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Infestation Of Tilapia *Oreochromis Niloticus* By Parasitic Trichodinids In The Urban And Peri-Urban Lakes Of The City Of Yamoussoukro (Central Ivory Coast)

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Abstract – This study focuses on the infestation of Trichodinid parasites on 480 individuals of Tilapia Oreochromis niloticus including 249 males and 231 females, coming from the lakes of the town of Yamoussoukro. Microscopic examination of the skin, gills and fins of these fish was carried out. An evaluation of parasite indices (parasite prevalence and intensity) was also carried out on individuals divided according to their origin (urban and peri-urban lakes), according to climatic seasons, size classes and their sex. The results made it possible to identify 5 species of parasites, including Trichodina magna, Paratrichodina africana, Trichodina centrostrigeata, Trichodinella sp and Trichodina compacta. Infestations with these parasites are highest in fish specimens caught in urban lakes. Also, the parasite prevalence is higher in male individuals than in females, with the greatest intensities observed in the rainy season for all fish.

Key words – Parasitic trichodinids, Oreochromis niloticus, Prevalence, Intensity of infestation, Lakes, Yamoussoukro.

1. CONTEXT

The presence of lake bodies of water in urban environments presents multiple interests both for human populations and for aquatic biodiversity. Through their storage capacity, they contribute to improving the quality of the living environment through the development of leisure activities, mainly by controlling the runoff of wastewater and rainwater in urban areas. It is in this context that lakes were developed in 1970 in the town of Yamoussoukro. However, the creation of these lakes has led, in addition to their initial vocation, to an increasingly growing fishing activity marked by significant exploitation of tilapia *Oreochromis niloticus* due to its economic value [1]. Unfortunately, anthropogenic pressures linked to the population growth of this city have caused the pollution of these lakes and the degradation of their habitats [2]. However, any pollution and degradation of lake habitats leads to a proliferation of parasites which pose a threat to fish communities. Among the latter, the populations of tilapia *Oreochromis niloticus*, the main product of fishing activities in the Yamoussoukro lakes, present a fairly high vulnerability to ectoparasites, in particular Trichodinidae [3]. These ciliated ectoparasites can affect the skin and gills of this fish, thus leading to a reduction in its exploited stock [4]. Despite the threat to this tilapia *Oreochromis niloticus* in the Yamoussoukro lakes, few studies have focused on the

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parasitic fauna of Trichodinidae. Indeed, the work carried out in the Agneby River (Ivory Coast) showed only the main Monogenean parasites of *Oreochromis niloticus* (*Cichlidogyrus cirratus, Cichlidogyrus halli, Cichlidogyrus tilapiae* and *Scutogyrus longicornis*) [5]. Also, the work which focused on a species of the same family of this fish in Lake Ayamé 1 made it possible to identify six species of Monogene parasites which are *Cichlidogyrus cirratus, Cichlidogyrus halli, Cichlidogyrus tilapiae, Cichlidogyrus thurstonae, Cichlidogyrus rognoni* and *Scutogyrus longicornis* [6]. The present study therefore aims at a better knowledge of the ectoparasites of the tilapia *Oreochromis niloticus* of the Yamoussoukro lakes. Specifically, this involves inventorying and determining the infestation rate of species of Trichodinidae parasitic on *Oreochromis niloticus* in the lakes of this city.

2. MATERIALS AND METHODS

2.1. Study sites

The city of Yamoussoukro is located in the center of Côte d'Ivoire and is the political capital of this country. With a population of 340,234 inhabitants, Yamoussoukro is the sixth city in Côte d'Ivoire according to the general population and housing census carried out in 2021. This city is subject to a humid tropical climate of transition, characterized by two distinct seasons : a dry season lasting from November to February and a rainy season extending from March to October, with maximum precipitation in September [7]. The physical environment of the town of Yamoussoukro is characterized by the existence of several artificial lakes distributed throughout the municipal territory. The sites selected for this study are six artificial lakes, three of which (lake 5, lake 6 and lake 8) are located in an urban area and three (lake 2, lake 4 and lake 10) in a peri-urban area. These two distinct zones were chosen in order to consider different levels of anthropization. The geographic coordinates and surface areas of the lakes studied are recorded in Table I.

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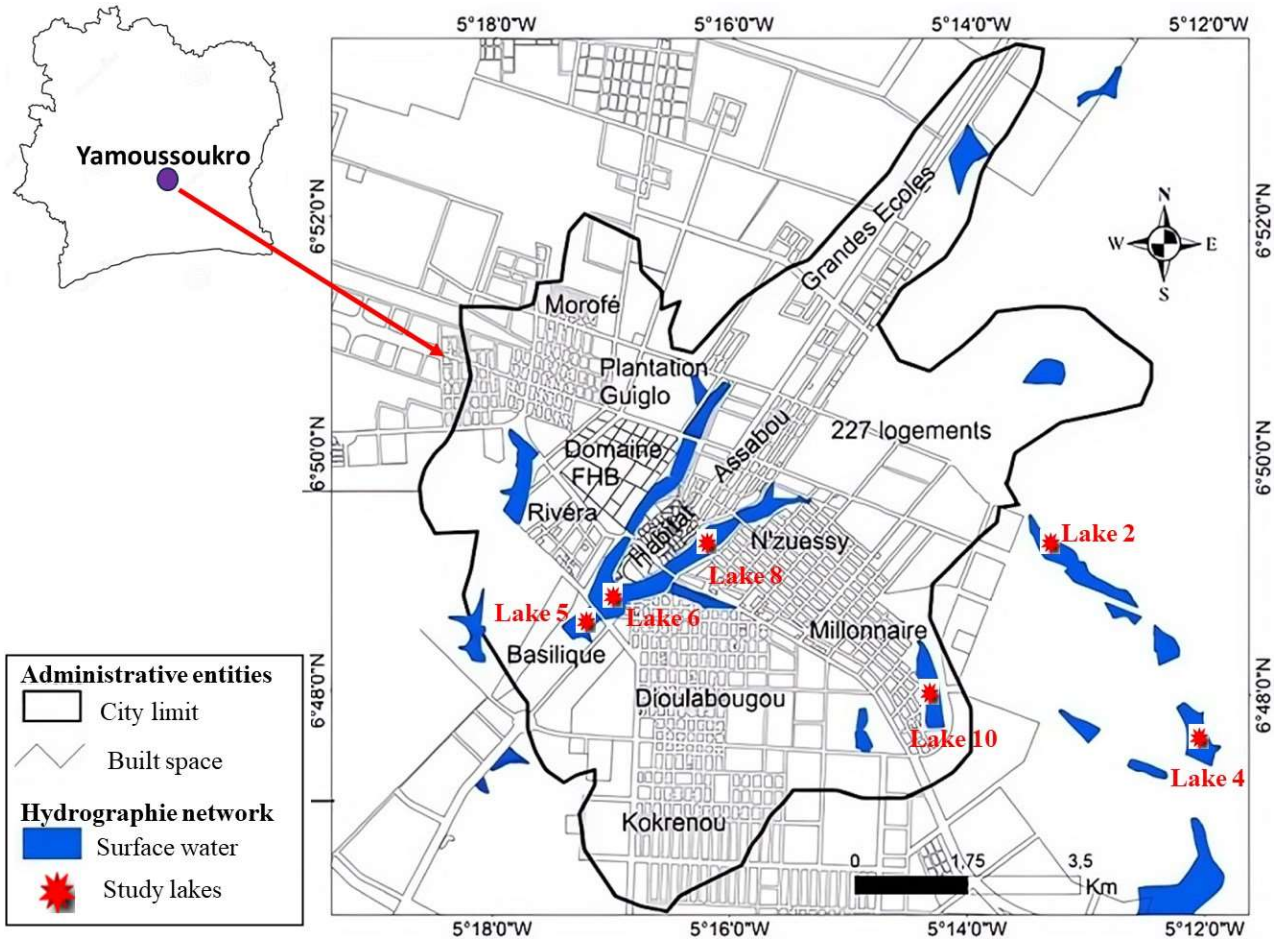

Figure 1 : Location of the lakes studied

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Table I : Geographic coordinates and surface areas of the lakes studied [8].

	Lakes	Coordinates	Area (ha)
Urban lakes	Lake 5	6°48‘40’’ N 5°16‘10’’ W	45,2
	Lake 6	6°48‘41’’ N 5°17‘9’’ W	10,8
	Lake 8	6°49’ 08’’ N 6°16’ 22’’ W	10,24
Peripheral lakes	Lake 2	6°50‘35’’ N 5°14‘44’’ W	10,1
	Lake 4	6°47‘35’’ N 5°12‘9’’ W	11,85
	Lake 10	6°48‘23’’ N 5°14‘35’’ W	11,97

1.2. Fish sampling and parasite collection

Sampling took place between December 2022 and November 2023. Thus, eight (8) sampling campaigns were carried out : four (4) during the dry season (December 2022, January 2023, February 2023 and November 2023) and four (4) during the rainy season (April 2023, June 2023, August 2023 and October 2023). The *Oreochromis niloticus* samples were obtained using experimental fishing. The latter was carried out using various gear including gill nets, cast nets, traps and bamboo traps. After capture, each fish specimen had mucus taken from the body (skin and fins) and the gills**.** The mucus obtained was fixed on slides with methanol for future laboratory analyses. The fish specimens collected were individually packaged in labeled plastics and stored in a cooler for laboratory analyses. In the laboratory, the different mucus slides were colored using the so-called “dry silver nitrate” method [9]. The colored slides were observed under an optical screen microscope in order to identify and enumerate the species of Trichodinidae.

The taxonomic identification of these Trichodinidae was carried out using the identification keys [10], [11] and [12]. The collected fish specimens were measured at standard length and dissected for sex determination.

2.3. Data analysis

After the inventory and enumeration of the species of Trichodinidae encountered in *Oreochromis niloticus* of the Yamoussoukro lakes, the parasitic prevalence (P) and intensity (I) of each species were determined according to the formulas below [13].

$$\mathbf{P = \frac{Ni}{Nt} X\ 100} \qquad \mathbf{(1)}$$

Ni : Number of individuals of *Oreochromis niloticus* infested by a genus or species of parasite

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Nt : Total number of *Oreochromis niloticus* individuals examined (infested or not).

$$\mathbf{I = \frac{Ntp}{Nth}} \qquad \mathbf{(2)}$$

Ntp: Total number of a genus or species of parasite;

Nth: Total number of hosts infested by the parasite genus or species.

The spatial and seasonal distribution of these parasite indices was analyzed. In addition, parasite indices were studied according to the size and sex of the host [14]. Four size classes were defined based on the recorded sizes. These are : [5-10cm[, [10-15cm[, [15-20cm[and [20-25cm[.

The Proportions Test was used to compare prevalences and the Mann-Whitney Test was used to compare infestation intensities between climatic seasons, as well as size classes and sexes of fish at the threshold (p) of 0, 05.

3. RESULTS

3.1. Parasitic trichodinids of *Oreochromis niloticus* in the urban and peri-urban lakes of Yamoussoukro

A total of 5 species divided into three genera have been recorded (Table I). These are : *Trichodina magna*, *Trichodina centrostrigeata*, *Trichodina compacta*, *Paratrichodina africana* and *Trichodinella* sp (figure 2). The spatial distribution of Trichodinidae indicates that the greatest species richness is obtained in urban lakes, in particular lakes 5 and 6 (5 species) while the lowest is obtained in peri-urban lakes, particularly lake 4 (1 species).

Table II : Trichodinid species of *Oreochromis niloticus* recorded in the Yamoussoukro lakes.

				Urban lakes			Peri-urban lakes		
Group	**Family**	**Genera**	**Species**	**Lake 5**	**Lake 6**	**Lake 8**	**Lake 2**	**Lake 4**	**Lake 10**
Protozoaires	Peritrichidae	Paratrichodina	*Paratrichodina africana*	+	+	+	+	+	+
		Trichodina	*Trichodina magna*	+	+	+	+		+
			Trichodina compacta	+	+	+	+		+
			Trichodina centrostrigeata	+	+		+	+	+
		Trichodinella	*Trichodinella sp*	+	+	+			

+ = presence

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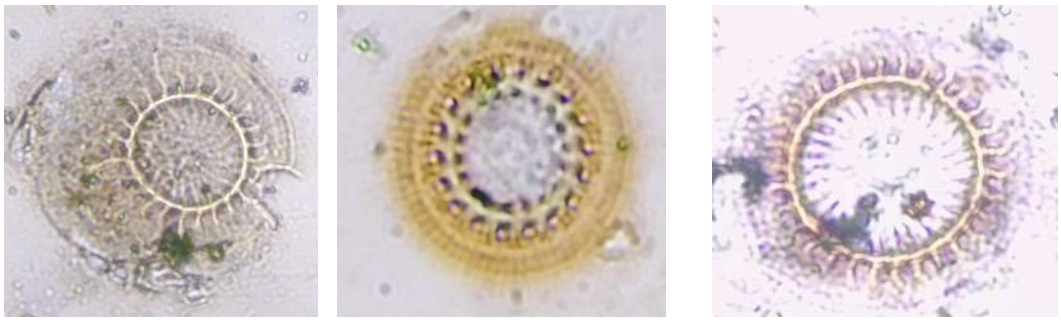
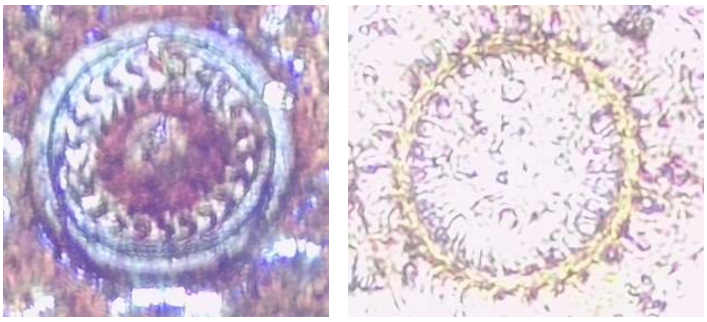


Trichodina magna *Paratrichodina africana* *Trichodinella* sp



Trichodina compacta *Trichodina centrostrigeata*

Figure 2 : Trichodinid species observed in *Oreochromis niloticus* in the Yamoussoukro lakes.

3.2. Spatial distribution of the prevalence and intensity of infestation of Trichodinids of *Oreochromis niloticus* in the lakes studied

In urban lakes, the recorded prevalence varies from 44.21% (*Trichodinella* sp) to 70.3% (*Trichodina magna*), while for peri-urban lakes, the prevalences obtained are between 32.8% (*Trichodina centrostrigeata*) and 16.33% (*Trichodina compacta*) (figure 3).

Relative to the intensity of infestation, this varies from 1.7 (*Trichodina centrostrigeata*) to 2.9 (*Trichodina magna*) in urban lakes while the infestation intensities recorded in peri-urban lakes are between 0, 8 (*Trichodina magna*) and 2.1 (*Trichodina centrostrigeata*) (Figure 4).

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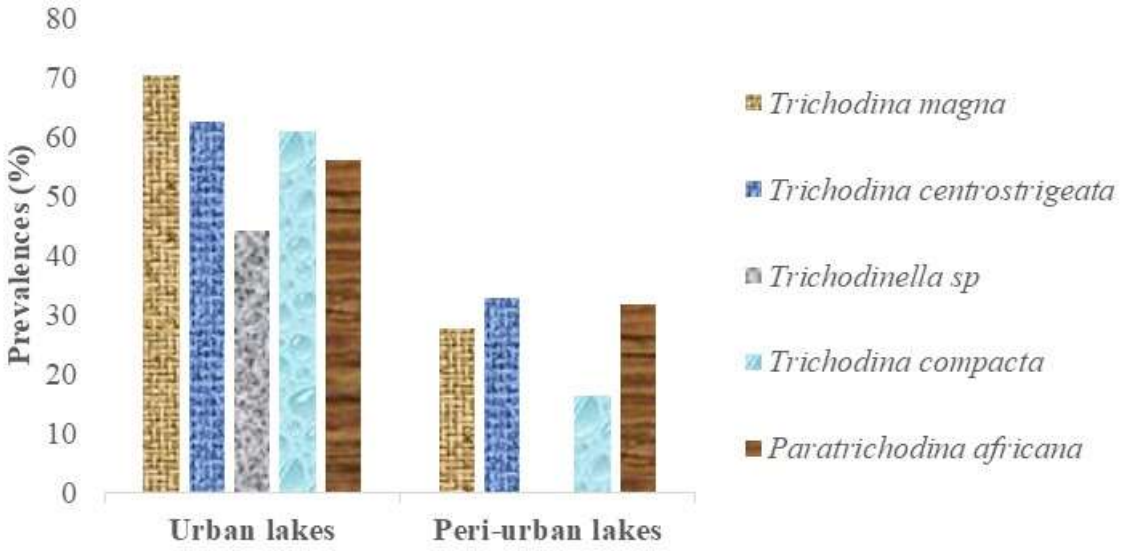

Figure 3 : Spatial distribution of the prevalence of *Oreochromis niloticus* trichodinids in the Yamoussoukro lakes.

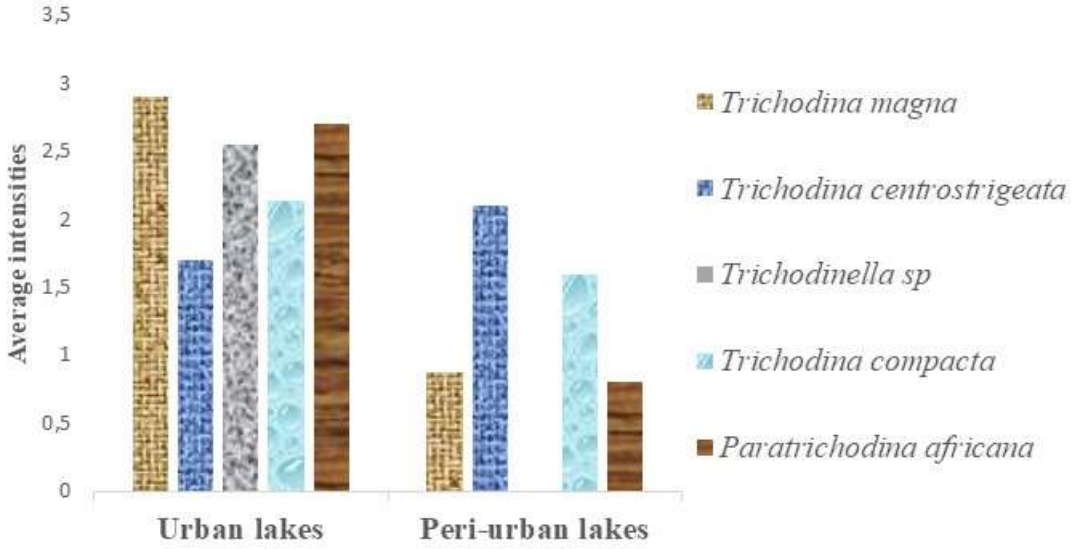

Figure 4 : Spatial distribution of the intensity of infestation of Trichodinids of *Oreochromis niloticus* in the Yamoussoukro lakes.

3.3. **Prevalence and average intensity of Trichodinid parasites of *Oreochromis niloticus* depending on the climatic seasons**

In urban lakes, the prevalence and intensity of Trichodinidae infestation are significantly ($p < 0.05$) higher in the rainy season (P = 90.18% and I = 6.72) than in the dry season. (P = 90.18% and I = 6.72). A similar trend is observed in peri-urban lakes. In the latter, the average prevalence and average intensity obtained in the rainy season are 21.92% and 2.14 respectively. In the dry season these parameters are 21.92 and 0.8 respectively (Table III).

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Table III : Seasonal variations in the prevalence and intensity of infestation of Trichodinids of *Oreochromis niloticus*

Lakes	Parasitic clues	Dry season	Rainy season	p significance
Urban	Prevalences (%)	50,33	90,18	Test of proportion, $p < 0.05$
	Intensity	2,63	6,72	Mann-Whitney test, $p < 0.05$
Peri-urban	Prevalences (%)	21,92	52,2	Test of proportion, $p < 0.05$
	Intensity	0,8	2,14	Mann-Whitney test, $p < 0.05$

3.4. Prevalence and intensity of Trichodinidae depending on the size of *Oreochromis niloticus*

With the exception of *Trichodina centrostrigeata*, the prevalence of which decreases among individuals of size class [20 - 25[, all the species of parasites inventoried present a diversity, followed by a prevalence and an intensity which increases with the host size classes (Figure 5). Small-sized individuals ([5 - 10[and [10 - 15[) are infested by fewer species of parasites (2 and 3 respectively) while large-sized fish ([15 - 20[and [20 - 25[) are infested by the greatest number of species (5).

Furthermore, the species *Trichodina centrostrigeata* presented the highest prevalences among individuals of size classes [5 - 10[and [10 - 15[while *Trichodina magna* and *Paratrichodina africana* respectively have the greatest prevalences among individuals of size class [15 - 20[and [20 - 25[. Relative to the intensity of infestation, *Trichodina magna* is the most virulent species for host individuals of all size classes (figure 6).

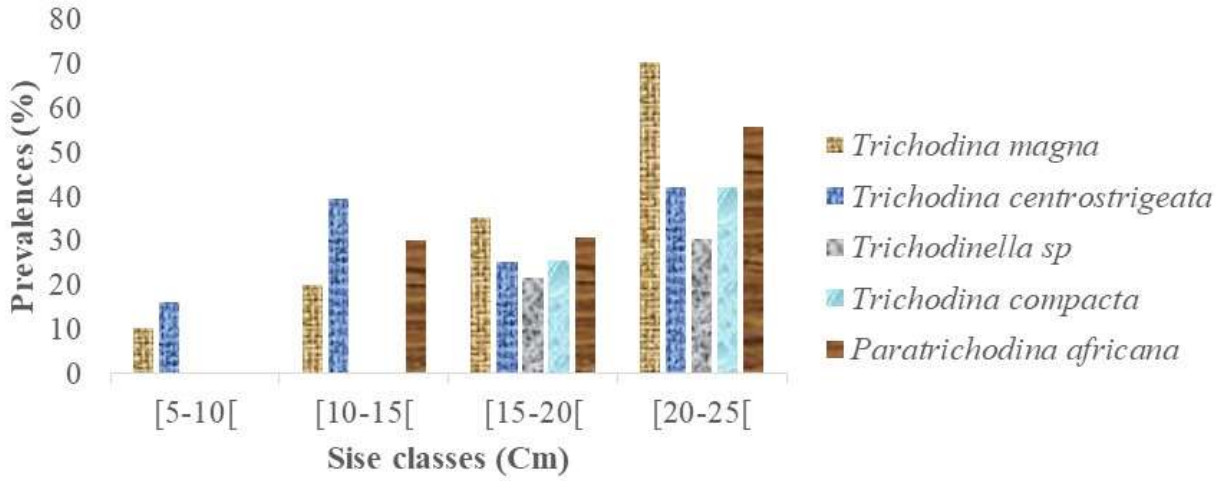

Figure 5 : Prevalence of Trichodinidae depending on the size of *Oreochromis niloticus*.

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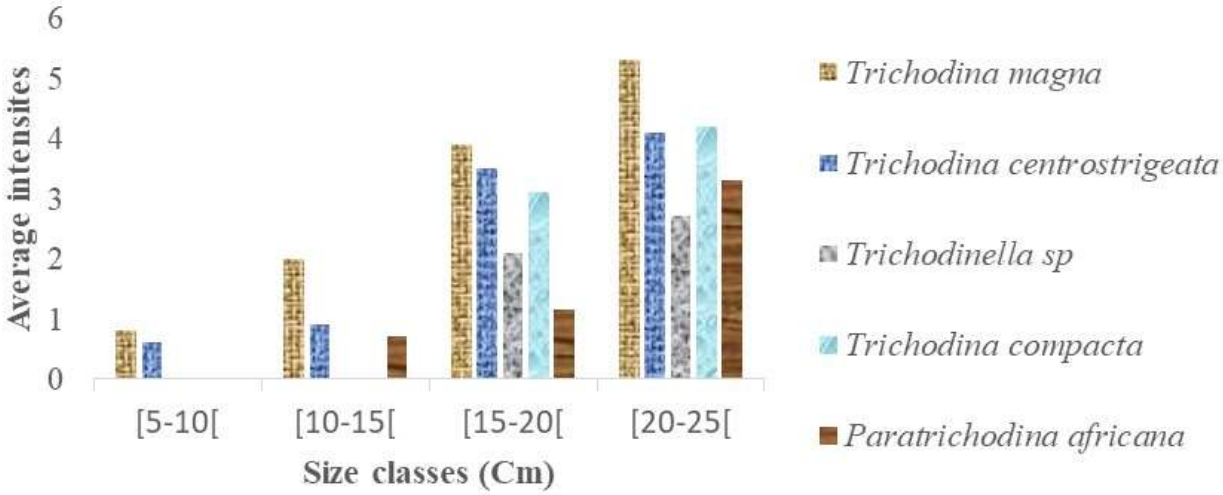

Figure 6 : Trichodinid infestation intensity depending on the size of *Oreochromis niloticus*.

3.5. **Variation in the prevalence and intensity of infestation of Trichodinids of *Oreochromis niloticus* depending on sex**

In urban lakes, the average prevalence and average intensity of Trichodinidae are significantly ($p < 0.05$) higher in males (P = 94.21% and I = 5.25) than in females (P = 60.7% and I = 4.78). A similar trend is observed in peri-urban lakes. The average prevalence and average intensity obtained in these lakes among males are 44.85% and 2.08 respectively. For females, these parameters are 20.73 and 1.36 respectively (Table IV).

Table IV : Prevalence and intensity of Trichodinidae infestation depending on the sex of *Oreochromis niloticus*.

Lakes	Parasitic clues	Males	Females	p significance
Urban	Prevalences (%)	94,21	60,7	Test of proportion, $p < 0.05$
	Intensity	5,25	4,78	Mann-Whitney test, $p < 0.05$
Peri-urban	Prevalences (%)	44,85	20,73	Test of proportion, $p < 0.05$
	Intensity	2,08	1,36	Mann-Whitney test, $p < 0.05$

4. DISCUSSION

The analysis of the parasitofauna of the species *Oreochromis niloticus* fished in the urban and peri-urban lakes of Yamoussoukro made it possible to identify five (5) species of Trichodinidae. These are *Trichodina magna*, *Paratrichodina africana*, *Trichodina centrostrigeata*, *Trichodinella* sp and *Trichodina compacta*. The spatial distribution of these Trichodinids also indicated a much higher infestation of fish sampled in urban lakes compared to those sampled in peri-urban lakes. This parasitic fauna is smaller than that observed by certain authors, numbering 10 species [15]. The difference in the number of species observed could be linked to the sources of pollution [16]. Indeed, each type of pollution promotes the development of specific species of parasites, depending on its nature and origin. This would explain the high infestation rate of fish in urban lakes observed in the present study. These lakes are subject to strong anthropogenic pressure causing various sources of pollution (agriculture, households, chemicals, sanitary waste, etc.) unlike peri-urban lakes which are located in moderately inhabited areas [17] and [18].

The evaluation of the prevalence and intensity of parasitic infestation during the climatic seasons revealed a much greater infestation of fish in the rainy season than in the dry season by trichodinids regardless of the location of the lakes. Our results are in agreement with certain authors who report that climatic seasons play an important role in the diversification and abundance of parasites [19] and [20]. Indeed, the rainy season remains the ideal period for transferring effluent from various waste production units to the lakes through the city's sewers and other pipes. The accumulation of this waste from various sources promotes the diversification of microorganisms, responsible for the increase in the prevalence and intensity of fish infestation in this season [21] and [22].

Relative to the size of fish, an increase in the diversity, prevalence and intensity of infestation of Trichodinid parasites is observed during the evolution of fish size. Small fish ([5 - 10[and [10 - 15[) are less infested with reduced diversity, prevalence and parasite intensity compared to large fish ([15 - 20[and [20 - 25 []). This observation would be due to the mobility and the infestation surface of the fish body. Indeed, large fish generally have a wider range of mobility for their survival, sometimes including migration zones several kilometers apart, unlike small fish whose mobility zone is reduced due to predators and the inability to withstand hostile environmental conditions. This great mobility of large individuals increases the risk of contracting various species of parasites, hence the high prevalences. Also, their large sizes favor large surfaces of exposure to parasites and an accumulation of them, thus reflecting the high infestation intensities observed. Our results are in accordance with several authors who have shown that large fish are generally more infested than small fish [23], [24] and [25].

Regarding the variation in the prevalence and intensity of parasite infestation depending on the sex of the fish, male individuals were more parasitized than females. This observation would be due to their reproductive physiology, requiring the synthesis of testosterone. Indeed, males invest a lot of energy in the synthesis of testosterone and this would reduce the effectiveness of their immune system which consequently makes them more vulnerable to infestations than females [26]. Our results are in accordance with the hypothesis according to which male fish, in their active search for a partner during reproduction and for food, are more exposed to parasite infestation [27].

5. CONCLUSION

The present study focused on the infestation of Trichodinidae parasites of tilapia *Oreochromis niloticus* fished in the Yamoussoukro lakes. The results made it possible to inventory five (5) species of parasitic Trichodinidae, including *Trichodina magna*, *Paratrichodina africana*, *Trichodina centrostrigeata*, *Trichodinella* sp and *Trichodina compacta*. The rate of infestation of this species of fish by the parasites encountered differs depending on the origin, climatic seasons, size classes and sex of the fish. The highest parasite prevalences and intensities were observed both in fish from urban lakes, during the rainy season, in large individuals and in male individuals.

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