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A STUDY OF DIETS AND ENTEROPARASITIC INFESTATION OF *CLARIAS GARIEPINUS* (BURCHELL, 1822) IN OBA RESERVOIR

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ABSTRACT

Oba reservoir is located in Oyo state, Nigeria. Knowledge of the diets of *Clarias gariepinus* and the various enteroparasites infesting the fish will assist in establishing a fisheries management programme for the reservoir and detect role of trophic interaction in transmission of the retrieved parasites. The fish specimens were collected from fishermen using cast nets only, they were sacrificed and dissected. Food contents in the stomach were identified using standard methods. Parasites in the enteron were retrieved and identified using standard methods. Seven taxa of food items were detected as food of *C gariepinus* in the reservoir. Immature fish were found to be carnivorous while the matured, though omnivorous had preference for food from animal sources. Six enteroparasites were retrieved from the enteron of the fish and most of the parasites used aquatic invertebrates that were found to be part of the diets of the fish as intermediate hosts.

KEYWORDS: *Clarias Gariepinus*, Enteroparasite, Enteron, Taxa

INTRODUCTION

Studies on natural feeding of fish could provide useful information on the trophic relationships in aquatic eco-systems [1]. This information could be used in formulating management strategy options in a multi species fishery. The study of the food and feeding habits of freshwater fish species is a subject of continuous research, because fish will eat any edible organism/substance available at any particular time in its habitat. The study therefore plays a fundamental integral part in the development of a successful fisheries management programme on fish capture and culture, [2]. Food items consumed by fish may result in identification of stable food preference and in creation of trophic models as a tool to understand complex ecosystems [3]. Knowledge on the natural food of fish species and its feeding is an integral part of aquaculture development; it suggests to fish farmers the type, as well as the quantity of local supplementary feed to use. It is important to study an animal in its habitat in order to be aware of its nutritional needs and interaction with other organisms [4].

Parasitic diseases of fish are very common all over the world and are of importance in the tropics due to environmental conditions, poor maintenance, and monitoring of the inland water ecosystems. Many parasites possess complex life cycles, because of this, they are indicative of many different aspects of their host's biology, such as host diet, migration, recruitment, population distinctness and phylogeny. 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 [5]. *Sarotherodon galilaeus* was reported to feed on a wide range of food items, because of its highly diverse diets, infestation by enteroparasite species was found to be diversified based on its choice of food [6]. The importance of parasitic infection and infestation on fish production has largely remained an issue of concern to fish farming industry; and some parasites have been discovered to have zoonotic potential in mammalian host including man thereby making them of public health importance [7]. Fish-borne zoonotic trematodes (FZT) are transmitted to humans as metacercariae that have encysted in fish [8]. Recent global health assessments have identified FZT as among the most important (and neglected) parasitic zoonotic diseases [7]. This study intends to investigate and identify the types of diets fed upon by *C. gariepinus;* this will assist in developing a fisheries management programme for the reservoir. The study will also assist in identifying the various enteroparasites infesting the fish thereby establishing the possibility of trophic interaction in the transmission of the parasites in Oba reservoir.

METHODS

Study Area

The main body of Oba reservoir lies between Latitude 8° 3" N to 8° 12" N and Longitude 4° 6" E to 4° 12" E, in Oyo state, Nigeria. The impounded area is 138 hectares of water surface with maximum and minimum depth of 16.36 meters and 0.83 meters respectively, it sustains a thriving artisanal fisheries industry and serves as a source of water for domestic use for a population of 198,720 in Ogbomoso North, and 100,815 in Ogbomoso South, [9].

Sampling Procedures

The fish specimens were collected from fishermen using cast nets only, to harvest their fish. This was done based on the submission of [2] 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. Identification of *Clarias gariepinus* specimens was done using fish identification guide by [10], [11], [12], and [13]. Sexes were distinguished using the description of [14]. The fish specimens collected 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. A total of 224 (185 matured, 39 immature) *Clarias gariepinus* specimens were used in 2011/2012 and 214, (184 matured, 30 immature) in 2012/2013.

Food and Feeding Habits Studies

Stomach Content Analysis

The specimens were sacrificed and dissected; 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, [15]. 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 [16] and [17]. Analysis was done using diet indices such as frequency of occurrence, numerical methods/percentage composition by numbers and stomach fullness as described by [18], [19], and [20] respectively.

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.

Examination and Identification of Parasites

Examination of fish for parasites, handling and processing followed standard procedure by [21]. Parasites were examined from the buccal cavity, stomach and the intestines. Parasites retrieved were identified using information provided by [22], [23]. And confirmed with the assistance of [24] and [14], who had earlier confirmed the identity of the parasites through the assistance of the British Museum, United Kingdom.

Processing of Recovered Parasites

Cestodes and nematode parasites recovered were stained using the procedure of [25]. Fixative used was Formalin acetic acid (FAA).

Statistical Analysis

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

RESULTS

Food and Feeding Habit

Seven different groups/Taxa of food were detected in the stomach of C. *gariepinus* in Oba reservoir. Frequency of occurrence and numerical methods/percentage composition by numbers of food found in the stomach of *C. gariepinus* were shown in Table 1. The percentage frequency of occurrence of each food item per season in immature and matured fish were shown in Table 1, while the analysis of empty stomach was shown in Table 2. Figure 1 showed the percentage composition by number of each food item in immature and matured fish for the two years combined.

Table 1: Summary of Seasonal Food Items Found in the Stomach of *Clarias gariepinus* of Oba Reservoir

Food Items	2011/2012									
	Rainy				Dry					
	Freq. of Occ.		%Cn		Freq. of Occ.		%Cn		2011/2012	
	Freq.	%	Nos.	%	Freq.	%	Nos.	%	% FOO	%Cn
	IMMATURE									
Detritus	8	80	-	-	9	60	-	-	68	-
Insect parts	10	100	417	43.80	12	80	382	48.54	88	45.95
Zooplankton	8	80	397	41.70	6	40	291	36.98	56	39.56
Unidentified materials.	3	30	138	14.50	5	33.33	114	14.49	32	14.49
Sand grains	8	80	-	-	12	80	-	-	80	-
Total	**SWF= 10**		**952**		**SWF= 15**		**787**		**SWF=25**	**100**
	MATURED									
Fish remains	51	100.0	557	25.28	63	85.13	605	28.01	91.20	26.63
Detritus	41	80.39	-	-	70	94.60	-	-	88.80	-
Insect parts	51	100.0	462	20.97	65	87.84	527	24.40	92.80	22.67
Plant materials	13	25.49	146	6.63	4	05.05	106	4.91	13.60	5.78
Zooplankton	41	80.39	444	20.15	54	72.97	347	16.07	76.00	18.13
Phyto-plankton	13	25.49	180	8.17	11	14.87	132	6.11	19.20	7.15
Gastropods	41	80.39	330	14.98	52	70.27	248	11.48	74.40	13.25
Unidentified materials.	24	47.06	172	7.81	33	44.60	107	4.95	45.60	6.40
Sand grains	27	52.94	-	-	41	55.41	-	-	54.40	-
Total	**SWF=51**		**2203**		**SWF=74**		**2160**		**SWF=125**	**100**

Food Items	2012/2013										
	Rainy				Dry				The whole Year2012/2013		The two years.
	Freq. of Occ.		%Cn		Freq. of Occ.		%Cn				
	Freq.	%	Nos.	%	Freq.	%	Nos.	%	% FOO	%Cn	% FOO
	IMMATURE										
Detritus	4	50	-	-	8	80	-	-	66.67	-	67.44
Insect parts	6	75	396	43.66	9	90	338	52.90	83.33	47.48	86.05
Zooplankton	6	75	418	46.09	10	100	259	40.53	88.89	43.79	69.77
Unidentified materials.	2	25	93	10.25	3	30	42	6.57	27.78	8.73	30.23
Sand grains	6	75	-	-	9	90	-	-	83.33	-	81.40
Total	**SWF=8**		**907**		**SWF=10**		**639**		**SWF=18**	**100**	**SWF=43**
	MATURED										
Fish remains	39	72.22	555	23.98	49	70.00	541	27.72	70.97	25.69	81.13
Detritus	27	50.00	-	-	58	82.86	-	-	68.55	-	78.72
Insect parts	52	96.30	410	17.72	53	75.71	440	22.54	84.68	19.93	88.76
Plant materials	7	12.96	118	5.10	0	0	0	0	5.65	2.77	9.64
Zooplankton	41	75.93	445	19.23	53	75.71	477	24.44	75.81	21.61	75.90
Phyto-plankton	15	27.78	216	5.01	11	15.71	130	6.66	20.97	8.11	20.08
Gastropods	49	90.74	517	22.34	37	52.86	240	12.30	69.36	17.75	71.89
Unidentified materials.	10	18.52	53	2.29	11	15.71	124	6.35	16.94	4.15	31.33
Sand grains	17	31.48	-	-	39	55.71	-	-	45.16	-	49.80
Total	**SWF=54**		**2314**		**SWF=70**		**1952**	**100**	**SWF=124**	**100**	**SWF=249**

Freq. of occ./FOO = Frequency of occurrence; $\%C_n$ = Percentage composition by number; Nos. = Numbers; SWF = Stomach with food.

Table 2: Analysis of Empty Stomachs of *Clarias Gariepinus* of Oba Reservoir

	2011/2012						2012/2013					
	Raining Season			Dry Season			Raining Season			Dry Season		
	Nos. Exam.	E.S	%	Nos. Exam.	E.S	%	Nos. Exam.	E.S	%	Nos. Exam.	E.S	%
Immature	15	5	33.33	24	9	37.50	12	4	33.33	18	8	44.44
Matured	73	22	30.14	112	38	33.93	75	21	28.00	109	39	35.78
Total	88	27	30.68	136	47	34.56	87	25	28.74	127	47	37.00
Immature	22	8	36.36	18	8	44.44	19	7	36.84	16	6	37.50

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

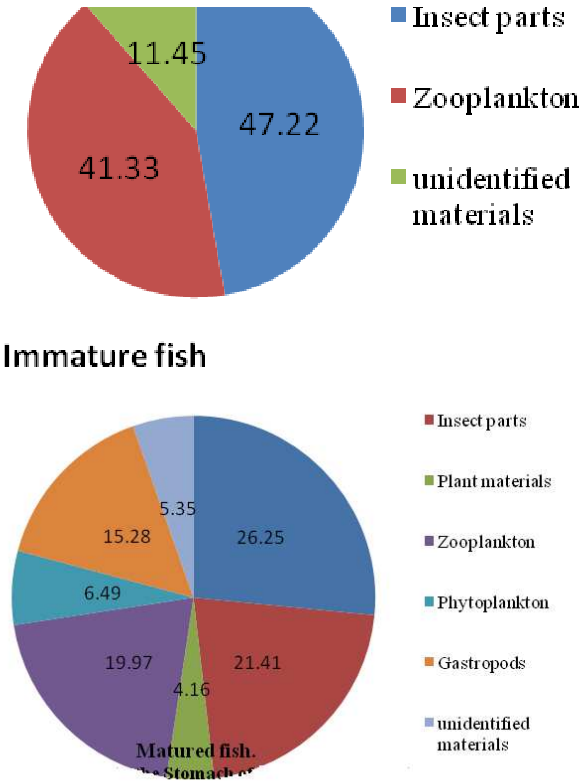

Figure1: Food Items in the Stomach of Immature and Matured Clarias Gariepinus in Oba Reservoir Using Percentage Compasition Number, By During the Study Period

Different Parasites Recovered in the Stomach and Intestine of *C. Gariepinus* and Their Distribution

The gastro - intestinal helminth parasites recovered comprised of two Nematodes; *Procamallanus laevionchus* (Wedl, 1862), *Paracamallanus cyathopharynx* (Baylis, 1923), three Cestodes; *Anomotaenia sp.*, *Monobothrium sp.*, *Polyonchobothrium clariae* and one Acanthocephalan; *Neoechinorhynchus rutili* (Mueller, 1780).

Significant Test between Rainy and Dry Seasons

A Kolmogorov-Smirnov Z test (KSZ-test, at p=0.05) between the means of rainy (67.00±2.40) and dry (mean of 133.71±5.34) seasons in 2011/2012 was significant. Whilst the test between the means of rainy (90.50±4.55) and dry (mean of 114.80±8.34) seasons in 2012/2013 was not significant.

Significant Test of Parasitemia between Sexes in Years of Study

A KSZ-test, at p=0.05 between the means of parasitemia load in male *C. gariepinus* at 22.75±2.53 and female mean of 87.77±8.19 in 2011/2012 was significant.

Whilst the test between the means of parasitemia load in male (46.06±3.61) and female (mean of 67.81±8.93) in 2012/2013 was not significant. Table 3 showed the seasonal level of parasitemia of the sexes in the two years of study.

Table 3: Seasonal Level of Parasitemia in Male and Female *C. gariepinus* during the Years of Study

	MALE							FEMALE								
Season	**Rainy**				**Dry**			**Rainy**					**Dry**			
	Stomach		**Intestine**		**Stomach**		**Intestine**	**Stomach**			**Intestine**		**Stomach**		**Intestine**	
Parasites Species.	**R.**	**TNP**	**R.**	**TNP**	**R.**	**TNP**	**R.**	**TNP**	**R.**	**TNP**	**R.**	**TNP**	**R.**	**TNP**	**R.**	**TNP**
2011/2012																
P. laevionchus	0	0	0-2	2	0	0	0	0	0	0	0-3	6	0	0	0	0
P. cyathopharynx	0-2	2	0-12	29	0-4	4	0-18	32	0-9	23	0-18	81	0-10	47	0-20	170
Anomotaenia sp	0	0	0-1	1	0	0	0	0	0	0	0	0	0	0	0-1	1
Monobothrium sp.	0-12	24	0-18	43	0-8	31	0-21	70	0-16	67	0-25	119	0-20	190	0-32	305
P. clariae	0	0	0-10	23	0	0	0-4	12	0	0	0-12	49	0	0	0-10	70
N. rutili	0	0	0	0	0	0	0-1	1	0	0	0	0	0	0	0-2	13
Total		**26**		**98**		**35**		**115**		**90**		**255**		**237**		**559**
	124				**150**			**345**					**796**			
	274 +							**1141 = 1415**								
2012/2013																
P. laevionchus	0	0	0-2	6	0	0	0-1	2	0	0	0-2	6	0	0	0-2	4
P. cyathopharynx	0-9	15	0-16	67	0-14	20	0-19	95	0-10	22	0-46	114	0-10	31	0-18	124
Anomotaenia sp	0	0	0-1	2	0	0	0-1	1	0	0	0	0	0-18	19	0-1	3
Monobothrium sp.	0-32	89	0-32	134	0-18	67	0-30	195	0-31	97	0-49	111	0-28	111	0-44	298
P. clariae	0	0	0-10	21	0-4	6	0-10	58	0	0	0-8	38	0-12	26	0-10	64
N. rutili	0	0	0-2	2	0	0	0-2	3	0	0	0	0	0	0	0-4	17
Total		**104**		**232**		**93**		**354**		**119**		**269**		**187**		**510**
	336				**447**			**388**					**697**			
	783 +							**1085 = 1868**								

R. = Range; TNP = Total Number of Parasites; R. = Range

Significant Test of Parasitemia between Years of Study

A KSZ-test, at p=0.05 between the means of parasitemia load in fish specimens of 2011/2012 (100.36±2.85) and 2012/2013 (104.00±3.24) was not significant.

DISCUSSIONS

Food and Feeding Habits

Different types of food items were found in the stomachs of *C. gariepinus* captured from Oba reservoir. The most prominent food items in the immature diets for the two years were terrestrial insect parts, which were found in 86.05 % of stomach with food in them and formed 47.22 % of the food component by number. This was followed by Zooplankton and unidentified food items. Sand grains and detritus were found in 81.40 % and 67.44 % of the stomach with food respectively. No food of plant origin was observed, which showed that in early life of *C. gariepinus* the important food class was protein, used for body growth at early stage of development. The high frequency of sand grains and detritus at this stage showed that the fish species is a bottom grazer and in the process of picking up their food from the floor of the reservoir the detritus and sand grains were also picked. The detritus and sand grains probably assisted in the grinding of the food particles pending the time the alimentary system is fully developed. This result was in agreement with that of [26] who reported that juvenile, *C. gariepinus* tended to feed on relatively higher proportion of insects and detritus. The matured added fish remains found in 81.13 % of the stomach with food, and formed 26.25 % of food composition by number, Zooplankton, and gastropods from animal source; Phytoplankton found in 20.08 % of stomach with food and formed 6.49 % of the food composition by number and plant materials from plant sources to the diets of the immature. Sand grains and detritus were still prominent, though the presence of sand grains in the matured stomach at 49.80 % was not as frequent as in immature 81.40 %. This indicated that the capability of the digestive system of the immature to break down some food items in the diet might be low and requires the assistance of the sand grains and detritus in the maceration of the food items.

The combination of food items in their diet made the adult *C. gariepinus* to be an omnivorous feeder. However, the result showed that diet of animal origin were the most preferred primary diet by adult *C. gariepinus* while those of plant origin were secondary or rather, fed on when those of animal origin were scarce. This showed that primarily *C. gariepinus* was probably a carnivore while food of plant source could be supplementary. This choice of diets from the immature stage by the fish species would very likely exposed them to high parasitic infestation and infection, since most of the invertebrates the fish feed upon also serves as the intermediate hosts to most piscine parasites. *C. gariepinus* had been described as euryphagous and generally regarded as an opportunistic, omnivorous predator; it has the ability to efficiently utilize and switch between alternative foods sources such as plants and detritus when prey animals become scarce [27]. Predation has been used by several authors to describe the mode of feeding of *C. gariepinus;* and the characteristics of a predator include the ability to pursue, kill, and feed on the prey. The first characteristic (pursuit) is lacking in the process of feeding on diets of plant origin hence, they may not be appealing to the fish species unless when it has no alternative; the natural diet is determined largely by prey abundance in any particular habitat. The frequency of fish remains was the highest during the period of study followed by insect parts, Zooplankton, and gastropod, an indication that *C. gariepinus* would prefer large mobile preys to floating food. [28] Reported that the use of zooplankton as food by adult *C. gariepinus* was probably a pointer that the lake lacks alternative larger prey for the fish and this may leads to competition with smaller fish that fed on the Zooplankton.

Seasonal variation in matured fish diet was observed in the frequency of occurrence of insect parts and fish remains whose composition by number was higher in the dry season than in rainy season in both immature and matured, but reverse was the case for gastropods. All other food items were more frequent in the rainy seasons when food was abundant for both the prey and the predator. The abundant food will attract the prey thereby exposing them to the predator. Empty stomachs were more in the dry season than the rainy seasons, this may be attributed to the fact that food were in abundance in the rainy season than the dry season. The procedure of using the cast net to harvest had greatly reduced regurgitation and made the result obtained closer to reality. Generally specimens harvested with food in their stomachs were higher numerically than those with empty stomachs which indicated that food was probably in abundance in the reservoir.

Enteroparasites

Different helminth parasites were retrieved from the enteron (stomach and intestine) of *C. gariepinus.* The enteroparasites comprised of two Nematodes *Procamallanus laevionchus* (Wedl, 1862), *Paracamallanus cyathopharynx* (Baylis, 1923), three Cestodes (*Anomotaenia sp., Monobothrium sp., Polyonchobothrium clariae*.), and one Acanthocephalan; Neoechinorhynchus *rutili* (Mueller, 1780). All six parasites were found to reside in the intestine while only four were found in the stomach, *Procamallanus laevionchus* and *Neoechinorhynchus rutili*, were absent in the stomach.

Prevalence and Intensities of Different Parasites in the Stomach and Intestine of *C. gariepinus*

Was found to be higher in females than males in the two years of study and it was higher in 2012/2013 than in 2011/2012. This showed that female *C. gariepinus* were more susceptible to parasitic infestation than males. This was supported by the intensity of parasitemia; the Kolmogorove-Smirnov Z (KSZ) test at p = 0.05 between the means of parasitemia load in male and female in 2011/2012 which was significant. Also the total number of parasites in the two sexes (Table 3) showed that female was more infested than male in the two years of study. This may be as a result of differential in feeding, either by quantity or quality of food eaten, or as a result of different degree of resistance to infestation. [29] Were of the opinion that the physiological state of the female, made most gravid females to have reduced resistance to infection and infestation by parasites. The result was in consonance with the work of authors like [30] who reported an intensity of 2.67 in females and 1.43 in males of *C. gariepinus* from Ilorin Nigeria; [31] also reported that female *C. gariepinus* in Bagauda fish farm in Kano, Nigeria had more incidence of infestation at 75.1 % than male at 24.9 %.

The intensity of all the parasites was higher in the intestine than the stomach in both sexes in the two years (Table 3). This may be due to the acidic medium of the stomach which made the environment not conducive to most parasites. The stomach is not an ideal environment for parasites that require completely digested food. Majority of the parasites retrieved from *C. gariepinus* were Cestodes; these are parasites without a digestive system, they rely on fully digested food in the intestine of their host which they absorb through their cyncitial body integuments. The intestine is an environment where most Cestodes are found in their vertebrate hosts. [32] Reported high intensity of the parasites in the intestine of *C. gariepinus* in Erinle reservoir. *Anomotaenia sp.,* a Cestode was found in the stomach of female *C. gariepinus* and had a higher intensity in the stomach than in the intestine in 2012/2013 whereas it was not found at all in the stomach of female the previous year 2011/2012; Also it was absent in the stomach of male fish in the two years of investigation. This kind of forage does occur occasionally according to [24] (personal communication, 2011), because of the anatomical structure of the stomach of *C. gariepinus* that is curved at the pyloric end. This portion of the stomach allows food to be retained temporarily before being pushed by peristalsis into the small intestine. It is also a region where the acidic content of the stomach had been weakened by the alkaline of the small intestine thereby given Cestodes probably overwhelmed by intra and inter specific competition in the intestine to come and feed.

Seasonal Influence on Parasitic Infestation

Parasitemia was higher in the dry season than the rainy season of the two years of investigation. The K-S test at p = 0.05 between the means in rainy and dry season in 2011/2012 was significant, but it was not significant in 2012/2013. Seasonal variation showed higher prevalence of parasite infestation in the dry season than the rainy season in the two years (Table 3). The result obtained may be due to eutrophication, which often raises parasitism because the associated increase in productivity will increase the abundance of the invertebrates which serve as intermediate hosts to the piscine parasites that were mostly fresh water insects and crustaceans. This probably brings the maturity of the parasites in the fish that fed on the infected invertebrates 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; this is in consonance with the submissions of [32]. Generally, the higher species diversity of parasites observed to be infesting *C. gariepinus* in Oba reservoir may be due to their diets which was noted to be primarily carnivorous, feeding on aquatic and terrestrial insects, copepods, gastropods, and molluscs which incidentally served as intermediate hosts to the various parasites. [33] Were of the opinion that predatory fish species harbor a greater diversity and abundance of larval Helminths than herbivorous and planktivorous species.

CONCLUSIONS

The diet of *C. gariepinus* was primarily from animal sources, but when food of animal source became scarce the species fed on food from plant sources and can generally be described as an omnivore with preference for animals in the reservoir. Parasite infestation of *C. gariepinus* was highly diversified species wise, with six species observed to infest the enteron. This high diversity was as a result of the diet of the fish which was mainly aquatic invertebrates that serves as intermediate hosts to the parasites. Hence, parasites within the fish host may be used as an indicator of food-web structure and biodiversity in the reservoir.

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