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Population Dynamics of Gill Monogenean Parasites in Blackchin Tilapia *Sarotherodon Melanotheron* (Cichlidae) Captured from Taabo Man-Made Lake (Côte d'Ivoire)

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Abstract

The tilapia *Sarotherodon melanotheron* is a fish species widely used in African fish farming due to its high market demand. It represented a significant proportion of the fish fauna in Taabo manmade lake in particular. However, the stock of this fish is facing parasitic infestation which deteriorates it considerably. In addition, there is no data on the parasitic epidemiology of this fish in this environment. These data are essential to finding strategies to avoid huge fish losses in the natural and the breeding environment. From March 2023 to April 2024, 1107 specimens of *S. melanotheron* were captured in this lake in order to study some aspects of their gill monogenean parasites. After host sampling and parasites mounting standard methods of parasitological examination were used for identification of monogenean species. Gill helminthofauna of this fish consisted of *Cichlidogyrus acerbus*, *C. halli, C. halinus*, *C. lagoonaris* and *Scutogyrus minus*. The fish captured in Ahondo station were the most infested. The infestation exhibited seasonal fluctuation with the maximum parasite species were recorded in the rainy seasons and the minimum one in the dry seasons. It was observed that the sex of this fish have an influence on parasitism infestation. These results could help to improve the productivity of this fish.

Keywords: *Sarotherodon Melanotheron*, Gills, Monogeneans, Population Dynmics, Côted'Ivoire.

1. INTRODUCTION

Freshwater fish have an essential part of ecosystem services in the continental environment. Indeed, fishes represent nearly 50% of animal protein in diet in many African countries [1]. Therefore, fish is one of the most valuable natural resources included in the diet in countries.

Indeed, fish is more or less a complete food because it contains fat, minerals, oils, and vitamins [2]. Thus, fishes contribute to fight against poverty, food and nutritional security. Among the latter, there is the tilapia *Sarotherodon melaotheron* which is very appreciated by consumers [3, 4]. Furthermore, due to its biological and zootechnical characteristics, this fish is one of the predominant species in African commercial fish farming [5]. It has therefore been the subject of immense research and popularization programs. Despite this importance for both food and economics, the gills of this fish are subject to infestation by parasitic monogeneans. These organism are helminth ectoparasites parasitizing mainly fish. They can fix to body surfaces, fins, swabs or nasal cavities of the hosts. They are highly host-specific and have a simple life cycle [6]. In addition to the scientific interest, these parasites are also potential biomarkers for ecology and trophic interactions [7, 8]. At the socio economic level, parasitic infections can cause severe economic losses in natural environments but especially in livestock environments. Indeed, these organisms can affect the fish health because there are the main cause of anemia. They consume the blood and cells from damaged tissue at the same time. Therefore, monogenean infection significantly is one of the major factors that contribute heavy mortality in farmed population fish [9-12]. Moreover, fish diseases that are bacterial and viral may be mechanically transmitted by monogeneans [13]. Thus, in view of the foregoing, it seems useful to carry out studies on these pathogens in a natural environment to have databases with a view to improving fish productivity not only in this environment but also in a breeding environment.

In Côte d'Ivoire, apart from the studies of [14, 15], carried out respectively in Lake Ayamé and in the Ebrié lagoon, there is no data relating to the infestation by monogenean gill parasites of this fish in the Taabo hydroelectric dam which is continually subject to human pressure creating the conditions for the proliferation of these pathogens. Furthermore, according to [16], the annual production of fish (size and stock) including the main species including *Sarotherodon melanotheron* continues to decline until this day in Taabo hydroelectric dam. The size and stock of this fish have declined sharply, suggesting that there are factors limiting their growth, among them are parasitic infections. Indeed, it has been shown that *Sarotherodon melanotheron* is the host of many gill monogenean parasites [17].

Considering this fish importance for the population and the fact that the data collected on parasite infestation in natural systems are very useful for the development of control measures in aquaculture, the present study was aimed to provide the first data relating to some ecological aspects of the gill monogenean fauna of *Sarotherodon melanotheron* captured in the Taabo hydroelectric dam. Taking to account that this fish is very important for populations and that these parasites represent a real danger for their massive production, the present study relating to ecological aspects of these pathogens in the *S. melanotheron*'s gills captured in the Taabo reservor was carried out in order to help minimize the catastrophic losses observed and improve fish productivity.

2. MATERIAL AND METHODS

2. 1. Study Area

Located between 5°07' and 5°33' West longitude and 6°25' and 6°56' North latitude, the Taabo hydroelectric dam lake is built on the main branch of the Bandama River (Figure 1). It is approximately 110 km downstream from the confluence of the White Bandama and the Red Bandama. With a catchments area about 58 700 km² and a mean annual flow of about 128.7 m3/s, this lake has an elongated NW-SE shape with a single eastern diverticulum and extends over an area of 69 km² [18, 19]. From a climatic point of view, the north of the basin is under the influence of the tropical transition regime [20]. Lake Taabo is directly influenced by the attenuated transitional tropical and transitional equatorial regimes. There are two rainy seasons (April to June and September to November) and two dry seasons (December to March and July to September). Two sampling stations have been defined. There are Ahondo and Courandjourou stations. Marked by an excessive presence of plants namely hyacinths covering average 8% of the water body, the Ahondo station (photograph 6) (6° 17' N - 6° 40'N, 5° 42" W- 5° 60'W) has a predominantly sandy substrate with mud and dead tree trunks in places. It is bordered by yam and cocoa plantations and a classified forest. The average depth value at this sampling site is 6 m. In the surrounding course of the lake (photograph 7), the Courandjourou station (6° 13'47" N - 6° 17'N, 5° 6'57" W – 5° 60'W) has a very low canopy, estimated at 5%. It is bordered by a forest and cocoa and plantain plantations. Dominated by sand, the substrate is dotted with mud, white clay and wooden forks making the body of water difficult to navigate. This water body has an average depth of 7.25 m.

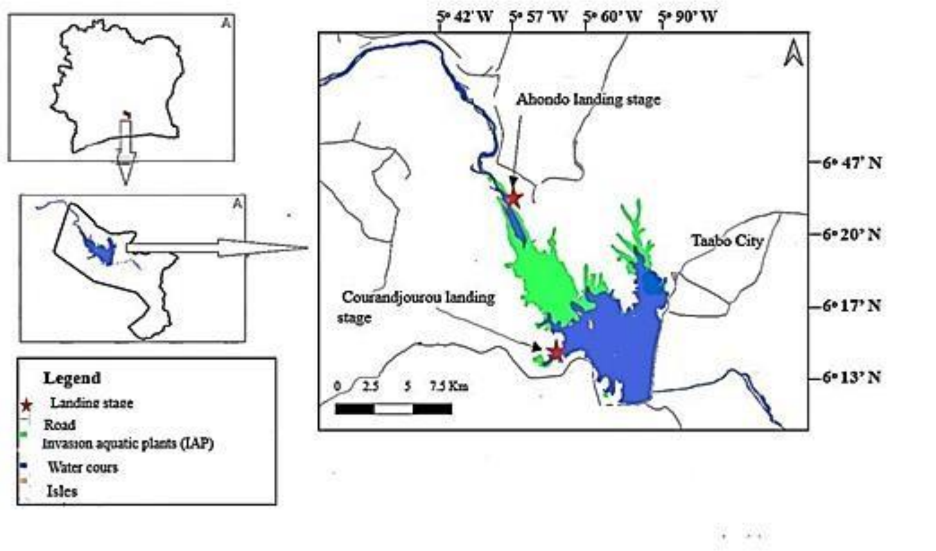

Figure-1 : Map of Taabo man-made Lake and the sampling sites.

2.2. Collection, Identification and Processing of Fish Samples for Parasite Examination

Fishes were sampled during May 2023 and April 2024. They were captured by the fishermen using gillnets in Taabo hydroelectric dam lake sampling sites. Two hundred seventynine fish specimens of *Sarotherodon melanotheron* were caught. In the field, after capture, fish specimens were identified based on the key by [21]. The sexes of the fishes were determined by either the presence or absence of an intromittent organ on the ventral side just before the anal fin which as confirmed later by the presence of testes or ovaries during dissection. Gills were carefully dissected. These gills were labelled according to the fish and then kept in ice (0°C) until they were taken to the laboratory where they were conserved in the refrigerator.

2.3. Parasitological Examination

In the laboratory, after thawing the gills, arches were placed in a Petri dish, and thoroughly rinsed using a wash bottle and tap water. Monogeneans observed under a stereomicroscope were removed using an entomological needle mounted on a mandrel, and placed between slide and coverslip into a drop of glycerin-ammonium picrate mixture [22]. The preparation was then covered with a cover slip and sealed with Glyceel. The mounts were observed specific determination of the parasites was carried out using the optical microscope, based on the shape and/or size of the sclerotised parts of their haptoral and copulatory complexes as described by [17].

The ecological terminology such as the prevalence, mean intensity and the abundance used was recommended by [23]. Based on the prevalence, species was considered as common or core if the prevalence value is greater than 50%, intermediate or secondary if prevalence value is between 10 and 50% and rare or satellite if prevalence value is less than 10% [24]. Concerning the mean intensity, the parasite species classification adopted is that of [25]. The mean intensity is high if its value is greater than 100, medium if its value ranged between 50 and 100, low if its value varied from 10 to 50 and very low if its value is less than 10.

2. 4. Statistical Analysis

The Chi-square ($\chi 2$) test was used to compare two or more proportions and the KruskalWallis test was used to compare the mean intensities of more than two samples. Mann-Whitney test was used to compare the parasitic intensities of two different samples. All steps of this method were computed using STATISTICA 7.1 software. The level of statistical significance was $p < 0.05$.

3. RESULTS

3.1. Specific Composition of Gill Monogenean Species

The observation of 1107 specimens of *Sarotherodon melanotheron*'s gills allowed to collect 57737 individuals of parasites. The morphological identification criteria used to identify these parasites revealed five monogenean species belonging to the genera *Cichlidogyrus* Paperna, 1969 and *Scutogyrus* Pariselle & Euzet, 2003. These monogeneans are *Cichlidogyrus halli* Price and Kirk, 1967; *C. halinus* Paperna, 1969; *C. lagoonaris* Paperna, 1969; *S. minus* (Dossou, 1982) et *Cichlidogyrus acerbus* Dossou, 1982. In the both Ahondo and Couradjourou stations, fish specimens hosted five gill monogenean parasite species.

3.2. Monogenean Parasites Distribution According to the Study Station

Table 1 presented the parasitic indices variations between Ahondo station and Courandjourou one. The prevalence high values of parasites species *Cichlidogyrus acerbus* (39.57 %) and *C. lagoonaris* (74.28 %) were noted at the Courandjourou station. On the other hand, those of parasites species *C. halli* (78.61 %), *C. halinus* (74.33 %) and *Scutogyrus minus* (42.60 %) were obtained in Ahondo station. The Chi-square test did not reveal a significant difference between the infestation of fishes caught at Ahondo station and Courandjourou one for parasites species *Cichlidogyrus halli*, *C. halinus* and *Scutogyrus minus* ($p > 0.05$). In contrast, there was a significant difference between the prevalence values of parasites *C. acerbus* and *C. lagoonaris* from fishes captured from these two study areas ($p < 0.05$). The corresponding mean intensity values were 12.90 ± 1.6 and 4.48 ± 0.82 respectively for species *C. acerbus* and *C. lagoonaris* in the Courandjourou station. The abundance parasite values of these species were 5.10 and 3.3 respectively in the same station. The Mann-Whitney test applied to parasitic intensities and abundances indicates that the fish sampled in the Ahondo station were more infested by parasites than those from the Courandjourou station ($p < 0.05$). In the parasite community collected on *Sarotherodon melanotheron*'s gills, with prevalence values greater than 50%, the parasites *Cichlidogyrus halli*, *C. halinus* and *C. lagoonaris* were core species at the Courandjourou station. Parasites *C. acerbus* (39.57%) and *S. minus* (37.59%) were the intermediate species of this component. Their prevalence values varied between 10% and 50%.

Except for low mean intensity values of the parasite *C. acerbus* ($10 < IM \leq 50$), those of the four other were very low ($IM < 10$). It ranged from 3.05 to 6.4 parasites per infested fish. On the other hand, with prevalences greater than 50%, the parasites *C. halli* and *C. halinus* were core species at the Ahondo station. With respective prevalence values of 45.28% and 42.60%, parasites *Cichlidogyrus lagoonaris* and *Scutogyrus minus* were secondary species ($10\% \leq$ prevalence $\leq 50\%$) while *C. acerbus* was the rare species (prevalence < 10%) of this component community. The parasite species mean intensities remained low ($10 < IM \leq 50$). Their values varied from 11.6 to 17.35 parasites per infested fish.

Table-1 : Spatial variation in prevalence, mean intensity and abondance of gill monogenean parasites species of *Sarotherodon melanotheron* from Taabo man-made lake.

Stations	Monogenean species	Number of fish examined	Number of infested fish	P (%)	MI±SE	A
Courandjourou	*C. acerbus*	556	220	39.57	12.9±1.6	5.1
	C. halli	556	429	77.16	12.1±0.8	9.33
	C. halinus	556	412	74.1	10.51±0.61	7.79
	C. lagoonaris	556	413	74.28	4.48±0.82	3.33
	S. minus	556	209	37.59	6.79±0.42	2.55
Ahondo	*C. acerbus*	561	12	2.14	9.17±0.43	0.2
	C. halli	561	441	78.61	22.88±1.41	17.99
	C. halinus	561	417	74.33	27.81±1.32	20.67
	C. lagoonaris	561	254	45.28	17.28±1.41	7.82
	S. minus	561	239	42.6	19.08±1.11	8.13

P : Prevalence, MI : mean intensity, A : Abundance, *C* : *Cichlidogyrus*, *S* : *Scutogyrus*, SE : *Standard error*

3.3. Monogenean Parasites Distribution According to the Host Sex

Epidemiological indices evaluation according to *Sarotherodon melanotheron*'s (n=1117) sex captured in the Ahondo and Courandjourou stations are represented by figures 2 and 3, respectively. At the Ahondo station, out of 561 specimens there were 279 males and 282 females while the study was carried out on a population of 556 individuals with 276 males and 280 females at the Courandjourou station.

The infection of *Sarotherodon melanotheron* depending on its sex by parasitic monogeneans was illustrated by Figure 2. This indicated that male and female hosts harbored more parasites by *C. acerbus*, *C. halli*, *C. halinus, C. lagoonaris* and *S. minus* at the Ahondo station. This figure analysis revealed that the prevalence values of parasites *C. halli* (90.68%) and *S. minus* (61.65%) were the highest in male hosts whereas that of parasites *C. acerbus* (2.13%), *C. halinus* (98.94%) and *C. lagoonaris* (68.44%) were the highest in female hosts.

The Chi-Square test (X^2) test applied indicated that *C. acerbus* was partitioned equally between males and females ($p > 0.05$). However, the Mann-Whitney test analysis showed that the females were more parasitized by *C. halinus* and *C. lagoonaris* than males and the last one were the most infested by *C. halli* and *S. minus* ($p < 0.05$).

In this sampling, the respective average intensities values and high abundances recorded for these species are 10.6 ± 2.4 and 0.19 for *C. acerbus*, then 31.67 ± 3.4 and 28.72 for *C. halli*, 23.85 ± 1.3 and 14.71 for *S. minus* in male sex fish. However, the high values of the average intensities of the monogenean species *C. halinus* (34.13± 0.1) and *C. lagoonaris* (20.21± 4.1) were obtained with female individuals. The values obtained from the abundances of these parasite species are 33.77 and 13.83, respectively. The male host were the most infested by monogenean species *C. acerbus*, *C. halli* and *S. minus* and the female one were the most parasitized by *C. halinus* and *C. lagoonaris* (Mann Whitney test, $p < 0.05$).

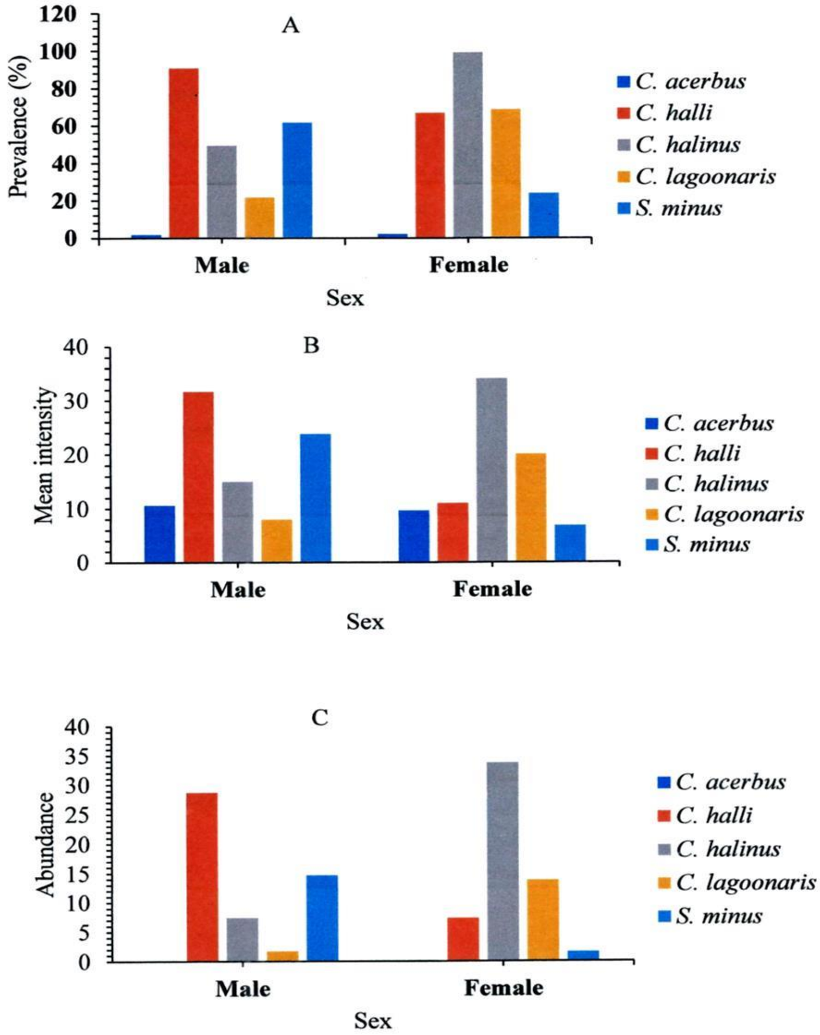

Figure 2: Prevalence (A), mean intensity (B) and abundance (C) of monogenean parasites depending on the sex of *Sarotherodon melanotheron* sampled at the Ahondo station

C: Cichlidogyrus; S: Scutogyrus

The infestation analysis of *Sarotherodon melanotheron* according to its sex by the parasitic monogeneans indicated that both male and female host were the most infested by *C. acerbus, C. halli, C. halinus, C. lagoonaris* and *Scutogyrus minus* at the Courandjourou station (Figure 3). In addition, this figure revealed also that the parasites prevalence values of *C. acerbus* (59.1%) and *C. halli* (99.3%) were the highest in male host whereas those of parasites *C. halinus* (76.4%), *C. lagoonaris* (63.6%) and *S. minus* (58.2%) were the highest in female individuals (Figure 3). No significant difference in the prevalence was observed according to host sex for monognean species *C. halinus* (Chi-Square, $p > 0.05$). However, the Mann-Whitney test applied to parasitic intensity and abundance indicated that male hosts harbored monogeneans *C. acerbus* and *C. halli* than female one ($p < 0.05$). On the other hand, female hosts were more infested by *C. lagoonaris* and by *S. minus* ($p < 0.05$).

The average intensity and high abundance obtained from these parasites are respectively 9.53±1.1 and 15.83 for *C. acerbus* and 14.86 ± 1.3 and 14, 96 for *C. halli* in male fish. On the other hand, high average intensity of the monogenean species *C. halinus* (7.25±3.5), *C. lagoonaris* (6.06 ±0.7) and *S. minus* (4.70 ± 1.6) were noted in female hosts. The values of the corresponding abundances obtained for these parasite species are 9.48, 9.53 and 8.08, respectively. The MannWhitney test applied to parasitic intensity and abundance revealed that male hosts were more infested by *C. acerbus* and *C. halli* than female one ($p < 0.05$).

On the other hand, female hosts were the most parasitized by *C. lagoonaris* and *S. minus* ($p < 0.05$) (Figure 3). No significant difference in the parasitic intensity and abundance for *C. halinus* was observed according to host sex ($p > 0.05$).

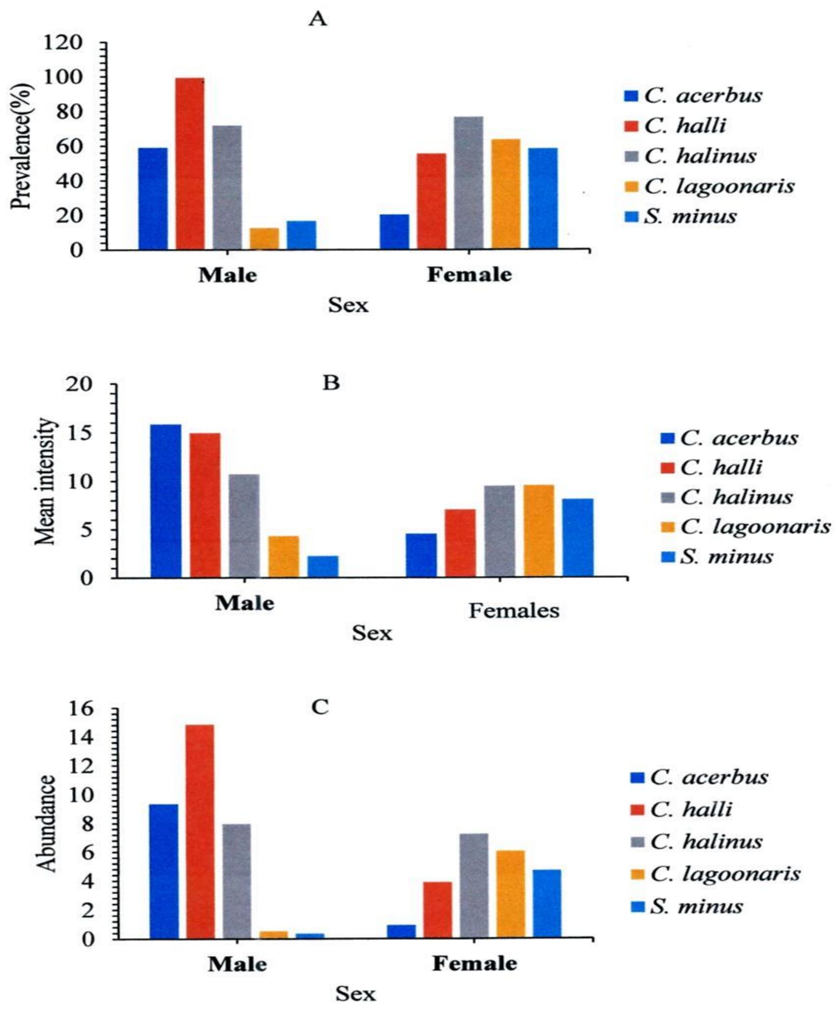

Figure 3. Prevalence (A), Mean intensity (B) and Abundance (C) of Monogenean parasites depending on the sex of *Sarotherodon melanotheron* sampled at the Courandjourou station. *C: Cichlidogyrus; S: Scutogyrus*

3.4. Temporal Variations of the Epidemiological Indices of Gill Monogenean Parasites of *Sarotherodon Melanotheron*

The monthly average variations of the parasitic epidemiological indices for five gill monogenean from *Sarotherodon melanotheron* in the Ahondo station are shown in Table 2. The latter's analysis indicated that the highest prevalence values were observed in the species *Cichlidogyrus acerbus* (8.7%) and *Scutogyrus minus* (50%) in May, *C. halli* (96.1%) and *C. halinus* (98.1%) in June and *C. lagoonaris* (50%) in September, which is the large and the small rainy season. However, the minimum prevalence values obtained were for *C. acerbus* (0%) during the period from November to February, for *C. halli* (63.8%) and *C. lagoonaris* (34%) in January, for *C. halinus* (52.3%) and *Scutogyrus minus* (31.8%) in February, corresponding respectively to the long dry season. The observed differences between the prevalence of *C. halinus*, *C. halli*, *C. lagoonaris*, *C. acerbus* and *S. minus* during different seasons were significant (Chi-Square test; $p < 0.05$).

In addition, the Table 2 analysis revealed that high average intensity values for the monogenean species *C. acerbus* (9 6.1) in September, then *C. halli* (41.2 ±3.4), *C. halinus* (50.1± 2.8), *C. lagoonaris* (33.3 ±0.8) and S. minus (31.7± 4.3) in June were noted at the small and large rainy season, respectively. The lowest average intensity values were obtained in *C. acerbus* (o) during the period from November to February, then in the monogenean species *C. halli* (8.8 ± 5.4), *C. halinus*

(9.7± 1.7), *C. lagoonaris* (4.2 ± 2.3) and *S. minus* (7.2 ± 5.1) in February, corresponding to the large dry season.

The variation in abundance of the five gill monogenean parasite species of this fish is quite similar to that of their average intensity variation (Table 2). The highest values were recorded for *C. acerbus* (0.6) during the period from May to June, followed by *C. halinus* (49.1), *C. halli* (39.6), *C. lagoonaris* (16.3) and *S. minus* (15.1) in February, corresponding to the long rainy season and the long dry season. In contrast, the lowest values were obtained for *C. acerbus* (0) during the period from November to February, then for the monogeneans *C. halli* (6), *C. halinus* (5.2), *C. lagoonaris* (2) and *S. minus* (2.3) during the month of February corresponding to the long dry season. For each parasite, the average intensities and abundances values were the highest in the rainy season. The Mann-Whitney (U) test performed on parasitic intensities and abundances established a significant difference ($p < 0.05$) in the infestation of *S. melanotheron* by monogenean species.

The temporal variation of parasitic indices of *Cichlidogyrus acerbus*, *C. halli*, *C. halinus*, *C. lagoonaris* and *Scutogyrus minus*, gill monogenean parasites of *S. melanotheron* caught in the Courandjourou station is presented in Table 3. This table shows that the highest prevalence values were obtained in *C. acerbus* (50%) and *C. halinus* (93.9%) in May, in *C. halli* (95.8%) in June and in *C. lagoonaris* (48.8%) and *S. minus* (50.1%) in September, corresponding to the small and long rainy seasons. In contrast, the low prevalence values obtained are for *C. acerbus* (20.9%), for *C. halli* (63%) and for *C. halinus* (52.3%) during February, followed by *C. lagoonaris* (27.1%) and by *S. minus* (25.6%) in January. These periods correspond to the long dry season. The Chi-Square test performed on the different monogenean species prevalence indicate that observed differences vary significantly on monthly and on seasonally ($p < 0.05$).

For the gill monogenean species average intensity (Table 3), high values were noted in *C. acerbus* (21.2 ± 0.8), *C. halli* (24 ± 4.3), *C. halinus* (20.6± 6.7), *C. lagoonaris* (17.6 ±0.4) and *S. minus* (14.3 ±2.3) during the period May and June, corresponding to the long rainy season.

However, low values were obtained in February for *C. acerbus* (5.4 ±1.5), *C. halli* (3.1 ±0.3), *C. halinus* (2.3 ±0.6), *C. lagoonaris* (3.2 ±1.1) and for *S. minus* (1.8 ±0.2).

The abundance highest values of monogenean parasites species of this fish were noted during June corresponding to the long rainy season. These values are for *C. acerbus* (10.1), *C. halli* (23), *C. halinus* (18.9), *C. lagoonaris* (8.1) and *S. minus* (5.9). However, the abundances lowest values of these monogeneans were obtained in *C. acerbus* (1.1) and *C. halli* (1.9) and *C. halinus* (1.5) during February, then in *C. lagoonaris* (1) during August and in *S. minus* (0,6) during January, corresponding to the long and small dry seasons. The Mann-Whitney (U) test performed on intensities and abundances indicated that the infestation of *S. melanotheron* by different monogenean species changes significantly ($p < 0.05$) seasonally.

Table-2 : Monthly average variations in Prevalence (P), Mean intensity (MI) and Abundance (A) of gill Monogenean parasites of *Sarotherodon melanotheron* sampled in of Ahondo station of Taabo man-made lake.

		AHONDO STATION											
Monogeneans species	Parasity Index	Mi	Jn	Ju	At	Sep	Oc	Nv	Dc	Jan	Feb	Ms	Ap
		St 1	St 1	St 1	St 1	St 1	St 1	St 1	St 1	St 1	St 1	St 1	St 1
C. acerbus	P (%)	8.7	5.9	8.3	0	4.3	8.2	0	0	0	0	0	2.1
	MI	7±0.5	7.7±0.7	6±0.2	0	9±1.1	3.8±0.3	0	0	0	0	0	2±0.2
	A	0.6	0.6	0.5	0.4	0.3	0	0	0	0	0	0	0
C. halli	P (%)	93.5	96.1	79.2	69	80.4	87.8	76.9	72	63.8	64.4	68.2	87.5
	MI	40.3±2.1	41.2±3.4	24±3.2	21.2±1.3	27.6±2.5	30.3±4.2	15±0.6	11.7±0.8	10.1±0.6	8.8±5.4	9.9±0.9	15.9±0.7
	A	37.7	39.6	19	14.6	22.2	26.6	11.6	8.4	6.4	6	6.4	13.9
C. halinus	P (%)	97.8	98	75	71.4	78.3	79.6	65.4	74.4	61.7	53.3	52.3	81.3
	MI	40.1±2.5	50.1±2.8	29.2±1.8	24.8±1.6	28.5±2.1	43.7±3.6	23.7±1.2	13.2±0.5	11.1±0.6	9.7±1.7	11.7±0.7	18.3±1.6
	A	39.2	49.1	21.9	17.7	22.3	34.8	15.5	9.8	6.9	5.2	6.1	14.9
C. lagoonaris	P (%)	47.8	50	47.9	45.2	49	49	36.5	48.8	34	40	47.7	47.9
	MI	31.3±2.1	33.3±0.8	15±0.6	11.7±0.5	21.8±1.6	31.5±2.3	10.9±1.2	10.6±0.8	8.3±0.6	2±0.3	5.7±0.4	12.5±0.6
	A	15	16.3	7.2	5.3	10.9	15.4	4	5.2	2.8	2	2.3	6
S. minus	P (%)	50	43.1	43.8	47.6	47.8	46.9	38.5	44.2	36.2	31.8	37.8	43.8
	MI	29.7±2.1	34.8±3.2	20.6±1.8	16±0.8	18.22±1.6	31.7±4.3	18.3±1.6	12.4±0.7	8.5±0.6	7.2±0.3	7.4±0.6	12.3±0.6
	A	14.8	15.1	9	7.6	8.7	14.9	7	5.5	3	2.7	2.3	5.4

C : *Cichlidogyrus*, S : *Scutogyrus* ; Mi : May ; Jn : June ; Ju : July ; At : August ; Sep : September ; Oc : October ; Nv : November ; Dc : December : Jan : January ; Feb : February ; Mar : March ; Ap : April

Table-3 : Monthly average variations in Prevalence (P), Mean intensity (MI) and Abundance (A) of gill Monogenean parasites of *Sarotherodon melanotheron* sampled in of Courandjourou station of Taabo man-made lake.

COURANDJOUROU STATION													
Monogenean species	Parasity Index	Mi	Jn	Jui	At	Sep	Oc	Nv	Dc	Jan	Feb	Mar	Ap
C. acerbus	P (%)	50	48	49	36.4	48.8	49	40	34.1	25	20.9	28.3	42.6
	MI	17±0.6	21.2±0.8	10.2±0.5	7.6±0.4	14.4±0.7	19.7±0.8	10.1±0.4	8.2±0.3	5.5±0.2	5.4±1.5	6.4±1.1	14.7±0.6
	A	8 .3	10.1	5.1	2.7	7.1	9.6	4.1	2.8	1.4	1.1	1.8	6.3
C. halli	P (%)	91.8	95.8	94	86.4	74.4	78.7	72	68.3	66.7	63	65.1	65.9
	MI	23±1.1	24±4.8	14.6±0.8	8.7±0.5	15.7±0.9	19±1.1	5.6±0.2	4.1±0.1	4.3±0.1	3.1±0.3	3.1±0.3	6.5±0,6
	A	21.1	23	13.7	7.5	11.7	15	4	2.8	2.8	2	1.9	4.3
C. halinus	P (%)	93.9	91.7	96	75	69.8	76.6	66	70.7	54.3	67.4	62.5	61.7
	MI	17.5±0.9	20.6±6.7	10.5±0.5	8.7±0.3	11.9±0.7	19.5±1.2	6.1±0.2	4.3±0.1	3.4± 0.5	2.3±0.6	2.7±0.3	7.1±0.6
	A	16.4	18.9	10	6.5	8.3	15	4	3.1	2.1	1.5	1.5	4.4
C. lagoonaris	P (%)	38.8	45.8	36	31.8	48.8	40.4	30	43.9	27.1	37.2	39.1	42.6
	MI	14±0.4	17.6±0.4	7.3±0.7	3.3±0.4	7.6±0.3	15.7±0.8	9.7±0.7	6.2±0.3	6.5±0.6	3.2±1.1	3.6±0.2	5.1±0.3
	A	5.4	8.1	2.6	1	3.7	6.3	2.9	2.7	1.8	1.2	1.3	2.2
C. minus	P (%)	42.9	41.7	38	29.5	46.5	42.6	26	51.2	25.6	41.9	34.8	34
	MI	12.5±.09	14.3±2.3	5.3±0.4	4.8±0.3	9.6±0.7	10.2±0.8	5±0.4	3±0.2	2.8±0.2	1.8±0.2	1.9±0.1	5.9±0,4
	A	5.4	5.9	2	1.4	4.5	4.3	1.2	1.5	0.7	0.6	0.8	2

C : *Cichlidogyrus*, S : *Scutogyrus* ; Mi : May ; Jn : June ; Jui : July ; At : August ; Sep : September ; Oc : October ; Nv : November ; Dc : Décember : Jan : January ; Feb : February ; Ms : March ; Ap : April

4. DISCUSSION

The study of gill monogenean parasites of *Sarotherodon melanotheron* from Taabo dam lake allowed to identify five parasite species. These were *Cichlidogyrus acerbus*, *C. halli*, *C. halinus*, *C. lagoonaris* and *Scutogyrus minus*. The parasite richness obtained is five in the Ahondo and Courandjourou stations. Previous studies made by [14, 15], had collected three and five gill monogenean parasite species on the same fish in Ayamé 1 lake and in Ebrié lagoon sector IV. It's well known that factors can act directly or indirectly on the parasite richness variation as pointed out by some authors such as [26, 27]. These include the effort of host individuals examined, life traits, size, behaviour, habitat and phylogeny of hosts and parasites. Compared to previous work, the parasite richness obtained could be due to habitat. Indeed, as each area has specific ecological conditions, it thus hosts groups of specific parasite species in composition and abundance as noted by [28]. In the present study, the same number of gill monogenean parasite species obtained at the Ahondo and Courandjourou stations suggests that these parasite species are cosmopolitan. They have therefore adapted to the different conditions of the Taabo dam lake.

The sex-specific parasitism study of the host fish revealed differential infestation. The gill of male fish sheltered more monogenean species *Cichlidogyrus acerbus*, *C. halli* and *S. minus*. This could be due to the behaviour that male fish develop when actively searching for food, as noted by [29]. Indeed, in order to feed, these fish explore various places or habitats and are therefore more exposed to parasitic infestation. This result could also be explained by the [30], hypothesis that males invest a lot of energy in the synthesis of testosterone and that this would reduce their immune system's effectiveness and therefore make them more vulnerable to infestations than females. Furthermore, the female fish's gills were most heavily parasitized by *C. halinus* and *C. lagoonaris*. Similar results had already been found by [31]. In this study, the high infestation of female fish could be due to the appearance of the fish and its sedentary behaviour during spawning. Indeed, depending on the reproductive activity, some female fish change their appearance by offering a larger area of colonization to parasites and become more sedentary as pointed out by [32]. These changes are favourable to the high parasite infestation. This is why [32], explained this phenomenon based on the females way of life during spawning as well as their large size that would increase their parasitism. Therefore, the sex differences in infection may be attributed to the immune response of the host due to the difference in endocrine glands activities between the male and female host fishes which have been suggested by [33], with myxosporean parasites in two tilapia species and Ibrahim and [34] with parasite community of wild and cultured *Oreochromis niloticus*.

This study indicated that *Sarotherodon melanotheron* fish are more likely to be infested with *C. halli*, *C. halinus* and *C. lagoonaris* during rainy seasons. Similar results had already been found by other authors with the gill monogenean parasites of this same fish and also with other fishes of the same family. This is the case of [14], and [35] with the gill monogenean parasites of *Sarotherodon melanotheron* and *Tilapia* (*Coptodon*) *zillii* in Ayamé lake and Lobo river, respectively. This is also the case for [31], with gill monogenean parasites of *Sarotherodon melanotheron* in Lake Ayamé 2. In this present study, the high infestation of fish during rainy seasons is thought to be related to their immune system failure during this period. Located near fields intensively treated with plant protection products, Taabo lake receives the water from these plant protection products and domestic wastewater from the city and surrounding villages. The water quality of this lake is therefore severely degraded, making aquatic organisms in general and fish in particular vulnerable to high levels of parasitic infestation as found by [36]. In addition, it's well known that in the rainy season, gill monogenean parasite larvae hatch when female hosts lay and their physiological condition and therefore their immune defenses are reduced; these weakened females, as well as the fry, are easy targets for the parasites. Therefore, the ephemeral nature of the host as a habitat has forced parasites to find ways to colonize new individuals as suggested by [37]. These authors also indicated that the hatching of monogenean eggs is closely linked to environmental cycles and direct host stimuli. Another reason to explain the high fish infestation during rainy seasons is the fact that the dry seasons were characterized by the mortality of adult worms due to higher water temperature as suggested by [38, 39], in their studies. Indeed, it is well known that the abundance of monogeneans is influenced by seasonal changes in water temperature which is due in part to its influence on their life cycle.

5. CONCLUSION

The study of population dynamic of gill monogenean parasites in blackin tilapia *Sarotherodon melanotheron* caught from Taabo man-made lake indicated that this fish specimen is infested by five species. There are species *Cichlidogyrus acerbus*, *C. halli*, *C. halinus*, *C. lagoonaris* and *Scutogyrus minus*. It also revealed that the effects of the study station and the season of a year. Moreover, this study has underlined that parasite infestation depends on the fish host sex. These informations obtained are essential in the search of strategies in aquaculture management to reduce potential economic losses of *S. melanotheron* caused by monogeneans infestation.

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Conflict of Interest: All authors have studied the manuscript and agreed to the terms and conditions of study. They declare that there is no conflict of interest.

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