ISSN 1029–3221

EAST AFRICAN JOURNAL OF SCIENCE

Volume 3 — Part 1 June 2001

Contents

An International Journal of Pure and Applied Science

East African Journal of Science 3(1): 1–12 (2001)

OCCURRENCE OF LARVAL CONTRACAECUM (NEMATODA: HETEROCHEILIDAE) IN THREE TELEOSTEAN FISH SPECIES FROM LAKE NAIVASHA, KENYA

P.A. Aloo
Department of Zoology, Kenyatta University, P.O. Box 43844, Nairobi, Kenya.

Occurrence of the larval nematode (*Contracaecum* sp.) in three teleostean species, viz: *Oreochromis leucostictus* (Trewavas), *Micropterus salmoides* (Lecepede) and *Tilapia zillii* (Gervais) in Lake Naivasha was investigated over a period of 12 months (September 1996 – August 1997). The work was carried out to establish the seasonal prevalence, variation in intensity of infection with size, sex and sampling stations and the effect of the parasite on the health status of the three hosts.

Results indicate that there was no significant monthly variation in the intensity of infection in the three fish species (P>0.05) and both males and females showed no significant difference in the rate of infection by the larval nematode. *Oreochromis leucostictus* was observed to be the most heavily infected (Mean parasite load = 15) while *Tilapia zillii* was the least infected (mean parasite load = 2)

Infection rate and parasitic load between length classes were very significant in *O. leucostictus* ($\chi^2_3 = 212.7$; P<0.001), *M. salmoides* ($\chi^2_3 = 12.93$; P<0.001) but not in *T. zillii* (P>0.05). There was however, a great variation in infection rate within sampling sites in all the three species; *O. leucostictus* ($\chi^2_4 = 20.66$; P<0.001), *T. zillii* ($\chi^2_4 = 12.10$; P<0.05) and in *M. salmoides* ($\chi^2_4 = 18.89$; P< 0.01). The nematode had no apparent effect on the well-being of the fishes as there was no significant relationship between condition factor and parasite load (P>0.05).

Key words: *Contracaecum*; Lake Naivasha; parasite; nematode; fish.

INTRODUCTION

Knowledge of parasites of fishes has accumulated in many parts of the world, especially Europe, Russia and the United States of America, but incentives for comparable studies in Africa have been lacking (Paperna,1980; Khalil & Polling , 1997). As the domestication of cows, chickens and other animals created the need to improve their growth and health all over the world, the same is presently happening with fish. However, in Africa the study of fish parasites has always lagged behind that of other aspects of the ecology of the fishes (Paperna, 1980). According to Douellou (1992), most studies on African fish parasites have been carried out in Western, Central and Southern Africa. Literature from Eastern Africa and Northern Africa is scanty due to lack of personnel experienced in fish parasitology.

Some reports are available on the occurrence of larval *Contracaecum* (Railliet & Henry) in many African fish species. Such studies include those of Paperna (1974), Okorie (1975), Paperna (1980) and Mashego (1989). Although the larvae of the nematode infect many fish families, the adult stage is known to occur in piscivorous birds such as pelicans, commorants and fish eagles (Huizinga, 1966).

However, in Kenya, Malvestuto and Ogambo-Ongoma (1978) reported that aspects of fish parasitology have been under-investigated compared to other aspects of the ecology of these animals. In Lake Naivasha, the various aspects of the fishes have been well documented by Hyder (1970), Siddiqui (1977, 1979), Harper (1984), Aloo (1988), Harper *et al.* (1990), Muchiri

(1990), Mwangi (1992) and Aloo & Dadzie (1995). However, on the parasitology of the fishes, the only reports available are those of Malvestuto (1975), Malvestuto & Ogambo-Ongoma (1978) and Muchiri (1990), all of whom reported on *Contracaecum* in *O. leucostictus* only, while Aloo & Dezfuli (1997) reported the occurrence of acathocephalan *Polyacanthorhynchus kenyensis* infecting the three fish species. No report is available on the occurrence of *Contracaecum* in the other two commercially important fish species. Therefore, the present study made an attempt to investigate the occurrence, variation in seasonal prevalence, variation in intensity of infection with size, sex and sampling stations in the three hosts. The effect of the parasites on the health status of their hosts was investigated in *Oreochromis leucostictus* only because it was the most heavily infected host.

The fish fauna of this lake consists mainly of three economically important species, all of which have been introduced: *Oreochromis leucostictus*, *Tilapia zillii* and the largemouth bass, *Micropterus salmoides*. The riverine species *Barbus amphigrama* (Bologna) and the Lousianan crayfish *Procambarus clarkii* (Girrard) also occur in the lake. The first three species form the mainstay of a commercial fishery that has been established in the lake for over 50 years.

MATERIALS AND METHODS

Study Area

Lake Naivasha (Fig. 1), lying at 0°45' S and 30°20'E, is the only freshwater body in the Kenyan portion of the Rift Valley. It is situated about 100 km north of Nairobi at an altitude of 1890m above sea level. The Naivasha basin is made of waterbodies: The Main Lake, Crescent Island Lake, the Oloidien Bay and the Sonacchi Crater Lake.

Fish Sampling

Sampling was carried out twice a month for a period of 12 months beginning September 1996 up to August 1997. There were a total of six sampling stations (Fig. 1) based on differences in the physical and chemical characteristics of the stations (Aloo, 1988). On every sampling occasion, five gill nets of different mesh sizes were laid overnight at every station. At each sample site nets of the following mesh sizes: 1½", 2", 3", 4", 5" (knot to knot) were used. Fish harvested from these nets were put into groups according to the sampling stations, samples were then transported to the laboratory at the Fisheries station by the lake shore. In the laboratory the fish were put into taxonomic groups and a subsample of each based on their lengths and sex was taken for parasitological studies.

Parasitological Studies

All subsampled fish were opened up and the peritoneal contents inspected for parasites, including the pericardial cavity, digestive tract, reproductive organs and other internal organs. If found, the worms were counted, the site infected recorded and the parasites killed in hot 70% alcohol then preserved in cold 70% alcohol for later identification. Any visual damage of infected organs was also recorded. The number of fish that were parasitised by larval nematodes each month was expressed as a percentage of the total number of fish examined; this showed monthly variation in prevalence. Infection rate in the different sizes was investigated by determining the number of fish infected and the total number of parasites in each length class. Mean parasite load was calculated for each length class as follows:

$$\text{Mean parasite load (M)} = \frac{\text{Total parasites}}{\text{No. of fish infected}}$$

Variation in infection rate between sampling stations was established by calculating the percentage of each fish species infected in all the six stations.

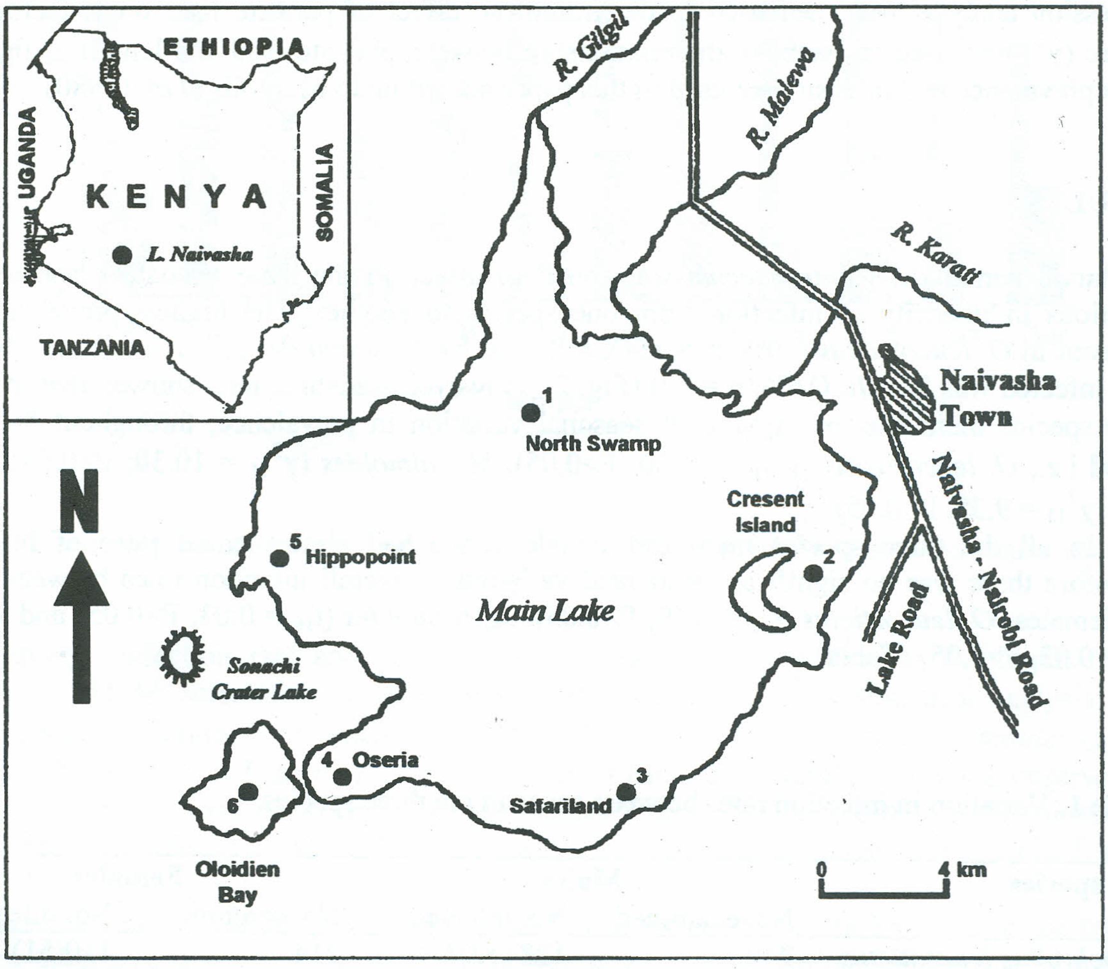

Figure 1. Lake Naivasha, showing its location and the sampling stations.

The difference in infection rates in different sexes was determined by calculating the percentages of males and females infected throughout the study period for each fish species. To determine the effect of the parasites on the health status of the fish, Fulton's K-factor was calculated using the formula:

$$K = \frac{100\ W}{L^3}$$

Where K = Condition factor (health status)
W = Weight (g)
L = Length (cm)

Regression analysis was then used to determine the effect of parasite load on K-factor. Chi-Square (χ^2) was used to establish the relationship between parasite load and length of fish. The terms prevalence and intensity are used in this paper according to Margolis *et al.* (1980).

RESULTS

The larval nematode, *Contracaecum* was found to infect all the three teleostean species with variations in intensity of infection from one species to another. The highest prevalence was observed in *O. leucostictus* (70%, n = 454), followed by *M. salmoides* (29%, n = 146) while the least infected was *T. zillii* (16%, n = 77) (Fig. 2). However, statistical tests showed that in all the three species there was no significant seasonal variation in prevalence, throughout the study period i.e., *O. leucostictus* (χ^2_{11} = 11.30; P>0.05), *M. salmoides* (χ^2_{11} = 10.30; P>0.05) and *T. zillii* (χ^2_{11} = 9.35; P>0.05).

In all the three species male and female fishes had almost equal rates of infection. Therefore there was no significant statistical variation in overall infection rates between males and females, *O. leucostictus* (t_{16} = 0.19; P>0.05), *M. salmoides* (t_{16} = 0.03; P>0.05) and *T. zillii* (t_{16} = 0.03; P>0.05) (Table1).

Table 1. Variation in infection rates between sexes in the three species.

Fish species	Males		Females	
	No. examined	No. infected	No. examined	No. infected
Oreochromis leucostictus	240	128 (53)*	214	110(51)
Micropterus salmoides	80	12 (15)	66	11(16)
Tilapia zillii	45	4 (9)	32	3(8.8)

*Numbers in parentheses indicate percentage of fish infected.

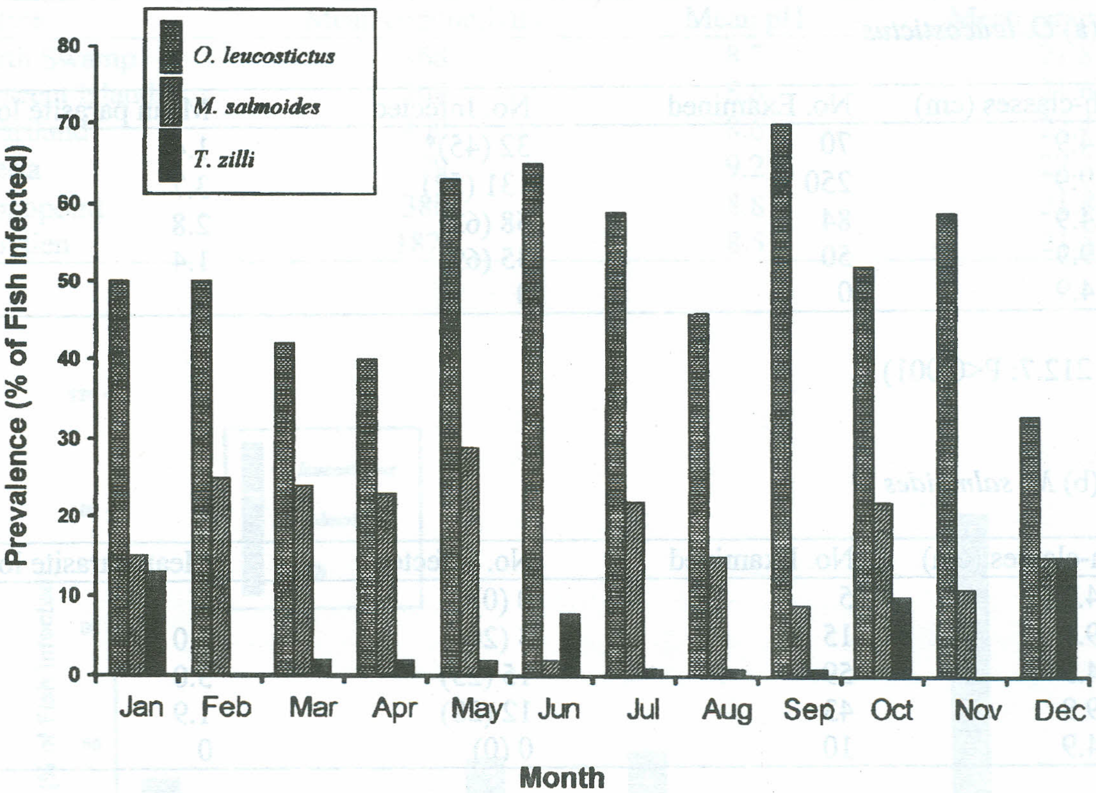

Figure 2. Monthly variation in prevalence of *Contracaecum* sp. in the three teleostean species.

Although infection rate and parasite load increased between the length classes in *O. leucostictus* and *M. salmoides*, no increase was observed in *T. zillii*. Statistical analysis also showed a great variation in *O. leucostictus* (χ^2_3 = 212.7; P<0.001) and in *M. salmoides* (χ^2_3 = 12.93; P<0.01) but not in *T. zillii* (χ^2_3 = 5.64; P>0.05) (Table 2). A similar trend was observed in variation in parasitic load between the length classes where *O. leucostictus* and *M. salmoides* showed highly significant variation (P<0.001), while there was no significant variation in *T. zillii* (P>0.05).

This study noted that about 98% of *O. leucostictus* caught from site 6 were infected by the nematode compared to the low infection rate observed in the other stations, while *T. zillii* and *M. salmoides* from the same station were also slightly more heavily infected than those from the other five stations. Station 6 differered from the other stations in that it was a more saline environment with very high conductivity readings (Table 3), hence a highly significant statistical variation was observed in all the three species; *O. leucostictus* (χ^2_4 = 20.66; P<0.001), *T. zillii* (χ^2_4 = 12.10; P<0.05) and *M. salmoides* (χ^2_4 = 18.89; P<0.01) (Fig. 3).

Table 2. Variation infection rate of *O. leucostictus*, *M. salmoides* and *T. zillii* with size classes. *Numbers in parentheses indicate percentage of fish infected.

(a) *O. leucostictus*

Length-classes (cm)	No. Examined	No. Infected	Mean parasite load
10 – 14.9	70	32 (45)*	1.4
15 – 19.9	250	131 (52)	3.7
20 – 24.9	84	58 (62)	2.8
25 – 29.9	50	35 (69)	1.4
30 – 34.9	0	0	0

(χ^2_3 = 212.7: P<0.001)

(b) *M. salmoides*

Length-classes (cm)	No. Examined	No. Infected	Mean parasite load
10 – 14.9	5	0 (0)*	0
15 – 19.9	15	3 (20)	1.0
20 – 24.9	59	15 (25)	3.0
25 – 29.9	43	12 (28)	1.9
30 – 34.9	10	0 (0)	0

(χ^2_3 = 12.93; P<0.01)

(c) *T. zillii*

Length-classes (cm)	No. Examined	No. Infected	Mean parasite load
10 – 14.9	23	2 (8.7)*	1
15 – 19.9	17	1 (5.8)	1
20 – 24.9	18	0 (0)	0
25 – 29.9	10	0 (0)	0
30 – 34.9	9	0 (0)	0

(χ^2_3 = 5.64; P<0.05)

The presence of this worm did not affect the health status of *O. leucostictus* in which it occurred abundantly (Fig. 4) as measured by the K-factor index. Moreover, no statistical relationship was observed between parasite load and health status of this fish (r_{18} = 0.27; P>0.05).

Table 3. Variation in the physico-chemical parameters within sampling stations.

Station	Mean conductivity	Mean pH	Mean temperature
North Swamp	368	8.7	21.8
Crescent Island	369	8.8	21.6
Safariland	400	8.6	22.4
Oseria	379	9.2	22.3
Hippopoint	380	8.8	21.8
Oloidien	1870	8.5	21.5

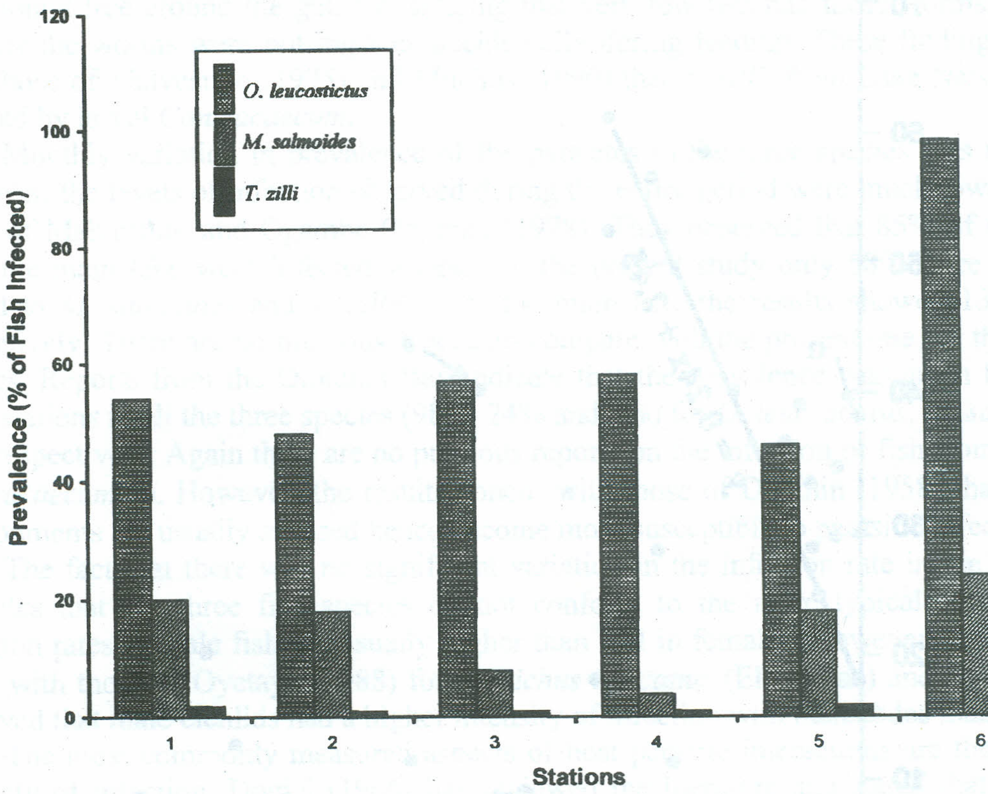

Figure 3. Variation in infection rate between sampling stations.

DISCUSSION

All the three teleostean species were found to be infected by the larval stage of the parasite *Contracaecum* sp. at different rates and in different organs. *Oreochromis leucostictus* was the most heavily infected while *T. zillii* was the least infected. This high infection rate in *O. leucostictus* does not agree with observations by Roberts and Sommerville (1982) that tilapiine species generally tend to be resistant to parasitic infections. In *O. leucostictus*, the worms were found unencysted in the pericardial cavity suggesting that the fish probably gets infected directly but not through feeding on an intermediate host (Crofton, 1971). These findings agree with those of Malvestuto (1975), who concluded that *O. leucostictus* from Lake Naivasha have a direct pathway of infection. However, the results do not agree with those of Huizinga (1966) that *O. leucostictus* usually get infected through feeding on infected intermediate hosts especially copepods.

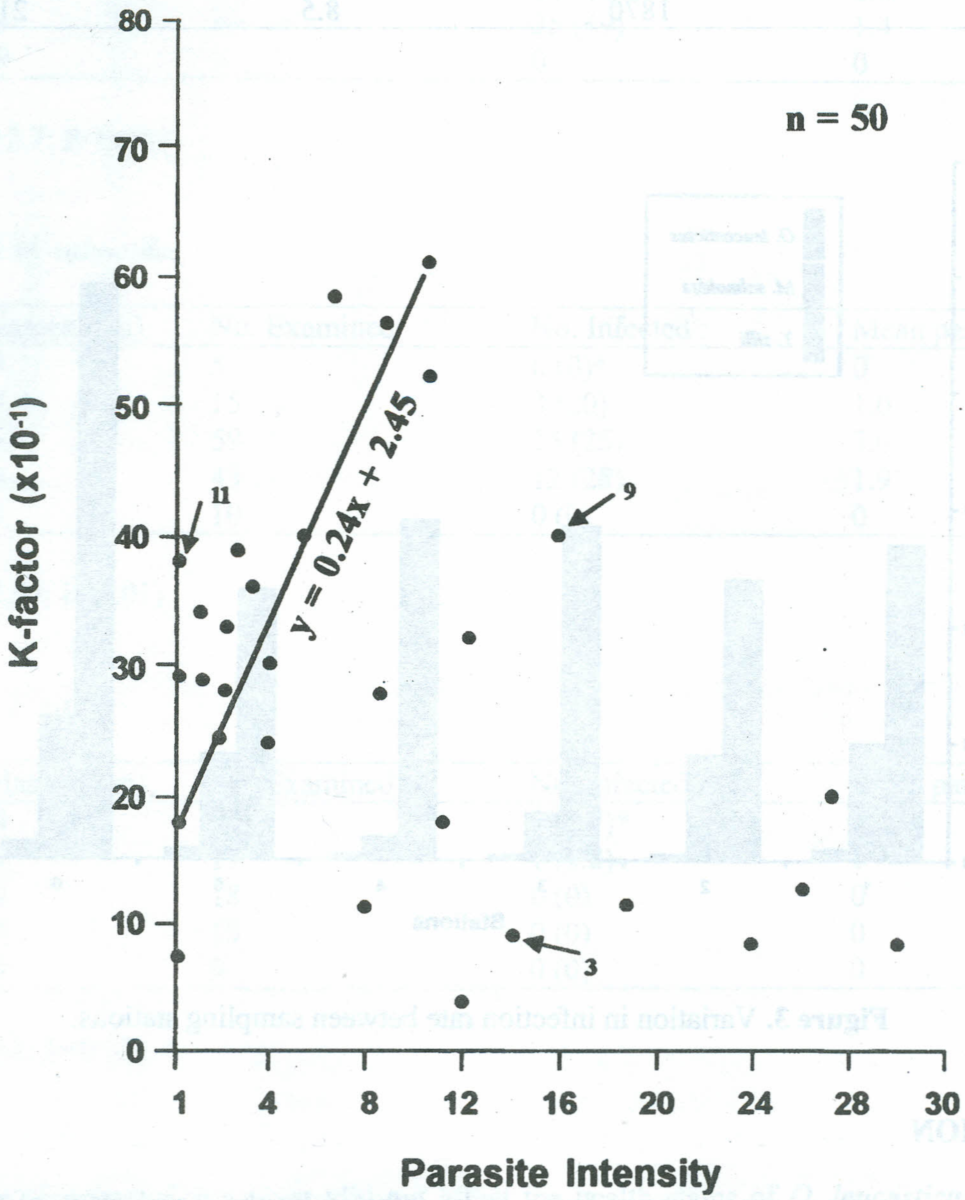

Figure 4. Effect of *Contracaecum* sp. intensity on K-factor of *O. leucostictus*.

The development of *Contracaecum* sp. in temperate waterbodies has been reported by Huizinga (1966). Fish species usually act as intermediate hosts to 3rd stage larvae of the parasite. Eggs are dropped in the water with birds' faeces and develop into 1st stage larvae, the larvae molt and become 2nd stage larvae which are either ingested by the fish directly or through an infected copepod. The larvae then develop to 3rd stage larvae in the fish but does not attain maturity unless the fish is eaten by piscivorous birds such as pelicans.

In *M. salmoides*, the worms were found encapsulated in the mesentery; this is an indication that the bass preys on infected intermediate hosts. This is very possible in the light of the reports by Aloo (1988) and Aloo & Dadzie (1995) that a substantial proportion of the diet of *M. salmoides* consists of fish fingerlings especially those of *O. leucostictus*, which are usually infected by the nematode.

Observations made on *T. zillii* are very difficult to interpret, since all the unencysted worms were found free around the gut. Considering that very few fish had these worms, it is not clear whether the worms were not ingested accidentally during feeding. These findings do not agree with those of Malvestuto (1975) and Muchiri (1990) that *T. zillii* from Lake Naivasha are never infected by larval *Contracaecum*.

Monthly variation in prevalence of the parasites in the three species was not significant. However, the levels of infection observed during the entire period were much lower compared to those of Malvestuto and Ogambo-Ongoma (1978). They observed that 85% of *O. leucostictus* from the main lake were infected whereas in the present study only 58% were infected. With regard to *M. salmoides* and *T. zillii*, from the main lake the results showed 13.6% and 1.4% respectively. There are no previous reports to compare with the present one for the last two fish species. Reports from the Oloidien Bay indicate that the prevalence was much higher than the other stations in all the three species (98%, 24% and 3%) for *O. leucostictus*, *M. salmoides* and *T. zillii* respectively. Again there are no previous reports on the infection of fish from Oloidien with *Contracaecum* sp. However, the results concur with those of Dubinin (1958) that fish in saline environments are usually stressed hence become more susceptible to parasitic infections.

The fact that there was no significant variation in the infection rate in the different sexes indicates that the three fish species do not conform to the more typical situation in which infection rates in male fish are usually higher than that in females. However, these observations agree with those of Oyetayo (1988) for *Rotrichus africanus* (Eleotridae) and Batra (1984), who observed that male cichlids had a higher intensity of infection with nematodes than females.

The most commonly measured aspects of host parasite interactions are the incidence and intensity of infection. Dogiel (1966) has reviewed the literature and stated that for freshwater fishes, there is normally an increase in the intensity and incidence of infection with age of the host. This is true for the infection of *O. leucostictus* and *M. salmoides* but not *T. zillii* in Lake Naivasha. Muchiri (1990) also observed a positive relationship between parasite load and length of *O. leucostictus*. His conclusion was that infection takes place throughout the life of the fish and the parasite does not leave the host until the fish is eaten by a predator. For *M. salmoides*, young fish feed on insects but as they grow, the fish preys on fish fingerlings, especially those of *O. leucostictus*, which are heavily infected by the nematode. This infection builds up in older fishes since they become more piscivorous with age (Aloo, 1988; Aloo & Dadzie, 1995). Results on *T. zillii* on this aspect needs further investigation before any conclusive remarks can be made. Other reports on increased infection rate with the age of the host include those of Mashego (1989), who reported that infection with larval *Contracaecum* increased with the age of the fish.

He attributed the above findings to constant infection via the diet or direct infection without the intervention of the first intermediate host.

There are no earlier reports on *Contracaecum* infections in the small lake, Oloidien Bay. Observations made during this study showed highly significant variation in infection between the sampling stations for the three fish species. All fish caught from Oloidien had a heavy parasitic load compared with those of the main lake. Earlier limnological investigations by Litterick *et al.* (1979) and Aloo (1995) revealed high conductivity in Oloidien than that of the Main Lake. The present results therefore agree with the views of Paling (1965) that parasitic infection of fish becomes most severe when the fish are exposed to unfavourable environmental conditions. The relative sizes of the two waterbodies suggests that the small Oloidien Bay might harbour more parasite eggs per unit area than in the Main Lake; unfortunately, empirical evidence is lacking. Moreover, all the infected *T. zillii* were from Oloidien.

The fact that there was no significant relationship between K-factor and parasitic load in *O. leucostictus* suggests that *Contracaecum* sp. has no observable effect on the health status of its host. Roberts and Sommerville (1982) stated that fish from wild population have a wide range of parasites, but most of these parasites exist as commensals having little effect on the host. In Lake Naivasha therefore, the relationship between *Contracaecum* and the teleostean species may be more commensalism rather than true parasitism.

ACKNOWLEDGEMENTS

I wish to thank the following institutions: the German Academic Exchange Centre (DAAD) for providing funds used for this research; the Fisheries Department at Naivasha provided technical assistance as well as a boat, and the Department of Zoology at Kenyatta University provided equipment used during sampling. My sincere thanks also go to Dr. V.E. Thatcher of Rio de Janeiro who helped in the identification of the parasite, J. Root of Lake Naivasha helped in data collection and my colleagues at the University, especially Professor R.O. Okelo for his assistance in data analysis and Professor A.S.S Orago for his constant encouragement during this work.

REFERENCES

Aloo, P.A. 1988. *Studies of the ecology of the blackbass,* Micropterus salmoides *(Lacepede) in Lake Naivasha, Kenya.* M.Sc. thesis, University of Nairobi.

Aloo, P.A. 1995. *Ecological studies of Helminth parasites of fish from Lake Naivasha, Kenya.* Ph.D thesis, Kenyatta University.

Aloo, P.A. & Dadzie, S. 1995. Diet of the largemouth bass, *Micropterus salmoides*.(Lacepede) in Lake Naivasha, Kenya. *Fisheries Management and Ecology* 2: 43–51.

Aloo, P.A. & Dezfuli, B.S. 1997. Occurrence of cystacanths of *Polyacanthorhynchus kenyensis* larva (Acanthocephala) in four teleostean fishes from a tropical lake, Lake Naivasha, Kenya. *Folia Parasitologica* 44: 233–238.

Batra V.J. 1984. Prevalence of Helminth Parasites in three species of cichlids from a man-made lake in Zambia. *Zoological Journal of the Linnean Society* 82: 319–333.

Crofton, H.D. 1971. A quantitative approach to parasitism. *Parasitology* 62: 179–193.

Dogiel, V.A. 1966. *General Parasititology*. Academic Press, New York.

Douellou, L. 1992. A survey of fish parasites in Lake Kariba, Zimbabwe. 71 pp. *Lake Kariba Research Station Bulletin* 1/92: 1–71. University of Zimbabwe.

Dubinin, V.B. 1958. The influence of the increased salinity of the River Malyi Uzen on the parasite fauna of fishes In: V.A. Dogiel, G.K. Petruchevski & I.Y. Polyansky (ed.), *Parasites of fishes*. Oliver & Boyd, Edinburgh & London.

Harper, D.M 1984. Recent changes in the ecology of Lake Naivasha, Kenya. *Verhandlungen Internationale für Theoritische und angewandte Limnologie* 22: 1192–1197.

Harper, D.M., Mavuti, K.M. & Muchiri S.M. 1990. Ecology and Management of Lake Naivasha, Kenya, in relation to climatic changes, alien species introduction and Agricultural Development. *Environmental Conservation* 17: 329–336.

Huizinga, H.W. 1966. Comparative studies on the life cycle and tissue invasion of two species of *Contracaecum* from piscivorous birds. In: William & A. Jones (ed.), *Parasitic Worms of Fishes*. Taylor and Francis, London & Bristol.

Hyder, M. 1970. Gonadal and reproductive patterns in *Tilapia leucosticta* (Teleostei, Cichlidae) in an equatorial lake, Lake Naivasha, Kenya. *Journal of Zoology* 162: 179–195.

Khalil, L.F. & Polling L. 1997. *Checklist of the Helminth parasites of African Freshwater Fishes*. University of the North, Republic of South Africa.

Litterick, M.R., Gaudet, J.J., Kalff, J. & Melack, J.M. 1979. *The Limnology of an African lake, Lake Naivasha, Kenya*. Manuscript prepared for the SIL-UNEP Workshop on Tropical Limnology, Nairobi. Mimeo.

Malvestuto, S. 1975. Contracaecumosis of *Oreochromis leucostictus* in Lake Naivasha, Kenya. M.Sc. thesis, University of Nairobi.

Malvestuto, S. & Ogambo-Ongoma. 1978. Observation on the infection of *Tilapia leucosticta* (Pisces: Cichlidae) with *Contracaecum* in Lake Naivasha, Kenya. *Journal of Parasitology* 64: 383–384.

Margolis, L., Esch, G.W., Holmes, J.C., Kuris, A.M. & Schad, G.A. 1982. The use of Ecological terms in parasitology. (Report of an *ad hoc* committee of the American Society of Parasitologists). *Journal of Parasitology* 68: 131–133.

Mashego, S.N. 1989. Nematode parasites of *Barbus* species in Lebowa and Venda, South Africa. *South African Journal of Wildlife Resources* 9: 35–37

Muchiri, S.M. 1990. *The Feeding Ecology of Tilapias and the Fishery of Lake Naivasha*. Ph.D. thesis, University of Leicester.

Mwangi, B.M. 1992. *Habitat Preference, Feeding Habits, Length–Weight Relationship and Relative Condition Factor of Juvenile Tilapias in Lake Naivasha, Kenya*. M.Sc. thesis. Kenyatta University.

Okorie, O.O. 1975. The Bionomics and population structure of *Tilapia nilotica* Linnaeus 1757 in Lake Baringo, Kenya. *African Journal of Tropical Hydrobiology and Fisheries* 4: 192–218.

Oyetayo, A.S. 1988. Infection of the Africa Eleotrid *Rotrichus africanus* (Steindancher 1980) by the nematode *Raphidas caroides africanus*. *Journal of Fish Biology* 32: 485–486.

Paling, J.E. 1965. The population dynamics of the Monogenean gill parasite *Discocotyle sagittata* Leuckart on the Windermere trout. *Parasitology* 55: 67–69.

Paperna, I. 1974. Larval *Contracaeum* in the pericardial cavity of fishes from East Africa. *Proceedings of Helminthological Society of Washington* 4: 252.

Paperna, I. 1980. *Infections and diseases of fish in Africa*. CIFA Technical Paper No. 7. FAO Publications, Rome.

Roberts, R.J. & Sommerville. 1982. Disease of Tilapias. In: R.S.V. Pullin & R.H. Lowe-McConnell (ed.), *The Biology and Culture of Tilapias*. ICLARM Conference Proceedings, Manilla, Phillippines 7: 247–263.

Siddiqui, A.Q. 1977. Lake Naivasha, Kenya (East Africa). Fishery and its management together with a note on food habits of fishes. *Biology of Conservation* 12: 217–227.

Siddiqui, A.Q. 1979. Changes in species composition of Lake Naivasha, Kenya. *Hydrobiologia* 64: 131–138.