Ecological studies of helminth parasites of the largemouth bass, *Micropterus salmoides*, from Lake Naivasha and the Oloidien Bay, Kenya

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ABSTRACT

ALOO, P.A. 1999. Ecological studies of helminth parasites of the largemouth bass, *Micropterus salmoides*, from Lake Naivasha and the Oloidien Bay, Kenya. *Onderstepoort Journal of Veterinary Research*, 66:73–79

The parasites of 541 largemouth bass, *Micropterus salmoides*, were studied over a period of 12 months. The results showed that the bass from Lake Naivasha are paratenic hosts of *Contracaecum* sp. larva and final hosts for the acanthocephalan *Polyacanthorhynchus kenyensis*. The nematode occurred in large numbers in fish caught in the more saline Oloidien Bay but only in small numbers in those in the main lake. Bass in the main lake, however, were more heavily infected with acanthocephalans than those in Oloidien Bay. One of the major pathological effects of the acanthocephalan was perforation of the liver by the spiny proboscis. Seasonal variation was not apparent for either of the parasites. The intensity of infection by *Contracaecum* sp. larva increased with the size of the host and female fish were more heavily infected than males.

Keywords: Ecology, helminth parasites, Kenya, Lake Naivasha, largemouth bass, *Micropterus salmoides*, Oloidien Bay

INTRODUCTION

Largemouth bass, *Micropterus salmoides*, (Lacepede) is an exotic fish species that was introduced into Lake Naivasha from North America in 1929, primarily for sport fishing (Aloo 1988). Bass populations have fluctuated over the years and today it is the second most important fish caught for commercial purposes after *Oreochromis leucostictus* (Trewavas). Despite its importance both commercially and as a sport fish, thorough ecological studies on this fish were only carried out recently (Aloo 1988; Dadzie & Aloo 1990; Hickley, North, Muchiri & Harper 1994; Aloo & Dadzie 1995). In North America Hofman (1970) reported that the bass is a host of numerous parasites from protozoa to crustaceans. However, the only report available on the parasitic fauna of *M. salmoides* in Lake Naivasha are those of Schmidt & Canaris (1967) and Amin & Dezfuli (1995) on the description of the acathocephalan from a few species of the bass. No thorough investigations have been carried out on the ecology of helminth parasites of the black bass, which forms an important aspect of the ecological studies of the fish in a tropical environment.

Accepted for publication 2 March 1999—Editor

MATERIALS AND METHODS

Study area

Lake Naivasha (Fig. 1), the only freshwater body in the Kenyan portion of the Rift Valley, is situated about 100 km north of Nairobi. The Naivasha basin is made up of four water bodies: the main lake, Crescent Island Lake, the Oloidien Bay and the Sonachi Crater Lake.

The fish fauna of this lake consists mainly of three economically important species of which all have been introduced. These three species form the backbone of a commercial fishery that has been established in the lake for over 50 years:

- *Oreochromis leucostictus* (Trewavas)
- *Tilapia zillii* (Gervais)

- *Micropterus salmoides* (Lacepede), the largemouth bass

The riverine species *Barbus amphigrama* (Bologna) and the Louisianian crayfish *Procambarus clarkii* (Girrard) also occur in the lake.

Fish sampling

Based on earlier reports of the distribution of the bass in the two water bodies (Aloo 1988), six sampling stations were established around the lake with five in the main lake and one at the Oloidien Bay (Fig. l). Eight gillnets of different mesh sizes (⅞, 1½, 2, 2½ 3, 3½, 4 and 5 inches, respectively) were laid overnight at each sampling station and the catch collected the following day (1 inch = 2,54 cm). Each station was fished once a month for a period of 12 months. Upon removal from the nets fish were thoroughly examined for ectoparasites. They were then transported to the laboratory by the lakeshore where a sub-sample of ten fish, based on the sex and size, was drawn from each station. In cases where the total number of fish caught from a station was less than ten, all were examined. The fish were divided into 5-cm length classes. The sub-sampled fish were then subjected to thorough parasitological examinations. The external surface, including the fins, nostrils, beneath the operculum and under the scales was examined for ectoparasites. Each fish was then opened dorso-ventrally and the digestive system separated from the other organs. It was placed in a petridish containing physiological saline in which it was opened and examined for endoparasites. The liver, kidney, and the urinary bladder were also examined as were the pericardial cavity and the musculature. A total of 541 fish, comprising 328 females and 213 males, were examined in this way.

Nematodes that were collected were killed in boiling 70 % ethyl alcohol. Acanthocephalans were placed in a refrigerator overnight in petridishes containing distilled water. This caused the proboscis, which is of taxonomic importance, to extrude. The parasites were then preserved in 70 % alcohol. Permanent whole mounts of each parasite were made for taxonomic studies. Each group of parasite was classified up to specific level where possible. The effect of parasites on the health status of the host was determined by calculating Fulton's condition factor (K-factor) using the formula:

K-factor = 100 (body mass [g]) ÷ body length [cm]

The value of the K-factor was then related to the number of worms in each host. The terms *prevalence* and *intensity* are used in this paper according to Margolis, Esch, Holmes, Kuris & Schad (1980). Three statistical analyses were used:

- ANOVA
- Regression analysis
- Chi-square tests

RESULTS

Micropterus salmoides from Lake Naivasha did not harbour any ectoparasites and the only helminth parasites were third stage larva of *Contracaecum* sp. and cystacanths of *Polyacanthorynchus kenyensis* (Schmidt & Canaris). The nematode occurred either inside the caecum or encysted within fatty tissues around the caecum. In some cases dead nematodes were also encountered within the fatty tissues. *P. kenyensis* parasites were encysted in the liver parenchyma, causing visible lesions in the organ. No trends in the seasonal variation were observed for either of the parasites ($P > 0,5$) (Fig. 2).

The interaction between the parasites, fish and the sampling stations showed a very significant variation ($P < 0,001$) where *M. salmoides* from the Oloidien Bay (conductivity = 1870 US cm^{-1}) were more heavily infected with *Contracaecum* than those from the main lake (conductivity = 365 US cm^{-1}), while fish from the main lake were more heavily infected with *P. kenyensis.*

An equally significant variation was observed in the abundance of the two parasites within the six sites ($P < 0,001$) where *Contracaecum* was more abundant in the fish caught at Oloidien (maximum intensity = 40) than fish caught from the main lake (maximum intensity = 5). *P. kenyensis* occurred abundantly in fish caught from sites 2 and 5 (Tables 1 and 2). Female fish were more heavily infected than males ($P < 0,001$) (Table 3). *P. kenyensis* did not affect the body condition of the fish ($P > 0,05$) (Table 4).

A very significant variation was observed between the intensity of infection with *Contracaecum* and the age (and thus the size) of the bass where intensity of infection increased with the increase in the size of the fish ($P < 0,001$) (Fig. 3). However, intensity of infection with *P. kenyensis* did not show any increase with the size of the host.

DISCUSSION

The low diversity of parasites infecting *M. salmoides* from Lake Naivasha does not agree with reports from its homeland, North America, where bass have been reported to be a host of a variety of parasites (Hofman 1970; Chandler, personal communication 1994). Its behaviour in this tropical environment further contradicts reports by Holmes (1982) that animals introduced into a new environment are usually more heavily infected by the native parasites than endemic species are. The only probable explanation of this fact is that there may be too few endemic species in Lake Naivasha which were observed to prefer the cichlid fish species to the bass (Aloo 1995). The absence of ectoparasites on the bass further testifies to this because they are very sensitive to changes in environmental conditions. Hence those that might have arrived with the bass from North America probably disappeared under tropical conditions.

Contracaecum sp. larvae were encapsulated in the hosts' caecum and not free floating in the pericardial cavity as in tilapias (Aloo 1995). This suggests that the bass becomes infected through feeding on infected intermediate hosts (Crofton 1971). The results obtained from Oloidien confirm the earlier observations of Aloo & Dadzie (1995) that the bass feeds mainly on the crayfish and fish fry. However, in the absence of crayfish in the Oloidien Bay, the fish feeds mainly on fish fry, especially those of *O. leucostictus*, which were heavily infected with *Contracaecum* sp. larvae (Aloo 1995). Bass from the main lake feeds more on the abundant crayfish (Aloo & Dadzie 1995), which explains the low rate of infection. The occurrence of dead *Contracaecum* in *M. salmoides* is dif-

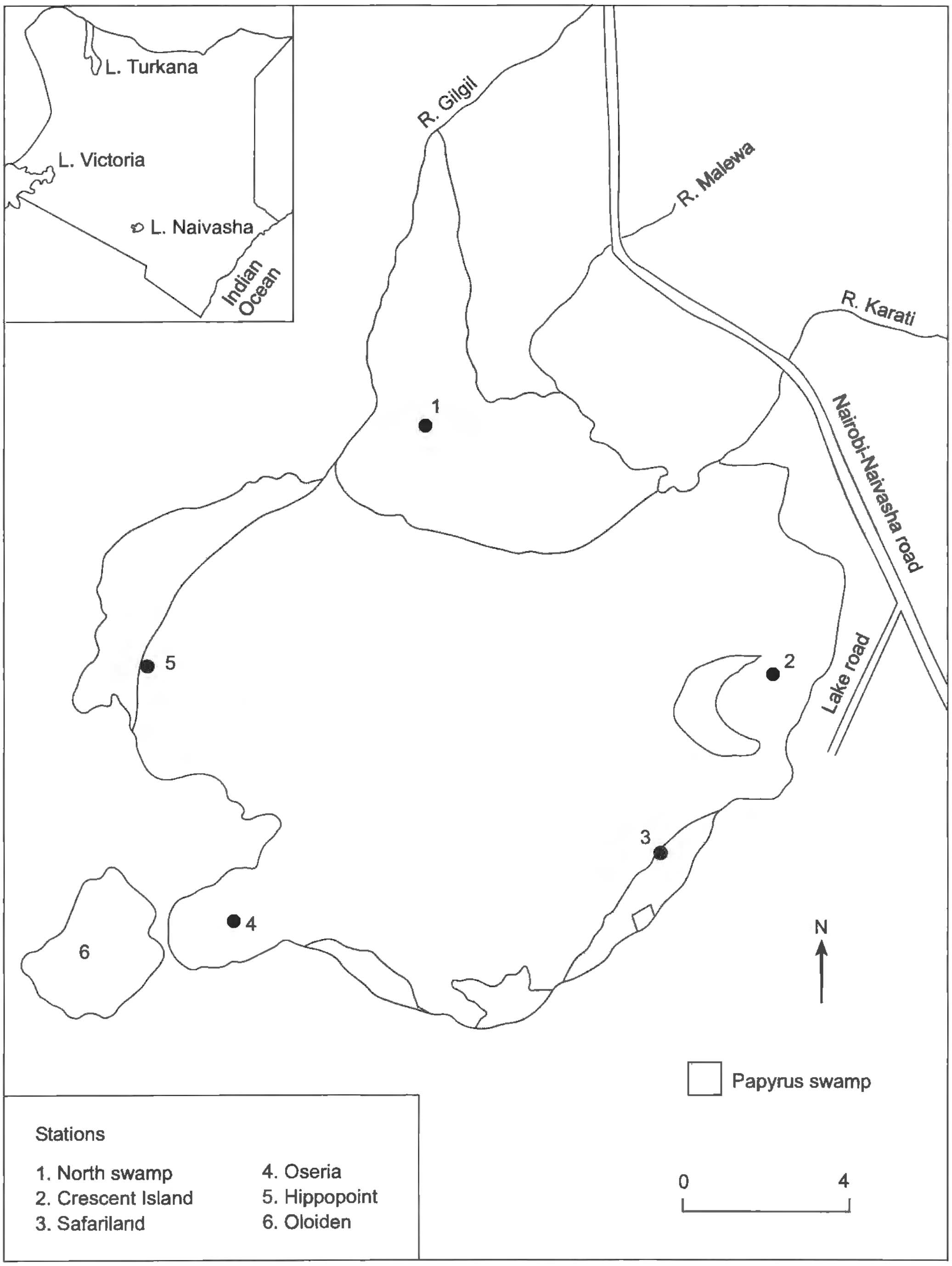

FIG. 1 A map of Lake Naivasha showing its location and sampling stations

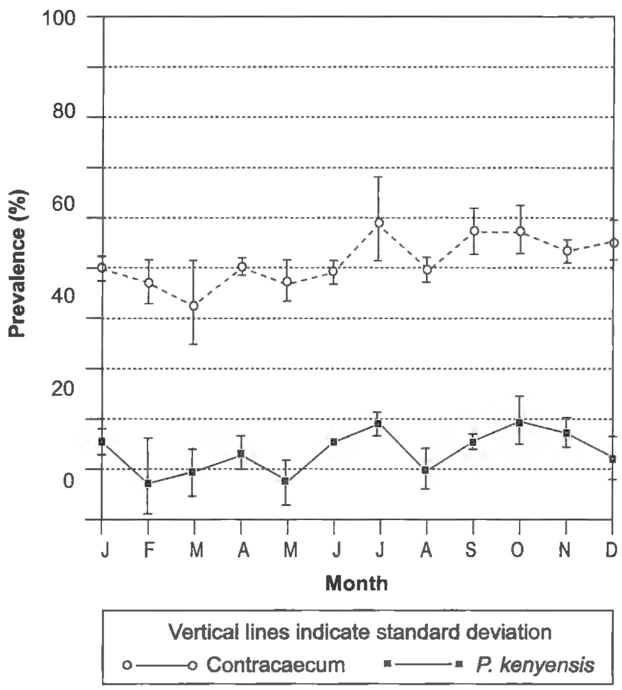

FIG. 2 Seasonal variation in the prevalence of *Contracaecum* and *P. kenyensis* in *M. salmoides*

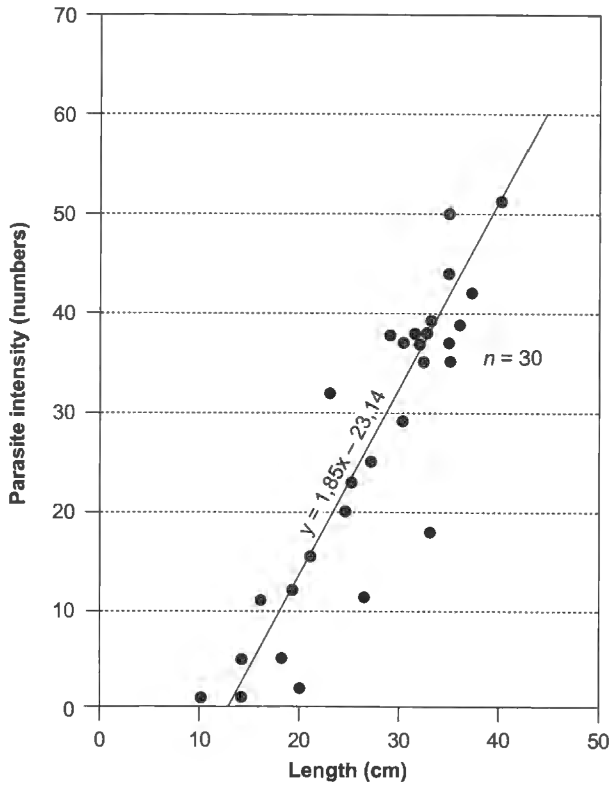

FIG. 3 Intensity of infection of *M. salmoides* of different sizes with *Contracaecum*

TABLE 1 Variation in prevalence and intensity of infection of *M.salmoides* with *Contracaecum* within sampling stations

Stations	No. of fish examined	No. of fish infected	Total no. of *Contracaecum*	Mean intensity ± SD
1. North Swamp	122	13 (10,6)	11	0,8 ± 1,4
2. Crescent Island	180	10 (5,6)	5	1,5 ± 0,7
3. Safariland	72	5 (6,9)	13	2,6 ± 0,4
4. Oseria	70	8 (11,4)	9	1,1 ± 1,1
5. Hippopoint	141	6 (4,3)	3	2,0 ± 0,2
6. Oloidien	55	21 (38,2)	114	5,4 ± 3,2

Figures in parentheses indicate prevalence

TABLE 2 Variation in prevalence and intensity of infection of *M. salmoides* with *P. kenyensis* within sampling stations

Stations	No. of fish examined	No. of fish infected	Total no. of *P. kenyensis*	Mean intensity ± SD
1. North Swamp	122	30 (31,1)	24	0,6 ± 1,6
2. Crescent Island	180	53 (29,4)	60	1,1 ± 1,1
3. Safariland	72	12 (16,7)	32	2,6 ± 0,4
4. Oseria	70	13 (18,6)	45	3,4 ± 1,2
5. Hippopoint	141	16 (13,3)	67	4,2 ± 2,0
6. Oloidien	55	4 (7,3)	6	1,5 ± 0,7

Figures in parentheses indicate prevalence

TABLE 3 Variation in intensity of infection of *M. salmoides* with *Contracaecum* sp. and *P. kenyensis* according to the sex of the fish

Parasite species	No. of fish infected	No. of males infected	No. of females infected	χ^2	*P*-value
Contracaecum sp.	63	30	33	54,43	$P < 0,001$
P. kenyensis	136	51	85	64,72	$P < 0,001$

TABLE 4 Effect of the intensity of *Contracaecum* sp. and *P. kenyensis* on the condition of *M. salmoides*

Contracaecum sp.			*P. kenyensis*		
Fish serial no.	Intensity parasites	K ± SD	Fish serial no.	Intensity parasites	K ± SD
1	3	1,1 ± 0,8	1	10	1,8 ± 0,6
2	4	2,1 ± 0,3	2	1	2,3 ± 0,6
3	1	1,8 ± 0,1	3	3	2,2 ± 0,2
4	10	1,8 ± 0,1	4	1	2,3 ± 0,2
5	1	2,8 ± 0,9	5	2	2,7 ± 0,4
6	1	1,9 ± 0,0	6	3	3,5 ± 1,1
7	18	1,4 ± 0,5	7	1	2,8 ± 0,4
8	4	1,8 ± 0,1	8	12	2,2 ± 0,2
9	7	2,3 ± 0,4	9	1	1,8 ± 0,6
10	2	1,8 ± 0,1	10	4	2,8 ± 0,4
11	3	2,1 ± 0,3	11	2	2,6 ± 0,2
12	4	1,9 ± 0,0	12	5	2,3 ± 0,2
13	1	1,8 ± 0,1	13	8	2,6 ± 0,2
14	1	3,0 ± 1,1	14	4	3,1 ± 0,7
15	1	1,4 ± 0,5	15	1	1,9 ± 0,5
16	2	3,2 ± 0,3	16	11	3,0 ± 0,6
17	1	2,1 ± 0,2	17	30	2,2 ± 0,2
18	1	1,7 ± 0,2	18	3	2,1 ± 0,3
19	2	1,8 ± 1,1	19	1	1,9 ± 0,5
20	1	1,6 ± 0,3	20	13	2,0 ± 0,4

ficult to explain because the parasites successfully use other fish species that grow to a greater size than bass, as intermediate hosts do (Boomker 1982). Huizinga (1965, cited by William & Jones 1994) reported that the final hosts of *Contracaecum* sp. are fish eating birds.

The presence of the acanthocephalan, *P. kenyensis* in *M. Salmoides* from Lake Naivasha had been reported early (Schmidt & Canaris 1967; Amin & Dezfuli 1995). However, these reports were not comprehensive as they only described the species without any detailed studies on its occurrence, seasonality, and its ecological relationship with the host as well as its effect on the host.

The present work revealed that the acanthocephalans occurred in very low numbers in fish from Oloidien because the supposed intermediate hosts, ostracods, cannot withstand the salinity of the water and therefore occur in very low numbers (Dogiel, Petruchevski & Polyanski Yu 1958). These findings concur with those of Dubinin (1958). The same parasites occurred in reasonable numbers in fish caught from the less saline main lake.

The fact that there was no seasonal variation in prevalence of the parasites suggests that the fish are infected throughout the year. However, Paperna (1980), Mbahinzireki (1984) and Batra (1984) reported on the seasonal prevalence of helminth parasites in the tropics, while Amin (1985) and Scholtz (1986) reported on the seasonal occurrence of acanthocephalan species in temperate waters. As there are no marked climatical differences between the seasons in the tropics the parasites tend to occur in their intermediate hosts throughout the year (William & Jones 1994). This perhaps explains the situation that was observed in Lake Naivasha.

M. salmoides from Lake Naivasha does not conform to the more typical situation in which the infection rate in male fish is higher than that in females. The present study proved the converse, which agrees with the findings of Oyetayo (1988) in *Rotrichus africanus* (Eleotridae).

Despite visible lesions caused by *P. kenyensis* in the liver, the presence of the two parasites did not seem to affect the body condition of their host. These findings agree with those of Chubb (1965), that in natural environments parasites are normally in a complex dynamic equilibrium with their hosts. However, this is only true as long as the environment is not disturbed, for example, through pollution (Moller 1987). An intensively cultivated land where large amounts of fertilizers and pesticides are used surrounds Lake Naivasha. These are likely to accumulate with time and might eventually lead to stressful conditions, which will make the fish more susceptible to the helminth parasites. On the other hand, the pollutants may kill the intermediate hosts of the parasites and the fish fry, which possibly would reduce the chances of infection. Reports on nematodes from tropical waters have indicated that they are usually harmless to their hosts (Tompkins 1976; Mbahinzireki 1984; Muchiri 1990). However, under stressful conditions, even the nematodes are likely to induce harmful effects on their hosts. This is already evident because *O. leucostictus* fry caught from the more saline Oloidien were more heavily infected than those from the main lake, which resulted in the heavy infection of *M. salmoides* that feed on them.

The intensity of infection of the bass with *Contracaecum* sp. increased with the size of the fish because they become more carnivorous with age (Aloo & Dadzie 1995). This implies that the older fish are more infected because they feed on the heavily infected fish fry. The intensity of infection increases with the size of the fish host because the larvae accumulate as the fish gets older and they probably remain in the fish until the final host devours it. These results concur with those of other workers such as Paperna (1980) on tilapias, Valtonen (1983) on *Coregonus laveratus*, Mashego (1989) on *Barbus* species and Erlwanger (1991) on *Tilapia rendalli*.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the following institutions or persons: the German Academic Exchange Centre (DAAD) in Nairobi for providing funds for the research, the Fisheries Department at Naivasha Station for providing technical assistance as well as a boat, Dr V.E. Thatcher of Rio de Janeiro and Dr B.S. Dezfuli from Italy who helped in the identification of the parasites. I also wish to thank my colleagues at Kenyatta University, especially Prof. A.S.S. Orago (Chairman of the Zoology Department) for his encouragement and support during this work, Prof. R.O. Okelo for analyzing the data, and finally, Prof. J. Boomker, Medical University of South Africa for giving valuable comments.

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