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A Comparative Study of the Common Protozoan Parasites of *Heterobranchus longifilis* from the Wild and Cultured Environments in Benue State

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Abstract: The aim of this study was to evaluate and compare the parasite load in populations of *Heterobranchus longifilis* obtained from a cultured environment (pond) and wild habitats. One hundred and twenty fishes were used for the study; 60 each from the cultured environment and wild which were further divided into 30 dead and 30 live fishes for each of the habitat sources. The results showed that 80% of dead *H. longifilis* from the pond were infested, as against 73.3% of the dead fishes from the wild by different protozoan parasites. Also, 83.3% of live *H. longifilis* from the pond were infested, as against 90% of the live fishes from the wild. Of the various protozoan parasites observed, *I. mutifilis* was the most abundant in both the pond (37.41%) and wild (36.40%). Among the body parts of the sampled fishes from the pond, the gills had the highest parasite load (46%). Also, the gills had the highest parasite load (44%) among the body parts of the fishes sampled from the wild. Live fishes from both sources had more protozoan parasites than the dead fishes. Bigger fishes of total length between 25-48 cm were more infected than smaller fishes of total length between 19-24 cm from both sources. Female fishes had more protozoan parasites than the male counterparts. Also, fishes between 150-750 g had more parasite load than the smaller ones of less than 150 g.

Key words: Protozoan parasites, *Heterobranchus longifilis*, wild environment, cultured environment, Benue State

INTRODUCTION

Fish is important to human populace in trade and economy; it is of importance in the diet of different countries especially in the tropics and subtropics where malnutrition is a major problem (Alune and Andrew, 1996; Osuigwe and Obiekezie, 2007). As the human population inevitably increases, the demand for fish as source of protein will grow (Abolarin, 1996). In recent times, there has been tremendous increase in the development of fish farming and culture attributable to the increased need for affordable animal protein especially in the tropics(Davies *et al*., 2006) therefore, catfishes of the family clariidae are increasingly being used for freshwater aquaculture in Africa owing to several favourable cultural characteristics (Obiekezie and Ekanem, 1995). Parasitic infection and diseases are some of the factors hindering high productivity in fish farming (Doglel *et al*., 1961; Kayis *et al*., 2009).

Parasites are the most diverse and common pathogens the aqua-culturist may likely encounter and parasitic diseases are very common in fish all over the world and are of particular importance in the tropics (Roberts and Janovy, 2000) and Protozoan among other parasites cause immeasurable damage to the fishing industry (Doglel *et al*., 1961). Fish parasites are numerous and many phyla in the animal kingdom have representative that are parasitic to fish. There are by far more parasite species that infect fish than any other group of infectious disease (Blazer, 1996). Fish parasites result in huge economic losses as they increase mortality; increase farm inputs via increased treatment expenses and cause reduction in growth rate and possibly weight loss during and after the period of parasitic disease outbreak. All these militate against expansion of aquaculture. (Kayis *et al*., 2009). The most commonly encountered fish parasites are protozoa (Klinger and Francis-Floyd, 2000) and Protozoan parasites cause serious losses in fishpond and wild in Nigeria; their lesions could render the fish unmarketable. In addition, fish carrying protozoan parasites are capable of passing on the infective disease to man after its consumption. Protozoan parasites, typically, do not required intermediate hosts to reproduce (direct life cycle) and are thus capable of building up to very high numbers when fish are crowded causing loss, debilitation and mortality (Klinger and Francis-Floyd, 2000).

Most fish in the wild are likely to be infested with parasites, but in the great majority of cases, no significant harm to the host may be ensued or identified, thus, there are only few reports of parasites causing

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mortality or serious damage to the fish populations, but this may be largely because such effects go unnoticed (Roberts, 2001). Fishermen or consumers often observe parasites in wild fish only when they are so obvious as to lead to rejection of fish (Roberts, 1995). In culture fish population on the other hand, parasites often cause serious outbreak of diseases (Kayis *et al*., 2009). The presence of dense populations of fish kept in particular environmental conditions may favour certain parasites so that the parasite population increases to a very high level (Rintamaki and Valtonen, 1997).

MATERIALS AND METHODS

The study took place in Makurdi the capital of Benue State, Nigeria, located at longitude 7° 43' N and latitude 8°32' E. The town is divided into the North- and South-bank by the River Benue. River Benue exists year round though the water volume fluctuates with season. The river overflows its banks during the rainy season (May-October), but decreases drastically in volume leaving tiny island in the middle of the river during the dry season (November-April). The river contains several species of freshwater fishes of different families such as Clariidae, Mormyridae, Centrpomidae etc.

One hundred and twenty *Heterobranchus ongifilis* (60 each from the wild and a pond), comprising of 30 live and 30 dead fishes of different sizes were bought from local fishermen along the course of River Benue (The wild) and from Jab-Bella farm (pond) both in Wadata, Benue state, Nigeria. Five samples each from both the wild and pond were collected fortnightly for a period of six (6) months, June-Nov. 2008. The fishes were identified using the field guide to Nigerian freshwater fishes by Babatunde and Aminu (2004). The total and standard lengths of each fish were measured in centimeters (cm) using meter rule, while the weight of each of the fishes was taken in grams (g) using an electronic meter balance. The sexes of the fishes were also determined examination of their papillae.

External examination of each of the fish for parasites was carried out using the technique of Emere and Egbe (2006) on the gills, fins and skin. The skin, gill and fins of each of the fish were also examined for ecto parasites using hand lens. The fish samples were also felleted using scalpel blade. The tissue was placed on a Petri-dish and 3 mls of 0.9% saline solution was added and stirred using a mounted pin. Some drops of the mixed solution were collected using dropper, placed on a slide and then covered with a cover slip after which, observation on a light binocular microscope was made. Later, the gills of each of the fish were dissected using a dissecting kit, each of the gill was placed in 10 mls of normal saline in Petri- dish, later removed and then place on a slide on which 1-2 drops of saline solution was added and observed on a binocular microscope. The stomach and the intestine of each of the fish were cut opened and contents washed into the Petri-dish containing the saline solution. The lining of the gut lumen was also scrapped out and placed in the saline solution. One to two drops of the preparation was placed on slide covered with slips and observed using a light binocular microscope for endoparasites. Ecto parasitic data were collected on the gills, fins and skins of the fish while the endo parasitic data were collected on the stomach and intestine of the fish using the techniques of Emere and Egbe (2006).

The parasites were identified by making their sketches as observed on the binocular microscope and compared with the pictorial Guide on fish parasites by Pouder *et al*. (2005). The parasites observed on the binocular microscope were counted and recorded. Two-way analysis of Variance was use to determine significant differences in sex, source and status of the specimens. The ANOVA was carried out using GENSTAT Discovery Edition from Lawes Agricultural Trust Rothamsted.

RESULTS

Results of the 30 dead and 30 live *H. longifilis* from the pond used for the study are as shown in Table 1. Out of the 30 dead *H. longifilis* used, 6 (20%) were not infested by any protozoan parasites while the remaining 24 (80%) of them were infested by different protozoan parasites and were observed to harbour a total number of 108 protozoan parasites. From the table above, *I. mutifilis* were found on the gill and skin and was the most abundant 40 (37.03%), followed by *Trichodina species* 25 (23.15%), which were found on the skin and fin, *C.iubilans* 19 (17.59%) in the stomach and intestine, *Ichthyobodo species* 17 (15.74%) on the gill, *Hexamita* 4 (3.70%), which were found in the stomach and intestine and lastly *Chilodonella species* 3 (2.78%) on the skin. It was observed that the gill has the highest number of protozoan parasites (39%) followed by the skin (30%) while the fin, intestine and stomach accounted for 16, 12 and 11% respectively. Whereas, out of the 30 live *H. longifilis* used, 5 (16.7%) were not infested by any protozoan parasites while 25 (83.3%) of them were infested by protozoan parasites and were observed to harbour a total number of 138 protozoan parasites. *I. mutifilis* were found on the gill and skin and was the most abundant 48 (37.78%), followed by *C. iubilans* 35 (25.36%), which were found in the stomach and intestine, *Trichodina species* 24 (17.39%), which were found and fin, *Ichthyobodo species* 21 (15.22%) on the gill and lastly *Chilodonella species* on the skin 10 (7.25%). It was also observed that the gill has the highest load of protozoan parasites (53%) followed by the skin (35%) while the stomach, intestine and fin accounted for 19, 16 and 15% respectively. The result shows that live *H. longifilis* from the pond has more protozoan parasites than dead *H. longifilis* from the same pond.

Table 1: Protozoa parasites and their locations in dead and live *H. longifilis* from the cultured environment (Pond)

	Number of fish infected by each protozoa parasite			Percentage parasite infection per location		Parasite load on each location		Percentage parasite species on fish	
Protozoa parasites	Dead	Live	Location of parasites	Dead	Live	Dead	Live	Dead	Live
Ichthyobodo sp	5	6	gill	39.00	53.00	17	21	15.74	15.22
I. multifilis	6	8	gill			22	32	37.03	37.78
I. multifilis	7	5	skin	30.00	35.00	18	16		
Chilodonella	1	3	skin			3	10	2.78	7.25
Trichodina	3	2	skin			9	9	23.15	17.39
Trichodina	7	6	fin	16.00	15.00	16	15		
C. iubilans	3	3	stomach	11.00	19.00	11	19	17.59	25.36
C. iubilans	3	4	intestine	12.00	16.00	8	16		
Hexamita	2	0	intestine			4	0	3.70	0.00
Total	37	37		108.00	138.00	108	138	100.00	100.00

Table 2: Protozoa parasites and their locations in dead and live *H. longifilis* from River Benue (Wild)

	Number of fish infected by each protozoa parasite			Percentage parasite infection per location		Parasite load on each location		Percentage parasite species on fish	
Protozoa parasites	Dead	Live	Location of parasites	Dead	Live	Dead	Live	Dead	Live
Ichthyobodo sp	5	6	gill	37.00	51.00	19	20	17.76	13.42
I. multifilis	5	8	gill			18	31	39.25	33.55
I. multifilis	8	5	skin	31.00	39.00	24	19		
Chilodonella	2	4	skin			5	13	4.67	8.72
Trichodina	1	2	skin			2	7	20.56	10.07
Trichodina	7	5	fin	20.00	8.00	20	8		
C. iubilans	3	7	stomach	13.00	27.00	13	21	17.76	27.52
C. iubilans	2	6	intestine	6.00	24.00	6	20		
Hexamita	0	2	Stomach	0.00	as above	0	6	0.00	6.71
Hexamita	0	2	Intestine	0.00	as above	0	4		
Total	33	47		107.00	149	107	149	100.00	100.00

Results of the 30 dead and 30 live *H. longifilis* from the wild used for the study are as shown in Table 2. Out of the 30 dead *H. longifilis* used, 8 (26.7%) were not infested by any protozoan parasites while the remaining 22 (73.3%) of them were infested by different protozoan parasites and were observed to harbour a total number of 107 protozoan parasites.

From the above table, *I. mutifilis* were found on the gill and skin and was the most abundant 42 (39.25%), followed by *Trichodina species* 22 (20.56%), which were found on the skin and fin, *Ichthyobodo species* 19 (17.76%) on the gill, *C. iubilans* 19 (17.76%) in the stomach and intestine and lastly *Chilodonella species* 5 (4.67%) on the skin. It was observed that the gill has the highest load of protozoan parasites (37%) followed by the skin (31%) while the fin, stomach and intestine accounted for 20, 13 and 6% respectively. Whereas, out of the 30 live *H. longifilis* used, 3 (10%) were not infested by any form of protozoan parasites while 27 (90%) of them were infested by different protozoan parasites and were observed to harbour a total number of 149 protozoan parasites. *I. mutifilis* were found on the gill and skin and was the most abundant 50 (33.55%), followed by *C.iubilans* 41 (27.52%), which were found in the stomach and intestine, *Ichthyobodo species* 20 (13.42%) on the gill, *Trichodina species* 15 (10.07%), which were found on the skin and fin, *Chilodonella species* 13 (8.72%) on the skin and lastly *Hexamita* 10 (6.71%), which were found in the stomach and intestine. It was also observed that the gill has the highest load of protozoan parasites (51%) followed by the skin (39%) while the stomach, intestine and fin accounted for 27, 24 and 8% respectively. The results also show that live *H. longifilis* from the wild has more protozoan parasites than dead *H. longifilis* from the same wild.

Figure 1 shows the result of the size distribution and percentage parasite infection in dead and live *H. longifilis* from the pond while Fig. 2 shows the result of the size distribution and percentage parasite infection in dead and live *H. longifilis* from the wild. It was observed that bigger fishes of total length between 25-48 cm were more infected than smaller fishes (total length between 19-24 cm) from both sources.

Figure 3 shows the results of sex and percentage parasite infection in dead and live *H. longifilis* from the cultured environment (pond) and River Benue. The results also show that the dead female *C. gariepinus* from the cultured environment (pond) had a greater rate of infection (74.01%) than the dead male *C. gariepinus* (25.93%) and the live female *C. gariepinus* had a greater rate of infection (83.33%) than the live male *C. gariepinus* (16.67%). In addition, the dead female *C. gariepinus* from River Benue had a greater rate of infection (62.62%) than the dead male *C. gariepinus*

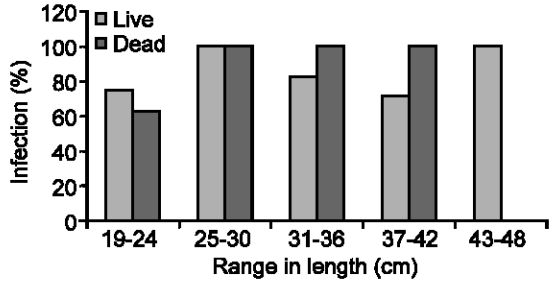

Fig. 1: Size distribution and percentage parasite infection in dead and live *H. longifilis* from the pond

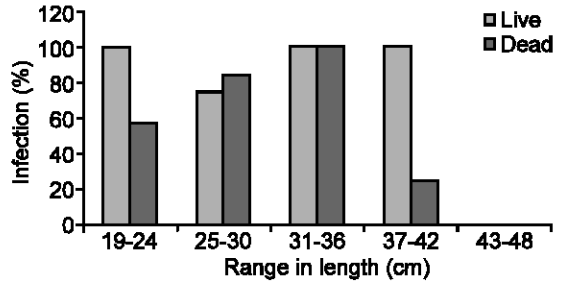

Fig. 2: Size distribution and percentage parasite infection in dead and live *H. longifilis* from the wild

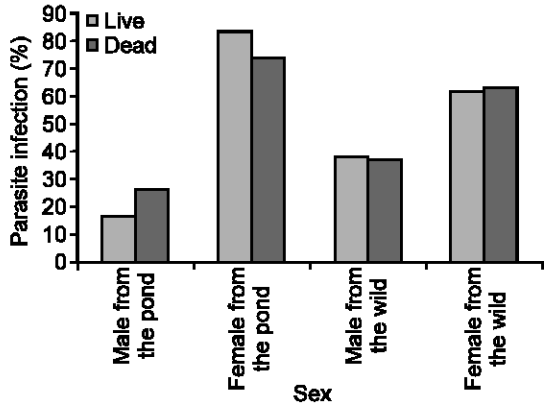

Fig. 3: Sex and percentage parasite infection in dead and live *H. longifilis* from the cultured environment (pond) and River Benue

(37.38%) and the live female *C. gariepinus* had a greater rate of infection (61.74%) than the live male *C. gariepinus* (38.26%).

Results of the percentage parasites load on the different body parts of both dead male and female and that of live male and female *H .longifilis* with respect to the weight of the fishes from the pond are as shown in Table 3 and 4 respectively. While Table 5 and 6 show the results of the percentage parasites load on the different body parts of both dead male and female and that of live male and female *H. longifilis* with respect to the weight of the fishes from the wild.

The results also show that fishes with bigger weight (150-750 g) had more parasites than smaller fishes with less than 150 g.

The mean total number of parasites for both dead male and female and live male and female *H. longifilis* from both origins is as shown in Table 7. There was a significant difference (2.91) between the live male and female *H. longifilis* from the pond but there was no significant difference between the dead male and female *H. longifilis* from the pond, live male and female *H. longifilis* from the wild and between dead male and female *H. longifilis* from River Benue. In addition, the live *H. longifilis* from both sources has higher mean number of parasites (4.03-cultured environment and 4.90 River Benue) than the dead samples (3.43-cultured environment and 3.51 River Benue) and the female samples have higher number of parasites (75 females and 45 males).

Statistical analysis of the correlation matrix for the total number of parasites found on *H. longifilis* by size, from both sources is as shown in Table 8.

From the above, there was a high correlation (0.738) between the Total Length (TL) and Total Number of Parasites (TNP) for dead *H. longifilis* collected from the culture environment (pond). In contrast, there was a low correlation (0.160) between the Total Length (TL) and Total Number of Parasites (TNP) for dead *H. longifilis* caught from River Benue. In addition, there was a high correlation (0.583) between the Total Number of Parasites (TNP) and Weight (WT) for dead *H. longifilis* collected from the culture environment (pond) but a negative correlation (-0.068) between the Total Number of Parasites (TNP) and weight for dead *H. longifilis*

Table 3: Percentage parasite load on the body parts of dead male and female *H. longifilis* from the pond

	Percentage (%) parasite load									
	Gill		Skin		Fin		Stomach		Intestine	
Weight of fish	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<150 g	54	16	15	37	15	26	15	11	0	11
150-250 g	0	30	100	30	0	20	0	0	0	20
250-350 g	57	64	43	8	0	12	0	16	0	0
350-450 g	0	0	0	20	0	0	0	50	0	30
450-550 g	0	0	0	0	0	0	0	0	0	0
550-650 g	0	0	40	0	0	0	0	0	60	0
650-750 g	0	0	0	0	0	0	0	0	0	0

Table 4: Percentage parasite load on the body parts of live male and female *H. longifilis* from the pond

	Percentage (%) parasite load									
	Gill		Skin		Fin		Stomach		Intestine	
Weight of fish	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<150	0	46	0	38	100	8	0	0	0	8
150-250 g	55	48	18	14	0	17	0	21	27	0
250-350 g	0	45	57	27	43	27	0	0	0	0
350-450 g	0	0	100	0	0	0	0	0	0	0
450-550 g	0	0	0	0	0	0	0	0	0	0
550-650 g	0	32	0	26	0	0	0	34	0	8
650-750 g	0	0	0	0	0	0	0	0	0	0

Table 5: Percentage parasite load on the body parts of dead male and female *H. longifilis* from the wild

	Percentage (%) parasite load									
	Gill		Skin		Fin		Stomach		Intestine	
Weight of fish	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<150 g	29	29	71	36	0	0	0	36	0	0
150-250 g	23	47	31	20	46	11	0	9	0	13
250-350 g	0	0	0	50	100	0	0	50	0	0
350-450 g	0	0	0	0	0	0	0	0	0	0
450-550 g	0	0	0	0	0	0	0	0	0	0
550-650 g	0	0	0	0	0	0	0	0	0	0
650-750 g	100	0	0	0	0	0	0	0	0	0

Table 6: Percentage parasite load on/in the body parts of live male and female *H. longifilis* from the wild

	Percentage (%) parasite load									
	Gill		Skin		Fin		Stomach		Intestine	
Weight of fish	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<150 g	21	0	36	100	29	0	0	0	14	0
150-250 g	25	37	50	20	0	5	25	43	0	15
250-350 g	0	63	0	15	0	4	29	0	71	19
350-450 g	20	24	20	33	0	0	40	24	20	19
450-550 g	0	0	0	0	0	0	0	0	0	0
550-650 g	0	0	0	0	0	0	0	0	0	0
650-750 g	0	0	0	0	0	0	0	0	0	0

Table 7: Mean total number of parasites for *Heterobranchus longifilis*

Sex	LHP	DHP	LHW	DHW	No.
Male	2.57[b]	2.80[a]	4.38[a]	3.08[a]	45
Female	5.48[a]	4.05[a]	5.41[a]	3.94[a]	75

Values on the same column with different superscripts differ significantly ($p<0.05$). Standard Error of Means = 0.715.

Note: LHP = Live *H. longifilis* from cultured environment (pond), DHP = Dead *H. longifilis* from cultured environment (pond), LHW = Live *H. longifilis* from River Benue, DHW = Dead *H. longifilis* from River Benue

caught from River Benue. Also in the culture environment (pond), a high correlation value (0.526) was recorded between the Total Length (TL) and Total Number of Parasites (TNP) for live *H. longifilis* and 0.708 for live *H. longifilis* caught from River Benue. In addition, there was a high correlation (0.686) between the Total Number of Parasites (TNP) and Weight (WT) for live *H. longifilis* collected from the culture environment (pond) and 0.676 between the Total Number of Parasites (TNP) and Weight (WT) for live *H. longifilis* caught from River Benue.

Damaging effects of parasites on the sampled *H. longifilis*: The following damages were observed to have been caused by the parasites found on the body parts of the sampled fishes; on the skin, *I. mutifilis* caused thickening of the epithelium. This caused restriction of the oxygen flow from the water to the blood in the gills of infected fishes. The respiratory folds of the gills, the lamellae, also become deformed, reducing the transfer of oxygen. The shear numbers of *I. mutifilis* covering the gills also could cause mechanical blockage of oxygen transfer. These conditions combine to stress the fish by hindering respiration. The epithelial layer of the gill may separate and cause loss of electrolytes, nutrients and fluids from the fish, making it difficult for the fish to regulate the water concentration in its body. Death in infected fishes resulted from asphyxiation. *Tricodina* species caused epidermal necrosis of the fin. This resulted in sluggish movement, loss of appetite, emaciation, loss of condition with larger head and darker skin than normal. Some infected fish showed

Table 8: Correlation matrix for total number of parasites found on *H. longifilis* by size

	Dead *H. longifilis* from the cultured environment (Pond)			Live *H. longifilis* from the cultured environment (Pond)		
	TL	TNP	WT	TL	TNP	WT
TL	1.00			1.00		
TNP	0.738	1.00		0.526	1.00	
WT	0.904	0.583	1.00	0.913	0.686	1.00
	Dead *H. longifilis* from River Benue			Live *H. longifilis* from River Benue		
	TL	TNP	WT	TL	TNP	WT
TL	1.00			1.00		
TNP	0.160	1.00		0.708	1.00	
WT	0.859	-0.068	1.00	0.938	0.676	1.00

Note: TL = Total Length; TNP = Total Number of Parasites; WT = Weight

detached scales with pale skin patches and more slimy skin. *Chilodonella* species caused epidermal necrosis of the skin and excess mucus formation on the skin. This caused the skin to appear slimy and it exhibited cloudiness and showed evidence of irritation as it tried (from time to time) to "scratch" off the organisms by rubbing against the walls of the fish pond. The fish also exhibited lethargy. *Hexamita* caused erosion of the intestine and ulceration of the stomach. As a result, infected fish lose appetite and become emaciated and lethargic. *C. iubilans caused* thickening of the intestinal wall. Infected fish showed inappetance, decreased activity and stayed isolated from other fish. These fish stayed near the surface and became increasingly tachypneic.

DISCUSSION

Several external parasites were observed and identified in the fishes used for this work. This is in agreement with the findings of Snieszko and Axelrod (1971) who reported that external parasites constitute the largest group of pathogenic organisms in freshwater fish. However, Mohamed (1999) observed that the majority of fish ecto-parasitic protozoa are commensals but some of them may produce serious diseases and mortality especially in fry, fingerlings and bigger fishes subjected to stress.

Different kinds of protozoan parasites were observed to be present in different locations in *H. longifilis*. *I. multifilis* occurred on the gill and skin where chronic infections of the fishes were observed, *Trichodina* species appeared on the skin and fin, *Ichthyobodo species* and *Chilodonella* species appeared on the skin, while *C. iubilans* and *Hexamita* appeared in the stomach and intestine. Emere and Egbe (2006), Richard (2003), Hines and Spira (1973, 1974) have reported the infection of the skin, fin and gills of fish by protozoan parasites. The present study revealed that *C. iubilans* affected only the intestine and stomach of the fish studied and in addition, these parasites were more in the intestine than the stomach but Somerville (1984) in his work reported that a large number of *Cryptobia* protozoan were found on the external surface of cultured rainbow trout in U.S.A.

The occurrence of *C. iubilans* in the intestine than the stomach either might be due to the presence of digested food present there or due to the greater surface area presented by the intestine (Adebanjo, 1979). Smith (1981) reported that most protozoan parasites inhabit the intestine because of their general feeding habits. Reduced number of the protozoan parasites in the stomach might be due to the movement of the stomach muscle and acid (HCl) nature of the stomach. Adebanjo (1979) observed that the acid nature of the stomach might inhibit the parasites there. Noble and Noble (1982) reported that protozoan parasites prefer a certain pH medium.

Gills were also observed to habour the highest number of protozoan parasites. This could be because the gills are the center of filter feeding and are the sites of gaseous exchange. This observation agrees with the reported works of Emere and Egbe (2006), Nyaku *et al.* (2007), who reported highest load of protozoan parasites in the gill of *Synodontis clarias*. Investigation by Roger and Gainer (1975) and Chakroff (1976) had shown the gills to be infected by different protozoan parasites. According to Robert and Somerville (1984), the sieving ability of the gill rakers may help to trap some organisms and this could be contributed to the presence of the protozoan parasites there.

Infection in the gills caused severe degeneration, necrosis and consequent degradation of the branchial epithelium and occlusion of the capillaries. Infection also induced massive proliferation of chloride and mucus cells and also caused hyperplasia of the lining filamental epithelium. However, degradation of the epithelial layer was either limited in extent or occurred in an uneven pattern. This observation was explained in the reported work of Paperna and Van As (1991) which stated that the epithelial degradation was counteracted by the extreme process of epithelial hyperplasia.

I. mutifilis caused erosion of the epithelium and thickening of the gills, this could be attributed to inflammatory processes which occured during infection with this parasitic ciliate as described by Sigh *et al.* (2004). Infection with *Trichodina spp* caused removal of the epithelium and excess mucus production so that the

fin and gills of infected fishes were covered in a thick layer of mucus, in which were contained the ciliates. This agrees with the reported work of Obiekezie and Ekanem (1995).

The heavy load of parasites on the gills relative to other parts of the body impaired the gills from functioning well as an organ of respiration, hence death could result. This agrees with the reported works of Borg (1960), Omoniyi *et al.* (2002), Rahman *et al.* (2002) and Aksit and Falakali (2007) who reported mortality in fishes with heavy parasite load on the gills.

The female *H. longifilis* have the highest number of protozoan parasites than the male counterparts. This might be due to the physiological state of the females, as most gravid females could have had reduced resistance to infection by parasites. In addition, their increased rate of food intake to meet their food requirements for the development of their egg might have exposed them to more contact with the parasites, which subsequently increased their chance of being infected. Emere and Egbe (2006); Adebanjo (1979); Holden and Reed (1972) had made similar observation. Bigger *H. longifilis* were observed to have higher rate of protozoan parasites than the smaller ones. This might be because the bigger ones cover wider areas in search of food. As a result, they take in more food than the smaller ones and this exposed them more to infection by parasites. In addition, they are omnivorous and feed on any thing that comes their ways. Emere and Egbe (2006), Holden and Reed (1972), had made similar observation in *S. clarias*.

Protozoan parasite load of fish from the cultured environment (pond) did not differ significantly from those from the River Benue (wild). However, the significantly higher load of parasites in the live fish as compared to the dead could be attributed to parasite migration as a result of death of the host (fish) which occurred soon after they died, prior to the examination as described by Klinger and Francis-Floyd (2000).

Some of the fishes observed did not exhibit clinical signs associated with the parasites identified on them. This is in agreement with the findings of Mohamed (1999) that clinical signs of parasitic diseases only appear on fish with heavy infections and cases of moderate ones that are usually exposed to one or more stress factors including, rough handling during transportation from ponds, overcrowding, malnutrition, high level of free ammonia and low level of oxygen concentration.

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