets, and cast nets in the reservoir. The fish specimens used for food and feeding habits were purchased from fishermen using cast nets only, based on the submission of [6] who recommended the use of cast nets for the harvesting of fish to be used for food and feeding habit studies, as the use of gill nets and other traps could make most of the fish caught to regurgitate. Collection of fish specimens was done from November 2011 to October 2013; purchases were done between 06:00 - 08:00 am. All fish specimens were still alive as at the time of purchase. 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 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 – [2].
The sexes were identified by examining the papillae; there are two orifices (openings) in the papillae of female and one in male [2]. The sexes were further confirmed after dissection with the presence of testes (in male) and ovaries (in female).

2.4 Immature and mature groups

The fish specimens harvested were divided into two groups – immature and mature -. The minimum sizes of the observable mature male and female specimens harvested, were taken as the maturity sizes. Hence all specimens of this size and above were regarded as matured while all those below were immature.

2.5 Seasonal studies

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

2.6 Morphometric study

2.6.1 Population of fish studied

A total of 308 fish specimens were studied during the two year period. The first year, November 2011 to October 2012 referred to as (2011/2012), 152 specimens; the second year, November 2012 to October 2013 referred to as (2012/2013), 156 specimen were investigated.

2.6.2 The Length – weight relationship (LWR)

The weight of each specimen was measured using a top loading mettler balance (model PN1200) to the nearest 0.1g after draining excess water with a pile of filter paper, while total length (TL) were measured in centimeter (cm) using a measuring board. Total length only was used because no evidence of cannibalism was observed during the pre-data and data collection periods. All the parts of the fish specimens harvested were complete (harvested whole).
The LWR was estimated by using the equation:

$W = a L^{b}$

Where W = Total weight (g)
L = Total length (cm)
a = intercept
b = regression coefficient. [17].

2.6.3 Analysis

The relationships total length versus body weight for infested and uninfested fish specimens were done by linear regression, [18] and the parameter r^2 (correlation coefficient) were estimated to detect if they had good fit to the line of regression, using the Microsoft – Excel package.
The means of the total lengths and weights of infested and uninfested samples for the sexes (male and female) in each year were compared for significance at 95% confidence interval, using independent student 't' test (2-tailed). The analysis was done using SPSS version 15.0 for Windows package.

2.7 Food and feeding habits

2.7.1 Population of fish studied

A total of 208 (160 matured, 48 immature) fish specimens were used in 2011/2012, while 229 (178 matured, 51 immature) specimens were used in 2012/2013.

2.7.2 Dissection

The specimens were dissected, and the stomach was removed and fixed in a mixture of 10% formaldehyde, glacial acetic acid and 5% ethanol in a ratio of 5:5:90, [19].
The different food items eaten by the fish were identified under the light microscope (at different magnifications as appropriate) by following the keys given by [20, 21].

2.7.3 Analysis

Analysis was done using diet indices such as frequency of occurrence, numerical methods/percentage composition by numbers and stomach fullness as described by [15, 16].

2.7.3.1 Frequency of occurrence:

The frequency of occurrence of each food item was calculated using the formula:

$$Fi = \frac{N_i}{N} \times 100\%$$

Where;
Fi = Frequency of occurrence of the ith food items in the sample,
N_i = Number of stomachs in which the ith item was found.
N = Total number of stomachs with food in the sample.

2.7.3.2. Numerical method

The quantity of each food item was determined using the formula:

$$N_i = \frac{F_i}{F} \times 100\%$$

Where Ni = Numerical percentage of the ith food item in the space
Fi = Total number of ith food item
F = Total number of all food item,

2.7.3.3 Stomach fullness

The percentage fullness of the stomach was visually calculated and categorized according to the following: 0/4 (empty), ¼ (almost empty), 2/4 (half), ¾ (almost full), 4/4 (Full), [22].

2.8 Enteroparasites

2.8.1 Examination for parasites

Examination of fish for parasites, handling and processing followed standard procedure by [23]. 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 scissors. 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.

2.8.2 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 [24, 25, and 26].

2.8.3 Processing of recovered parasites

Cestodes and nematode parasites recovered were stained using the procedure of [27]. 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.

2.8.4 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 K-S test) at 95 % level of confidence using SPSS version 15.0 for Windows.
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.

3. Result.

3.1. Food and feeding habits

Frequency of occurrence and numerical methods/percentage composition by numbers of food found in the stomach of 208 (160 matured, 48 immature) in 2011/2012 and 229 (178 matured, 51 immature) in 2012/2013 were shown in Table 1. The matured were greater than 12.00 cm (female) and 12.70 (Male) while the immature were lesser than 12.00 cm (female) and 12.70 (Male), while Figure 1 showed the percentage composition by number of each food item in immature and mature fish for the two years combined.
Analysis of the empty stomachs in *S. galilaeus* for the 2011/2012 and 2012/2013 years of study was shown in Table 2.

Table 1: Frequency of occurrence of seasonal food contents in the stomach of *Sarotherodon galilaeus* in Oba reservoir.

	2011/2012					2012/2013					
	Rainy Season		Dry Season			Rainy Season		Dry Season			
Food items	Frequency	%	Frequency	%	2011/2012	Frequency	%	Frequency	%	2012/2013	The two years
Spirogyra sp.	13	76.47	9	69.23	73.33	20	95.24	11	78.57	88.57	81.54
Closterium sp.	16	94.12	9	69.23	83.33	21	100	13	92.86	97.14	90.77
Volvox sp.	11	64.71	8	61.54	63.33	20	95.24	10	71.43	85.71	75.39
Copepods	13	76.47	11	84.62	80.00	20	95.24	11	78.57	88.57	84.62
Insect parts	16	94.12	12	92.31	93.33	21	100	11	78.57	91.43	92.31
Sand grains	11	64.71	9	69.23	66.67	12	57.14	10	71.43	62.86	64.62
Detritus	14	82.35	11	84.62	83.33	15	71.43	10	71.43	71.43	76.92
Total	SWF= 17		SWF = 13		SWF = 30	SWF = 21		SWF = 14		SWF = 35	SWF = 65
MATURE											
Spirogyra sp	50	62.50	23	69.70	64.60	36	43.90	12	30.77	39.67	51.71
Volvox sp.	42	52.50	13	39.39	48.67	19	23.17	9	23.08	23.14	35.47
Closterium sp.	23	28.75	15	45.46	33.63	20	24.39	6	15.39	21.49	27.35
Chlamydomonas	15	18.75	9	27.27	21.24	3	3.66	6	15.39	7.44	14.10

sp.											
Plant mat.	36	45.00	13	39.39	43.36	22	26.83	3	7.69	20.66	31.62
Detritus	23	28.75	9	27.27	28.32	40	48.78	3	7.69	35.54	32.05
Unidentified materials.	42	52.50	5	15.15	41.59	6	7.32	8	20.51	11.57	26.07
Copepods	53	66.25	19	57.58	63.72	76	92.68	35	89.74	91.74	78.21
Insect parts	37	46.25	17	51.52	47.79	59	71.95	33	84.62	76.03	62.39
Molluscs	55	68.75	15	45.46	61.95	67	81.71	33	84.62	82.65	72.65
Sand grains	68	85.00	21	63.64	78.76	56	68.29	35	89.74	75.21	71.20
Total	SWF=80		SWF=33		SWF=113	SWF=82		SWF=39		SWF=121	SWF=234

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 Acanthocephalan (*Neoechinorhynchus rutili, Acanthocentius tilapia*) the metacercariae of a Trematode (*Clinostomum tilapia*) and the two nematodes (*Procamallanus laevionchus* and *Paracamallanus cyathopharynx*). 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.

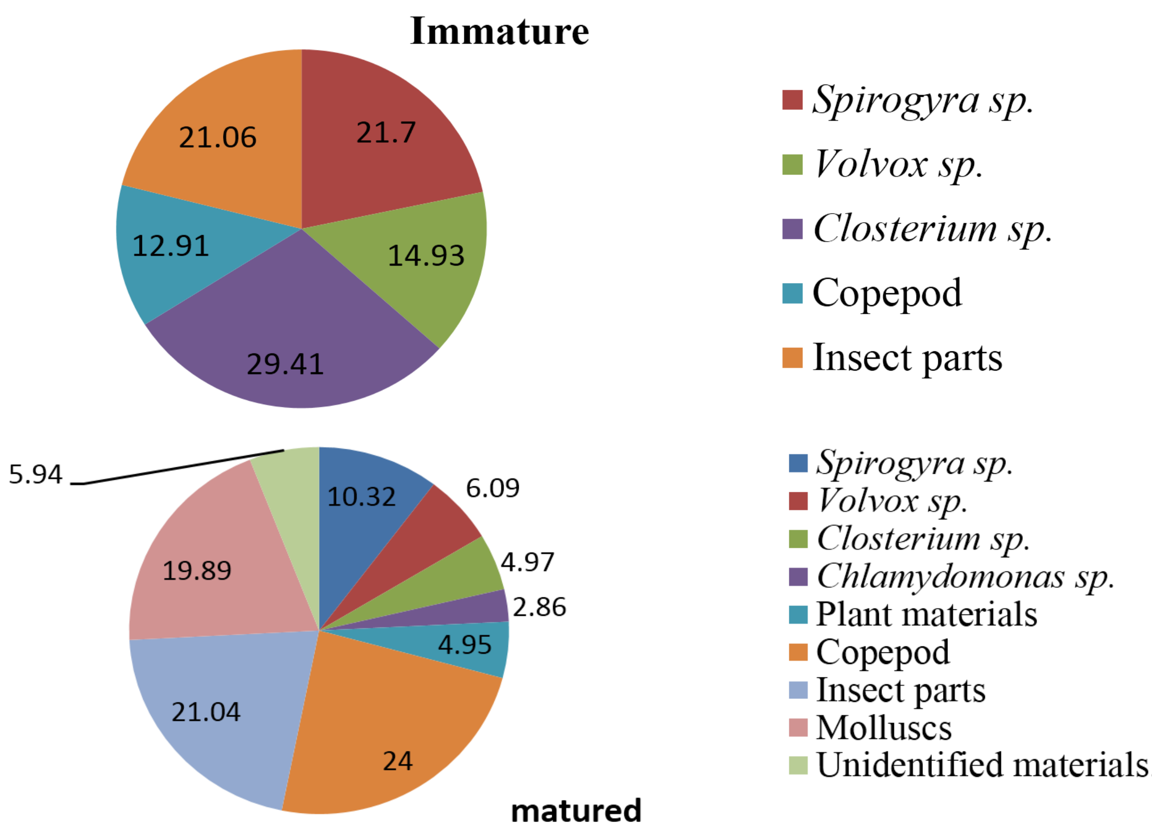

Fig 1: Food items in immature and matured *Sarotherodon galilaeus* in percentage composition by number.

Table 2: Analysis of empty stomachs of *Sarotherodon galilaeus* in Oba reservoir.

Fish species		**2011/2012**						**2012/2013**					
		Rainy Season			**Dry Season**			**Rainy Season**			**Dry Season**		
		Nos. Exam.	**E.S**	**%**	**Nos. Exam.**	**E.S**	**%**	**Nos. Exam.**	**E.S**	**%**	**Nos. Exam.**	**E.S**	**%**
S. Galilaeus	Immature	27	10	37.04	21	8	38.10	30	9	30.00	21	7	33.33
	Matured	112	32	28.57	48	15	31.25	113	31	27.43	65	26	40.00
	Total	139	42	30.22	69	23	33.33	143	40	27.97	86	33	38.37

Nos. Exam. = Number Examined; E.S. = Empty stomachs; % = Percentage of empty stomachs.

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

Prevalence was 17.72 %, 13.92 % for females and males respectively in 2011/2012 and 13.92 %; 16.67 % respectively in 2012/2013. Prevalence was found to be dependent on season (Table 3).

Table 3: Seasonal prevalence of parasitic infestation in *Sarotherodon galilaeus* in Oba Reservoir.

2011/2012	INFESTED		UNINFESTED		TOTAL
	Nos.	Prevalence (%)	Nos.	Prevalence (%)	Nos
Dry Season	22	40.74	32	59.26	54
Raining Season	28	26.92	76	73.08	104
Total	50	31.65	108	68.35	158
2012/2013					
Dry Season	34	62.96	20	37.04	54
Raining Season	26	25.49	76	74.51	102
Total	60	38.46	96	61.54	156

3.2.3 Relationship of parasitemia and body weight:
In 2011/2012, a student t test was carried out to find the significant difference (at p =0.05) between the means of the body weight of infested male *S. galilaeus* (232.64+26.18) and uninfested (228.82+13.32) was not significant. In infested females (278.86+30.12) and uninfested (259.85+14.59) it was also not significant. In 2012/2013, the student t test between the means of the body weight of infested male *S. galilaeus* (233.00+17.15) and uninfested (236.63+11.94) was not significant. In infested females (279.50+15.12) and uninfested (285.42+14.20) it was not significant.

3.2.4 Relationship of parasitemia and total length
In 2011/2012, a student t test was carried out to find the significant difference (at p =0.05) between the means of the total length of infested male *S. galilaeus* (20.82+1.39) and uninfested (20.91+0.68) was not significant. In infested females (22.02+1.25) and uninfested (22.20+0.73) it was also not significant. In 2012/2013, the test between infested male (18.93+1.05) and uninfested (18.60+0.72) was not significant; in infested female (19.14+1.21) and uninfested (19.87+1.09), the difference was not significant.

3.2.5 Intensities of the parasites in relation to sex and seasons.
A Kolmogorov-Smirnov Z test (p=0.05. 2-tailed) between the means of parasitemia in male (15.20+4.74) and female (mean of 27.00+7.23) in 2011/2012 was not significant, P = 0.187. In 2012/2013 the test between the means of male (11.00+2.43) and female (mean of 27.00+7.21) was not significant, P = 0.759.
Intensities of the various parasites were season dependent; figures 2 and 3.

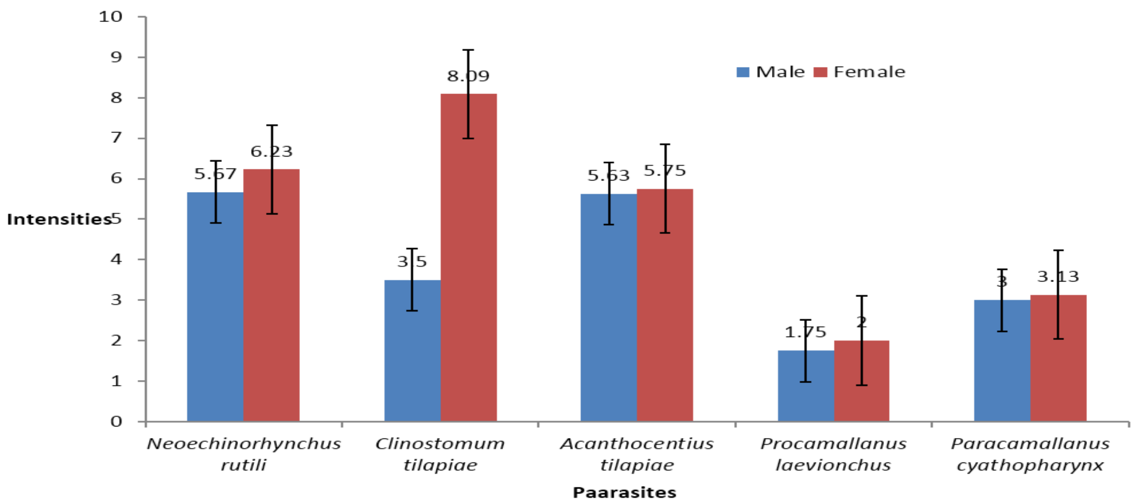

Fig 2: Intensities of parasites in Male and Female *Sarotherodon galilaeus* in Dry season.

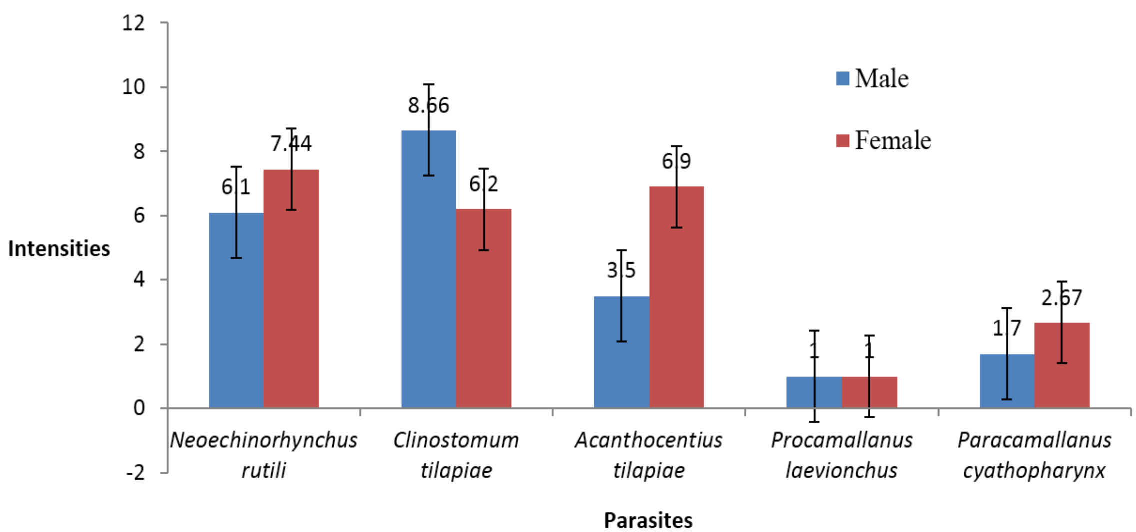

Fig 3: Intensities of parasites in Male and Female *Sarotherodon galilaeus* in Rainy season.

3.2.6 Influence of parasitemia on correlation coefficient value of length – weight regression of infested and uninfested fish

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

4. Discussion

Investigation into the diet of 437 *S. galilaeus* comprising of 338 mature and 99 immature specimens was carried out. There were ten types of food items exploited by adults *S. galilaeus* while the juveniles exploited seven (Table 1). The matured fed on *Spirogyra sp., Volvox sp., Closterium sp., Chlamydomonas sp.,* and plant materials as food from plant origin; Copepods, insect parts and molluscs as food from animal origin; unidentified materials, detritus and sand grains from the substratum. In the immature fish specimen's diets, *Chlamydomonas sp.,* plant materials, and Molluscs were absent; both detritus (76.92) and sand grains (64.62) were very conspicuous. The percentage composition of food in mature stomach (Figure 1) showed Copepods as the highest followed by insect parts, unidentified materials and the least was *Chlamydomonas sp.* (2.86 %) This result showed that *S. galilaeus* had preference for food items of animal origin in both immature and matured stages. This indicated that the fish species may primarily be a carnivore and only fed on diets from plant sources as an alternative. [21] Reported there were nine taxa of food items exploited by adults *S. galilaeus;* [28] reported that the juveniles exploited ten taxa; [8] also reported nine and ten Taxa for adult and juveniles respectively; the food items recorded in Oba reservoir had a higher diversity of food resources for *S. galilaeus* indicating abundant food availability and a richer habitat. The presence of detritus and sand grains in the stomach of immature and mature indicated that the fish species though a pelagic dweller, was also a bottom grazer. It also indicated that the sand may be helpful in maceration of food in the stomach; this is in agreement with [19] who reported that a sandy substation may be ecologically important for juveniles of the fish.

The ability to exploit different varieties of food from both plant and animal source made *S. galilaeus* in Oba reservoir an omnivore. [29] was of the opinion that most aquatic animals appear to be opportunistic feeders consuming a large diversity of prey. This result showed that *S. galilaeus* was a non-selective opportunistic feeder and [30] reported that unspecialized feeders eats insects, plankton, detritus and plant matter according to their abundance. The percentage of stomach with food, in both mature and immature was higher than empty stomach (Table 2) which indicated that food was probably in abundance in the reservoir. The amount of stomach with food in the rainy season was comparatively higher than the dry season maybe as a result of more availability of food in the rainy season than the dry season. The rainy period is a period of influx of rain water which brought along dead terrestrial insects and other organic matter that could serve as food for the fish. In addition, eutrophication could set in which would have increased the amount of algae and other phytoplankton, thus enriching the water body. The ability of *S. galilaeus* to feed on a wide range of food items probably makes it to possess a high aquaculture potential. This is particularly important for the culture of this species, since it is possible to formulate artificial diets necessary for its mass production [8].

The result indicated that the intensity of *C. tilapia* was the highest, followed by *N. rutili*; *P. laevionchus* had the least infestation (Figures 2 and 3). *C. tilapia* resides in the buccal cavity where blood capillaries provide nutrients which the parasites feed on probably 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 [31] Clinostomatid metacercariae had predilection for the mesenteries' of blood capillaries in the buccal cavity; this explains the high prevalence and abundance in the buccal cavity. [32] in their findings reported that the infection of *C. tilapia* was very high in the infected fishes (*Hemichromis fasciatus*). *C. tilapia* is known to use cichlids as intermediate host while the definitive hosts are piscivorous birds [33].

The intensity of the acanthocephalans in the intestine was not as high as that of *C. tilapia* in the buccal cavity in both rainy and dry seasons of the two years. Their restriction to the intestine may be attributed to the abundance of food supply in the gut; its proboscis also serves as an organ of attachment to the gut wall. The feeding pattern of *S. galilaeus* is an important factor in their infestation with parasites. 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 [34]. Piscine acanthocephalans have aquatic insects and crustaceans (amphipods, isopods, copepods, and ostracods) as their foremost intermediate hosts [34]. In this study *S. galilaeus* was reported to feed on food items of animal origin like insects and copepods which may be the source of its infestation and the reason for the species diversity recorded. [35] were of the opinion that predatory fish species harbor a greater diversity and abundance of larval helminths than herbivorous and planktivorous species. [36] Reported a high incidence of parasite infection in *Channa punctatus* was found in the river, lake or beel area compares with the farmed fish. Seasonally, infestation followed the same pattern in both male and female *S. galilaeus* in the two years with both *N. rutili* and *C. tilapia* being higher in the rainy season and *A. tilapia* and the two nematodes higher in the dry seasons.

The prevalence was observed to be higher in females than in males in the two years of study, 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.* [32]. and [33]. 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 *?*: than female in Kenya. [38] worked on parasitic infection of three freshwater fishes in India reported that the percentage of infection was 62.5% and 45.45% for females and males, respectively in *Notopterus notopterus,* 31.25% for females and 17.46% for males of *Channa punctata* and 10% and 8.33% for females and males of *Heteropneustes fossilis* respectively. Poulin and Morand, (2004) 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 statistical difference

(K.S.at P = 0.05) in the degree of parasitemia or intensity between the sexes.
Result revealed that there was no significant difference (p=0.05) between the weights of infested and uninfested fish of both sexes in the two years in Oba reservoir; which indicated that the fish body weight may not be affected by the parasitic infestation. [37]. reported that the condition factor of *O. niloticus* was not affected in any way by the infestation by *C. tilapia.* [39] Reported that generally, there was no significant difference in prevalence by size and gender at p > 0.05 in the incidence of nematode parasites of African snakehead, *Parachanna obscura* of the lower Cross River system. [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. The result also showed that parasitemia had no effect on the total length of *S. galilaeus* in Oba reservoir. [41]. 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. [33]. 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). The regression results showed that parasitic infestation of *S. galilaeus* in Oba reservoir had little effect on the length weight relationship within the data collected in this study. The correlation coefficient (r^2) value obtained for uninfested and infested male and female of the two years though high showing that the relationship had a good fit to the line of regression; it however indicated a lower values for the infested specimens in both sexes. This is an indication that the parasites may have an effect on the weight or length of the fish which may not be severe in fishes harvested and was not indicated by the student t tests carried out on the length and weight of infested and uninfested specimens. [40] were of the opinion that clinostomum infection can have several effects on fish, among them been reduced growth, offset weight loss and prominent exophthalmia.

5. Conclusion.

Sarotherodon galilaeus feed on ten different types of food items in Oba reservoir. The fish was found to be primarily a carnivore but when food of animal source become scarce, it can also feed on food items from plant source, it is therefore generally classified as an omnivore. The fish though a pelagic species was also a bottom grazer, and sand grains was found to be a constant component of its diet. The ability of *S. galilaeus* to feed on a wide range of food items makes it to possess a high aquaculture potential. Because of its highly diverse diets, infestation by enteroparasite species was found to be diversified based on its choice of food. Parasitic prevalence within the context of the data available in this study was sex dependent while the intensity of various parasite species was dependent on season.

6. References

1. Arawomo GAO, Fawole OO. The food and feeding habits of *Sarotherodon galilaeus* (Artedi) in Opa reservoir of Obafemi Awolowo University, Ile-Ife, Nigeria, *Biosci. Res. Commun* 1997; 9:15-20.
2. Adesulu EA, Sydenham DHJ. The freshwater fishes and fisheries of Nigeria. Macmillan Nigeria Publishers Limited, 2007, 397.
3. Shelton WL, Popma TJ. Biology, Culture and Nutrition. Food Products Press, an imprint of The Haworth Press, Inc, NY. 200; USA, 645, 13904-1580.
4. Fitzsimmons K. Potential to Increase Global Tilapia Production. Global Outlook for Aquaculture Leadership. Kuala Lumpur. The Global Aquac. Alliance 2010; 13:21-28.
5. Oronsaye CG, Nakpodia FA. A comparative study of the food and feeding habits of *Chrysichthysnigrodigitatus* and *Brycinus nurse* in a tropical river. Pak J Sci Ind Res 2005; 48:118-121.
6. Oso JA, Ayodele AI, Fagbuaro O. Food and feeding habits of *Oreochromis niloticus* (L.) and *Sarotherodon galilaeus* (L.) in a tropical reservoir. World J of Zoo 2006; 1(2):118-121.
7. Mequilla AT, Campos WL. Feeding relationships of dominant fish species in Visayan Sea. *Science Diliman* 2007; 19:35-46
8. Alhassan EH, Commey A, Bayorbor TB. An Investigation into the Food and Feeding Habits of *Sarotherodon Galilaeus* (Pisces: Cichlidae) in a Shallow Tropical Reservoir. Res J of Fish and Hydrobio 2011; 6(2):74-77.
9. MacKenzie K, Williams HH, Williams B, McVicar AH, Sidall R. Parasites as indicators of water quality and the potential use of helminth transmission in marine pollution studies. Advances in Parasitology 1995; 35:85-144.
10. Marcogliese DJ, Cone DK. Food webs: A plea for parasites. Trends in Ecology and Evolution 1997; 12:320-325.
11. Bichi AH, Yelwa SI. Incidence of piscine parasites on the gills and gastro-intestinal tract *of Clarias gariepinus* at Bagauda fish farm Kano. Bayero J of Pure and Appl Sc 2010; 3(1):104-107.
12. FAO/WHO. Multicriteria based ranking for risk management of foodborne parasites (Report of a joint FAO/WHO expert meeting, Rome, 3-7 September), 2012.
13. Clausen HJ, Madsen H, Van TP, Dalsgaard A, Murrell KD. Integrated parasite management: path to sustainable control of fishborn trematodes in aquaculture. Trends in Parasitology 2015; 31(1):8-15.
14. Hotez P. The global burden of disease study 2010: Interpretation and implications for the neglected tropical diseases. PLos Negl Trop Dis 2014; 8:e28.
15. Hyslop EJ. Stomach content analyses- A review of methods and their application. J Fish Biol 1980; 17:411-429.
16. Costal JL, Almeida PR, Moreira FM, Costal ML. On the food of the European eel, *Anguilla anguilla* (L.) in the upper zone of the Tagus estuary, Portugal. J Fish Biol 1992; 41:841-850.
17. Froese R. Cube law, condition factor and weight– length relationships: history, meta-analysis, and recommendations. J. Applied Ichthyol 2006; 22:241-253.
18. Hossain MY, Ahmed ZF, Leunda PM, Islam AKMR, Jasmine S, Oscoz J *et al*. Length-weight and length-length relationships of some small indigenous fish species from the Mathabhanga River, southwestern Bangladesh. J of Appl Ichthyo 2006; 22:301-303.
19. Amisah S, Agbo NW. An investigation into the food and feeding ecology of a potential aquaculture candidate, *Sarotherodon galilaeus multifasciatus* in a meteoritic

crater lake in Ghana. Journal of Applied Science and Environmental Management 2008; 12(3):15-18.

20. Prescott GW. Algae of the Western Great Lakes Area Wm. C. Brown co, Pub. Dubuque, Lowa, 1962, 946.
21. Jeje CY, Fernando CH. A Practical Guide to the Identification of Nigerian Zooplankton (Cladocera, Copepoda and Rotifera). Kainji Lake Research Institute Publishers, 1986.
22. Williams MJ. Methods for analysis of natural diet in portunid crabs (Crustacea: Decapoda: Portunidae). J. of Exptal. Mar Biol and Ecol 1981; 52:103-113.
23. Moravec F. Some aspects of the taxonomy and biology of dracunculoid nematodes parasitic in fishes: A review. *Folia Parasitol*., 2004: 51:1-13.
24. Yamaguti S. *Systema Helminthum.* The Acanthocephalans. Inter Science Publishers, Inc. New York, 1963, V.
25. Juan JA, Windsor EA. Scanning electron microscopy of *Neoechinorhynchus* sp. (Acanthocephala: Neoechinorhynchidae), a possible new species of intestinal parasite of the tail fin croaker *Micropogonias altipinnis* (Gunther, 1864). *Parasitol. Latinoam* 2006; 60:48-53.
26. Edoh DA, Ewool J, Owusu EO, Davies H. Scanning electron microscopy of *Neoechinorhynchus sp*. And *Echinorhynchus sp. (*Acanthocephala: Neoechinorhynchidae and Echinorhynchidae), in the black chinned tilapia, *Sarotherodon melanotheron* (Rupell, 1852) from cultured and open lagoon in Ghana. Afri. J. of Sci. and Tech., and Engnr 2008; 9(2):90-95.
27. Khalil LF. Techniques for identification and investigative helminthology. *Helminthology manual.* International Institute of Parasitology, St. Albans, UK, 1991, 156.
28. Kone T, Teugels GG. Food habits of Sarotherodon melanotheron (Rüppell) in riverine and lacustrine environment of a West African coastal basin. Kluwer Academic Publishers, 2003.
29. Cortes E. Standardized diet compositions, and trophic levels of sharks. ICES Journal of Marine Science 1999; 56:707-717.
30. Welcomme RL. Inland fisheries: Ecology and management. Oxford: Fishing New Books, Blackwell Science, 2001.
31. Echi PC, Eyo JE, Okafor FC, Onyishi GC, Ivoke N. First record of co-infection of three Clinostomatid parasites in Cichlids (Osteichthys: Cichlidae) in a tropical freshwater lake. Iranian J. Publ Health 2012; 41(7):86-90.
32. Olurin KB, Somorin C. A Intestinal Helminths of the Fishes of Owa Stream, South-west Nigeria. Research Journal of Fisheries and Hydrobiology 2006; 1(1):6-9.
33. Olurin K, Okafor J, Alade A, Asiru R, Ademiluwa J, Owonifari K, Oronaye O. Helminth Parasites of *Sarotherodon galilaeus* and *Tilapia zillii* (Pisces: Cichlidae) from River Oshun, Southwest Nigeria. International Journal of Aquatic Science 2012; 3(2):113-116.
34. Food and Agriculture Organization (FAO) The state of the world's Fisheries and Aquaculture, FAO Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations Rome, 2006, 3-16.
35. Poulin R, Morand S. *Parasite Biodiversity.* Washington, DC: Smithsonian Institution Press, 2004.
36. Shanchita Zaman Chowdhury, Md. Mer Mosharraf Hossain. Isolation and characterization of internal parasites in Snakehead. International Journal of Fisheries and Aquatic Studies 2015; 2(4):17-22.
37. Ochieng VO, Matolla GK, Khyria SK. A Study of Clinostomum affecting *Oreochromis niloticus* in small water bodies in Eldoret-Kenya. International Journal of Scientific and Engineering Research 2012; 3(4):158-163.
38. Ratnabir Singha M. Shomorendra and Devashish Kar. Parasite infection of three freshwater fishes in Dolu Lake, Silchar, Assam. International Journal of Fisheries and Aquatic Studies 2015; 2(3):125-127.
39. Oden Esther M, Ama–Abasi Daniel, Ndome Chris. Incidence of nematode parasites in snakehead, *Parachanna obscura* of the lower Cross river system, Nigeria. International Journal of Fisheries and Aquatic Studies *2*015; 2(4):331-336
40. Garacia MLJ, Osorio SO, Constantino F. Prevalence of parasites and the histological lesions they produce in Tilapia from Amela Lakes. Tecoman Colima. Vet Mex 1993; 4:3:199-205.
41. Echi PC, Eyo JE, Okafor FC. Co-parasitism and morphometrics of three Clinostomatids (Digenea: Clinostomatidae) in *Sarotherodon melanotheron* from a tropical freshwater Lake. Animal Research International 2009; 6(2):982-986.