SPATIAL DISTRIBUTION OF PARASITES ALONG THE GUT OF THE CATFISH *CLARIAS GARIEPINUS* (BURCHELL, 1822) (CLARIIDAE) FROM THE MWANZA GULF, LAKE VICTORIA

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ABSTRACT

The diversity, abundance and spatial distribution of parasites in the alimentary tract of Clarias gariepinus *from the Mwanza Gulf were investigated. Ten parasite species were recovered; the Trematoda, Cestoda and Nematoda were each represented by three species while* Dolops ranarum *was the only crustacean recovered from the posterior part of the buccal cavity. Parasites diversity was highest in the small intestine and the stomach. Although the gut community of* C. gariepinus *studied was rich in intensity and individual numbers of helminth species, helminth infection in most sections of the gut comprised of monospecific infection and thus cohabiting interspecific interaction was not evident. Differences in physicochemical environment in the gut, availability, nature and amount of food supply are factors that most likely limit the distribution of parasites in different sections of the alimentary tract.*

INTRODUCTION

The digestive tract and its inhabitants comprise an ecosystem, one whose inhabitants might be expected to interact strongly with one another due to the limited physical extent and variety of habitats relative to the free-living ecosystems (Simberloff 1990). Many kinds of parasites infect the gut of fish; trematodes, cestodes, nematodes and acanthocephalans have been recorded. Furthermore, most parasites in the gut and its accessories are acquired through feeding on intermediate hosts containing infective stages of the parasites (Williams & Jones 1994).

The alimentary tract may be divided into several sections and each species of parasite has a characteristic distribution within the intestine (Simberloff 1990, Holmes & Bartoli 1993). The duodenum, ileum, large intestine and the caecum have been cited as the most popular sites for intestinal helminthes (Williams & Jones 1994). Adult trematodes and cestodes for instance, prefer the duodenum, whereas most adult nematodes reside in the ileum and the large intestine.

The specificity in parasites distribution along the gut is probably determined by differences in physicochemical environment in various regions of the gut. Changes in pH, availability, nature and amount of food supply are some of the factors that limit not only the parasite distribution but the numbers of species in an infracommunity as well. The number of parasite species of the vertebrate alimentary tract has been found to be limited to only a few species per infracommunity (Dogiel *et al.* 1958, Shotter 1980, Simberloff 1990). The objective of the present study was to investigate the diversity, abundance and spatial distribution of parasites in the alimentary tract of *C. gariepinus*.

MATERIAL AND METHODS

Sampling was carried out from September 2000 to September 2001 along the gulf of

Mwanza. Fish were caught by long-lines and hand-lines with baited hooks. Dead fish were transported in an ice-cooled box and live fish in buckets filled with water from the lake, to the laboratory. Examination of fish for parasites, handling and processing of parasites followed standard procedures as by Moravec *et al.* (1991a, b).

All parasite individuals of each species in the different sections of the gut were counted. This allowed for the determination of diversity indices in each section of the alimentary tract, the total number of parasite species, parasite intensity, abundance and prevalence at an infracommunity and component level. Parasite diversity was determined by calculating the Shannon-Wiener diversity index $H = -\sum p_i \ln p_i$, where p_i is the proportion of a particular species in a sample. Ecological terms used are as defined by Bush *et al.* (1997).

Table 1: Prevalence, mean intensity and mean abundance of the parasites isolated from the 1071 *Clarias gariepinus*

	Prevalence		Mean abundance	Mean intensity			
Trematoda	**n**	**%**	**8 ± S.E**	**8 ± S.E**	**Range**	**N**	**%**
Astiotrema reniferum	59	5.51	0.31 ±0.12	5.64 ± 0.78	26	333	8.64
Allocreadium mazoensis	37	3.45	0.24 ± 0.11	5.79 ± 0.78	24	261	6.77
E. bangweulensis	62	5.79	0.33 ± 0.11	5.79 ± 0.78	24	359	9.31
Cestoda							
P. clarias	324	30.25	0.89 ± 0.15	2.77 ± 0.19	29	897	23.26
M. woodlandi	66	6.16	0.51 ± 0.18	9.29 ± 2.29	103	613	15.90
Proteocephalus sp.	1	0.09	0.0065	7.0		7	0.18
Nematoda							
P. laevionchus	23	2.15	0.06 ± 0.03	2.26 ± 0.3	7	52	1.35
P. cyathopharynx	329	30.72	1.12 ± 0.19	3.57 ± 0.37	112	1176	30.50
Spinitectus petterae	14	1.31	0.06 ± 0.02	3.71 ± 1.14	14	52	1.35
Crustacea							
Dolops ranarum	34	3.17	0.1 ± 0.05	3.32 ± 0.55	17	113	2.93
Totals	**949**	**88.6**				**3,811**	

'n' number of infected fish, 'N' number of helminthes isolated,Range = Maximum-minimum+1

RESULTS

The abundance of parasites in the gut

Out of 1071 *C. gariepinus* examined for parasites, 949 (88.6%) were infected by a total of ten species (nine helminths and one crustacean) of parasites comprising 3,811 individuals. The species found in the gut of *C. gariepinus*, their prevalence, mean intensity and mean abundance are given in Table 1. *Polyonchobothrium clarias* and *Paracamallanus cyathopharynx* were the most prevalent, infecting 324 (30.25%) and 329 (30.72%) hosts with a mean intensity of 2.77 and 3.57, respectively. Collectively, the cestodes were the most common parasites with 39.16% of parasite individuals. *Spinitectus petterae* and *Procamallanus laevionchus* exhibited the lowest mean abundance, 0.06 worms per host examined.

Generally the prevalence of most parasites was lower than 10% and no species reached or exceeded the prevalence of 40% (Table 1, Fig.1). This suggests that there were no core parasites in the intestinal parasite population studied.

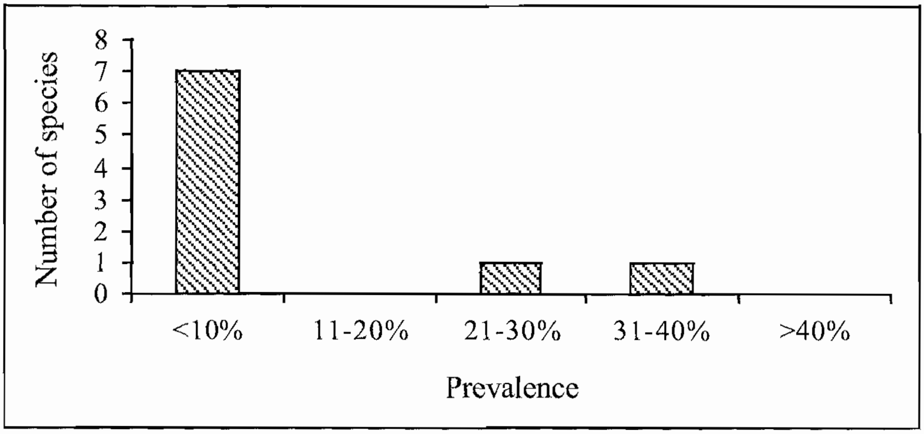

Figure 1: Frequency distribution of the intestinal parasites in *Clarias gariepinus* from the Mwanza Gulf, Lake Victoria

Table 2: Prevalence (%) and mean abundance (in parenthesis) of the parasites along the gut of *Clarias gariepinus*

Parasite	Oral cavity	Stomach	Duodenum	Small intestine	Rectum	Bile duct	Gall bladder
D. ranarum	3.17(0.11)	-	-	-	-	-	-
S. petterae	-	1.3 (0.05)	-	-	-	-	-
P. laevionchus	-	2.33(0.46)	-	-	-	-	-
P. clarias	-	0.37(0.01)	9.9(0.22)	0.56(0.02)	-	18.5(0.46)	4.1(0.13)
A. reniferum	-	-	-	5.32(0.31)	0.19(0.002)	-	-
A. mazoensis	-	-	0.19(0.002)	3.36(0.24)	-	-	-
M. woodlandi	-	0.28(0.01)	1.68 (0.07)	4.39(0.5)	-	-	-
P. cyatopharynx	-	-	-	-	30.6(1.09)	-	-
E. bangweulensis	-	0.56(0.02)	1.96 (0.12)	3.17(0.16)	0.47 (0.04)	-	-
Proteocephalus sp	-	-	0.09(0.007)	-	-	-	-

Parasite species composition and spatial distribution along the gut

Different parasites occupied different sections of the alimentary tract (Table 2). *P. clarias* was the only parasite found in almost all parts of the gut and its accessories except the oral cavity and rectum. *P. clarias* was however, most commonly (18.5%) recovered from the bile duct with an abundance of 0.46 worms per host examined. *P. cyathopharynx* infected 30.6% of the hosts. This was the highest prevalence recorded. *P. cyathopharynx* displayed the highest abundance with 1.09 worms per host examined and was only found in the rectum. *Dolops ranarum* a crustacean was only found in the posterior part of the buccal cavity, *S. petterae* and *P. laevionchus* only from the stomach, and *Proteocephalus* species only from the duodenum (Table 2).

Intestinal parasite diversity

Parasites diversity varied in different sections of the alimentary tract. The small intestine and the stomach had the highest diversity recorded (H' = 1.36 and H' = 1.31, respectively). The lowest diversity was recorded in the rectum (H' = 0.16), while the overall diversity was, H' = 2.27. The highest number of parasite individuals was recovered from the small intestine (1318) and the rectum (1208). The rectum was the most frequented section of the gut with 31.16% of the hosts infected in that section (Table 3). The maximum and minimum number of species per individual host was six (6) and one (1) respectively.

Parasites infection in most sections of the alimentary tract was dominated by monospecific infections. Where more than two helminth species were recorded, they all came from two different individual hosts. About 333 *C. gariepinus* were infected by only one parasite species in the rectum, 34 by one species in the oral cavity and 34 by one species in the stomach. 19 hosts had two helminth species in the small intestine (Table 3).

Table 3: Species richness, diversity and prevalence of parasites in different sections of the gut of 1071 *Clarias gariepinus*

	Freq./No of spp			H'	No of Parasites	No of hosts infected	Prevalence
	0	1	2				%
Stomach	1033	34	5	1.31	136	39	3.64
Duodenum	928	140	4	1.07	441	144	13.43
S/intestine	911	142	19	1.36	1318	161	15.02
Rectum	738	333	1	0.16	1208	334	31.16
Bile duct	872	199	0	-	497	199	18.56
Gall bladder	1027	44	0	-	144	44	4.10
Buccal cavity	1037	34	0	-	113	34	3.17

DISCUSSION

Most parasites recorded in the present study have been reported previously. Boomker (1982) and Mashego & Saayman (1981) recovered five and four species of nematodes from *C. gariepinus* in South Africa, respectively. In Tanzania, Kibebe (1994), Nkwengulila (1998) and Timbuka (1999), respectively recorded 15, 25 and 13 species of parasites from *C. gariepinus* from Mindu Dam and Ruvu River. Most of these parasites were recovered from the gut of the *C. gariepinus*. In the present study 10 species, comprising of nine helminth species and one crustacean, were isolated from the alimentary tract of *C. gariepinus*. This represents a community rich in intensity and numbers of individual parasite species.

The intensity and the diversity (species richness) of the parasite communities can be influenced by diet and vagility of the host (Balbuena & Raga 1993, Holmes & Bartoli 1993). *C. gariepinus* is a highly vagile fish that can transverse a wide range of habitats and thus increasing its chances of being infected by a diverse parasite fauna at varied intensities. Furthermore, *C. gariepinus* is omnivorous (Awachie & Ezenwaji 1981, Mwebaza-Ndawula 1984) which makes it prone to infection by many parasites. The high parasite diversity in *C. gariepinus* in the present study might also be attributed to the size of the lake. The Mwanza Gulf in view of its size is likely to provide a variety of habitats for a variety of intermediate hosts of parasites. For instance, the bays constituting the shoreline of the gulf have different characteristics, ranging from muddy to rocky shores (Mbahinzireki 1984). The different shoreline characteristics, such as sandy-muddy shore along Nyegezi bay, the rocky shore (Butimba/Kirumba bays) and the vegetation covered shore (Lake Malimbe), favour the establishment of various intermediate hosts and a diverse fish fauna, which further favours the occurrence of a diverse parasite fauna as demonstrated by the present findings.

Other factors that may have influenced the abundance and diversity of parasites in *C. gariepinus* include seasons. As noted by Marcogliese (1995) distribution of zooplankton and zoobenthos between the wet and dry seasons have a direct influence on the abundance and diversity of fish parasites. Zooplankton and zoobenthos constitute food items for *C. gariepinus* (Corbet 1961, Mwebaza-Ndawula 1984) and also save as intermediate hosts for a variety of parasites (Paperna 1980, Marcogliese 1995).

The method of fishing and the time of examination after capture are among the factors that may affect the intensity of parasites in a community. Fish collected by using traumatic techniques tend to expel some of their alimentary canal metazoan parasites (Williams *et al.* 1991) thereby affecting the intensity of parasites recorded in a community. Some collecting methods are selective in nature, for instance, long-lines and lines with baited hooks used in the present study, select healthy fish able to compete for the bait leaving behind blind and stressed fish unable to compete for the bait. This further has effects on the intensity and probably diversity of parasites recovered. Post-mortem migration of larval nematodes from the gut into the flesh of their piscine host has been reported in fish left long before gutting (Adams *et al.* 1997). All these might have affected the number and diversity of parasites recorded in *C. gariepinus* in the present study.

Parasites found in *C. gariepinus* were differentially distributed in different sections of the alimentary tract. The distribution extended from the back of the buccal cavity where, *D. ranarum*, a crustacean, were exclusively found, to the rectum dominated by the nematode *P. cyathopharynx*. This pattern of distribution along the gut may be attributed to specific nutritional requirements of the parasites. The sites of the gut with a readily available supply of food (the region between stomach and small intestine) had a richer species composition than the sites with less amount of readily available food (e.g. rectum). *P. cyathopharynx* prefers semi-solid food and was therefore exclusively found in the rectum. *P. clarias*, as well as other cestodes - *M. woodlandi* and *Proteocephalus* species, on the other hand, absorb nutrients through the cuticle and thus needs a region with readily absorbable food, hence they predominated the duodenum (Holmes 1973, Williams & Jones 1994).

Provision of suitable attachment sites has been cited as another factor determining parasites distribution along the gut (Holmes 1973). Areas with mucous that protect parasites from the effect of digestive enzymes, and those with crypts and villi that favour helminth attachment have been found to harbour a wide composition of parasites species (Smyth 1994, Williams & Jones 1994, Le Pommelete & Silan 1998). In the present study the stomach, duodenum and the small intestine, were found to harbour diverse parasite species, possibly due to the anatomical configurations and as discussed above. Cestodes, for example, because of their attachment needs for crypts and villi were mostly found along the small intestine.

Interactive competition for site and food among cohabiting species has also been implicated as another factor determining parasite distribution in different sections of the gut (Holmes 1973, Williams & Jones 1994). As noted by Holmes (opp. cit.) closely related species coexisting in the same habitat at the same time either compete or interact so as to specialize and hence segregate their niches. This can be achieved in different ways; parasites may use different age classes of the same host, use of different populations of the intermediate hosts or through anatomical specialization for the use of different resources in the same habitat. Parasites-site segregation along the gut is also dictated by certain specific stimuli such as pressure differences between sites. Changes in microhabitat associated with maturation of certain parasites and short-term migration in response to the movement of food in the alimentary tract may also influence the distribution of parasites in the gut (Holmes 1973). However, there is still insufficient information on what really determines site specificity in parasites distribution (Williams & Jones 1994). In the present study *P. cyathopharynx* was only found in the rectum, while *S. petterae* and *P. laevionchus* were only recovered from the stomach. Similar findings have been reported by Mashego & Saayman (1981), Boomker (1982) and Timbuka (1999).

Despite the above observations, there was no site found to harbour more than two parasite species in the same individual fish. Most of the sites contained a single species of parasite. Where more than one species were recorded, the species were normally found in different individuals (Table 3). Cohabiting interactions among different species in different sections were thus not evident. It is therefore possible that, availability of suitable food and / or provision of suitable attachment sites were the cause of the observed parasite distribution in the present study.

CONCLUSION

While no parasite species could described as common, the intestinal parasite community of *Clarias gariepinus* is rich and diverse. This is result perhaps of such factors as host factors (size, diet and vagility) and habitat characteristics. The distribution of the parasites along the gut is most likely a function of parasite specific requirements, physico-chemical factors of the gut, availability, nature and amount of food supply in the different sections of the gut.

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