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Parasites of South African freshwater fish. VI. Nematode parasites of some fish species in the Kruger National Park

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ABSTRACT

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The nematode parasites of 30 spot-tailed robbers, *Brycinus imberi*, five tiger-fish, *Hydrocynus vittatus*, 77 large-scaled yellowfish, *Barbus marequensis*, two mudsuckers, *Labeo molybdinus*, 114 catfish, *Clarias gariepinus*, 46 silver barbel, *Schilbe intermedius*, 66 squeakers, *Synodontis zambezensis*, three eels, *Anguilla* spp., 83 Mozambique bream, *Oreochromis mossambicus*, 81 red-breasted bream, *Tilapia rendalli swierstrae* and 32 large-mouthed bream, *Serranochromis meridianus*, caught in the Sabie, Crocodile and Olifants Rivers in the southern and central regions of the Kruger National Park, were collected, identified and counted.

A single *Camallanus* sp. male was recovered from one of the mudsuckers; *Capillaria* spp. from three catfish and one squeaker; philometrid nematodes from two silver barbel, 15 squeakers and a large-mouthed bream; *Paracamallanus cyathopharynx* from one tiger-fish, 80 catfish, 28 silver barbel and one squeaker; *Procamallanus laeviconchus* from a single catfish; *Rhabdochona esseniae* from six large-scaled yellowfish; *Rhabdochona versterae* from 14 spot-tailed robbers; *Rhabdochona* spp. from 20 catfish, 17 silver barbel, eight squeakers, two eels, one large-mouthed bream and two red-breasted bream; *Raillietnema synodontisi* from 33 squeakers; *Spinitectus petterae* from 37 catfish; *Spinitectus zambezensis* from 55 squeakers; *Spinitectus* spp. from one tiger-fish and four silver barbel, and *Spirocamallanus daleneae* and *Synodontisia thelastomoides* from 33 and 35 squeakers, respectively. Second- and third-stage *Contracaecum* spp. larvae were recovered from 26 spot-tailed robbers, five tiger-fish, one large-scaled yellowfish, 53 catfish and ten silver barbel and unidentified nematode larvae from two spot-tailed robbers, 57 large-scaled yellowfish, both mudsuckers, 105 catfish, 45 silver barbel, 58 squeakers, all three the eels, 29 Mozambique bream, 33 red-breasted bream and 26 large-mouthed bream.

Camallanus sp. in mudsuckers, *Capillaria* spp. in catfish and squeakers, *Rhabdochona* spp. in eels, catfish, silver barbel, squeakers, large-mouthed bream and red-breasted bream, *Spinitectus* spp. in tiger-fish and silver barbel, *Paracamallanus cyathopharynx* in silver barbel, tiger-fish and squeakers, *Raillietnema synodontisi* and *Synodontisia thelastomoides* in squeakers, constitute new parasite records for the respective hosts in South Africa.

With few exceptions, the fishes harboured more nematode larvae than adult nematodes but no pattern of seasonal abundance of either of the developmental stages was evident for any of the fish species examined.

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INTRODUCTION

Despite the variety of freshwater fishes in South Africa, the nematode parasites infecting these fishes have been the subject of few papers. Several of these papers record incidental findings of nematodes in fishes (Lombard 1968; Prudhoe & Hussey 1977; Bruton 1979), while others are of a taxonomic nature (Mashego 1989; 1990; Boomker 1993a; b; Boomker & Petter 1993). The papers of Whitfield & Heeg (1977), Mashego & Saayman (1981), Mashego (1989) and Boomker (1982) record the results of surveys conducted in various areas in the country, while those of Khalil (1971) and Van As & Basson (1984) are the first to establish host-parasite lists for several of the fish species. Two papers deal with disease or mortalities caused by nematodes (Lombard 1968; Jackson 1978).

Surveys of the nematode parasites of freshwater fishes have been done outside the Park in the Olifants River that flows through the central region and the Limpopo and Levuvhu Rivers that flow through the northern region of the Kruger National Park (Mashego & Saayman 1981; Mashego 1989; 1990). Although the worms recovered by Mashego & Saayman (1981) and Mashego (1989; 1990) should and indeed do occur in the Kruger National Park, as is indicated in this study, no actual records of nematodes of fishes in the Park itself could be found in the literature.

The survey was undertaken to determine the species and numbers of parasites of fishes in two major rivers in the southern region of the Kruger National Park and also to determine the seasonal prevalence of these parasites. A previous paper (Boomker 1984) describes *Phyllodistomum bavuri* (Trematoda: Gorgoderinae) from the urinary bladders of catfish and discusses the trematode's seasonal prevalence. This paper deals with the numbers and species of nematodes of all the fish species collected during the survey and, where possible, indicates trends in the seasonal fluctuation of these nematodes.

MATERIALS AND METHODS

The survey was conducted from February 1980 to January 1981 in the Sabie and the Crocodile Rivers. These are the two major rivers in the southern part of the Kruger National Park. Both rivers form part of the eastern drainage system (Wellington 1955, cited by Jubb 1967) and both arise in the mountains of the eastern Transvaal escarpment. Both are major perennial sources of water in the Park and the water in both the rivers is extensively used by agricultural activities outside the Park. On a single occasion some fish species were also caught in the Olifants River in the central region of the Park.

The fishes were caught with baited handlines and their parasites collected as described by Boomker (1982). The nematodes were recovered and counted under a stereoscopic microscope and identified under a standard microscope with interference contrast illumination. Except for second- and third-stage *Contracaecum* spp., larvae were not specifically identified, and are grouped as unidentified nematode larvae.

The terms "prevalence" and "intensity" are used here in accordance with the definitions of Margolis, Esch, Holmes, Kuris & Schad (1982).

RESULTS AND DISCUSSION

A total of 539 fishes were processed, and the collection and morphometric data of the fishes, together with the mean intensities and prevalence of their larval and adult nematode burdens, are presented in Table 1. The nematode species recovered, their mean monthly intensities and mean total intensities, range and prevalence are listed in Tables 2–4.

The helminths

Enoplida: Trichuridae

A *Capillaria* sp. and *Capillaria fritschi*, both recovered from electric eels, *Malapterurus electricus*, as well as *Capillaria yamagutii*, found in *Bagrus bayad* (Campana-Rouget 1961; Tadros & Mahmoud 1968; Khalil 1971), are the only *Capillaria* spp. recorded from African fishes. Moravec (1974a), however, regarded all these nematodes as synonyms of *Capillaria fritschi*.

Only damaged specimens were recovered from the intestines of catfish and squeakers during this survey, and they could not be assigned to a species. This is the first record of *Capillaria* spp. in South Africa.

No *Capillaria* spp. were found in the fishes from the Olifants River and only catfish in the Crocodile River were infected. Catfish and squeakers in the Sabie River were infected with small numbers of the nematodes.

Oxyurida: Pharyngodonidae

Synodontisia thelastomoides are small nematodes originally described from the intestines of *Synodontis sorex* in Senegal and *Synodontis ocellifer* in Chad (Petter, Vassiliades & Troncy 1972). The genus *Synodontisia* shows morphological similarities to the genus *Cithariniella* but differs from it in the number and configuration of the cloacal papillae and in the configuration of the pharyngeal teeth. The genus *Cithariniella* has not yet been found in South Africa and this is the first record of *Synodontisia thelastomoides* in this country. In view of its prevalence in more than 50 % of the squeakers examined, it should be regarded as a definitive parasite.

TABLE 1 Collection data and nematode infection of fishes in the Kruger National Park

Fish species and locality	Sex of fishes and number examined				Length of fishes (cm)	Mean intensity of nematodes		Prevalence of nematodes	
	Undetermined	♂♂	♀♀	Total	(Mean ± SD)	Larvae	Adults	Larvae	Adults
Sabie River									
Brycinus imberi	1	10	12	23	16,0 ± 1,9	11	5	96	61
Barbus marequensis	9	42	9	60	26,3 ± 12,5	30	1	80	10
Clarias gariepinus	0	37	30	67	53,5 ± 13,5	40	5	99	88
Schilbe intermedius	5	14	22	41	23,7 ± 9,6	195	3	98	78
Synodontis zambezensis	7	13	31	51	15,1 ± 6,0	9	131	88	100
Anguilla spp.	2	0	0	2	84,0 ± 33,0	28	3	100	100
Oreochromis mossambicus	2	27	21	50	21,7 ± 5,9	6	0	44	0
Tilapia rendalli swierstrae	5	30	9	44	19,0 ± 8,2	4	1	36	2
Serranochromis meridianus	4	17	11	32	16,7 ± 6,5	15	2	81	9
Crocodile River									
Brycinus imberi	0	2	5	7	13,7 ± 1,3	2	0	51	0
Hydrocynus vittatus	0	1	2	3	37,5 ± 5,1	161	7	100	33
Barbus marequensis	0	11	6	17	41,5 ± 4,4	11	0	65	0
Labeo molybdinus	2	0	0	2	ND[a]	2	1	100	50
Clarias gariepinus	0	25	20	45	52,6 ± 11,8	50	10	93	76
Schilbe intermedius	0	2	1	3	17,3 ± 3,5	15	1	100	67
Synodontis zambezensis	0	4	9	13	19,7 ± 3,7	33	32	85	92
Anguilla sp.	1	0	0	1	125,0	73	0	100	0
Oreochromis mossambicus	3	18	12	33	21,2 ± 4,6	2	0	21	0
Tilapia rendalli swierstrae	2	24	11	37	21,3 ± 5,6	3	1	46	3
Olifants River									
Hydrocynus vittatus	0	2	0	2	42,8 ± 4,8	37	0	100	0
Clarias gariepinus	0	0	2	2	53,5 ± 1,5	12	17	100	100
Schilbe intermedius	0	2	0	2	30,3 ± 2,7	46	5	100	100
Synodontis zambezensis	0	1	1	2	20,5 ± 0,5	1	34	50	100

[a] ND = No data

The life cycle of this nematode is unknown, but embryonated eggs are laid. Most oxyurids have a direct life cycle, and since *Synodontis zambezensis* is a bottom-feeder, it is assumed the fishes are infected by ingesting the eggs of the nematodes with their food.

Synodontisia thelastomoides was recovered from all three localities and while the ranges varied greatly, the prevalence was 50–55 %.

Ascaridida: Cosmocercidae

The genus *Raillietnema* consists of about 21 species, of which *Raillietnema synodontisi* is the only one occurring in fishes and then only in the genus *Synodontis*. It was described from *Synodontis ocellifer* in Senegal by Vassiliades (1973) and has since been recovered from *Synodontis frontosus* in Chad (Vassiliades & Troncy 1974, cited by Moravec & Řehulka, 1975) and *Synodontis eupterus* in Czechoslovakia (Moravec & Řehulka 1987). In the latter case, it is suspected that the nematode was imported along with its host into Europe (Moravec & Řehulka 1987). This is the first record of *Raillietnema synodontisi* in a South African fish species. The nematodes were not found in any other fish species examined during this study and should be regarded as a definitive parasite of squeakers as they were present in large numbers in more than 50 % of the fishes examined.

The life cycle of this nematode is unknown but is presumed to be direct (Moravec & Řehulka 1987). Eggs are embryonated when laid (Vassiliades 1973) and infection possibly takes place when the eggs are ingested by the final host with its food.

Large numbers of *Raillietnema synodontisi* were recovered from 65 % of squeakers caught in the Sabie River, but only one nematode was found in one of the 13 squeakers in the Crocodile River and one in one of the two squeakers in the Olifants River. This may indicate either that the conditions for the survival of the embryonated eggs are better in the Sabie River, or that the population of *Synodontis*

TABLE 2 The mean monthly and mean total intensities of adult and larval nematodes of various fish species collected in the Sabie River, Kruger National Park, from February 1980 to January 1981

Host and parasite species	Mean monthly intensity												Mean total intensity		Range	Prevalence
	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Larvae	Adults		
Brycinus imberi (23 fish)																
Rhabdochona versterae	ND[b]	ND	ND	ND	ND	ND	ND	3	5	1	6	5	1	5	1–14	61
Contracaecum spp. larvae[a]	ND	ND	ND	ND	ND	ND	ND	12	6	10	1	16	11	–[c]	1–47	91
Unidentified nematode larvae	ND	ND	ND	ND	ND	ND	ND	0	0	1	1	0	2	–	1	9
Barbus marequensis (60 fish)																
Rhabdochona esseniae	2	0	0	0	1	3	2	0	0	0	0	0	1	1	1–4	10
Unidentified nematode larvae	6	2	7	5	132	9	23	28	37	9	4	70	30	–	1–412	80
Clarias gariepinus (67 fish)																
Capillaria sp.[a]	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	2
Rhabdochona spp.[a]	1	1	2	0	1	3	1	0	0	0	2	0	0	2	1–5	18
Paracamallanus cyathopharynx	2	3	7	5	3	4	2	3	4	2	3	4	2	6	1–16	79
Spinitectus petterae	1	2	0	3	3	0	13	2	3	0	2	0	2	5	1–35	24
Contracaecum spp. larvae	2	5	4	19	3	1	3	8	2	0	1	5	4	–	1–35	43
Unidentified nematode larvae	57	54	23	25	47	72	33	32	56	25	13	24	38	–	1–208	97
Schilbe intermedius (41 fish)																
Philometrid nematode	ND	0	0	0	1	ND	0	0	0	0	0	1	0	1	1	5
Rhabdochona spp.[a]	ND	9	4	0	0	ND	0	1	7	6	4	2	7	4	1–19	46
Spinitectus spp.[a]	ND	3	2	0	0	ND	0	1	0	0	0	0	3	1	1–4	10
Paracamallanus cyathopharynx[a]	ND	3	1	4	2	ND	1	8	3	1	1	3	8	2	1–6	59
Contracaecum spp. larvae	ND	0	1	0	0	ND	1	4	0	2	1	2	2	–	1–4	17
Unidentified nematode larvae	ND	52	170	141	381	ND	217	101	250	219	168	287	193	–	6–521	98
Synodontis zambezensis (51 fish)																
Philometrid nematode	2	0	0	0	2	ND	3	0	0	3	2	2	0	2	1–3	28
Capillaria spp.[a]	0	0	2	0	0	ND	0	0	0	0	0	0	0	2	2	4
Rhabdochona spp.[a]	0	1	1	0	0	ND	0	0	2	0	1	0	0	1	1–3	10
Raillietnema synodontisi[a]	20	212	100	57	11	ND	285	337	64	152	50	34	0	131	1–1 000	65
Spinitectus zambezensis	35	40	3	87	23	ND	31	59	35	35	22	24	9	31	1–220	88
Spirocamallanus daleneae	6	6	2	1	6	ND	6	4	11	14	18	8	7	5	1–28	61
Synodontisia thelastomoides[a]	10	22	9	27	21	ND	17	32	31	46	12	7	0	23	1–96	55
Unidentified nematode larvae	1	5	1	0	2	ND	1	3	0	1	0	3	2	–	1–11	33
Oreochromis mossambicus (50 fish)																
Unidentified nematode larvae	0	ND[b]	5	0	4	3	3	18	2	3	1	5	6	–[c]	1–63	44
Tilapia rendalli swierstrae (44 fish)																
Rhabdochona sp.[a]	0	0	0	0	1	ND	0	0	0	0	0	0	0	1	1	2
Unidentified nematode larvae	7	0	2	0	0	ND	4	3	2	0	0	0	4	1	1–11	39
Serranochromis meridianus (32 fish)																
Philometrid nematode	ND	ND	ND	0	0	0	0	1	0	0	0	ND	0	1	1	3
Rhabdochona spp.[a]	ND	ND	ND	0	0	0	2	0	0	2	0	ND	0	2	2	6
Unidentified nematode larvae	ND	ND	ND	25	11	18	6	3	31	5	22	ND	15	–	1–72	81
Anguilla spp.																
Rhabdochona spp.[a]	ND	ND	ND	ND	ND	ND	ND	7	ND	ND	ND	2	2	3	2–7	100
Unidentified nematode larvae	ND	ND	ND	ND	ND	ND	ND	50	ND	ND	ND	2	26	–	2–50	100

[a] New host record [b] ND = No data [c] – Not applicable

TABLE 3 The mean monthly and mean total intensities of adult and larval nematodes of various fish species collected in the Crocodile River, Kruger National Park, from February 1980 to January 1981

Host and parasite species	Mean monthly intensity												Mean total intensity		Range	Prevalence
	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Larvae	Adults		
Brycinus imberi (7 fish)																
Contracaecum spp. larvae[a]	ND[b]	ND	ND	ND	ND	ND	ND	2	1	ND	ND	ND	1	0	1–6	71
Hydrocynus vittatus (3 fish)																
Spinitectus sp.[a]	0	ND	ND	ND	ND	ND	ND	ND	ND	7	ND	ND	1	6	7	50
Paracamallanus cyathopharynx[a]	0	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	1	0	1	50
Contracaecum spp. larvae[a]	125	ND	ND	ND	ND	ND	ND	ND	ND	178	ND	ND	160	–[c]	90–266	100
Barbus marequensis (17 fish)																
Contracaecum sp. larvae	ND	ND	ND	1	ND	0	ND	0	0	0	ND	0	1	–	1	6
Unidentified nematode larvae	ND	ND	ND	11	ND	0	ND	0	12	19	ND	2	11	–	2–27	53
Labeo molybdinus (2 fish)																
Camallanus sp.[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	1	–	1	50
Unidentified nematode larvae	ND	ND	ND	ND	ND	ND	ND	ND	ND	4	ND	ND	2	–	1–3	100
Clarius gariepinus (45 fish)																
Capillaria sp.[a]	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	4
Rhabdochona spp.	1	1	1	5	0	1	0	0	0	0	1	0	0	2	1–5	13
Paracamallanus cyathopharynx	3	11	1	1	5	2	2	1	4	3	6	14	5	4	1–16	56
Spinitectus petterae	4	29	1	15	7	55	4	6	1	2	0	40	3	12	1–101	47
Contracaecum spp. larvae	23	1	67	1	72	1	2	2	3	0	0	1	32	–	1–351	49
Unidentified nematode larvae	193	30	74	19	130	4	11	5	6	79	10	15	50	-	1–503	93
Schilbe intermedius (3 fish)																
Rhabdochona spp.[a]	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	1	1	1	–	1	67
Contracaecum spp. larvae	ND	ND	ND	ND	1	ND	ND	ND	ND	ND	0	1	1	-	1	67
Unidentified nematode larvae	ND	ND	ND	ND	24	ND	ND	ND	ND	ND	8	12	16	–	8–24	100
Synodontis zambezensis (13 fish)																
Rhabdochona spp.[a]	ND	ND	ND	ND	0	ND	ND	1	0	ND	1	ND	0	1	1	15
Raillietnema synodontisi[a]	ND	ND	ND	ND	0	ND	ND	1	0	ND	0	ND	0	1	1	8
Spinitectus zambezensis	ND	ND	ND	ND	112	ND	ND	28	21	ND	33	ND	41	16	1–153	69
Spirocamallanus daleneae	ND	ND	ND	ND	2	ND	ND	2	2	ND	2	ND	2	2	1–4	69
Synodontisia thelastomoides[a]	ND	ND	ND	ND	0	ND	ND	18	0	ND	36	ND	0	23	1–39	54
Unidentified nematode larvae	ND	ND	ND	ND	7	ND	ND	2	0	ND	0	ND	4	-	1–14	38
Oreochromis mossambicus (33 fish)																
Unidentified nematode larvae	ND	0	0	ND	ND	0	2	ND	1	3	1	2	2	–	1–6	21
Tilapia rendalli swierstrae (37 fish)																
Rhabdochona sp.[a]	ND	0	0	0	ND	0	0	1	0	0	0	0	0	1	–	3
Unidentified nematode larvae	ND	2	1	0	ND	1	2	4	4	2	2	1	3	-	1–10	46
***Anguilla* sp.** (1 fish)																
Unidentified nematode larvae	ND	ND	ND	ND	ND	ND	ND	ND	ND	73	ND	ND	73	–	–	100

[a] New host record [b] ND = No data [c] – Not applicable

TABLE 4 The mean total intensity of larval and adult nematodes from various fish species caught in the Olifants River, Kruger National Park, during October 1980

Host and parasite species	Mean total intensity		Range	Prevalence
	Larvae	Adults		
Hydrocynus vittatus (2 fish)				
Contracaecum spp. larvae[a]	37	–[b]	31–42	100
Clarias gariepinus (2 fish)				
Rhabdochona spp.[a]	0	32	32	50
Paracamallanus cyathopharynx	2	1	1–2	100
Procamallanus laeviconchus	0	1	1	50
Contracaecum spp. larvae	2	–	2	100
Unidentified nematode larvae	9	–	3–15	100
Schilbe intermedius (2 fish)				
Paracamallanus cyathopharynx[a]	0	5	3–6	100
Contracaecum spp. larvae	1	–	1	50
Unidentified nematode larvae	45	–	15–75	100
Synodontis zambezensis (2 fish)				
Philometrid nematode	0	4	4	50
Rhabdochona spp.	0	36	36	50
Paracamallanus cyathopharynx[a]	0	1	1	50
Raillietnema synodontisi[a]	0	1	1	50
Spinitectus zambezensis	0	10	5–15	100
Spirocamallanus daleneae	0	1	1	50
Synodontisia thelastomoides[a]	0	4	4	50
Unidentified nematode larvae	1	–	1	50

[a] New host record [b]– Not applicable

zambezensis in this river is considerably higher than those in the other rivers, thus facilitating the spread of the nematodes.

Ascaridida: Anisakidae

Prudhoe & Hussey (1977) recovered *Contracaecum* spp. larvae from the bile ducts or cysts in the mesenteries and body wall of catfish from Swaziland and two localities in the Transvaal, and stated that these larvae are exceedingly common in African freshwater fishes. Whitfield & Heeg (1977) recorded the larval *Contracaecum* spp. from five species of marine fishes as well as from catfish and Mozambique bream in Lake St Lucia. Mashego & Saayman (1981) stated that *Contracaecum* spp. larvae occur in catfish, silver barbel and 14 *Barbus* spp. in Lebowa and Venda. Van As & Basson (1984) and Mashego (1989), however, list only five *Barbus* spp. as being infected and Van As & Basson (1984) did not include the record from silver barbel in their host-parasite check-list. Boomker (1982) recorded canary kurper, *Chetia flaviventris*, as yet another host, and spot-tailed robbers and tiger-fish are recorded here as new hosts for the nematodes.

As far as their intermediate and paratenic hosts are concerned, *Contracaecum* spp. larvae do not seem to be host specific and a variety of marine and freshwater fishes can be infected. However, Thomas (1937) was unable to recover adult *Contracaecum* spp. from experimentally infected domestic ducks and chickens, thereby implying a degree of specificity for the final host. Whitfield & Heeg (1977) also reported a certain degree of host specificity of the adult nematodes.

From this and previous surveys it would appear that larger fishes, such as catfish and tiger-fish, are major paratenic hosts of *Contracaecum* spp. larvae. The nematodes were recovered from 46,5% of all catfish examined in the Kruger National Park as opposed to the 57 % and 100 % recorded by Mashego & Saayman (1981) and Boomker (1982), respectively. The numbers of worms recovered from catfish range from 1–2860 (Mashego & Saayman 1981) to 53–775 (Boomker 1982) and 1–351 (this study). Similarly, the tiger-fish from the Crocodile River harboured 90–266 larvae and those from the Olifants River 31–42. This possibly indicates either that greater numbers of *Contracaecum* spp. larvae occur in water bodies which support large piscivorous bird populations (many of which could be the final hosts of the nematodes), or that the intermediate host is more plentiful in dams than in streams or rivers. In addition, infection with

Contracaecum spp. larvae seems to be cumulative, with larger (and therefore older) fishes having more worms.

Spirurida: Camallanidae

The single *Camallanus* sp. male recovered from *Labeo molybdinus* was badly damaged and could not be identified to species level. The genus appears to be uncommon in African freshwater fishes and only *Camallanus kirandensis* from a *Barbus* sp. in Tanzania, *Camallanus lacustris* from *Lucioperca sandra* in Egypt, *Camallanus ctenopomae* from *Ctenopoma kingsleyae* in Senegal and a female *Camallanus* sp. from *Barbus paludinosus* in South Africa, have thus far been recorded (Baylis 1923; Khalil 1971; Vassiliades & Petter 1972; Mashego 1989).

Paracamallanus cyathopharynx has previously been recorded in Africa only from the clariid fishes, *Clarias* and *Heterobranchus* (Khalil 1971; Moravec 1974a, b; Mashego & Saayman 1981; Boomker 1982; Van As & Basson 1984), and some aspects of its biology have been summarized by Mashego & Saayman (1981) and Boomker (1982). The former authors do not state the prevalence of infection in their study, but 70 % of all the catfish examined during this and a previous survey (Boomker 1982) were infected with the nematodes, indicating that the intermediate host is widespread in both rivers and dams. In this study nematodes were, for the first time in this country, recovered from tiger-fish, squeakers and silver barbel, indicating that the host range may be wider than has thus far been recorded. *Paracamallanus cyathopharynx* should be considered an accidental parasite of tiger-fish and squeakers, but a definitive parasite of catfish and silver barbel.

Although the genus *Procamallanus* contains many species, the only ones recorded from South Africa are *Procamallanus laeviconchus* in catfish (Mashego & Saayman 1981; Boomker 1982; Van As & Basson 1984), and *Procamallanus slomei* and *Procamallanus brevis* from toads (Ivashkin, Sobolev & Khromova 1971). *Procamallanus laeviconchus* is one of the most prevalent and widespread nematodes (Khalil 1971; Moravec 1975) and has been recorded from 23 species of fishes, most often siluroids (Khalil 1971; Moravec 1974a).

The occurrence of one nematode in only one of the catfish (0,9 %), from the Olifants River, is surprising as it was present in 9 % (range 1–23 worms) and 32,5 % (range 1–22 worms) of catfish examined by Mashego & Saayman (1981) and Boomker (1982), respectively. This probably indicates that the intermediate host may have a limited distribution or is more common in dams.

Spirocamallanus daleneae is a recently described nematode of squeakers (Boomker 1993a), and occurred in more than half of the fishes of this species examined from each of the three localities. *Spirocamallanus spiralis*, to which *Spirocamallanus daleneae* is closely related, has not been found in this country, but has been recorded from siluroid fish elsewhere in Africa (Khalil 1971).

The Camallanidae are all ovoviviparous, live larvae escaping with the faeces of the host. The intermediate host is attracted by their movement and consumes them, and further development takes place in this host. The life cycles of *Paracamallanus cyathopharynx* and *Procamallanus laeviconchus* have been described by Moravec (1974b; 1975), who found that copepods are the intermediate hosts. The intermediate host in South Africa is, however, unknown.

Spirurida: Philometridae

Two species of philometrid nematodes have been recorded from African freshwater fishes (Khalil 1971).

They are *Nilonema gymnarchi* from *Gymnarchus niloticus* and *Thwaitia bagri* from *Bagrus bayad* (Khalil 1960; 1965). The nematodes of this family recovered from silver barbel, squeakers and large-mouthed bream in the present survey could not be identified, because of extensive damage.

The life cycles of some of the *Philometra* spp. have been described by Furuyama (1934, cited by Khalil 1969), Molnár (1966) and Moravec (1977a). These authors found that gravid females leave the fishes through the skin, the mouth or the rectum and rupture in the water to release numerous larvae. The larvae are ingested by copepods in which further development takes place and the copepods are in turn ingested by fishes to complete the life cycle.

Spirurida: Rhabdochonidae

Rhabdochona esseniae was recorded from several *Barbus* species, including *Barbus marequensis*, in Lebowa and Venda, South Africa (Mashego 1989; 1990), but Mashego (1990), in his description of the new species, does not mention the type host. Mashego (1989) limited his studies to the north-western part of the Transvaal, with the Loskop Dam in the Olifants River, which forms part of the Limpopo drain-age system, as the most southern locality. *Barbus marequensis*, however, occurs wide-spread in the Transvaal Lowveld (Jubb 1967) and the recovery of *Rhabdochona esseniae* in large-scaled yellowfish in the Sabie River is therefore not unexpected. Although present in only 10 % of the *Barbus marequensis* from the Sabie River examined during this study and in 16 % of those examined by Mashego (1989), the nematode should be considered a definitive parasite of this host. Despite their low prevalence in *Barbus lineomaculatus* (2 %), *Barbus paludinosus* (1 %) and *Barbus trimaculatus* (11 %), the nematodes should also be regarded as a definitive parasite of these hosts.

Rhabdochona versterae is a recently described nematode of spot-tailed robbers in the Sabie River (Boomker & Petter 1993). In view of its occurrence in 61 % of these fishes in this river, it should be considered a definitive parasite of this host. The nematodes were, however, not found in spot-tailed robbers in the Crocodile River.

With the exception of Mozambique bream, *Rhabdochona* spp. were recovered from all the other fish species examined in the Sabie River and only from catfish, silver barbel and squeakers in the Crocodile River, and catfish and squeakers in the Olifants River. The range and prevalence of the *Rhabdochona* spp. in catfish and squeakers in the Sabie and Crocodile Rivers were approximately the same, but considerably more worms were recovered from the small numbers of these hosts examined in the Olifants River. A few worms were recovered from some redbreasted bream from the Sabie and Crocodile Rivers, but many silver barbel in these rivers were infected.

Moravec (1972a) revised the African species of the genus and described the life cycle of *Rhabdochona ergensi* and *Rhabdochona phoxini* in Czechoslovakia (Moravec 1972b, 1977b). In both cases the intermediate hosts were found to be the nymphae of mayflies (Ephemeroptera). The life cycles of the South African species, however, are not known.

Spirurida: Cystidicolidae

Both *Spinitectus petterae* and *Spinitectus zambezensis* are recently described nematodes of catfish and squeakers, respectively (Boomker 1993b). Catfish in the Crocodile River harboured more of these nematodes and more were infected than those in the Sabie River. The two catfish examined in the Olifants River were not infected. In the Sabie River, squeakers harboured more *Spinitectus zambezensis* and more fish were infected than was the case in the Crocodile River. The two squeakers examined in the Olifants River had small burdens. The differences in the intensity and prevalence of infection could be due to the distribution of the intermediate host.

The *Spinitectus* spp. recovered from one of the tigerfish and four of the silver barbel could not be assigned to any known species. Both, however, are closely related to *Spinitectus petterae* in the configuration of the lips, and the number of caudal papillae in the males.

The life cycles of the *Spinitectus* spp. are poorly known and only brief notes on their developmental stages have been published (Moravec 1972b). It appears that *Spinitectus* spp. in Europe utilize mayfly and caddis-fly (Trichoptera) nymphae, as well as freshwater shrimps (Gustafson 1939; Johnson 1966). To the best of my knowledge, no attempt has been made to elucidate the life cycles of any of the *Spinitectus* spp. in Africa and none of the intermediate hosts is known.

Remarks

The determination of the seasonal occurrence of the various nematodes was to a large extent, probably, precluded because not all the fish species were represented during each month of the survey. However, despite some of the fish species being represented monthly, no seasonal pattern of abundance was evident even in these fishes, and nematodes were continuously present, with only minor fluctuations in their numbers.

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REFERENCES

BAYLIS, H.A. 1923. Some parasitic worms, mainly from fishes from Lake Tanganyika. *Annals and Magazine of Natural History*, 1:552–562 (Series 10).

BOOMKER, J. 1982. Parasites of South African freshwater fish. I. Some nematodes of the catfish [*Clarias gariepinus* (Burchell, 1822)] from the Hartbeespoort Dam. *Onderstepoort Journal of Veterinary Research*, 49:41–51.

BOOMKER, J. 1984. Parasites of South African freshwater fish. II. Redescription of the African species of the genus *Phyllodistomum* Braun, 1899 (Trematoda: Gorgoderinae) and the description of a new species. *Onderstepoort Journal of Veterinary Research*, 51:129–139.

BOOMKER, J. 1993a. Parasites of South African freshwater fish. IV. Description of *Spirocamallanus daleneae* n. sp. (Nematoda: Camallanidae) with comments on *Spirocamallanus spiralis* (Baylis, 1923). *Onderstepoort Journal of Veterinary Research*, 60:131–137.

BOOMKER, J. 1993b. Parasites of South African freshwater fish. V. Description of two new species of the genus *Spinitectus* Fourment, 1883 (Nematoda: Cystidicolidae). *Onderstepoort Journal of Veterinary Research*, 60:139–145.

BOOMKER, J. & PETTER, ANNIE J. 1993. Parasites of South African freshwater fish. III. *Rhabdochona (Rhabdochona) versterae* n. sp. (Nematoda: Rhabdochonidae) from the spot-tailed robber, *Alestes imberi* Peters, 1852. *Onderstepoort Journal of Veterinary Research*, 60:23–27.

BRUTON, M.N. 1979. The food and behaviour of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with emphasis on its role as a predator of cichlids. *Transactions of the zoological Society of London*, 35:47–114.

CAMPANA-ROUGET, Y. 1961. Nématodes de poissons. *Exploration hydrobiologique des lacs Kivu, Edouard et Albert (1952–1954). Rèsultats scientifiques*, 3:1–61.

GUSTAFSON, P.V. 1939. Life cycle studies on *Spinitectus gracilis* and *Rhabdochona* sp. (Nematoda: Thelaziidae). *Journal of Parasitology*, 25:12–13, Supplement.

IVASHKIN, V.M., SOBOLEV, A.A. & KHROMOVA, L.A. 1971. *Essentials of nematology*, Vol. 22, edited by K.I. SKRJABIN. Jerusalem: Israel Programme for Scientific Translations.

JACKSON, P.B.N. 1978. Health and disease in aquaculture. *Journal of the South African Veterinary Association*, 49:57–59.

JOHNSON, S. 1966. On a *Spinitectus* larvae (Spiruroidea: Nematoda) from a shrimp (Crustacea) in India. *Indian Journal of Helminthology*, 18:49–52.

JUBB, R.A. 1967. *Freshwater fishes of southern Africa*. Cape Town, Amsterdam: A.A. Balkema.

KHALIL, L.F. 1960. On a new nematode, *Nilonema gymnarchi* gen. et sp. nov. (Dracunculidae), from a freshwater fish in the Sudan. *Journal of Helminthology*, 34:55–58.

KHALIL, L.F. 1965. On a new philometrid nematode, *Thwaitia bagri* sp. nov., from a freshwater fish in the Sudan. *Journal of Helminthology*, 39:309–312.

KHALIL, L.F. 1969. Studies on the helminth parasites of freshwater fishes in the Sudan. *Journal of the Zoological Society, London*, 158:143–170.

KHALIL, L.F. 1971. Check list of the helminth parasites of African freshwater fishes. *Technical Communication of the Commonwealth Institute of Helminthology*, 42:xi + 80.

LOMBARD, G.L. 1968. A survey of fish diseases and parasites encountered in Transvaal. *Newsletter of the Limnological Society of southern Africa*, 11:170–174.

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 Research*, 19:35–37.

MASHEGO, S.N. 1990. A new species of *Rhabdochona* Railliet, 1916 (Nematoda: Rhabdochonidae) from *Barbus* species in South Africa. *Annals of the Transvaal Museum*, 35:147–149.

MASHEGO, S.N. & SAAYMAN, J.E. 1981. Observations on the prevalence of nematode parasites of the catfish, *Clarias gariepinus* (Burchell, 1822), in Lebowa, South Africa. *South African Journal of Wildlife Research*, 11:46–48.

MOLNÁR, K. 1966. Life-history of *Philometra ovata* (Zeder, 1803) and *Ph. rischta* Skrjabin, 1917. *Acta Veterinaria Academiae Scientiarum Hungaricae*, 16:227–242.

MORAVEC, F. 1972a. A revision of the African species of the nematode genus *Rhabdochona* Railliet, 1916. *Věstník Československé Společnosti Zoologické*, 36:196–208.

MORAVEC, F. 1972b. Studies on the development of the nematode *Rhabdochona (Filochona) ergensi* Moravec, 1968. *Folia Parasitologica (Praha)*, 19:321–333.

MORAVEC, F. 1974a. On some nematodes from Egyptian freshwater fishes. *Věstník Československé Společnosti Zoologické*, 38:32–51.

MORAVEC, F. 1974b. The development of *Paracamallanus cyathopharynx* (Baylis, 1923) (Nematoda: Camallanidae). *Folia Parasitologica (Praha)*, 21:333–343.

MORAVEC, F. 1975. The development of *Procamallanus laeviconchus* (Wedl, 1862) (Nematoda: Camallanidae). *Věstník Československé Společnosti Zoologické*, 39:23–38.

MORAVEC, F. 1977a. Life history of the nematode *Rhabdochona phoxini* Moravec, 1968 in the Rokytka brook, Czechoslovakia. *Folia Parasitologica (Praha)*, 24:97–105.

MORAVEC, F. 1977b. The development of the nematode *Philometra abdominalis* Nybelin, 1928 in the intermediate host. *Folia Parasitologica (Praha)*, 24:237–245.

MORAVEC, F. & ŘEHULKA, J. 1987. First record of the cosmocercoid nematode *Raillietnema synodontisi* Vassiliades, 1973 from the aquarium-reared upside-down catfish, *Synodontis eupterus* Boulenger. *Folia Parasitologica (Praha)*, 34:163–164.

PETTER, ANNIE J., VASSILIADES, G. & TRONCY, P.M. 1972. Trois espèces d'oxyures parasites de poissons en Afrique. *Annales de Parasitologie* (Paris), 47:569–579.

PRHUDHOE, S. & HUSSEY, C.G. 1977. Some parasitic worms in freshwater fishes and fish-predators from the Transvaal, South Africa. *Zoologica Africana*, 12:113–147.

TADROS, G. & MAHMOUD, M.I. 1968. On *Capillaria yamagutii* sp. nov. (Nematoda: Trichuridae) from the Nile fish *Bagrus bayad*. *Journal of veterinary Science of the United Arabian Republic*, 5:133–142.

THOMAS, L.J. 1937. On the life cycle of *Contracaecum spiculigerum* (Rud.). *Journal of Parasitology*, 23:429–431.

VAN AS, J.G. & BASSON, LINDA 1984. Checklist of freshwater fish parasites from southern Africa. *South African Journal of Wildlife Research*, 14:49–61.

VASSILIADES, G. 1973. Un nouveau *Raillietnema* (Nematoda: Cosmocercoidea) parasite de poisson, au Senegal. *Bulletin de l'Institut Fondamental d'Afrique Noire*, 35:815–821.

VASSILIADES, G. & PETTER, A.J. 1972. *Camallanus ctenopomae* n. sp. (Nematoda: Camallanidae) parasite de *Ctenopoma kingsleyae* Gunther (Poisson: Anabantidae) au Sénégal. *Annales de Parasitologie* (Paris) 47:383–389.

WHITFIELD, A.K. & HEEG, J. 1977. On the life cycles of the cestode *Ptychobothrium belones* and nematodes of the genus *Contracaecum* from Lake St Lucia, Zululand. *South African Journal of Science*, 73:121–122.