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Helminth Fauna of *Oreochromis leucostictus* (Pisces: CICHLIDAE) from a tropical lake, Lake Naivasha, Kenya

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ABSTRACT

The helminth fauna of *Oreochromis leucostictus* (Trewavas) from Lake Naivasha is described. The study was carried out on 1,050 gillnetted fish caught over a period of 24 months at different sites within the lake. *Oreochromis leucostictus* which is a commercially important fish was observed to be a host of four helminth parasites. These were: an acanthocephalan *Polyacanthorhynchus kenyensis* (Schmidt and Canaris), a nematode *Contracaecum* sp., a trematode *Clinostomum* sp. and a dilepidid cestode *Amirthalingamia* sp.

Seasonal variation in prevalence, intensity of infection, organs infected and the variation in infection with the size, sex and body condition of the host are described. There was no seasonal variation in prevalence but intensity of infection was observed to increase with the age of the fish. Although male fish were observed to be more heavily infected, the parasites did not seem to have any significant effect on the body condition of the fish.

INTRODUCTION

Lake Naivasha is the only freshwater lake in the eastern arm of the Kenyan portion of the Rift Valley. It is situated about 100 km north of Nairobi, the capital city (Fig. 1). The fish fauna of this lake is made up of three introduced teleostean species; *Oreochromis leucostictus* (Trewavas), *Micropterus salmoides* (Lace'p'ede) and *Tilapia zillii* (Gervais). These three species form the mainstay of a commercial fishery, which has been established in the lake for over 40 years - with *O. leucostictus* being the most important commercial fish. Also present in Lake Naivasha are the riverine species, *Barbus amphigramma* (Boulenger), and the Red swamp crayfish, *Procambarus clarkii* (Girrard). The various aspects of the ecology of these fish species have received adequate attention, but the only reports available on the parasitic fauna are those of MALVESTUTO (1975) on *Contracaecum* sp. of *O. leucostictus* and MALVESTUTO and OGAMBO-ONGOMA (1978) on the infection rate of *O. leucostictus* with the same parasite. The present study reports on the occurrence of other parasites in this fish.

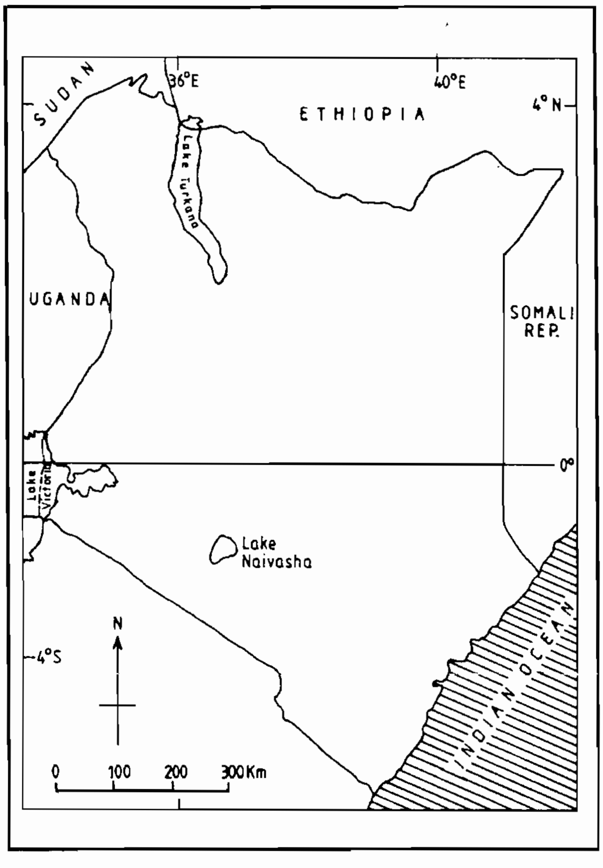

Fig. 1. A map of Kenya showing the location of Lake Naivasha

MATERIALS AND METHODS

Fish were caught from 13 different sampling stations established around the lake (Fig. 2) between October 1991 and June 1994. The stations were selected based on broad categories of different habitats found in the lake, (e.g. rocky shores, papyrus fringes and submerged macrophyte beds). A fleet of 8 gillnets of mesh sizes $1^1/2$, 2", $2^1/2$, 3", $3^1/2$, 4", $4^1/2$ and 5" were laid at each station overnight starting from 6 a.m. to 10 a.m. and the fish collected the following day at the same time. The total number of *O. leucostictus* caught at each station was enumerated to establish its abundance in the different habitats.

During removal from the net, fish were thoroughly examined to recover parasites such as monogeneans that may fall off after removal of the fish from water. Fish samples were then transported to the laboratory by the shores of the lake. In the laboratory, the lengths of fish from each station were measured and the fish divided into 5 cm size classes. Sex of each fish was also recorded and subsamples from each station was drawn based on sex and size. For ectoparasites, the fish were placed in containers under running water, scrubbed using a brush, and the washings sieved and examined under a dissecting microscope. Various organs such as around the fins, beneath the operculum, nostrils and eyes were examined for ectoparasites.

Endoparasites were recovered by opening the fish dorso-ventrally to expose the internal organs. The entire digestive system was removed and placed in a petri-dish containing saline solution. The stomach and the intestines were separated and each opened up and searched for parasites. Other internal organs examined for parasites included the gonads and urinary bladder.

The parasites found were subjected to different treatments as follows: Nematodes were killed in 70% alcohol which made them remain stretched for easy counting and taking morphometric measurements. Acanthocephalans and cestodes were placed in petri-dishes of cold water and kept in a refrigerator overnight to facilitate the extrusion of the proboscis and scolex principally used as taxonomical features in their identification. Trematodes were pressed between 2 slides with a drop of glacial acetic acid which made them transparent so that internal organs were visible under a dissecting microscope. Permanent whole mount preparations were then made for taxonomical studies. The effect of *Contracaecum* and *P. kenyensis* on the health status of *O. leucostictus* was investigated by establishing the relationship between parasite intensity and the condition factor (K-factor) of the fish and K-factor was calculated using the formula:

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

where: L = length (cm)
W = weight (g)

Statistical analysis used during this work included Split-Plot technique, regression analysis and Chi-square tests. The terms prevalence and intensity are used in this paper as defined by MARGOLIS *et al.*, (1982).

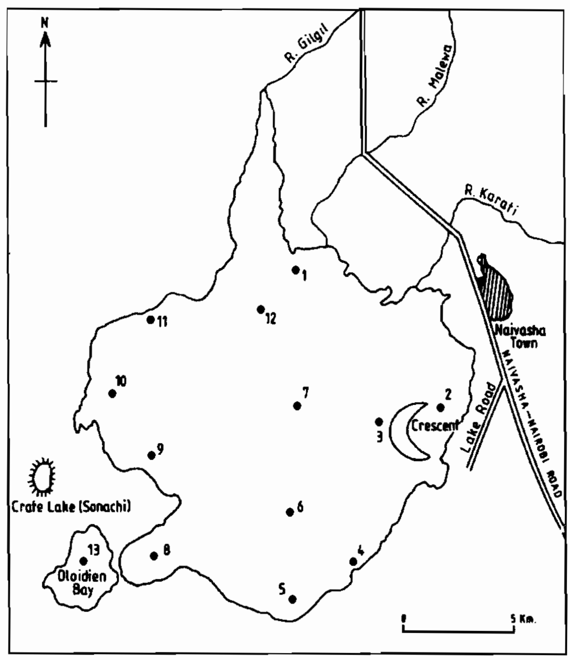

Fig. 2. A map of Lake Naivasha showing Sampling Stations

Stations

1. North Swamp
2. Crescent Island
3. Flamingo Farm
4. Safariland
5. Fisherman's Camp
6. Lakeside Farm
7. Middle Lake
8. Oseria
9. Hippo Point
10. White House
11. Korongo
12. Hop Craft
13. Oloidien

RESULTS

Oreochromis leucostictus from Lake Naivasha did not harbour any ectoparasites. However, the fish was a host to four helminth parasites which were abundant in the following order: cystacanths of *Polyacanthorhynchus kenyensis* (Schmidt and Canaris) found encysted in the liver; third stage larvae of a nematode, *Contracaecum* sp., which were found free in the pericardial cavity; metacercariae of a trematode *Clinostomum* sp. which occurred in the pharyngeal region; and cysticercoids of a dilepidid cestode *Amirithalingamia* sp. which were either encysted in the liver or free floating in the intestines (Figures 3 - 6).

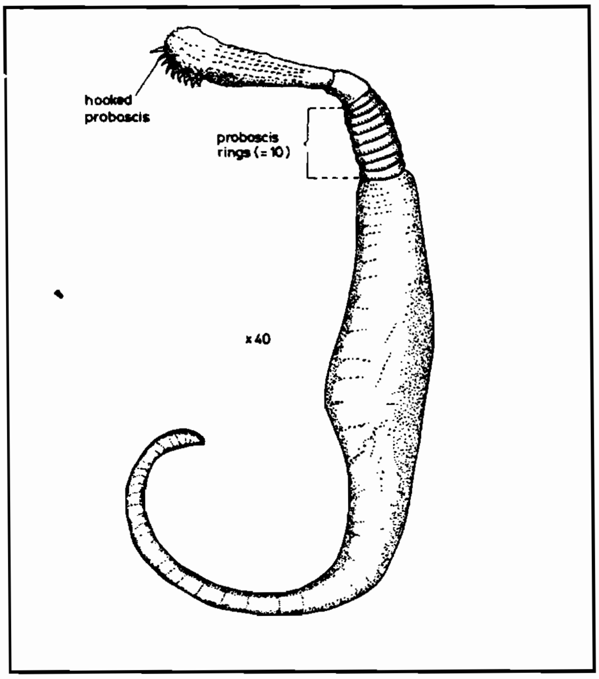

Fig. 3. *Polyacanthorhynchus kenyensis*

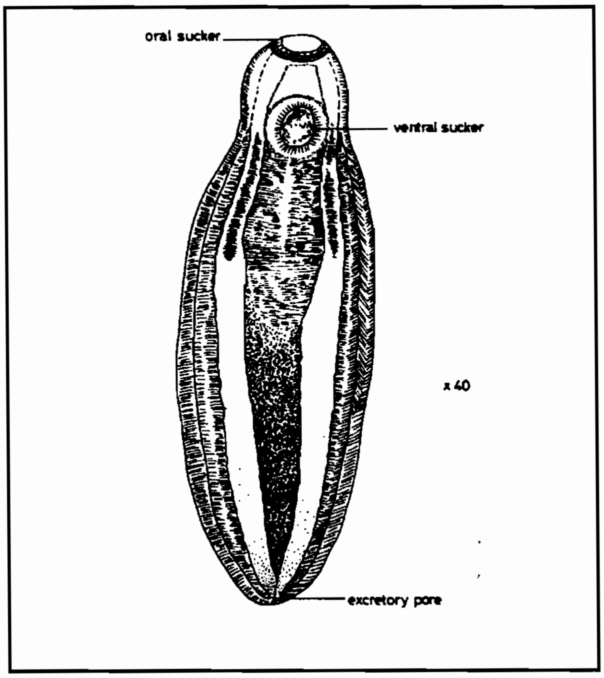

Fig. 5. *Clinostomum* sp.

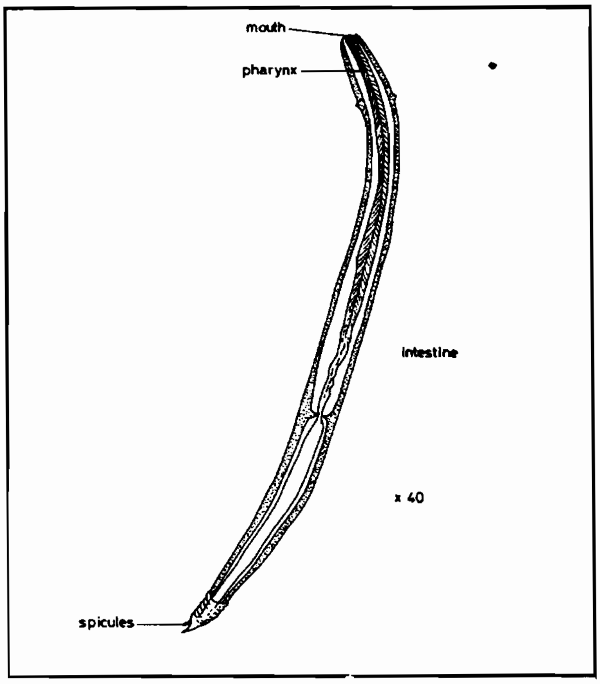

Fig. 4. *Contracaecum* sp.

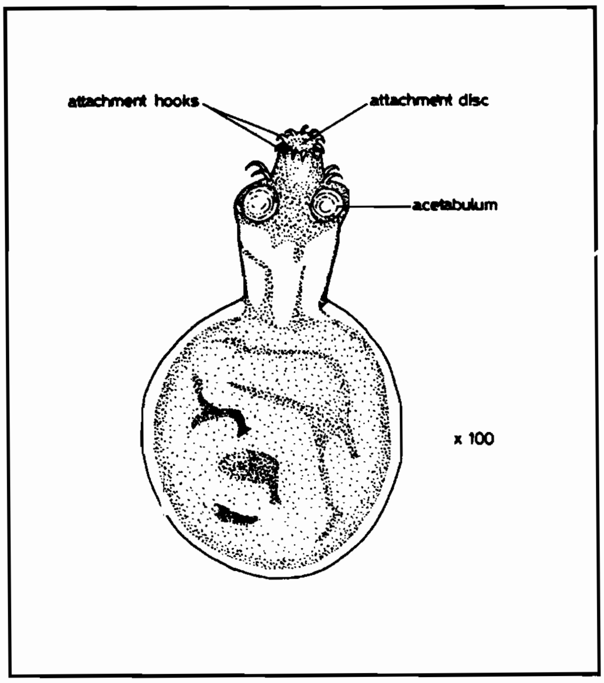

Fig. 6. *Amirthaligamia* sp. (Cystercercoid)

The parasites did not show any seasonality in the intensity of infection throughout the study period. The results also showed no significant variation in prevalence between months (Fig. 7).

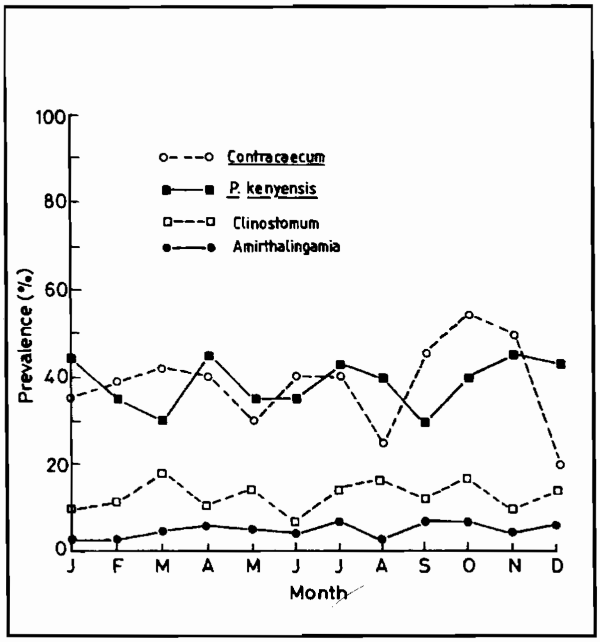

Fig. 7. Monthly Variation in the Prevalence of Parasites in *Oreochromis leucostictus* in Lake Naivasha

However, a very significant variation was observed in the prevalence of the *Contracaecum* within sampling stations, with Oloidien bay recording the highest number of infected hosts while towards the middle of the lake no infected hosts were found (Table I). Another significant variation was observed in the intensity of infection at various sites where *O. leucostictus* from Oloidien were more heavily infected by the nematode *Contracaecum* than fish caught at other stations (Table I) (maximum intensity = 68 parasites per host). *Polyacanthorynchus kenyensis* was observed to occur more abundantly in hosts caught at North Swamp (max. intensity = 104 parasites), Korongo (max. intensity = 98 parasites) and Cresent (max. intensity = 52 parasites); while *Amirthalingamia* sp. were observed to infect mainly fish from Oloidien (F_{60}, 2,860 = 7.79; P<0.001).

Regression analysis revealed that there was non-significant inverse relationship between the intensity of infection with *Contracaecum* and the size of the fish. However, the intensity of infection with *P. kenyensis* increased significantly with increase in the size of the fish (t_4 = 7.06; P<0.001) (Tables II and III).

Highly significant relationships were observed between the prevalence of *Contracaecum* and *P. kenyensis* and the size of *O. leucostictus*. This was more evident in the case of *P. kenyensis* (t_4 = 3.8; P<0.002) (Fig. 8).

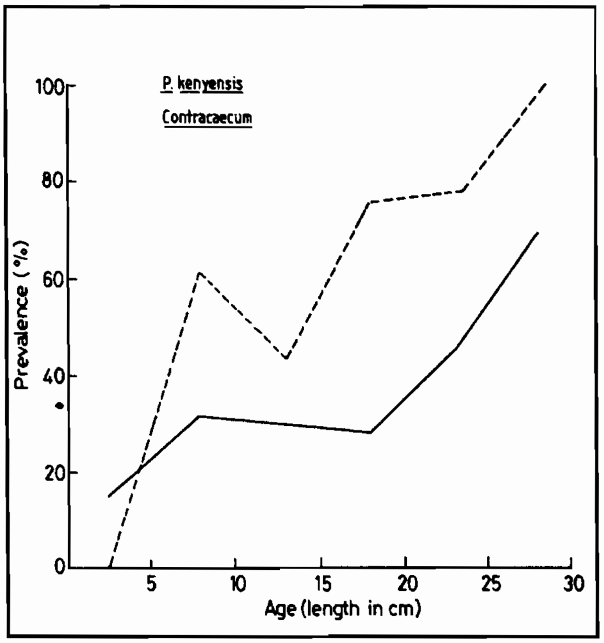

Fig. 8. Prevalence of *Contracaecum* and *P. kenyensis* with the Age of *O. leucostictus*

Using Chi-square analysis, it was observed that there was a very significant relationship between the sex of *O. leucostictus* and the intensity of infection ($X^2_{(1)}$ = 64.43; P<0.001). Male fish were observed to harbour more parasites than their female counterparts (*Contracaecum* = 205 in females vs 908 in males; and *P. kenyensis* = 778 in females vs 1766 in males) (n=540).

Results obtained have revealed that there was no significant relationship between K-factor and the number of worms (*Contracaecum* and *P. kenyensis*) (Fig. 9).

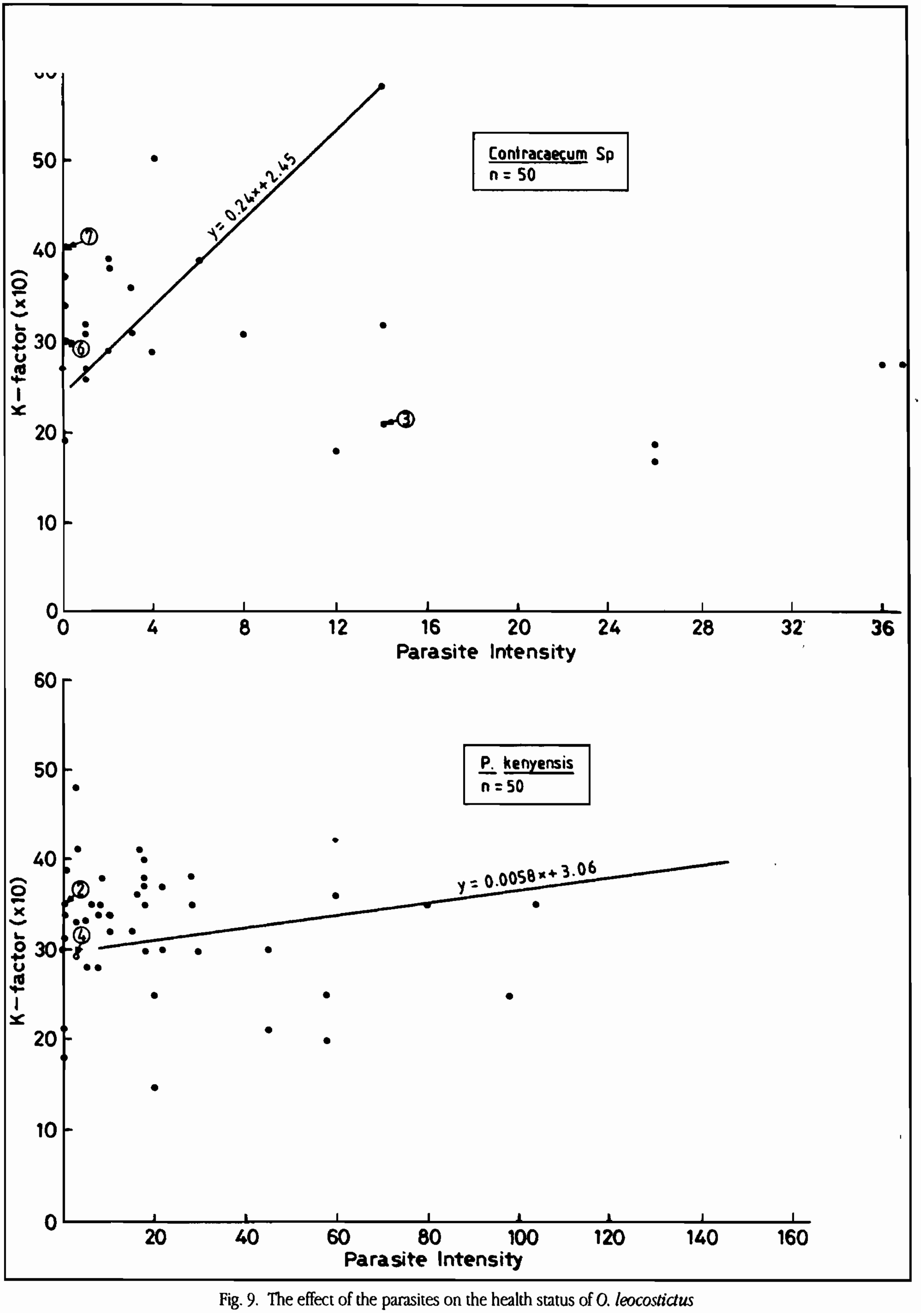

Fig. 9. The effect of the parasites on the health status of *O. leocostictus*

Table I Variation in total number of parasites within sampling stations

Stations	Total No. of *Contracaecum*	Total No. of *P. kenyensis*	Total No. of *Clinostomum*	Total No. of *Armithalingamia*	Total No. of Fish examined
1. Northswamp	39 (31)	577 (110)	33 (22)	4	165
2. Crescent	163 (98)	526 (132)	43 (20)	0	180
3. Flamingo Farm	19 (11)	156 (64)	22 (18)	12 (8)	80
4. Flamingo	75 (38)	348 (51)	41 (27)	15 (7)	65
5. Fishermen's Camp	139 (49)	347 (85)	38 (19)	13 (6)	70
6. Lakeside Farm	24 (18)	110 (40)	13 (11)	6 (4)	58
7. Middle of lake	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8. Oseria	43 (31)	345 (48)	33 (14)	10 (6)	69
9. Hippopoint	27 (15)	478 (94)	14 (10)	18 (11)	105
10. Whitehouse	38 (20)	132 (42)	11 (7)	0 (0)	74
11. Northswamp	54 (42)	488 (61)	47 (23)	47 (16)	81
12. Hopcraft	32 (28)	141 (28)	32 (12)	13 (10)	42
13. Oloidien	1282 (61)	90 (42)	7 (5)	41 (24)	61

• Numbers in parentheses indicates infected hosts

Table II Mean Intensity of infection of *O. leucostictus* with *Contracaecum*

Length class (cm)	No. of fish examined	No. of fish infected	Mean intensity (MI)	Total No. of parasites	Range of parasites
0 - 5	10	2	2.0	4	1 - 1
0 - 10	30	20	7.5	150	1 - 6
11 - 15	320	210	8.6	1800	1 - 14
16 - 20	362	172	1.4	1241	1 - 68
21 - 25	241	82	2.8	229	1 - 5
26 - 30	70	38	6.8	259	1 - 5
31 - 35	17	8	1.9	15	1 - 2

Table III Mean Intensity of infection of *O. leucostictus* with *P. kenyensis*

Length class (cm)	No. of fish examined	No. of fish infected	Mean intensity (MI)	Total No. of parasites	Range of parasites
0 - 5	10	0	0	0	0
0 - 10	30	8	1.9	15	1 - 3
11 - 15	320	125	60	750	1 - 9
16 - 20	362	194	7.2	1,406	1 - 24
21 - 25	241	37	27.6	1,023	1 - 24
26 - 30	70	16	28.6	458	1 - 68
31 - 35	17	8	10.8	86	1 - 104

DISCUSSION

Since the introduction of *O. leucostictus* in Lake Naivasha, the only probable explanation for the absence of ectoparasites is that these parasites are easily affected by any change in environmental factors such as salinity and temperature. Therefore, those that arrived into the lake with the fish may have disappeared due to the above changes. Various ectoparasites such as the argulids and ergasiliids have been reported to occur on the same fish in Lake Victoria from which *O. leucostictus* was introduced (FRYER and ILES, 1972, PAPERNA, 1980; 1991). PAPERNA (1980) also reported on the occurrence of monogenean trematodes on the tilapiine species of Lake Victoria. However, in Lake Naivasha even the other 3 fish species do not harbour any ectoparasites (ALOO, 1995). The present results have challenged those of MALVESTUTO and OGAMBO-ONGOMA (1978) and PAPERNA (1980) who reported that *O. leucostictus* from Lake Naivasha were infected only by *Contracaecum* sp.

The fact that there was no significant variation in intensity and prevalence between the months suggests that the fish are infected throughout the year. These findings do not agree with other reports from tropical waters in which the seasonality of fish parasites has been observed such as PAPERNA (1980) on *Clinostomum* sp. in tilapias in Kenya, MBAHINZIREKI (1980) on helminth parasites of *Haplochromis* spp. in Uganda and BATRA (1984) on helminth parasites of cichlids from Zambia. However, various reports on the acanthocephalans from temperature regions indicated that they infect their hosts throughout the year. These include the findings of SCHOLTZ (1986) on the *Acanthocephalus lucii* infecting *Perca fluviatilis* and AMIN (1985) on *Echinorhynchus salmonis* infecting the rainbow smelt, *Osmerus mordax*. In the tropics there is no marked seasonality as in the temperature regions hence the occurrence of parasites throughout the year as was observed during this study. Since MALVESTUTO and OGAMBO-ONGOMA (1978) suggested that *O. leucostictus* becomes infected with *Contracaecum* directly and not through an intermediate host, it is therefore possible that the parasites will be found in the hosts throughout the year because seasonality will only have a direct effect on intermediate hosts. WILLIAM and JONES (1994) linked seasonality in prevalence of fish parasites to many ecological factors e.g. water temperatures, the feeding behaviour and the diet of the hosts.

Both prevalence and intensity of infection were observed to vary from one site to another. This was attributed to the differences in the physico-chemical parameters among the sites. For example, the nematode *Contracaecum* was observed to be most abundant at Oloidien (site 13) which was a more saline environment, whereas the other parasites especially *Clinostomum* were present in very low numbers at the same site. These findings concur with those of DOGIEL *et al.*, (1958) (*In* WILLIAM and JONES, 1994) that increase in salinity increases the prevalence and abundance of some parasites but also leads to the disappearance of those parasites whose intermediate host cannot withstand high salinity such as trematodes. The second point related to variation in prevalence and intensity from site to site is the size and isolation of site 13. Depletion of parasite fauna with isolation and size of habitats had been reported (DOGIEL *et al*, 1958) (*In* WILLIAM and JONES, 1994). This was attributed to the poor invertebrate fauna of small isolated water bodies; therefore parasites that require invertebrate intermediate hosts are predominated over by those with direct life cycles. The authors concluded that among the parasites observed, *Contracaecum* seem to have a direct life cycle hence their abundance in site 13.

The present study has shown a positive trend in both prevalence and intensity of infection by *Contracaecum* sp. and *P. kenyensis* with increase in the length of the fish. The results agree with a number of reports on the same subject such as PAPERNA (1980) who reported an increase in infection rate of tilapias by the trematode *Clinostomum* as the fish increased in size. MASHEGO (1989) also reported increased intensity of infection of *Barbus* sp by the nematode *Contracaecum* with increase in fish length. Although the two did not give reasons for their observations, the present work indicates that in the case of *Contracaecum* it is possible the fish feeds more on the bottom materials containing larval worms, whereas in the case of *P. kenyensis,* the fish probably feed more on the supposed intermediate hosts (Ostracods) as they grow. Another explanation to this observation is that larval parasites will accumulate in the host over a period of time.

That male fish were observed to harbour more worms than their female counterparts is in accordance with the findings of other authors such as PALING (1965) who observed that male windermere trouts were more intensely infected than the females. He attributed this to a higher physiological resistance in females and to the large size of male fish which make them consume more food including the intermediate hosts hence more parasites. While working on the helminth parasites of the cichlids in Zambia, BATRA (1984) also observed that male fish had a higher intensity of infection than females and WILLIAM and JONES (1994) concluded that in general, male fish tend to be more heavily infected than females.

This study indicates that the presence of the nematode, *Contracaecum*, and the acanthocephalan, *P. kenyensis,* did not seem to affect the body condition of *O. leucostictus.* This agrees with the findings of MALVESTUTO (1975) and MUCHIRI (1990). Elsewhere, TOMPKINS (1976) also reported that *Contracaecum* did not affect the body condition of *O. leucostictus* from Lake Turkana while MBAHINZIREKI (1984) likewise observed that unlike *Eustrongyloides* sp, *Contracaecum* seemed to be harmless to the *Haplochromis* spp. from Lake Victoria.

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