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Impact of gill Monogenean parasites infestation on the condition factor of Nile Tilapia *Oreochromis niloticus* (Cichlidae) in the Taabo man-made lake, Côte d'Ivoire

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Abstract
Oreochromis niloticus, or Nile tilapia, is one of the most heavily exploited species in the Taabo man-made lake in Côte d'Ivoire, where it represents a strategic fishery resource. However, this aquatic environment is increasingly affected by anthropogenic pressures that promote the proliferation of parasites, particularly gill Monogeneans. Between May 2023 and April 2024, a parasitological study identified eight species of gill Monogeneans belonging to the genera *Cichlidogyrus* and *Scutogyrus* in 1180 specimens of *O. niloticus*. The recorded species were: *Cichlidogyrus rognoni*, *C. cirratus*, *C. thurstonae*, *C. sclerosus, C. tiberianus*, *C. halli*, C. *tilapiae* and *Scutogyrus longicornis*. The results showed that fish from the Ahondo station were more heavily infested than those from Courandjourou, both in terms of parasite diversity and abundance. This infestation had a marked impact on fish health: parasitized individuals displayed significantly lower condition factor (K), particularly at Ahondo (K = 0.36±0.01). The negative effects were more pronounced during the rainy season (K = 0.37±0.02) and in males (K = 0.30±0.01), who showed more deteriorated body condition than females (K = 0.52±0.2). Additionally, larger fish carried higher parasite loads, although their condition factor (K = 0.43±0.10) was slightly higher than that of smaller individuals. These findings highlight the detrimental impact of Monogeneans on the physiology of Nile tilapia and emphasize the need for eco-parasitological monitoring to ensure the sustainable management of the Taabo lake fishery.

Keywords: Fish, parasites, condition factor, Taabo Lake, Côte d'Ivoire

1. Introduction

Oreochromis niloticus, commonly known as Nile tilapia, is a freshwater fish species belonging to the family Cichlidae. Native to the Nile basin, it is now among the most widely farmed fish species globally, owing to its rapid growth, tolerance to a wide range of environmental conditions, and significant socio-economic importance, particularly in developing countries (Shaukat, 2008) [1]. In West Africa, *O. niloticus* serves as a crucial source of animal protein for rural communities and is a cornerstone of artisanal fisheries and aquaculture. However, like many aquatic species, *O. niloticus* is frequently exposed to pathogenic agents, including parasites. Among these, monogeneans flatworm ectoparasites of the class Monogeneans are commonly found on the gills and skin of freshwater fish. These parasites, which have a direct life cycle, feed on the host's tissues or mucus, causing tissue damage, epithelial cell hyperplasia, and respiratory distress in infected fish (Hathal *et al.*, 2020) [2]. In cases of heavy infestation, monogeneans can impair growth, reduce reproductive output, and even cause mortality. One of the biological indicators frequently used to assess fish health is the condition factor (K). This parameter relates body weight to length and reflects the overall well-being of the individual. A high condition factor generally indicates good nutritional and physiological status, whereas a low condition factor may signal stress, malnutrition, or disease (Bichi and Yelwa, 2010; Dan-Kishiya, 2013) [3, 4]. The length-weight relationship (LWR) is thus a fundamental tool in fish ecology, useful for stock management, productivity assessment, and the detection of biological disturbances (Hossain *et al.*, 2012; Bolognini *et al.*, 2013; Am *et al.*, 2018) [5, 6, 7]. Various factors can influence fish growth and condition factor, including diet, temperature, photoperiod, gonadal development, water quality and notably parasitic infections (Alfei *et al.*, 1994; Baroiller and D'Cotta, 2001; Poulin, 1996) [8, 9, 10]. Several studies have demonstrated the negative impact of Monogeneans on the physiological performance of *O. niloticus*, though such investigations remain limited and highly localized. In Côte d'Ivoire, research on Monogenean parasites of *Oreochromis niloticus* has primarily focused on species inventories and certain ecological aspects (Blahoua *et al.*, 2016) [11]. However, no studies have specifically examined the impact of Monogenean infestations on the condition factor or body condition of *O. niloticus*. This study focuses on *O. niloticus*, a fish species heavily exploited in the Taabo reservoir an ecosystem subject to intense anthropogenic pressure, characterized by riparian deforestation, domestic and agricultural pollution, and overfishing. Field observations around the lake have noted that many *Tilapiae* exhibits pronounced emaciation, morphological anormalities, and visible gill lesions, often leading to their rejection after capture. The objective of this study was to evaluate the effect of gill Monogenean infestation on the condition factor of *Oreochromis niloticus* in the Taabo Lake.

2. Material and methods

2.1 Study area

2.1.1 Description of study station

The study was conducted in the Taabo Reservoir, located in south-central Côte d'Ivoire between latitudes 6°10' N and 6°60' N, and longitudes 5°20' W and 5°90' W. This artificial lake was created in 1978 on the Bandama River, approximately 120 km downstream of Lake Kossou and 110 km from the confluence of the White and Red Bandama Rivers (Kouassi *et al.*, 2007; Aliko *et al.*, 2010) [12,13]. The reservoir covers an area of 69 km² and drains a watershed of 58,700 km², with an estimated annual average discharge of 128.7 m³/s. The region experiences an Attie-type climate, classified as equatorial transition, characterized by two rainy seasons (April to June and September to November) and two dry seasons (December to March and July to August) (Berté *et al.*, 2008) [14]. Vegetation is dominated by semi-deciduous forests alternating with pre-forest savannas in the north and dense forests in the south (Groga, 2012; Guillaumet and Adjanohoun, 1971) [15,16]. Gallery forests border the water body, with typical vegetation including *Ceiba pentandra*, *Triplochiton scleroxylon*, and various herbaceous species. Two sampling stations were selected for this stud: Ahondo and Courandjourou. The Ahondo station (6°20'N - 6º 47'N et 5°42'W-5°57'W) is characterized by extensive coverage of aquatic plants, particularly water hyacinths (*Eichhornia crassipes*), which cover approximately 80% of the water surface. The substrate is mainly sandy, interspersed with dead tree trunks. The area is surrounded by yam and cocoa plantations, as well as a classified forest. The average water depth is 6 meters. The Courandjourou station (6°13'N - 6º17'N et 5°42'W - 5º 60'W) is located in the main channel of the lake. It is marked by a very low canopy cover, estimated at around 5%. The surrounding area includes cocoa and plantain plantations, as well as dense forest. The aquatic substrate is predominantly sandy, with patches of silt, white clay, and submerged wooden structures (forked branches), which make navigation difficult. The average water depth is approximately 7.25 meters.

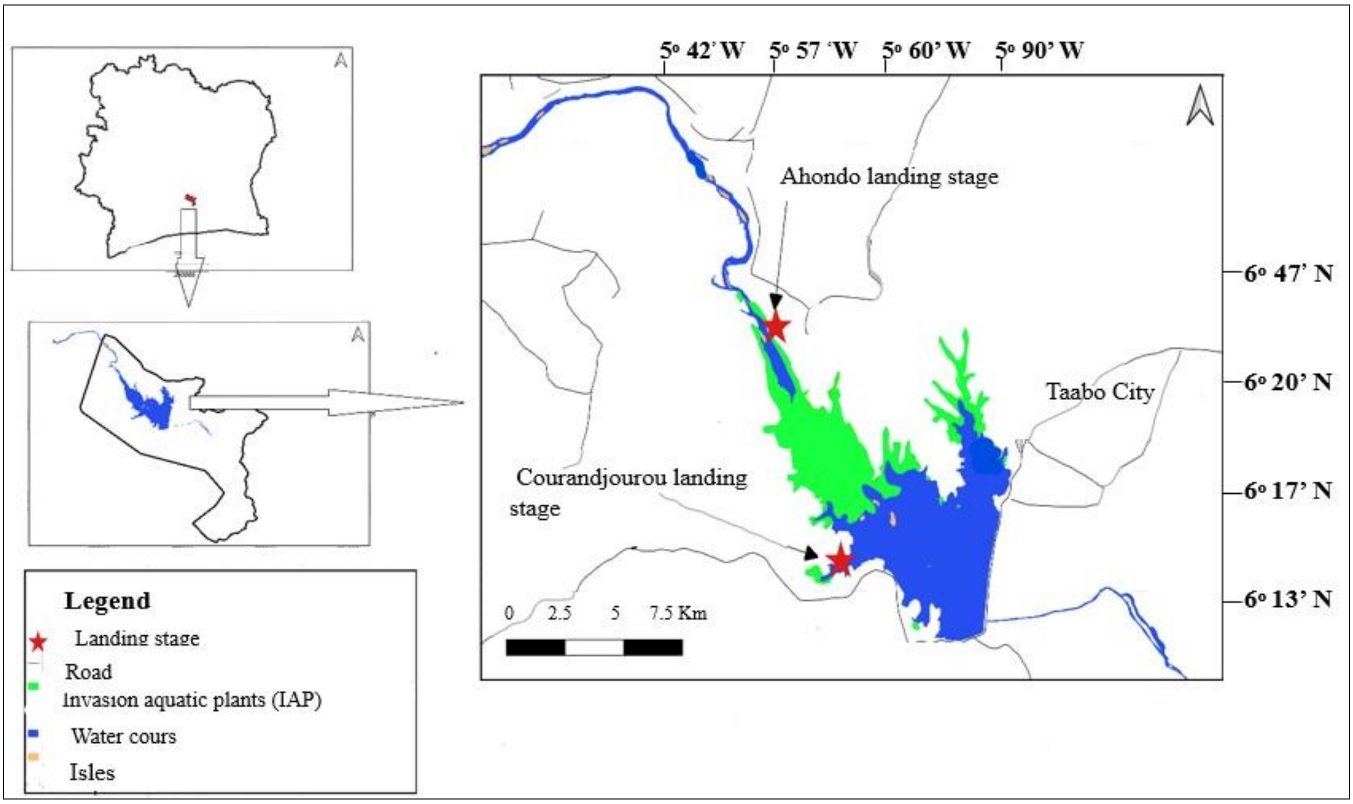

Fig 1: Map of Taabo man-made lake and the sampling stations.

2.1.2 Anthropogenic factors

According to Vei (2005) [17], forest cover in the Taabo region, which accounted for 78% of the area prior to the filling of the lake, declined to 66% in 1982 and dropped further to only 25% in the early 1990s. This decline is primarily attributed to the expansion of agricultural activities by the local riparian populations. The National Environmental Agency of Côte d'Ivoire (ANDE-CI, 2003) [18] has reported intensive and uncontrolled use of pesticides in these agricultural zones, with residues potentially contaminating the lake's waters through surface runoff. The intensification of agriculture within the watershed has led to a gradual enrichment of the lake waters with nutrients, thereby promoting eutrophication. This process has resulted in the excessive proliferation of aquatic vegetation, particularly invasive species such as water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*), and giant salvinia (*Salvinia molesta*), among others. Since the 1990s, the area covered by these plants has continued to expand, threatening the ecological balance of the lake and disrupting both fishing activities and boat navigation.

2.2 Fish sampling and parasite collection

A total of 1180 specimens of *Oreochromis niloticus* were collected from the Taabo lake between May 2023 and April 2024. Samples were obtained using gillnets. Each fish was measured and weighed in the field using an ichthyometer graduated in centimeters (cm) and an electronic balance with a 2000 g capacity and 0.01 g precision. Taxonomic identification of the fish was conducted immediately after capture, following the identification keys proposed by Teugels and Thys van den Audenaerde (2003) [19]. The gills were excised from both sides of each specimen, wrapped in aluminum foil, and stored in a cooler containing ice until laboratory processing. Sex and gonadal maturity stage were determined in the field using a standard gonadal maturity scale. In the laboratory, the gill samples were thawed and examined under a stereomicroscope. Monogeneans were isolated and mounted on microscope slides in a drop of ammonium picrate-glycerin mixture, following the method described by Malmberg (1957) [20]. Parasite identification was carried out under a light microscope based on the morphology and measurements of the sclerotized structures of the haptoral and copulatory complexes, according to the descriptions provided by Pariselle and Euzet (2009) [21].

2.3 Data analysis

2.3.1 Parasitological indices

To assess the effect of parasitism, the main epidemiological indices were calculated according to the definitions provided by Bush *et al.* (1997) [22]: prevalence, mean intensity and abundance.

Prevalence (P%) is the percentage ratio between the number of hosts infested (N) by a given parasite species and the number of fish examined (H).

$$P = N/H \times 100$$

Based on the prevalence, species was considered as common (core) if the prevalence is greater than 50%, intermediate (secondary) if prevalence is between 10 and 50% and rare if prevalence is less than (Valtonen *et al.*, 1997) [23] 10%.

Mean parasite intensity (IM) is the ratio of the total number of individuals of a parasite species (n) in a sample of hosts to the number of infested hosts (N) in the sample.

$$IM = n/N$$

Abundance (A) refers to the average number of parasites (n° found per host in the entire sample population, including both infected and uninfected individuals (H). It is calculated using the following formula.

$$A = n/H$$

2.4 Condition factor (K)

The Fulton's Condition Factor (K) suggests that the weight of the fish is proportional to the cube of the length and was used to assess the general health of the fishes, on individual and population level. In all individuals' total length, standard length and body mass were measured. The allometric equation where the b exponent is a constant was used to compare the health index of the different category of fishes.

Thus, Fulton's condition factor (K) was calculated using the formula:

$$K = W*100/ L^b$$ (Le Cren, 1951) [24]

Where W = weight of fish (g), L = standard length of the fish (cm), b = coefficient of allometry considered equal to 3).

The Fulton's condition factor was multiplied with 100 to get it close to 1, and the number 1 indicated a normal condition of the fish, greater 1 indicated fat fish and less than 1 indicated skinny fish. This morphometric index assumes that the heavier fish for a given length the better condition.

2.5 Statistical analysis

Data analysis was performed using STATISTICA software, version 7.1. Prevalence rates of Monogenean infestation were compared between groups using the Chi-square test (X^2). For comparisons of parasitic intensities and abundances, two non-parametric tests were employed: the Kruskal-Wallis test for comparisons involving more than two groups, and the Mann-Whitney U test for comparisons between two independent groups. Furthermore, condition factor (K) values were compared between parasitized and non-parasitized fish using the Mann-Whitney U test, due to the non-normal distribution of the data. Differences were considered statistically significant when the p-value was less than 0.05.

3. Results

3.1. Monogeneans species composition

A parasitological examination of the *Oreochromis niloticus* gill from Lake Taabo led to the identification of eight Monogenean species, classified within the genera *Cichlidogyrus* and *Scutogyrus*. The species identified included *Cichlidogyrus rognoni*, *C. cirratus*, *C. thurstonae*, *C. sclerosus*, *C. tiberianus*, *C. halli*, *C. tilapiae*, and *Scutogyrus longicornis*. Notable variation in species richness was observed among sampling locations: fish collected from the Ahondo site hosted five Monogenean species, whereas individuals from the Courandjourou site harbored four species.

3.2. Spatial distribution of recovered parasites

Table-1 summarizes the variation in parasitological indices observed between the Ahondo and Courandjourou sampling stations. The highest prevalence rates were recorded at the Ahondo station for the species *Cichlidogyrus rognoni* (35.08%), *C. cirratus* (35.42%), *C. thurstonae* (71.19%), *C. sclerosus* (68.64%), *C. tiberianus* (35.59%), *C. halli* (63.56%) and *C. tilapiae* (61.02%). In contrast, *S. longicornis* exhibited a higher prevalence at the Courandjourou site (57.79%). Chi-square statistical analysis revealed no significant differences in infestation rates between the two stations for *C. cirratus*, *C. thurstonae*, *C. sclerosus*, *C. tiberianus*, *C. halli*, and *C. tilapiae* (p>0.05). However, significant differences were observed for *C. rognoni* and *S. longicornis* ($p<0.05$). Mean parasite intensities at Ahondo were respectively 19.28±0.1, 28.78±0.3, 30.01±1.3, 19.19±1.6, 27.79±1.9, and 30.40±1.2 for *C. cirratus*, *C. thurstonae*, *C. sclerosus*, *C. tiberianus*, *C. halli*, and *C. tilapiae*. At Courandjourou, the highest intensities were observed for *C. rognoni* (10.860±0.3) and *C. longicornis* (16.83±1.6). In terms of parasite abundance, *C. cirratus* (6.83), *C. thurstonae* (20.49), *C. sclerosus* (20.60), *C. tiberianus* (6.83), *C. halli* (17.66) and *C. tilapiae* (18.55) were the most represented species at Ahondo. At Courandjourou, the abundance values of *C. rognoni* and *S. longicornis* were 3.64 and 9.73, respectively. The Mann-Whitney U test applied to parasite intensity and abundance data indicated that fish sampled from Ahondo were significantly more parasitized than those from Courandjourou ($p<0.05$). Analysis of the gill parasite community structure in *Oreochromis niloticus* identified *C. thurstonae*, *C. sclerosus*, *C. halli*, and *C. tilapiae* as dominant species at Ahondo (prevalence > 50%). *C. rognoni*, *C. cirratus*, and *C. tiberianus*, with prevalence values between 10% and 50%, were classified as intermediate. At Courandjourou, only *S. longicornis* displayed a dominant prevalence (57.79%).

Table 1: Spatial variation of Prevalence (P), Mean Intensity (MI) and Abundance (A) of Monogenean parasites of *Oreochromis niloticus*

Station	Monogeneans	Fish Examined	Infested Fish	P (%)	MI	A
Ahondo	C. rognoni	590	207	35.08	1.84±0.1	6.65
	C. cirratus	590	208	35.42	19.28±0.1	6.83
	C. thurstonae	590	420	71.19	28.78±0.3	20.49
	C. sclerosus	590	405	68.64	30.04±1.2	20.72
	C. tiberianus	590	210	35.59	19.78±1.6	6.63
	C. halli	590	375	63.56	27.78±1.9	17.65
	C. tilapiae	590	360	61.02	30.04±1.2	18.55
	S. longicornus	590	27	4.58	3.89±0.1	0.18
Courandjourou	C. rognoni	590	198	33.55	10.86±0.3	3.64
	C. cirratus	590	32	5.42	2.90±0.1	0.15
	C. thurstonae	590	420	71.18	15.70±0.2	11.18
	C. sclerosus	590	405	68.64	14.56±1.1	10.01
	C. tiberianus	590	192	32.54	10.81±1.2	3.53
	C. halli	590	337	57.11	17.64±1.6	10.05
	C. tilapiae	590	336	56.44	15.99±1.3	9.02
	S. longicornus	590	341	57.79	16.83±1.6	9.73

3.3 Impact of parasitism on the condition factor (K) of *Oreochromis niloticus* according to sampling stations

Condition factor (K) values for both parasitized and uninfested fish from the Ahondo and Courandjourou stations are presented in Table-2. At Ahondo, out of 590 examined fish, 420 were found to be parasitized, while 170 were not. At Courandjourou, from the same number of specimens, 408 were parasitized and 182 non-parasitized. At the Ahondo station, parasitized fish exhibited a mean condition factor of 0.36±0.01, compared to 0.75±0.10 in uninfested individuals. The Mann-Whitney U test revealed a statistically significant difference between the two groups ($p<0.05$), indicating a negative impact of parasitic infestation on the somatic condition of the hosts. Similarly, at Courandjourou, parasitized fish had a mean condition factor of 0.57±0.02, significantly lower than that of non-parasitized fish (0.81±0.01). This difference, also confirmed by the Mann-Whitney U test ($p<0.05$), supports the deleterious effect of parasites on host condition. Furthermore, inter-station comparison of parasitized fish revealed a significant difference in condition factor between Ahondo (K = 0.36±0.01) and Courandjourou (K = 0.57±0.02), as indicated by the Mann-Whitney U test ($p<0.05$). This finding highlights that fish from the Ahondo station were not only more heavily parasitized but also exhibited significantly poorer body condition.

Table 2: condition factor (K) Variation between infected and uninfected *Oreochromis niloticus* specimens according to the stations of the Taabo man-made lake

Stations	Hosts	Number	Condition Factor (K)	p-value
Ahondo	Examined	590	-	-
	Infected	420	0.31±0.01	
	Uninfected	170	0.75±0.1	0.001
Courandjourou	Examined	590	-	-
	Infected	408	0.57±0.02	
	Uninfected	182	0.81±0.1	0.01

3.4 Impact of parasitism on the condition factor (K) of *Oreochromis niloticus* according to host sex

The analysis of the condition factor (K) of *Oreochromis niloticus* by sex at the Ahondo and Courandjourou stations is summarized in Table-3. At Ahondo, among the 590 fish examined, 297 were males, of which 295 were parasitized and only 2 were not. Among the 293 females, 290 were parasitized and 3 were not. In males, the mean condition factor was 0.30±0.01 in parasitized individuals, compared to 0.54±0.01 in uninfested ones. The Mann-Whitney U test revealed a statistically significant difference between these groups ($p<0.05$), indicating a detrimental effect of parasitism on male body condition. In females from the same station, the mean K values were 0.52±0.20 for parasitized and 0.76±0.01 for uninfested individuals, with the difference also being statistically significant (Mann-Whitney U test, $p<0.05$). Comparison of parasitized males and females at Ahondo showed that males had a significantly lower condition factor (0.30±0.01) than females (0.52±0.20). Difference confirmed by the Mann-Whitney U test ($p<0.05$). At the Courandjourou station, 289 males were examined, of which 280 were parasitized and 9 non-parasitized. The mean condition factor was 0.58±0.02 in parasitized males and 0.83±0.01 in uninfested ones, with the difference being statistically significant (p<0.05), confirming the negative impact of parasitism on host condition. Among the 301 females examined, 290 were parasitized and 11 non-parasitized. The mean condition factor was 0.39±0.03 in parasitized females and 0.85±0.02 in uninfested ones. This difference was highly significant (Mann-Whitney U test, p<0.05). Finally, comparison between parasitized males and females at Courandjourou revealed a significant difference (p<0.05), with males (K = 0.58±0.02) showing a higher condition factor than females (K = 0.39±0.03), despite a higher prevalence of infestation in males

Table 3: Condition factor (K) Variation between parasitized and unparasitized *Oreochromis niloticus* specimen from Taabo man-made Lake according to the host sex.

Stations	Sex	Hosts	Number	Condition Factor (K)	p-value
Ahondo	Males	Examined	297	0.34±0.01	-
		Infected	295	0.34±0.01	0.002
		Uninfected	2	0.54±0.01	-
	Females	Examined	293	0.52±0.2	-
		Infected	290	0.52±0.2	0.01
		Uninfected	3	0.76±0.01	-
Courandjourou	Males	Examined	289	0.58±0.02	0.03
		Infected	280	0.58±0.02	-
		Uninfected	9	0.83±0.01	-
	Females	Examined	301	0.39±0.3	0.04
		Infected	290	0.39±0.3	-
		Uninfected	11	0.85±0.02	0.001

3.5 Impact of parasitism on the condition factor (K) of *Oreochromis niloticus* according to seasons

The seasonal analysis of the condition factor (K) in *Oreochromis niloticus* sampled at the Ahondo and Courandjourou stations is presented in Table-4. At the Ahondo station, during the rainy season, infested fish exhibited a mean condition factor of 0.37±0.02, which was significantly lower than that of non-infested fish (0.71±0.10) (Mann-Whitney test; p =0.01 < 0.05), indicating a substantial impact of infestation on body condition during this period. During the dry season, the condition factor values were 0.51±0.01 for infested fish and 0.85±0.10 for uninfested fish. The observed difference was also significant (Mann-Whitney test; p =0.03 < 0.05). The comparison between the two seasons for infested fish at Ahondo revealed a significant improvement in condition factor during the dry season (0.51±0.01) compared to the rainy season (0.37±0.02). The Mann-Whitney test confirmed a statistically significant difference between these two periods (p =0.04 < 0.05). At Courandjourou, infested fish during the rainy season showed a mean condition factor of 0.34±0.03, significantly lower than that of non-infested fish (0.82±0.20) (Mann-Whitney test; p =0.04 < 0.05). In the dry season, the K values were 0.51±0.04 for infested fish and 0.90±0.10 for uninfested fish. Again, the Mann-Whitney test revealed a significant difference (p =0.03 < 0.05). The intra-station comparison between seasons for infested fish also showed a significant increase in the condition factor during the dry season (0.51±0.04) compared to the rainy season (0.34±0.03). This seasonal variation was deemed significant according to the Mann-Whitney test (p =0.02 < 0.05).

Table 4: Condition factor (K) Variation between infected and uninfected *Oreochromis niloticus* specimens according to the seasons of the Taabo man-made lake

Station	Season	Hosts	Number	Condition Factor (K)	p-value
Ahondo	RS	Examined	295	0.73±0.02	-
		Infected	269	0.73±0.02	0.01
		Uninfected	26	0.71±0.1	-
	DS	Examined	295	0.54±0.1	-
		Infected	239	0.51±0.1	0.04
		Uninfected	56	0.85±0.1	0.03
Courandjourou	RS	Examined	295	0.34±0.03	-
		Infected	270	0.34±0.03	0.02
		Uninfected	25	0.82±0.2	-
	DS	Examined	295	0.51±0.04	-
		Infected	235	0.51±0.04	0.03
		Uninfected	60	0.94±0.1	-

3.6 Impact of parasitism on the condition factor (K) of *Oreochromis niloticus* according to size classes

The variations in the mean condition factor (K) according to size classes of *Oreochromis niloticus* at the two sampling stations of the Taabo dam lake are presented in Table-5. Four size classes were defined: [17-20[, [20-23[, [23-26[, and [26-29]. At the Ahondo station, in the [17-20[size class, out of 148 fish examined, 70 were infested and 78 were uninfested. The mean condition factor was 0.32±0.10 for infested fish and 0.72±0.02 for non-infested fish. The Mann-Whitney test revealed a significant difference (p = 0.001< 0.05). In the [20-23[class, among 147 examined fish, 79 were infested and 68 uninfested. The condition factor averaged 0.37±0.03 for infested fish and 0.84±0.20 for uninfested fish. This difference was also significant according to the Mann-Whitney test (p =0.003 < 0.05). For the mid-size class [23-26[, 140 fish were infested compared to only 7 uninfested of the 147 examined. The condition factors were 0.41±0.01 and 0.78±0.02, respectively. A significant difference was found between the two groups (Mann-Whitney; p =0.02 < 0.05). In the large size class [26-29], out of 148 fish examined, 147 were infested and only one was uninfested. The K values were 0.43±0.10 for the infested and 0.62±0.01 for the uninfested individual. The overall analysis of condition factors for infested fish showed a progressive increase in average values across size classes: 0.32; 0.37; 0.41; 0.43, accompanied by a parallel increase in total parasite load. The Mann-Whitney test confirmed a significant difference between these groups (p =0.02 < 0.05), indicating that although larger fish have a slightly higher condition factor than smaller infested ones, they are generally more heavily parasitized and thus more physiologically impacted. At the Courandjourou station, in the [17-20[class, out of 148 fish examined, 72 were infested and 76 were uninfested. The condition factor was 0.46±0.02 for infested fish compared to 0.84±0.10 for uninfested fish, with a significant difference (Mann-Whitney; p =0.01 < 0.05). For the [20-23[class, 93 were infested and 54 uninfested among 147 examined fish. The K values were 0.51±0.40 for infested fish and 0.87±0.20 for uninfested fish, with a significant difference according to the Mann-Whitney test (p =0.03 < 0.05). In the [23-26[class, 144 infested fish were recorded compared to only 5 uninfested among 149 examined fish. The results revealed a significant difference in condition factors (exact values not reported), confirmed by the Mann-Whitney test. Finally, in the [26-29] class, among 146 examined fish, 141 were infested and 5 were uninfested. The evaluation of mean condition factors also showed a significant difference between the two groups (p = < 0.05), with infested fish being significantly leaner.

Table 5: Condition factor (K) variation between infected and uninfected *Oreochromis niloticus* specimens in the Taabo man-made lake according to the host size

Station	Size (mm)	Hosts	Number	Condition Factor (K)	p-value
Ahondo	[170-200]	Examined	148	-	-
		Infected	70	0.32 ± 0.1	-
		Uninfected	78	0.72 ± 0.1	0.001
	[200-230]	Examined	147	-	-
		Infected	79	0.37 ± 0.03	-
		Uninfected	68	0.84 ± 0.1	0.003
	[230-260]	Examined	147	-	-
		Infected	140	0.41 ± 0.1	-
		Uninfected	7	0.78 ± 0.02	0.02
	[260-290]	Examined	148	-	-
		Infected	147	0.43 ± 0.1	-
		Uninfected	1	0.83 ± 0.01	0.001
Courandjourou	[170-200]	Examined	148	-	-
		Infected	72	0.46 ± 0.02	-
		Uninfected	76	0.82 ± 0.1	0.02
	[200-230]	Examined	147	-	-
		Infected	94	0.51 ± 0.04	-
		Uninfected	53	0.81 ± 0.03	0.03
	[230-260]	Examined	144	-	-
		Infected	139	0.53 ± 0.03	-
		Uninfected	5	0.81 ± 0.01	0.001
	[260-290]	Examined	146	-	-
		Infected	141	0.54 ± 0.1	-
		Uninfected	5	0.81 ± 0.01	0.001

4. Discussion

This study assessed the diversity, spatial distribution, infestation intensity, and physiological impact (K condition factor) of gill Monogeneans on *Oreochromis niloticus* at two stations of the Taabo dam lake: Ahondo and Courandjourou. Eight species of Monogeneans were identified, belonging to the genera *Cichlidogyrus* and *Scutogyrus*. This specific richness, higher than that reported in previous studies (Blahoua, 2013; Adou *et al.*, 2021) [25, 26], suggests a significant parasitic diversity, likely driven by the ecological complexity of lake Taabo and its varied environmental gradients. The similar parasitic richness observed between the two stations (eight species each) indicates that the identified species are euryxenous and well-adapted to the lake's ecological conditions. This cosmopolitan distribution may be due to relatively homogeneous environmental conditions across the lake or efficient larval dispersal via mobile hosts. At Ahondo, dominant species such as *C. thurstonae*, *C. sclerosus*, *C. halli*, and *C. tilapia* all showed prevalence above 50%, contrasting with Courandjourou, where only *C. longicornus* was dominant. This disparity in parasite community structure may reflect local environmental differences (pollution, water currents, substrate type, presence of secondary hosts), as discussed by Zharikova (2000) [27].

The mean condition factor (K) was consistently below for all infested fish across both stations, indicating compromised physiological status. This observation confirms the findings of Oso *et al.* (2017) [28], who associated K values below 1 with physiological stress or nutritional and health imbalances. Infested fish systematically exhibited significantly lower K values than non-infested individuals, both overall and when analyzed by station, sex, season, and size, clearly demonstrating the deleterious impact of parasitic infestation on fish health. Sex-based effects on parasitic condition revealed greater vulnerability of males at Ahondo, whereas at Courandjourou, infested females displayed the lowest K values. These differences may reflect sex-specific behavioral or hormonal strategies. Males may expose their gills more while searching for food or mates, increasing susceptibility to infection, as proposed by Siddiqui *et al.* (2014) [29]. Furthermore, the energetic investment in testosterone production may reduce male immunocompetence (Poulin, 2006) [30]. For females, reproductive periods may promote sedentary behavior and increased gill surface exposure, facilitating Monogenean colonization (Ibrahim, 2012) [31]. This may explain why some females also showed high infestation levels, as observed by Adou (2018) [32].

One of the key findings of this study is the pronounced seasonal influence on the physiological condition of the fish. The lowest condition factors were recorded during the rainy season at both Ahondo and Courandjourou. This trend could be attributed to several ecophysiological factors. First, environmental degradation during the rainy season such as increased pollutant loads from agriculture (pesticides, fertilizers) and domestic wastewater can impair water quality, weakening fish immune defenses (Kemp and Spotila, 1997) [33]. Second, Monogenean reproduction is often favored by higher humidity and water temperatures in the rainy season, increasing parasitic pressure (Ibrahim, 2012) [31]. Additionally, the reduction in condition factor may also reflect decreased feeding activity due to habitat disturbance or stress responses. This hypothesis is consistent with the observed reduction in parasite load during the dry season, when fish exhibited relatively better body condition. Thus, seasonality emerges as a key factor modulating both parasite intensity and host physiological status.

The relationship between fish size and parasite infestation showed a clear trend: larger individuals harbored more parasites. Although their condition factor was slightly higher than that of smaller infested fish, they remained significantly more affected than uninfested individuals. These findings support the results of Koyum (2012) [34] and Saha *et al.* (2015) [35], who noted that infestation increases with host age and size. Larger fish provide more surface area for colonization and are exposed to parasites over longer periods (Marcogliese, 2002; Atalabi *et al.*, 2018) [36, 37]. However, other studies (Biu *et al.*, 2014) [38] have reported greater susceptibility in juveniles, suggesting that immune resistance may improve with age. In this study, although larger fish were more heavily infested, their physiological condition was less compromised than in smaller individuals, possibly indicating increased tolerance to infestation or better metabolic regulation capacities.

5. Conclusion

The parasitological study conducted on *Oreochromis niloticus* in the Taabo man-made lake revealed a high diversity of gill Monogeneans, with eight species identified, belonging to the genera *Cichlidogyrus* and *Scutogyrus*. The observed parasitic richness, which was similar between the Ahondo and Courandjourou stations, reflects a broad ecological adaptation of these parasites to the local environmental conditions of the lake. The results showed a significant parasitic infestation, in terms of prevalence, abundance, and intensity, with marked physiological effects on the infested fish. These effects were notably expressed through a significant decrease in the condition factor (K), a key indicator of fish health and well-being. Analyses demonstrated that infested fish exhibited poorer body condition than non-infested individuals, regardless of sex, size, season, or sampling station. The rainy season, stations subject to strong anthropogenic pressure (notably Ahondo), certain size classes, and males in specific contexts were identified as aggravating factors of both parasitic infestation and deterioration in body condition. These findings highlight the critical role of environmental and biological factors in shaping parasitic dynamics and their impact on fish populations.

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