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Influence of Rainfall Seasonality on Endohelminth Parasites of *Oreochromis niloticus baringoensis* (Trewavas, 1983) at River Molo Inlet in Lake Baringo, Rift Valley, Kenya

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ABSTRACT

This study was conducted at the inlet of River Molo in Lake Baringo, Kenya during dry and wet seasons. Dissolved oxygen, temperature, turbidity and pH were measured in-situ. Fish samples collected were preserved in a cool box then immediately transported to the laboratory for analyses. Out of 447 specimens of *Oreochromis niloticus baringoensis*, 340 were infected with six parasite genera belonging to three classes: *Contraceacum (Nematode), Amirthalingamia (Cestode), Tylodelphys, Apharyngostrigea, Clinostomum* and *Euclinostomum (Trematodes).* Overall, *Amirthalingamia* parasite had the highest (3924) followed by *Tylodelphys* (1509) while *Apharyngostrigea* had the least (13) intensity. However, *Tylodelphys* infected the highest number (252) of fish. During dry season, the female fish recorded the highest parasite intensity than males, whereas in wet season, nearly all males were most infected than females. Correspondence analysis showed that turbidity and dissolved oxygen had strong negative relationship with the intensity of *Amirthalingamia* and *Tylodelphys* respectively, whereas the intensity of *Contracaecum, Clinostomum* and *Euclinostomum* were strongly positively related to temperature and pH. However, *Apharyngostrigea* were not affected by any of the water quality parameters. Consumers are advised to cook fish properly as a precautionary measure due to the presence of zoonotic parasites. More attention is needed to address water pollution control since the study reveals that variations in physico- chemical parameters have influence on parasitic infections of fish.

Keywords: *Oreochromis niloticus baringoensis*, endohelminths, rainfall seasonality, intensity, pH, Temperature. Turbidity, Dissolved Oxygen

INTRODUCTION

The fish community of Lake Baringo, Kenya comprises of seven species, namely: *Protopterus aethiopicus* (Heckel, 1851), *Clarias gariepinus* (Burchel,1822), *Oreochromis niloticus baringoensis* (Trewavas, 1983), *Barbus intermedius australis* (Banister, 1973), *Barbus lineomaculatus* (Boulenger, 1903), *Labeo cylindricus* (Peters, 1852) and *Aplocheilichthys sp. (*Aloo, *2002;* Odada *et al., 2006).* Four of these species are exploitable (*O. niloticus baringoensis,P. aethiopicus, C. gariepinus, B. intermedius* and *L. cylindricus*) providing income to the local communities.

Oreochromis niloticus baringoensis is an endemic sub-species of *Oreochromis niloticus* in Lake Baringo (Hickley *et al*., 2004; Britton *et al*., 2008). The fish is characterized by its compressed body form and an interrupted lateral line and can grow to a maximum standard length of 39.5 cm (Seegers *et al*., 2003).It is pelagic and sight-feeder with a diet dominated by phytoplankton and benthic algae (Omondi *et al*., 2013). Cichlids such as *Oreochromis niloticus baringoensis* host major infections which comprise protozoan, helminths and arthropod parasites (Branson and Southgate, 1992). Fish parasites are categorized into two groups, namely: Ecto- and endoparasites. Ectoparasites infect the external body parts of fish, such as the skin, gills and rectum, whereas, endoparasites live inside the body cavities and organs of the fish (Zander, 1998). Endoparasites comprise parasite groups such as digenetic trematodes, cestodes and nematodes (Zander, 1998). A parasite could be harmless, harmful or beneficial to the host. Parasites are both important agents of natural selection and factors contributing to the dynamics of host populations (Ebert *et al.*, 2000; Albon *et al.*, 2002; Marcogliese, 2004).

The diverse bird species in Lake Baringo is anticipated to act as the final hosts for the completion of parasites' life cycles. Parasite infections in fish cause production and economic losses through direct fish mortality, reduction in growth and condition, reproduction, energy loss, increase in the susceptibility to disease and predation. This affects the marketability of fish, thus raising a lot of public health concerns, especially when raw or smoked fish is eaten. It can also be a source of infection to human and other vertebrates that consume fish. In the natural water systems, parasites may threaten the abundance and diversity of indigenous fish species. *Oreochromis niloticus baringoensis* represents a very important food source of protein for low-income populations. Much of fish endohelminth parasites have not been studied in the lake (Britton *et al*., 2009). Therefore, the study provides information on the parasitic infection of this fish which is important to the human society by reducing risk of food-borne zoonoses. Similarly in aquaculture, knowledge on fish parasites is useful in the development of measures to their control.

MATERIALS AND METHODS

The study was conducted in the River Molo Inlet to Lake Baringo, Kenya (0 º42´4N and 35º 59´36 E)during August and December 2015. Dry season comprised August- October, whereas December was the wet month. Physico-chemical water quality parameters were measured *in-situ*. Dissolved oxygen was measured using SX716 dissolved oxygen meter, pH and temperature of water was measured using pocket pH/temperature meter (Combo pH and EC, HANNA model): following the methods described by Ademoroti (1996). Turbidity was determined by use of Secchi Disk and a ruler. Fishing was done using nylon gillnets of mesh sizes 2.5-4.0 inches, 60 m long and 1.5 m wide. After every week, the nets were set in the evening and retrieved in the morning. A total of 221 and 226 fish were collected during dry and wet seasons, respectively. The fish were preserved in a cool box with ice blocks and then transported to the laboratory for clinical and parasitological analyses within 48 hours.

Laboratory analysis

Sex of the fish was determined by visual inspection of the external genital prominence (papilla) located just behind the anus as described by Imam and Dewu (2010).Each fish was laid on its back on plastic dissecting tray and the abdominal cavity was cut open using a scalpel and a pair of surgical scissors which was inserted through the urogenital opening and a slit was made to the pelvic bones following methods described by Olurin and Samorin (2006). The body cavity, the digestive tract, heart, liver, gills, kidney, swim bladder, spleen, gonads and peritoneal cavity were carefully observed using a dissecting microscope (x4) for the presence of parasite larvae or cysts following the methods described by Bichi and Ibrahim (2009).

The organs were then extracted and each placed in properly labeled sterile petri-dishes filled with normal saline (0.9% salt concentration). Thin transparent sections were cut using scalpels and dissecting needles to expose contents which were examined at various magnifications for worms based on parasite morphological features as described by Kabata (1985). The eyes were also isolated, immersed in normal saline and teased apart. The freshly recovered parasites were fixed in 70% ethanol. Parasites were then removed from the preservative, washed with distilled water and placed on a clean slide with a few drops of normal saline. Staining with Giemsa and/or hematoxylin-eosin on the wet mounts was done and cleared in lactophenol. The contents of each petri-dish and isolated parasites were then observed under a compound microscope using x 10, x 40 and x 100 objectives respectively depending on the relative sizes of the parasites. Identification of endohelminths were done using taxonomic keys of fresh water fish parasite pictorial guides by Woo (1995) and Paperna (1996). The eye parasites were counted using colony counter.

Data analysis

The intensity of parasites were determined following the method described by Bush *et al* (1997):

Intensity (of infection, I) is the number of individuals of a particular parasite species (or taxonomic group) in a single host.

All statistical analyses used significance at 95% confidence level using Minitab statistical software, version 17. Kruskal-Wallis test was used to test the intensity of parasites in relation to sex of fish and season. Correspondence analysis was used to determine the relationship between parasite intensity and water quality parameters.

RESULTS

The results for number of fish infected and parasite intensity are summarized in Table 1 below. Overall, *Amirthalingamia* parasite had the highest (3924) followed by *Tylodelphys* (1509) while *Apharyngostrigea* had the least (13) intensity. However, *Tylodelphys* infected the highest number (252) of fish in comparison with other parasites even in both seasons. *Amirthalingamia* had highest intensity during the dry (3033) than wet (891) season. During dry season, the female fish recorded the highest parasite intensity than males, whereas in wet season, nearly all males were most infected than females (Table 1). However, there was no significant difference in parasite intensity in relation to sex of fish and season (p>0.05, Table 2).

The effect of water quality parameters and intensity of parasites of *Oreochromis niloticus baringoensis* was determined by correspondence analysis (Fig. 1). Turbidity and dissolved oxygen had strong negative relationship on the intensity of *Amirthalingamia* and *Tylodelphys* respectively, whereas the intensity of *Contracaecum*, *Clinostomum* and *Euclinostomum* were strongly positively related to temperature and pH. However, none of the water quality parameters under the study related to the intensity of *Apharyngostrigea*.

Table1: Intensity of endohelminth parasites in male and female *Oreochromis niloticus baringoensis* during the dry and wet seasons in Lake Baringo.

Parasite genera	Dry season (N=221)						Wet season(N=226)						Grand Total	
	♂ Inf.	I	♀ Inf.	I	Total fish Inf.	Total No. parasites	♂ Inf.	I	♀ Inf.	I	Total fish Inf.	Total No. parasites	No. fish inf.	No. of parasites
Contracaecum	10	14	22	32	32	46	16	24	6	11	22	35	54	81
Amirthalingamia	23	1057	30	1976	53	3033	16	545	17	346	33	891	86	3924
Clinostomum	18	59	26	82	44	141	23	79	24	89	47	168	91	309
Tylodelphys	44	253	59	406	103	659	83	445	66	405	149	850	252	1509
Euclinostomum	10	30	7	27	17	57	19	70	15	64	34	134	51	191
Apharyngostrigea	2	5	1	3	3	8	1	1	2	4	3	5	6	13

♂-male; ♀-female; Inf.-infected; I-intensity

Table2: Statistics of parasite intensity in relation to sex of fish and season

Parasite genera	Sex		Season	
	Kruskal-Wallis(H)	**p-value**	**Kruskal-Wallis(H)**	**p-value**
Contracaecum	0.15	0.699	0.15	0.699
Amirthalingamia	0.00	1.000	2.40	0.121
Clinostomum	2.40	0.121	0.60	0.439
Tylodelphys	0.00	1.000	1.35	0.245
Euclinostomum	0.60	0.439	0.00	1.000
Apharyngostrigea	0.00	1.00	0.60	0.439

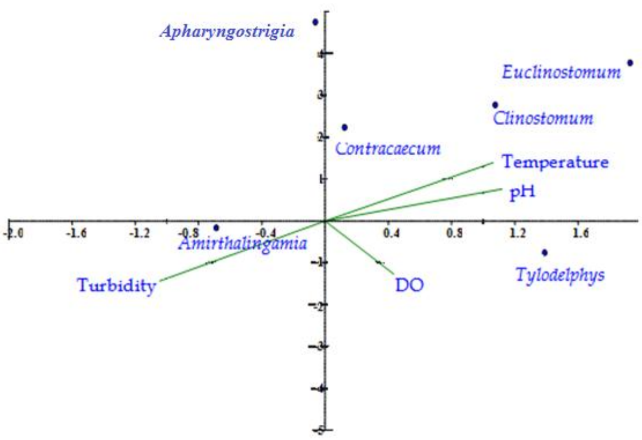

Figure1: Correspondence Analysis of relationships between water quality parameters and the intensity endohelminth parasites of *Oreochromis niloticus baringoensis* in Lake Baringo

DISCUSSION

Tylodelphys was found unencysted in the vitreous humour of the eye of the infected fish. It has also been reported in *Clarias gariepinus* in Lake Victoria by Mwita (2014) andin the eyes of *O. niloticus* from Lakes Babogaya and Awassa (Birhanu, 2009).*Clinostomum* endoparasite was found in the gills. It is known to render the fish unsightly and unsuitable for human consumption. Similar studies by Lemma (2013) from Lake Ziway reported the presence of *Clinostomum* parasites in *Oreochromis niloticus* and *Clarias gariepinus*. It has also been reported in *Tilapia zillii* (Aloo, 2001); in *Oreochromis leucostictus* (Aloo, 2002;Ochieng *et al*, 2012)from Lake Naivasha. *Euclinostomum* has been recorded in Lake Opi, Nigeria, in *Tilapia Zilli*, (Echi *et al*., 2012), as well as in *Oreochromis niloticus* from Lake Tana and Koko reservoir by Eshetu and Mulualem (2003) and Eshetu *et al*., (2013), respectively.

Apharyngostrigea was found as an encysted parasite around the eyes of the fish. In similar studies, diplostomids (*Tylodelphys* and *Apharyngostrigea)* have also been reported in the wild at the BOMOSA Kenyan sites which were observed in *O. niloticus (*Maria *et al*., 2009). *Contracaecum* was found in the pericardial and body cavities, thus suggesting that this parasite infects the fish directly through feeding without the intervention of an intermediate host (Malvestuto and Ogambo-Ongoma, 1978). *O. niloticus baringoensis* feed primarily on phytoplankton and decomposed organic matter so it is possible that it is directly infected by *Contracaecum*via copepod intermediate host (Fryer and Iles, 1972). Similar studies have reported the presence of *Contracaecum*in *Oreochromis niloticus* in Lake Tana, Lake Awassa, Lake Naivasha and in Lake Baringo (Yimer and Enyew, 2003; Tadesse, 2009; Otachi *etal*., 2014; Paperna,1980; Malvestuto and Ogambo-Ongoma, 1978;). The presence of this parasite in various Lakes in different countries confirms it as a cosmopolitan parasite. This can be attributed to the geographical differences and possible seasonal environmental changes in the ecosystem and habitat which greatly influences the distribution of the definitive and intermediate hosts during their study periods (Yimer and Enyew, 2003).

Amirthalingamia was found in the intestinal tube. It has also been reportedin the liver of *O. niloticus* from Wonji ponds (in Ethiopia) by Birhanu Tadesse (2009), and sometime found encysted in the intestines of *Tilapia zillii* from Oloidien Bay (Aloo, 2002). This observation is therefore in general agreement that cestodes are typical parasites of fish in lakes or reservoir (Dick and Choudhury, 1999; Roberts, 2001). The occurrence of this parasite in the intestine of fish concur with the findings of Okedi (1980) that cestodes are common parasites of the intestine. Aloo (2002) identified *Amirthalingamia* in the intestinal wall of *Tilapia zilli* and *Cyclustera* in the liver of *Oreochromis leucostictus* from Lake Naivasha, Kenya. The presence of *Amirthalingamia* isrelated to its life cycle requiring at least one intermediate host (first larvae-procercoids) found in Crustaceans and complete their life cycle as adults in the definitive host (fish) (Scholz *et al*., 2002).

Although there were no significant differences in intensities of the parasites between male and female fish, most of the parasites infected females more than males. The higher intensity of parasites in the female fish of *Oreochromis niloticus baringoensis* may be indicative of the fact that the females are more prone to infections by endohelminths. This is attributed to differences in their physiological conditions (Simkova *et al*., 2005). The female fish, especially the gravid ones are susceptible to helminth infections in periods of investment in gonad development (Simkova *et al*., 2005). This reduces their resistance to infection by these parasites(Ugwuzor, 1987; Holden and Reed, 1972). The findings of this study indicating that females (of *Oreochromis niloticus baringoensis*) were more prone to infections by endohelminths agrees with that of Imam and Dewu (2010); Bichi and Ibrahim (2009); Mheisen *et al*., (1988);Thomas, 1964;Emere and Egbe (2006). However, this differs with studies by (Akinsanya *et al*., (2008); Allumma and Idowu (2011); Aloo, 2002; Idris *et al*., 2013), who reported male *O. niloticus* to be more infected than female. The authors argued that the relatively high intensity of infection in male fish may be attributed to high testosterone levels which can cause immune suppression in the infected fish making them more susceptible to parasites than the females.

There was no evidence of seasonality of endohelminth parasites in this study. This may be attributed to the environmental conditions whereby environmental variations did not influence parasitic infection. The results are similar to those of Scholz (1986) but contradict

(Paperna, 1980; Mbahinzireki, 1984; Batra, 1984), who reported seasonal variation of various parasite species in tropical waters. In temperate regions, Crozier (1987) demonstrated the seasonality of *Contracaecumsp* in angler fish. *Amirthalingamia* (larval cestodes) recorded the highest overall intensity in Lake Baringo, which is in agreement with studies by Paperna (1980) who showed that cestodes are common among cichlids and wild fishes. The highest intensity of *Amirthalingamia* could be attributed to the complex life cycles of tapeworms which involve more than one intermediate host, usually planktonic copepods and fish. The birds are definitive hosts that spread the infection and make it difficult to control worm infections (Barson and Avenant-Oldewage, 2006).

It is also possible that *Oreochromis niloticus baringoensis* being a phytoplanktivorous fish and sometimes feeding on decomposed organic matter (Fryer and Iles, 1972; Malvestuto and Ogambo-Ongoma, 1978) could be directly infected by *Amirthalingamia* during feeding thereby picking up larval stages of parasites without the intervention of an intermediate host. The high intensity of *Amirthalingamia* during the dry than the wet season could be attributed to the seasonal dynamics in the environmental conditions on water quality which could have favoured the parasites' biology as well as enhancement of the presence of intermediate hosts hence contributing to their intensity (Chandra, 2006; Hussen *et al*., 2012).

Tylodelphys parasite infected the highest number of fish in both seasons. This is in agreement with Kadlec *et al* (2003) who argued that an increase in *Tylodelphysclavata* infections could be attributed to the accumulation of snails after flood currents. The rainy season is associated with reproduction and proliferation of intermediate hosts which could therefore explain the higher infection of *Tylodelphys* parasites. The dry season is linked to the effect of hot temperatures that favours the development snails which are the primary intermediate hosts of this parasite. This could be due to increased hosts density and greater overlap of intermediate and definitive hosts in a shrunken environment (Choudhury and Dick, 2000), facilitating the transmission of *Tylodelphys* parasites resulting to high infection in fish.

The positive correlation between turbidity and *Amirthalingamia* could be attributed to increased sediment load of organic and inorganic material into River Molo inlet as a result of runoffs associated with increased nutrient levels likely to favour the recruitment of crustaceans acting as intermediate hosts to this parasite (Roberts, 2001). The influence of temperature and pH on the intensity of *Clinostomum* and *Euclinostomum* (Trematodes) could be associated to the fact that occurrence of fish trematodes is primarily determined by temperature (Chubb, 1979). Field investigations by Wootten, 1974; Stables and Chappell, 1986a found out that infection of fishes with *D. spathaceum* is temperature dependent. They indicated that infections takes place when the water temperature is at a minimum of 10 °C. This is in agreement with the findings of this study which recorded an average temperature of 27.6 º C. Studies by Bauer (1959) cited in Chubb (1979) on the influence of temperature upon activity of *D. spathaceum* have indicated that cercarial shedding from host snails (*Lymnaea spp*.) that take place at a minimum of 9-10 °C.

Tylodelphys was influenced by Dissolved Oxygen. Oxygen variation within the river mouth could be caused by pollution probably as a result of anthropogenic activities. Suspended material and organic matter can reduce oxygen concentration (Department of Water Affairs and Forestry, 1996). *Apharyngostrigea* did not show any relationship with any of the physico-chemical parameters, suggesting that either the fish lived in balance with the parasite or environmental disturbances could have caused changes in the water quality (Banu *et. al*., 2004) with fatal negative impacts on the parasites' lifecycles leading to decrease in parasitism and prevalence (Eissa *et al., 2014).*

CONCLUSION & RECOMMENDATION

Oreochromis niloticus baringoensis of lake Baringo were found to be infected with six genera of endohelminth parasites under three classes including *Contracaecum (*Nematode), *Amirthalingamia* (larval Cestode), *Tylodelphys, Clinostomum, Euclinostomum* and *Apharyngostrigea* (Trematodes) were found to infect *O. niloticus baringoensis* in Lake Baringo. The female fish had the highest parasite intensity than males during the dry season, whereas in wet season, nearly all males were most infected than females. Temperature and pH influenced the intensity of *Contracaecum, Euclinostomum* and *Apharyngostrigea*, whereas DO and turbidity influenced *Tylodelphys* and *Amirthalingamia* respectively. Consumers are therefore advised to cook fish properly as a precautionary measure due to the presence of parasites with zoonotic potential of diseases to humans(*Contracaecum*, *Euclinostomum* and *Clinostomum*). Water pollution control is vital since the study reveals that variations in physico- chemical parameters have influence on parasitic infections of fish.

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