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Research Article

Comparison of Specific Ecological Parameters of Nematodes in Six Common Fish Species from the Senegal River and the Gambia River

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Abstract

The Senegal River and the Gambia River share the same sedimentary basin, the same source, and have geographical proximity. This study, conducted over three consecutive years in the Senegal River and the Gambia River, aimed to perform a comparative analysis of the prevalence, abundance, mean intensity, and abundance index of nematodes in six fish species common to both locations: *Citharinus citharus, Clarias gariepinus, Chrysichthys maurus, Hydrocynus forskahlii, Mormyrops anguilloides,* and *Synodontis ocellifer*. The inventory of parasitic nematodes in these fish revealed that *Chrysichthys maurus* hosts the highest diversity of parasitic nematodes, with nine genera identified. *Citharinus citharus* and *Mormyrops anguilloides* are each parasitized by only one nematode genus, Cithariniella and Contracaecum, respectively. Except of Spirocamallanus and Camallanus, which were found exclusively in *C. maurus*, most nematode genera are shared among the different fish hosts. The genus Anisakis exhibits the highest prevalence, with 29.03% in the Senegal River, while Cithariniella shows the highest abundance, mean intensity, and abundance index. Other nematode genera, such as Paracamallanus, Procamallanus, Rhabdochona, Contracaecum, Spirocamallanus, Spinitectus, and Falcaustra, display variable ecological parameters. These nematodes are distributed within the liver and various sections of the digestive tract.

Keywords

Fish, Nematodes, Prevalence, Abundance, Mean Intensity, Abundance Index

1. Introduction

Several studies on the distribution of African freshwater fish have shown that ichthyofauna is unevenly distributed across the continent over geological time. In fact, continental aquatic biodiversity is the result of a long evolutionary history of species, shaped by climate and geomorphological changes [12].

Senegal and The Gambia are two geographically, economically, socially, and culturally close countries. The Senegal and Gambia Rivers, which flow through these nations, are located within the same Senegal-Mauritanian sedimentary basin, extending from Mauritania to Guinea-Bissau. Both rivers originate in the Fouta-Djallon highlands in Guinea and flow into the Atlantic Ocean [20, 11]. Given these similarities, the two rivers are likely to share several fish species that may

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host the same parasites.

The aim of this study is to inventory several fish species common to both the Senegal and Gambia Rivers and their parasitic nematodes. We note that the fish studied in this work are infected with several other groups of parasites. However, we specialize in the study of nematodes to ensure continuity. Indeed, in Senegal, several authors have studied fish nematodes [21]. Therefore, this current work adds to the many studies already carried out. It seeks to evaluate ecological parameters, including prevalence (P), abundance (A), mean intensity (MI), and the specific dominance index (DI) of parasitic nematodes, based on location, season, and host sex. Additionally, the study assesses the relationships between prevalence and the infestation sites of nematodes. These results will also allow us to establish a correlation between parasitic nematodes in fish and those in humans, and to determine the times of year when parasitism is highest.

2. Materials and Methods

The fish were collected at Richard-Toll (16°27′31.96″ N, 15°41′38.56″ W) on the Senegal River (S) and at Gouloumbou (13°34′58.82″ N, 13°41′44.21″ W), a Senegalese territory located on the Gambia River (G). The following map shows the sampling locations.

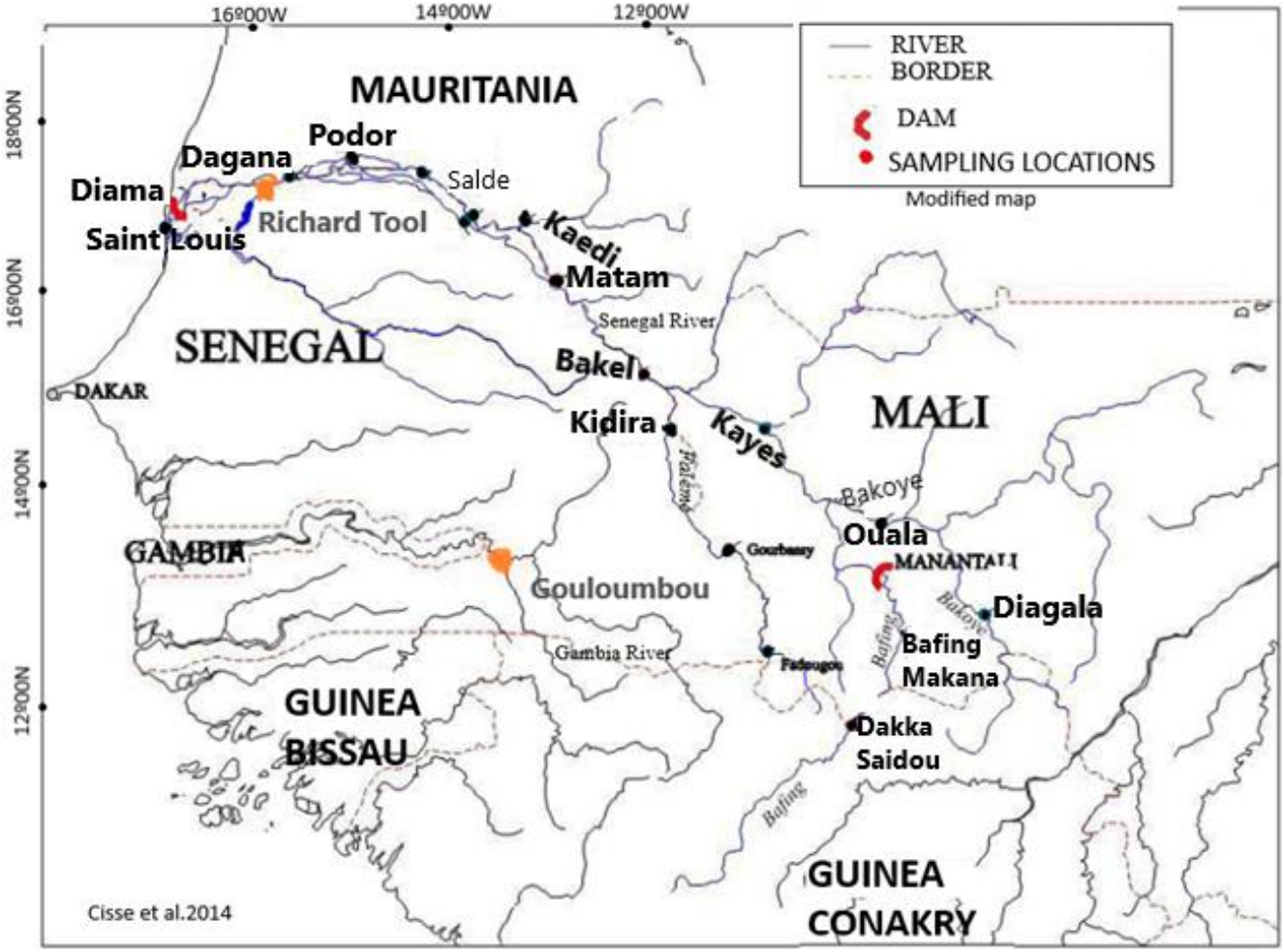

Figure 1. *Geographical distribution of sampling locations.*

Fish sampling was carried out randomly between 2018 and 2021 during both the rainy and dry seasons and in two different localities, the Senegal River and the Gambia River [21]. The fish specimens were transported to Cheikh Anta Diop University in Dakar, specifically to the Animal Biology Department within the Faculty of Science and Technology.

Fish identification was performed according to [14]. Dissection enabled determination of sex and collection of nematodes from various organs (stomach, intestine, rectum, and liver). These roundworms were subsequently preserved in 70% ethanol and examined using a Nikon optical microscope.

Statistical Analysis

We calculated prevalence, mean abundance, dominance index and mean intensity following the methodology of [26]. Ecological terms:

Prevalence is given by the following formula:

$$P (\%) = N/H * 100$$

Where (N) is the number of hosts infested by a parasite species and (H) is the number of fish examined.

The average abundance (A) corresponds to the total number of individuals of a parasite species (n) out of the total number of individuals examined (H).

$$A = n/H$$

The average intensity is the total number of parasites of a particular species found in a sample divided by the number of hosts infected by that parasite.

$$MI = n/N$$

Where (n) is the total number of individuals of a parasite species and (N) is the number of infested hosts.

The dominance index corresponds to the percentage ratio of the number of individuals of a parasite species (n) to the total number of individuals (all species combined) (Ni).

$$DI (\%) = n/Ni * 100$$

Data entry and statistical computations were performed using R software (version 4.0.0) and Microsoft Word (2016).

3. Results

The Senegal River and Gambia River exhibit substantial ichthyological diversity. Among their fish communities, six species were common to both systems: *Citharinus citharus*, *Clarias gariepinus*, *Chrysichthys maurus*, *Hydrocynus forskahlii*, *Mormyrops anguilloides*, and *Synodontis ocellifer*. A total of 749 fish specimens were collected. Table 1 presents the distribution of host fishes by sex, location, and seasonal variation.

Table 1. *Distribution of Host Fish by Sex, Locality, and Season.*

Host Fishes	Senegal River				Gambia River			
	Dry season		wet season		Dry season		wet season	
	Male	Female	Male	Female	Male	Female	Male	Female
Citharinus citharus Geoffroy Saint-Hilaire, 1809	29	34	30	18	21	18	39	25
Clarias gariepinus Burchell, 1822	17	9	13	12	0	0	15	16
Chrysichthys maurus Valenciennes, 1840	37	29	0	0	21	22	27	37
Hydrocynus forskahlii Cuvier, 1819	19	21	22	23	26	23	21	14
Mormyrops anguilloides Linnaeus, 1758	0	21	0	0	22	14	0	0
Synodontis ocellifer Boulenger, 1900	13	13	0	0	13	15	0	0

A total of 360 fish were sampled in the Senegal River compared to 339 in the Gambia River. The dry season sampling yield was higher in the Senegal River than in the Gambia River, while the reverse pattern was observed during the rainy season. Overall, fish catch numbers were significantly greater during the dry season than the rainy season (t-test, $p<0.05$). This likely reflects increased fish availability during low water levels caused by seasonal evaporation.

Male fish specimens outnumbered females across all sampling locations and seasons. *Citharinus citharus*, *Chrysichthys maurus*, and *Hydrocynus forskahlii* were the most abundantly represented species, forming the dominant taxa at all collection sites.

Following nematode collection, parasitological metrics (prevalence, abundance, mean intensity, and dominance index) were calculated and summarised in Table 2.

Table 2. *Site-Specific Parameters by Locality.*

	Nematode Species	Site-Specific Ecological Parameters							
		Prevalence (%)		Mean Abundance		Mean parasitic intensity		Dominance Index (%)	
		Senegal River	Gambia River	Senegal River	Gambia River	Senegal River	Gambia River	Senegal River	Gambia River
C. citharus	Chathariniella citharini Khalil, 1964	9,91	-	1,243	-	12,545	-	100	-
	Chathariniella sp	-	27,885	-	5,442	-	19,517	-	100
	Contracaecum larvae	6.452	0	0.839	0	13	0	6.046	0
	Paracamallanus sp	0	12,903	0	0,613	0	4,75	0	90,476
C. gariepinus	*Procamallanus laeviconchus* Wedl, 1862	16,129	-	2,613	-	16,2	-	18,837	-
	Procamallanus sp	-	9,524	-	0,064	-	1	-	9,524
	Anisakis larvae	29,03	0	4,37	0	15,05	0	0,6	0
	Chathariniella khalili Petter and al., 1972	0	2,062	0	0,062	0	3	0	9,231
	Paracamallanus sp	0	1,031	0	0,01	0	1	0	1,538
	Procamallanus sp	0	9,278	0	0,319	0	3,444	0	47,692
	Larvae of *Rhabdochona sp*	0	1,031	0	0,01	0	1	0	1,538
C. maurus	Contracaecum larvae	1,316	2,062	0,131	0,021	10	1	100	3,077
	Anisakis larvae	0	1,031	0	0,144	0	14	0	21,538
	Spirocamallanus sp	0	2,062	0	0,144	0	1	0	3,077
	Spinitectus sp	0	1,031	0	0,01	0	1	0	1,538
	Larvae of *Falcaustra guiersi* Vassilades, 1973	0	2,062	0	0,062	0	3	0	9,231
	Camallanus ctenopomae Petter (1972).	0	1,031	0	0,01	0	1	0	1,538
	Rhabdochona sp	3,158	2,703	0,031	0,392	1	3,222	100	60,417
H. forskahlii	Contracaecum larvae	0	4,054	0	0,216	0	5,333	0	33,333
	Spinitectus sp	0	1,351	0	0,027	0	2	0	4,167
	Anisakis larvae	0	1,351	0	0,013	0	1	0	2,083
M. anguilloides	Contracaecum larvae	0	7,692	0	0,077	0	1	0	100
	Chathariniella khalili Khalil, 1964	0	7,143	0	0,178	0	2,5	0	6,097
	Spinitectus sp	0	3,571	0	0,036	0	1	0	1,219
S. ocellifer	*Falcaustra guiersi* Vassilades, 1973	0	42,857	0	2,714	0	6,333	0	92,683
	Procamallanus laeviconchus Wedl, 1862	7,692	0	0,385	0	5	0	90.90	0
	Contracaecum larvae	3,846	0	0,038	0	1	0	9.909	0

Citharinus citharus exclusively harboured nematodes of the genus *Chathariniella*. Prevalence, abundance, and mean intensity values were significantly higher in the Gambia River for *Chathariniella* sp. (Fisher, pvalue =8.079e-07), whereas the Senegal River population was parasitised solely by *Chatharini-iella citharini*.

In the Gambia River, *C. gariepinus* were parasitised by *Contracaecum* and *Anisakis* larvae, alongside nematodes of the genus *Procamallanus*. In the Senegal River the fish harboured *Procamallanus* infections, with significantly higher parasitological metrics (prevalence, abundance, and intensity) for *Procamallanus laeviconchus* in the Senegal River (Fisher, p < 1.2e-15). The Gambia River specimens additionally hosted *Paracamallanus* sp.

Chrysichthys maurus harboured nematodes from ten genera, though only *Contracaecum* occurred in both river systems. *Contracaecum* exhibited significantly higher abundance, mean intensity, and dominance index in the Senegal River (p < 0.01), while prevalence was greater in the Gambia River (p = 0.017).

Four nematode genera parasitise *Hydrocynus forskahlii*: Rhabdochona, Contracaecum, Spinitectus, and Anisakis. Rhabdochona occurred in both river systems, with significantly higher prevalence, abundance, and intensity in the Senegal River (p < 0.05). In contrast, Contracaecum, Spinitectus, and Anisakis were restricted to H. forskahlii populations in the Gambia River.

Mormyrops anguilloides was parasitised exclusively by *Contracaecum* sp. in the Gambia River. In *Synodontis ocellifer*, three nematode taxa (*Chathariniella khalili*, *Spinitectus* sp., and *Falcaustra guiersi*) were restricted to the Gambia River population, while the Senegal River population hosted *Procamallanus laeviconchus* and *Contracaecum* sp. larvae.

Seasonal ecological parameter calculations are summarised in Table 3.

Table 3. *Season-Specific Parameters.*

	Nematode Species	Season-Specific Ecological Parameters															
		Prevalence (%)				Mean Abundance				Mean Intensity				Dominance Index (%)			
		Dry Season		Rainy Season		Dry Season		Rainy Season		Dry Season		Rainy Season		Dry Season		Rainy Season	
		G	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S
C. citharus	Chathariniella citharini Khalil, 1964		4.76		16.66		0.34		2.41		7.33		14.5		1		1
	Chathariniella sp.	100		0		24.93		0		24.93		0		1		0	
	Contracaecum larvae	0	7.69	0	0	0	1	0	0	0	13	0	0	0	6.04	0	0
	Paracamallanus sp.	0	0	12.9	0	0	0	0.61	0	0	0	4.75	0	0	0	0.9	0
C. gariepinus	*Procamallanus laeviconchus* Wedl, 1862		19.23		0		3.11		0		16.2		0		1		0
	Procamallanus sp.	0		6.45		0		0.06		0		1		0		0.09	
	Anisakis larvae		29,03	0	0	0	4,37	0	0		15,05	0	0	0	0,6	0	0
C. maurus	*Chathariniella khalili* Petter and al., 1972	0	0	3.12	0	0	0	0.09	0	0	0	3	0	0	0	0.09	0
	Paracamallanus sp.	0	0	1.56	0	0	0	1.56	0	0	0	1	0	0	0	0.01	0
	Procamallanus sp.	0	0	14.06	0	0	0	0.48	0	0	0	3.44	0	0	0	0.5	0
	Larvae of *Rhabdochona sp.*	0	0	1.56	0	0	0	0.015	0	0	0	1	0	0	0	0.016	0
	Contracaecum larvae	6.06	1.31	0	0	0.06	0.13	0	0	1	10	0	0	0.66	1	0	0
	Anisakis larvae	0	0	1.56	0	0	0	0.21	0	0	0	14	0	0	0	0.22	0

	Nematode Species	Season-Specific Ecological Parameters															
		Prevalence (%)				Mean Abundance				Mean Intensity				Dominance Index (%)			
		Dry Season		Rainy Season		Dry Season		Rainy Season		Dry Season		Rainy Season		Dry Season		Rainy Season	
		G	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S
	Spirocamallanus sp.	0	0	3.12	0	0	0	0.03	0	0	0	1	0	0	0	0.03	0
	Spinitectus sp.	0	0	1.56	0	0	0	0.01	0	0	0	1	0	0	0	0.01	0
	Larvae of *Falcaustra guiersi* Vassilades, 1973	0	0	3.12	0	0	0	0.09	0	0	0	3	0	0	0	0.09	0
	Camallanus ctenopomae Petter (1972).	3.03	0	0	0	0.03	0	0	0	1	0	0	0	0.3	0	0	0
	Rhabdochona sp.	6.12	3.33	24	3.07	0.28	0.03	0.6	0.03	4.66	1	0.4	2	0.46	1	0.83	2
H. forskahlsg7ii	Contracaecum larvae	4.08	0	4	0	0.28	0	0.08	0	7	0	2	0	0.46	0	0.11	0
	Spinitectus sp.	2.04	0	0	0	0.04	0	0	0	2	0	0	0	0.06	0	0	0
	Anisakis larvae	0	0	4	0	0	0	0.04	0	0	0	1	0	0	0	0.05	0
M. anguilloides	Contracaecum larvae	7.40	0	0	0	0.07	0	0	0	1	0	0	0	1	0	0	0
	Cithariniella khalili Khalil, 1964	7.14	0	0	0	0.17	0	0	0	2	0	0	0	0.06	0	0	0
	Spinitectus sp.	3.5	0	0	0	0.03	0	0	0	1	0	0	0	0.01	0	0	0
S. ocellifer	*Falcaustra guiersi* Vassilades, 1973	42.85	0	0	0	2.71	0	0	0	6.33	0	0	0	0.92	0	0	0
	Procamallanus laeviconchus Wedl, 1862	0	7.69	0	0	0	0.38	0	0	0	5	0	0	0	0.9	0	0
	Contracaecum larvae	0	3.8	0	0	0	0.03	0	0	0	1	0	0	0	0.09	0	0

In *C. citharus*, nematodes of the genus *Citharinella* show higher prevalence, abundance, and mean intensity in the Gambia River during the dry season, particularly *Cithariniella* sp. The dominance index remains constant and equal to 1 at both sampling sites. However, during the rainy season, these parameters drop to zero in the Gambia River. In contrast, in the Senegal River, *Cithariniella citharini* displays higher prevalence, abundance, mean intensity, and dominance index during the rainy season compared to the dry season.

In *C. gariepinus*, the genus *Paracamallanus* was present during the rainy season in the Gambia River (*Paracamallanus* sp.), whereas *Anisakis* occurred in the Senegal River during the dry season. This host also harboured *Procamallanus* spp. year-round, though infection parameters (prevalence, abundance, intensity) were higher for *Procamallanus laeviconchus* in the Senegal River.

In *C. maurus*, the nematodes *Cithariniella khalili*, *Paracamallanus* sp., *Procamallanus* sp., larval *Rhabdochona* sp., *Anisakis*, *Spirocamallanus* sp., *Spinitectus* sp., and larval *Falcausatra guiersi* were absent during the dry season but present exclusively in the Gambia River during the rainy season. In contrast, larval *Contracaecum* occurred only in the dry season, with higher infection parameters in the Gambia River. The nematode *Camallanus ctenopomae* parasitised *C. maurus* solely in the dry season and only in the Senegal River.

In *H. forskahlii*, *Rhabdochona* sp. was present year-round in both rivers, with higher prevalence in the Gambia River. Larval *Contracaecum* and *Spinitectus* sp. were also detected in *H. forskahlii* in the Gambia River, but only during the dry season, with *Contracaecum* exhibiting higher infection metrics. *Anisakis* was restricted to the Gambia River and occurred exclusively in the rainy season.

In *S. ocellifer*, nematodes of the genera *Contracaecum*, *Citharinella*, *Spinitectus* and *Falcaustra* were present exclusively during the dry season in the Gambia River, with higher infection parameters observed for *Falcaustra guiersi*. How-

ever, *Procamallanus laeviconchus* and *larval Contracaecum* occurred only in the Senegal River during the dry season.

The calculation of prevalence, abundance, mean intensity and dominance index by sex yielded the following results (Table 4).

Table 4. *Sex-Specific Parameters.*

Host Fish	Nematode species	Gender-specific ecological parameters															
		Prevalence (%)				Abundance				Mean Intensity				Dominance Index (%)			
		Male		Female		Male		Female		Male		Female		Male		Female	
		G	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S
C. citharus	Chitariniella citharini Khalil, 1964		11,86		7,69		1,10		1,40		9,28		18,25		100		100
	Chitariniella sp.	29,58		25		5,89		4,62		19,90		18,5		100		100	
	Contracaecum larvae	0	10	0	0	0	1.3	0	0	0	13	0	0	0	9.48	0	0
C. gariepinus	*Paracamallanus sp.*	20	0	6,25	0	0,87	0	0,37	0	4,33	0	6	0	86,67	0	100	0
	Procamallanus laeviconchus Wedl, 1862		20		9,09		3,4		1,18		17		13		24,82		8,33
	Procamallanus sp.	13,33		0		0,13		0		1		0		13,33		0	
	Aanisakis larvae	0	55	0	63,63	0	7,2	0	11,54	0	13,09	0	18,14	0	0,52	0	0,81
C. maurus	*Chitariniella khalili* Petter and al., 1972	2,08	0	2,04	0	0,08	0	0,04	0	4	0	2	0	13,33	0	5,71	0
	Paracamallanus sp.	2,08	0	0	0	0,02	0	0	0	1	0	0	0	3,33	0	0	0
	Procamallanus sp.	6,25	0	12,24	0	0,12	0	0,51	0	2	0	4,17	0	20	0	71,43	0
	Larvae *of Rhabdochona sp.*	2,08	0	0	0	0,02	0	0	0	1	0	0	0	3,33	0	0	0
	Larvae of Contracaecum	0	0	4,08	3,45	0	0	0,04	0,34	0	0	1	10	0	0	2,86	100
	Anisakis larvae	2,08	0	0	0	0,29	0	0	0	14	0	0	0	46,67	0	0	0
	Spirocamallanus sp.	2,08	0	2,17	0	0,02	0	0,02	0	1	0	1	0	3,33	0	2,86	0
	Spinitectus sp.	0	0	2,17	0	0	0	0,02	0	0	0	1	0	0	0	2,86	0
	Larvae of *Falcaustra guiersi* Vassilades, 1973	2,08	0	2,17	0	0,06	0	0,06	0	3	0	3	0	10	0	8,57	0
	Camallanus cteno-pomae Petter (1972).	0	0	2,17	0	0	0	0,02	0	0	0	1	0	0	0	2,86	0
	Rhabdochona sp.	10,81	1,96	13,51	4,54	0,30	0,02	0,49	0,04	3	1	3,6	1	91,67	100	50	100
H. forskahlii	Contracaecum larvae	0	0	8,11	0	0	0	0,43	0	0	0	5,33	0	0	0	43,24	0
	Spinitectus sp	0	0	2,70	0	0	0	0,54	0	0	0	2	0	0	0	5,56	0
	Anisakis larvae	2,70	0	0	0	0,03	0	0	0	1	0	0	0	8,33	0	0	0
M. anguilloides	Contracaecum larvae	0	0	14,28	0	0	0	0,14	0	0	0	0	0	0	0	100	0
S. ocellifer	*Chitariniella khalili* Khalil, 1964	7,69	0	6,67	0	0,31	0	0,07	0	4	0	1	0	15,38	0	1,78	0
	Spinitectus sp.	0	0	6,67	0	0	0	0,07	0	0	0	1	0	0	0	1,78	0

Host Fish	Nematode species	Gender-specific ecological parameters															
		Prevalence (%)				Abundance				Mean Intensity				Dominance Index (%)			
		Male		Female		Male		Female		Male		Female		Male		Female	
		G	S	G	S	G	S	G	S	G	S	G	S	G	S	G	S
	Falcaustra guiersi Vassilades, 1973	23,08	0	60	0	1,69	0	3,6	0	0	7,33	6	0	84,61	0	96,43	0
	Procamallanus laevi-conchus Wedl, 1862	0	0	0	15,38	0	0	0	0,77	0	0	0	5	0	0	0	90,91
	Contracaecum larvae	0	0	0	7,69	0	0	0	0,08	0	0	0	1	0	0	0	9,09

Nematodes of the genus *Citharinella* exhibited higher prevalence in male *C. citharus*, particularly within the Gambia River. In *C. gariepinus*, *Paracamallanus* sp. infections were more frequent in males from the Gambia River, while *Procamallanus* spp. were absent in females from the same location. Male *C. gariepinus* showed elevated infection parameters for *Paracamallanus* and *Procamallanus*, whereas *Anisakis* metrics were significantly higher in females.

For *C. maurus*, *Citharinella khalili*, *Paracamallanus sp*., *Procamallanus sp*., *Rhabdochona sp*., *Spirocamallanus sp.*, and larval stages of *Falcaustra guiersi* and *Anisakis* occurred exclusively in the Gambia River, with males displaying higher infection parameters - except for *Procamallanus* which showed female-biased infections. Larval *Contracaecum*, *Spinitectus* sp. and *Camallanus ctenopomae* were absent in males but present in females from this river.

In *H. forskahlii*, females demonstrated significantly greater prevalence, abundance, mean intensity and dominance indices than males, particularly in Gambia River specimens. Larval *Contracaecum* and *Spinitectus sp.* infections were restricted to females in the Gambia River, while *Anisakis* occurred exclusively in males.

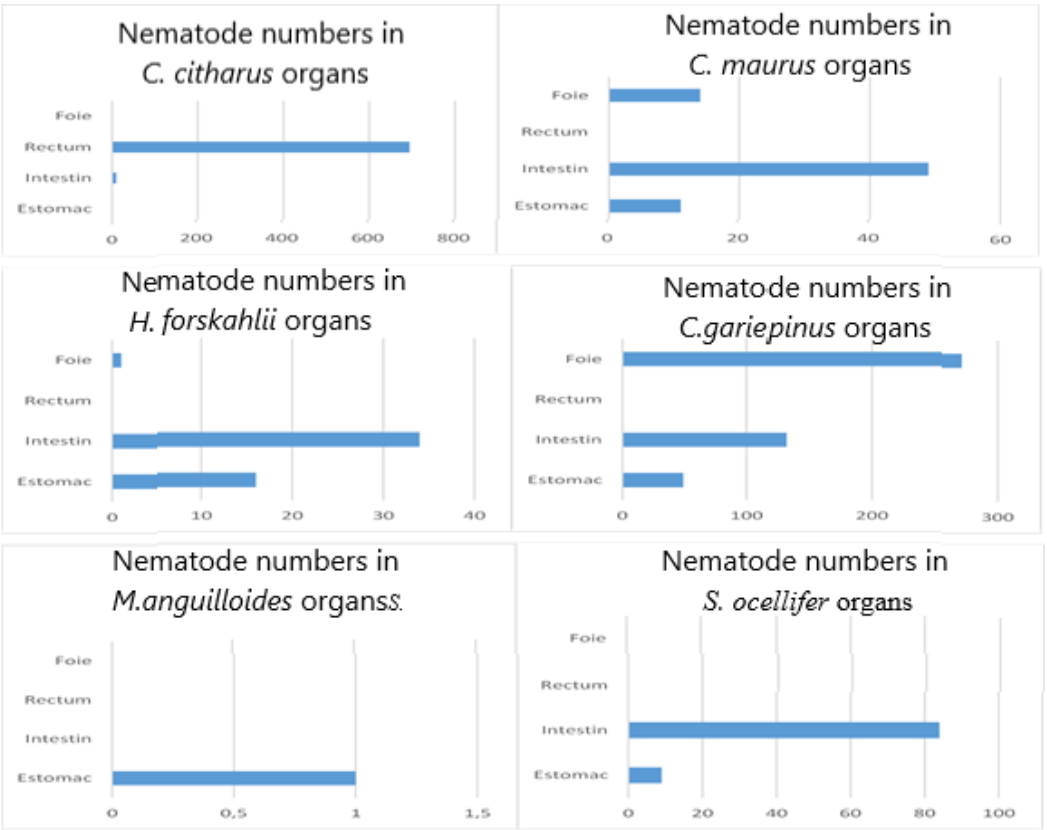

Figure 2. *Distribution of nematodes in the organs of host poisons.*

Certain fish organs exhibited particularly high nematode densities. The rectum of *C. citharus* (primarily infected by *Citharinella* spp.) and the liver of *C. gariepinus* (dominated by *Anisakis* spp.) showed the heaviest parasite loads. Conversely, other organs demonstrated lower infestation rates, including the intestines of *C. citharus* and *M. anguilloides*, and the liver of *H. forskahlii*.

Moderate parasite burdens were observed in *C. maurus* and *S. ocellifer*, though their intestinal tracts consistently harboured higher nematode numbers than other organs. Notably, parasite biodiversity did not correlate with infection intensity - hosts with the highest worm burdens were typically infected by just a single genus.

4. Discussion

Our findings demonstrate that only nematodes of the genus *Citharinella* parasitize *C. citharus*, observed across all sampled fish from both localities and during both seasons. This aligns with the work of [10], who described three *Citharinella* species (*C. citharini*, *C. khalili*, and *C. gonzalesi*) in fish collected in November, shortly after the rainy season in Senegal. Notably, *C. citharini* infecting *C. citharus* exhibited a prevalence of 60%. In contrast, [8] reported a lower prevalence of 10% in the same host species sampled between May and November in Nigeria, suggesting spatial and temporal variability in infection dynamics.

Our results further highlight seasonal and geographical variations in prevalence, with the Gambia River showing higher infection rates during the dry season. This pattern may be linked to host migratory behaviour. Indeed, [6] identified *Citharinus citharus* as a migratory species, moving in response to flood and drought cycles. [13] documented its seasonal dispersal from Lake Guiers to the Senegal River during flood periods, which could facilitate the species' broad geographical distribution and explain observed prevalence fluctuations.

Clarias gariepinus was found to host nematodes of the genera Procamallanus, Paracamallanus, and Anisakis. These findings align with previous reports from various African localities [1-3, 28]. Notably, our specimens exhibited higher Procamallanus infection rates during the dry season, consistent with observations by [7].

While most aforementioned studies reported no significant sex-based differences in infection rates for *C. gariepinus*, our data revealed male-biased parasitism for both *Procamallanus* and *Paracamallanus*. This discrepancy may reflect regional variations in host ecology or parasite transmission dynamics.

Regarding organ distribution, [22] documented heavier intestinal infections by adult *Procamallanus* and *Paracamallanus* nematodes, while [23] reported the first occurrence of these genera in bile vesicles. Contrasting with our findings, neither study detected nematodes in liver tissue, suggesting potential differences in parasite tropism across host populations or geographical regions.

In *H. forskahlii*, four nematode genera (*Rhabdochona*, *Contracaecum*, *Spinitectus*, and *Anisakis*) were identified in specimens from the Gambia River, while only *Rhabdochona* was found in those from the Senegal River. This genus was similarly reported by [18] in Lake Turkana, Kenya. The observed disparity in parasite diversity between rivers may reflect differences in food web complexity, with more diverse infection sources likely existing in the Gambia River system.

Contracaecum emerged as the most prevalent nematode genus in *H. forskahlii*, consistent with findings by [25, 15], and [27]. However, our study recorded lower and seasonally stable prevalence rates for this genus, contrasting with the significantly higher values reported by [25] and [27]. Notably, we observed sex-biased infection patterns, with females showing higher prevalence, mean intensity, and abundance of *Contracaecum* - a finding that aligns with [27]'s results.

Certain nematodes are common to specific hosts. Indeed, the genus *Contracaecum* parasitises *S. ocellifer*, *M. anguilloides*, and *C. maurus*. Its prevalence and abundance are higher in *M. anguilloides*, while its mean intensity is higher in *C. maurus*. It is also the only nematode found in *M. anguilloides*, where *Dujardinascaris mormyropsis* has been reported by [17]. The genera *Citharinella*, *Spinitectus*, *Falcaustra*, and *Procamallanus* are also common to *S. ocellifer* and *C. maurus*. The prevalence and abundance of the genera *Citharinella*, *Spinitectus*, and *Falcaustra* are higher in *S. ocellifer*, whereas the genus *Procamallanus* exhibits higher parameters in *C. maurus*. These nematode genera have also been reported by other authors in various hosts. Thus, [24] reported the genus *Contracaecum* in *Synodontis nigrita*, while [4] demonstrated the presence of the genera *Procamallanus* and *Citharinella* in *Synodontis schall* and *Synodontis nigrita*. [5, 9] reported the presence of the genera *Rhabdochona*, *Spinitectus*, and *Procamallanus* in *Synodontis schall* and *Synodontis bentosoda*. In contrast, other nematode genera are host-specific. This is the case for *Paracamallanus* and *Camallanus*, which are found exclusively in *C. maurus*. Their presence could be explained by a combination of biological, ecological, and evolutionary factors that interact dynamically to establish highly specialised relationships between the nematode and its host. Regarding infestation sites, they are diverse and vary according to the nematode's developmental stage, corresponding to specific areas adapted to the morphology and feeding physiology of the nematodes. Indeed, adult nematodes typically colonise the intestine and stomach, while larvae are found in the body cavity or in certain organs such as the kidney and liver.

Thus, in *C. gariepinus*, various body parts can be infected by parasites. The intestine and stomach are the most frequently parasitised organs, as shown by our results, which are consistent with those of [1, 2]. However, other organs can also harbour nematodes, such as the rectum [3] or the skin [28].

The intestine and stomach are the most frequently parasi-

tised organs in *H. forskahlii* and *M. anguilloides*. Indeed, nematodes encyst within the intestinal wall or remain free in the intestinal lumen, as shown by the work of. They can also be found on the stomach wall [17]. Other organs, such as the liver, can also be infected.

In *C. citharus*, the rectum is the most frequently parasitised organ, confirming the findings of [10] and [19]. However, other parts of the digestive tract can also harbour nematodes, such as the oesophagus, intestine, and stomach, as reported by [8, 16].

Abbreviations

P	Prevalence
A	Abundance
MI	Mean Intensity
DI	Dominance Index
S	Senegal River
G	Gambia River

Conflicts of Interest

The author declares no conflicts of interest.

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