



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 76.37

(GIF) Impact Factor: 0.549

IJFAS 2024; 12(2): 115-121

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www.fisheriesjournal.com

Received: 02-02-2024

Accepted: 05-03-2024

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Size structure, size-weight relationship and condition factor of *Coptodon dageti* and *Sarotherodon galilaeus*, two Cichlids from Lake Sélingué, Mali

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DOI: <https://doi.org/10.22271/fish.2024.v12.i2b.2919>

Abstract

The present contribution aims to study the size and weight structures, the size-weight relationship and the condition factor of *Coptodon dageti* and *Sarotherodon galilaeus* from Lake Sélingué. Fish samples, collected during the rainy season, were measured and weighed. The relationship between the standard length (Ls) and the total length (Lt) is given by the equation of the line $L_t = 1.267L_s + 3.025$ for *Coptodon dageti* and $L_t = 1.301L_s - 0.720$ for *Sarotherodon galilaeus*. That between the eviscerated weight (Pe) and total weight (Pt) is $Pe = 0.869Pt + 0.047$ for *Coptodon dageti* and $Pe = 0.892Pt - 1.117$ for *Sarotherodon galilaeus*. The allometric growth decreases both for *Coptodon dageti* ($b=2.84$) and for *Sarotherodon galilaeus* ($b=2.98$). The values of the condition factor are 4.90 ± 0.49 for *Coptodon dageti* and 2.31 ± 0.19 for *Sarotherodon galilaeus*, reflecting good body condition in both species. The results can be used as reference data in fisheries development programs for Lake Sélingué.

Keywords: *Coptodon dageti*, *Sarotherodon galilaeus*, allometry, condition factor, Lake Sélingué, Mali

1. Introduction

The size-weight relationship (allometry) and the condition factor (overweight) can express weight growth in fish (Diop *et al.*, 2019; Traoré *et al.*, 2020; Sanogo *et al.*, 2022) ^[1, 2, 3]. According to Lévêque (2006) ^[4], growth is a complex process by which part of the energy produced by metabolism is mobilized to increase the weight of fish.

The study of growth has several uses in fish biology and fisheries management. According to Da *et al.* (2018) ^[5], the analysis of the structure and dynamics of fish populations are among these utilities. Growth is also used as an indicator of habitat quality (Searcy *et al.*, 2007) ^[6]. The use of the size-weight relationship and the condition factor to express the growth of fish is very common because the parameters used are weight and size, easily accessible in the field.

The size-weight relationship and condition factor have been studied in many fish species. In West Africa, some recent work is by Coulibaly (2008) ^[7] and Da *et al.* (2018) ^[5], in Burkina Faso, Chikou *et al.* (2015) ^[8] and Hazoume *et al.* (2017) ^[9] in Benin, Atsé *et al.* (2009) ^[10] and Boni *et al.* (2019) ^[11] in Ivory Coast, Niaré *et al.* (2013) ^[12], Diop *et al.* (2019) ^[1], Traoré *et al.* (2020) ^[2], Dembélé *et al.* (2022) ^[13] and Sanogo *et al.* (2022) ^[3] in Mali, Abdul *et al.* (2010) ^[14], Lude *et al.* (2011) ^[15] and Olufelo *et al.* (2016) ^[16] in Nigeria and Ndiaye *et al.* (2015) ^[17] in Senegal. These authors showed the importance of the size-weight relationship and the condition factor in the study of fish biology and management.

Sarotherodon galilaeus and *Coptodon dageti* are fish of the Cichlidae family, widely distributed in the river basins of West Africa (Paugy *et al.*, 2003b) ^[18]. In Mali, the two species are found in the basins of the Niger and Senegal rivers (Sanogo *et al.*, 2015; Karembé *et al.*, 2019; Sanogo *et al.*, 2023) ^[19, 20, 21]. These fish occupy an important place in the Sélingué fishery catches in the Niger River basin (Kantoussan, 2007) ^[22]. The Sélingué lake fishery is located along the Sélingué hydroelectric dam lake, the main Carrière landing stage concentrates all catches intended for urban centers. The biological characteristics of some species common in this fishery have recently been studied, notably *Hemichromis fasciatus* (Traoré, 2020) ^[2], *Chrysichthys auratus* and *Auchenoglanis biscutatus*

(Konaté *et al.*, 2022) [23], *Coptodon zillii* (Sanogo *et al.*, 2022; Dembélé *et al.*, 2022) [3, 13].

Data on biological characteristics, notably the size-weight relationship and the condition factor of *Sarotherodon galilaeus* and *Coptodon dageti*, common in the Sélingué fishery deserve to be explored for better management of the species.

The aim of the present study is a contribution to enrich the data on the biological characteristics of these two cichlids from the Sélingué Lake fishery.

2. Material and methods

2.1 Study site

The fish were collected at the Carrière landing stage located along Lake Sélingué, 3 km from the hydroelectric dam bridge (figure 1). Lake Sélingué has an oligo-mesotrophic trophic status, with an area of 409 km², 5 m average depth and 2.2 billion m³ of water. The lake is located in the pre-guinean zone with average annual precipitation varying between 1200 and 1400 mm of rain and average annual temperatures between 23.7°C and 28.6°C (Dembélé, 2023) [24].

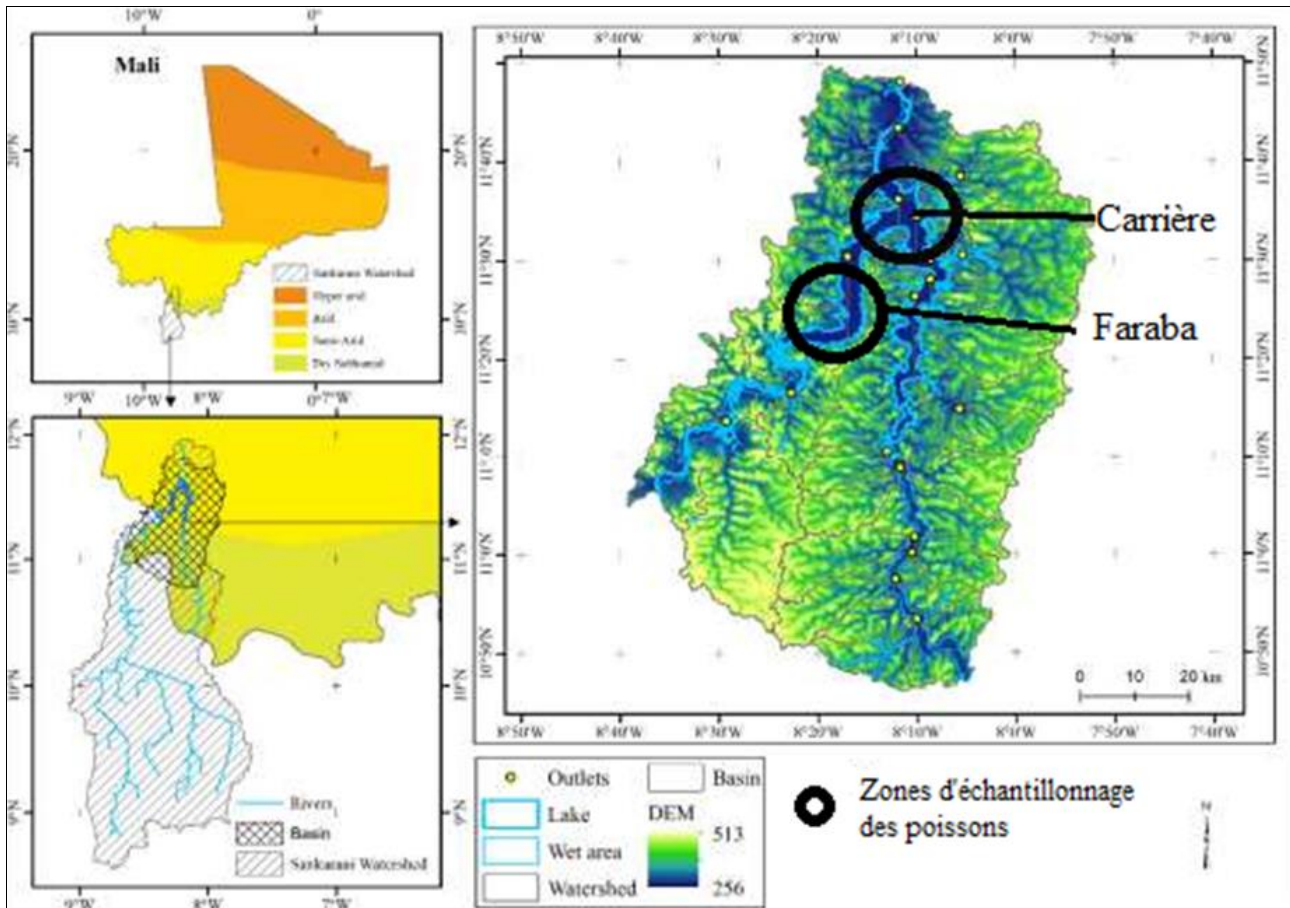


Fig 1: Location of study areas (Karembé *et al.*, 2021) [20]

2.2 Methods

The fish collected were measured and weighed. The measurements were based on the standard length and the total length using a caliper graduated in mm and the weighings were on the total weight and the eviscerated weight using a precision balance of 0.01g and 2kg of scope.

2.3 Data analysis

The collected data were processed on Excel 2016 software to establish relationships between sizes, between weights, between standard length (height) and weight (total weight), calculate the condition factor and averages.

The size-weight relationship: the relationship between the total length of fish and their weight is generally exponential. It is determined by the following relationship (Le Cren, 1951) [25].

$Pt = aLt^b$ with Pt = total weight of the fish in g; Lt = total length of the fish in mm; a and b are factors characteristic of the environment and the species.

By logarithmic transformation, we obtain a linear type relationship:

$$\log Pt = \log a + b \log Lt$$

This transformation makes it possible to reduce variability and homogenize the two variables (Pt and Lt). The coefficient b (slope of the regression line) varies between 2 and 4, but it is often near to 3. It expresses the relative shape of the body of a fish. When it is equal to 3, growth is said to be isometric. When it is different from 3, growth is allometric. A coefficient b greater than 3 indicates better growth in weight than in length and if b is less than 3 growth is better in length than in weight (Micha, 1973; Ricker, 1980) [26, 27].

The condition factor: the following formula was used:

$$K = \frac{Pt}{Ls^3} \times 100$$

When K is greater than 1, the fish population has a good condition factor and well-being during the various stages of its life cycle and when it is less than 1, the fish are in poor condition (Diop, 2022) [28].

3. Results

3.1 Height and weight structures

The standard length varied from 73.91 mm to 138.75 mm with an average of 99.50 ± 18.18 mm in *Coptodon dageti* while it was between 80.62 mm and 175.61 mm with an average of

119.41 ± 14.72 mm in *Sarotherodon galilaeus* (table 1). The weights varied from 16.37 g to 133.97 g in *Coptodon dageti* and from 10.98 to 122.32 g in *Sarotherodon galilaeus* with respective averages of 53.20 ± 26.70 g and 41.92 ± 5.80 g (table 1).

Table 1: Average values of size and weight in the species studied

Species	Standard length in mm			Total weight in g		
	Min	Average	Max	Min	Average	Max
<i>Coptodon dageti</i>	73.91	99.50 ± 18.18	138.75	16.37	53.20 ± 26.70	133.97
<i>Sarotherodon galilaeus</i>	80.62	119.41 ± 14.72	175.61	10.98	41.92 ± 5.80	122.32

Legend: Min = minimum; Max = maximum.

The regression coefficients (r) of the equations for the relationship between standard length (Ls) and total length (Lt) were 0.99 for *Coptodon dageti* and 0.97 for *Sarotherodon*

galilaeus. The equation of the line was $L_t = 1.267L_s + 3.025$ in *Coptodon dageti* (figure 2) and $L_t = 1.301L_s - 0.720$ in *Sarotherodon galilaeus* with aligned point clouds (figure 3).

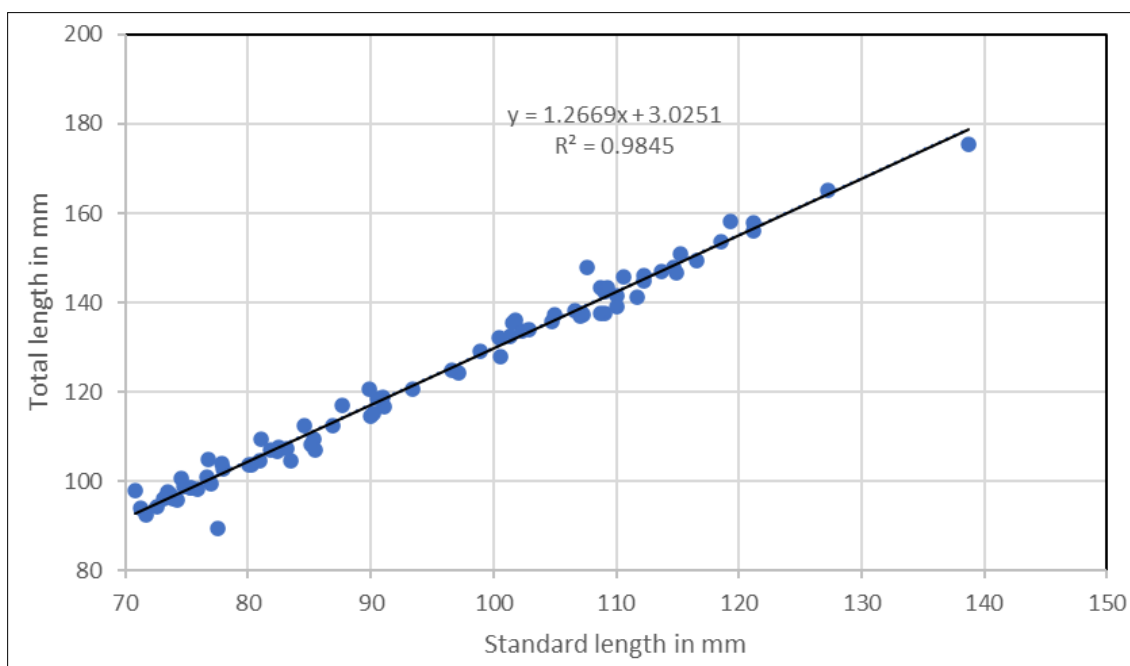


Fig 2: Curve of the total length-standard length relationship in *Coptodon dageti*.

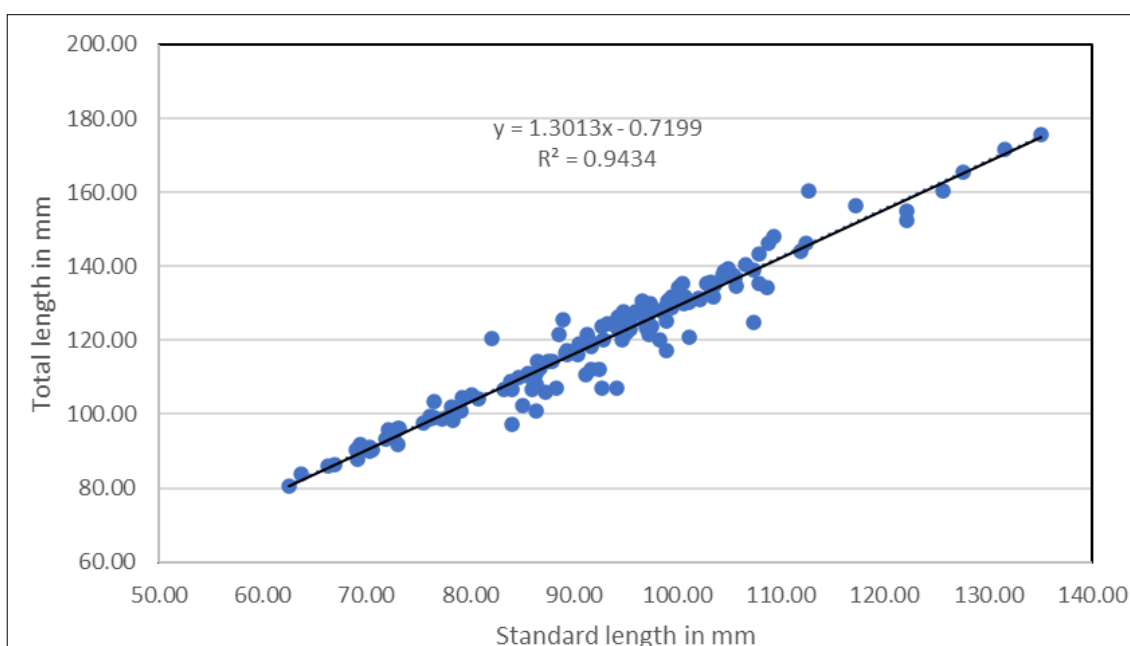


Fig 3: Curve of the total length-standard length relationship in *Sarotherodon galilaeus*.

The regression coefficient (r) of the equations of the relationship between total weight (Pt) and eviscerated weight (Pe) is 0.99 in *Coptodon zillii* and *Sarotherodon galilaeus*.

These equations of the line were $Pe = 0.869Pt + 0.047$ in *Coptodon dageti* (figure 4) and $Pe = 0.892Pt - 1.117$ in *Sarotherodon galilaeus*, with aligned point clouds (figure 5).

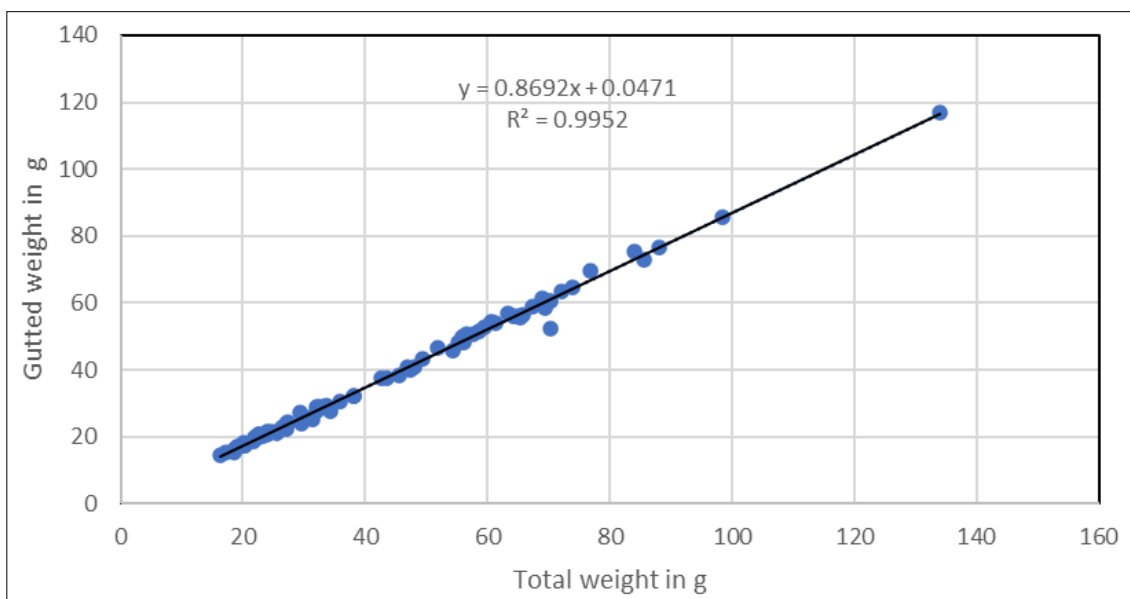


Fig 4: Curve of the eviscerated weight-total weight relationship in *Coptodon dageti*.

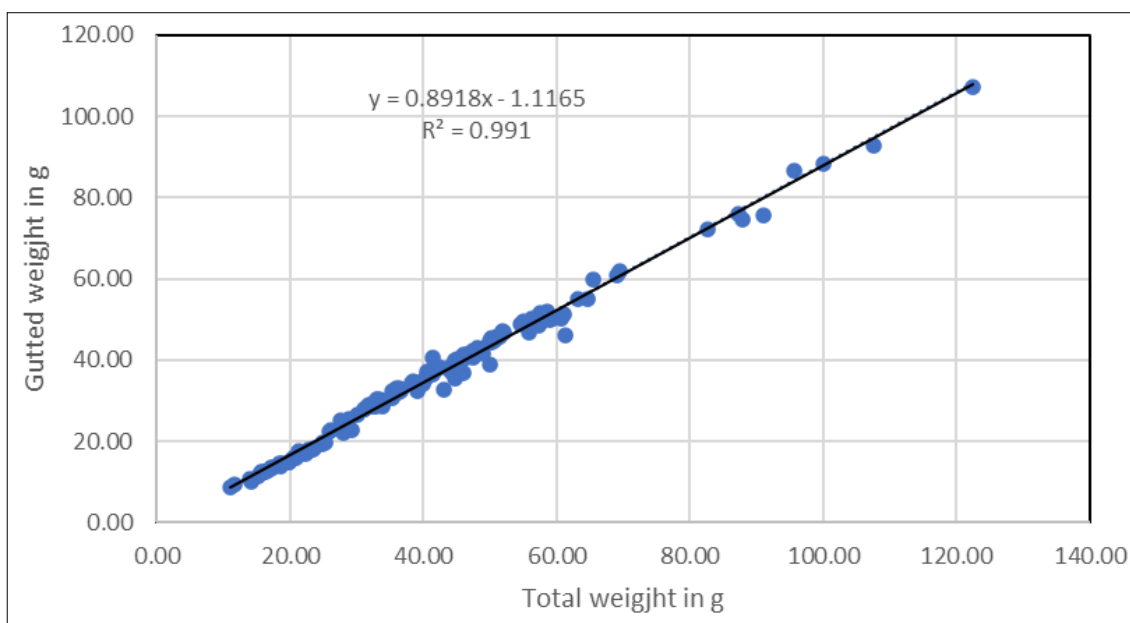


Fig 5: Curve of the eviscerated weight-total weight relationship in *Sarotherodon galilaeus*.

3.2 Height-weight relationship

The parameters of the size-weight relationship are shown in Table 2. There is a correlation between size and weight in both species. The regression coefficient is 0.98 for the equation of the logarithmic line of the size-weight relationship in *Coptodon dageti* and 0.97 in *Sarotherodon galilaeus* (table 2). The value of b is 2.84 in *Coptodon dageti* and 2.98 in *Sarotherodon galilaeus*, lower than the theoretical value 3, reflecting a lower allometry with a faster growth rate in size than in weight (table 2).

Table 2: Parameters of the size-weight relationship in the species studied

Species	Number	a	b	r
<i>Coptodon dageti</i>	81	0.0183	2.84	0.98
<i>Sarotherodon galilaeus</i>	142	0.0099	2.98	0.97

Figures 6 and 7 show clouds of points aligned on the lines of the logarithmic equations of the size-weight relationship in the two species.

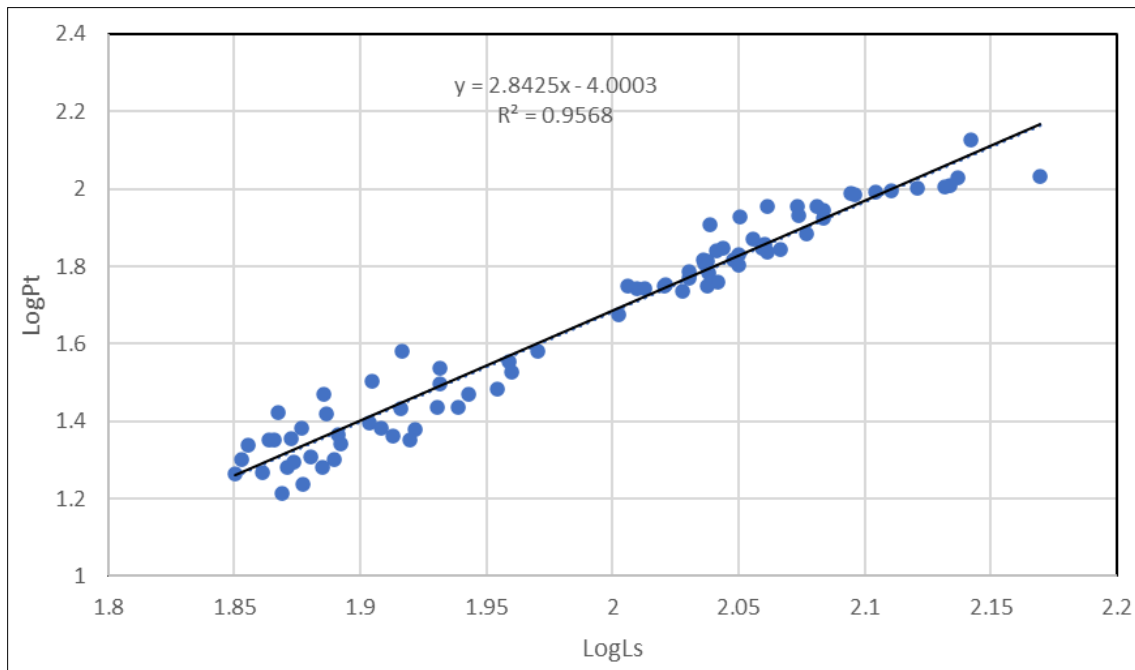


Fig 6: Logarithmic diagram of the size-weight relationship in *Coptodon dageti*.

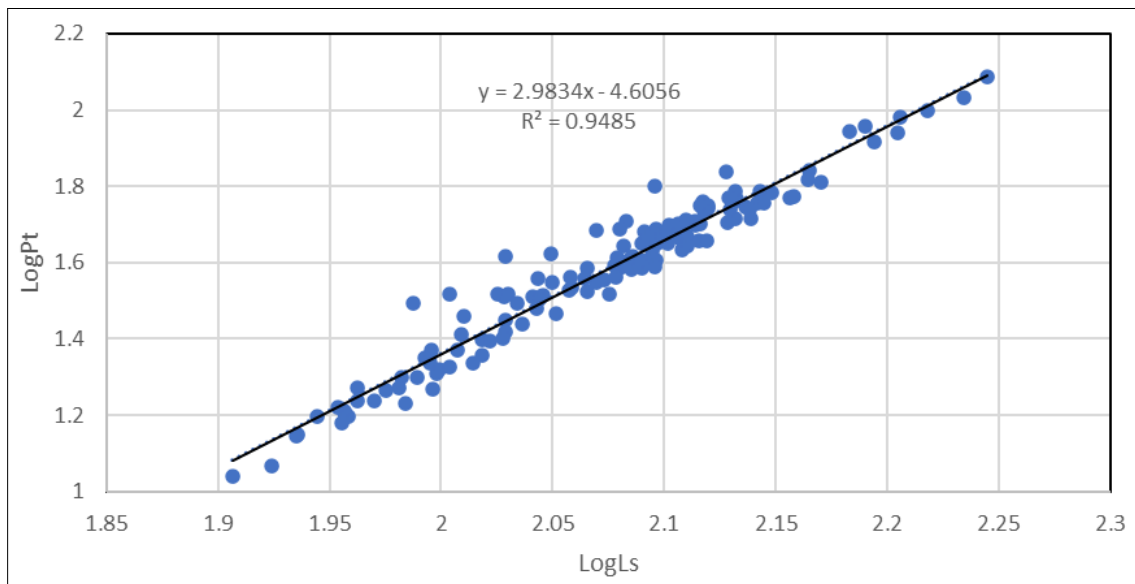


Fig 7: Logarithmic diagram of the size-weight relationship in *Sarotherodon galilaeus*

3.3 Fish condition factor

Condition factor values ranged from 3.34 to 6.79 with a mean of 4.90 ± 0.49 in *Coptodon dageti* and from 1.91 to 3.40 with a mean of 2.31 ± 0.19 in *Sarotherodon galilaeus* (Table 3). All individuals encountered presented a condition factor higher than the theoretical value 1. However, *Coptodon dageti* presented a higher average condition factor than *Sarotherodon galilaeus* (Table 3).

Table 3: Average values of the condition factor in the species studied.

Species	Number	Minimum	Average	Maximum
<i>Coptodon dageti</i>	81	3.34	4.90 ± 0.49	6.79
<i>Sarotherodon galilaeus</i>	142	1.91	2.31 ± 0.19	3.40

4. Discussion

The study showed that there is a good correlation between standard length and total length and between total weight and eviscerated weight in the samples of *Coptodon dageti* and

Sarotherodon galilaeus collected. A good correlation between lengths was reported in *Coptodon zillii* (Dembélé *et al.*, 2022)^[13], in *Auchenoglanis occidentalis* and *Chrysichthys auratus* (Konaté *et al.*, 2022)^[23], from Lake Sélingué. The maximum size and maximum weight encountered are 138.75 mm and 133.97 g in *Coptodon dageti* and 175.61 mm and 122.32 g in *Sarotherodon galilaeus*. The sizes obtained in the present study are smaller than those reported by Teugels and Thys van den Audenaerde (2003)^[29] i.e. 310 mm in *Coptodon dageti* and 340 mm in *Sarotherodon galilaeus*. Our results show that fishing affects small individuals (99.50 ± 18.18 and 119.41 ± 14.72 mm and 41.92 ± 5.80 g and 53.20 ± 26.70 g). The study showed that growth was allometric in both species during the period considered. Sadio *et al.*, (2021)^[30] reported a lowering allometry in *Sarotherodon galilaeus* coming from Lake Sélingué ($b=2.953$), Da and Ouéda (2018)^[5] reported it in the same species ($b=2.41$) in the Lake Bam in Burkina Faso. Reducing allometric growth has been reported in other species of Cichlids, notably in *Coptodon zillii* from Lake

Sélingué (Sadio *et al.*, 2021 and Sanogo *et al.*, 2022) ^[30, 3], from Lake Timsah in Egypt (Mahomoud *et al.*, 2011) ^[31] and from Lake Manantali in Mali (Sadio *et al.*, 2021) ^[30], Chez *Hemichromis fasciatus* from Lake Sélingué in Mali (Traoré, 2020) ^[32].

Growth from the height-weight relationship is either allometric or isometric. Allometric growth is decreasing or increasing. The allometric growth reduction indicates that the growth rate is faster in height than in weight. Allometric growth indicates that growth is faster in weight than in height and isometric growth shows that growth in weight and height have the same speed.

In our study, growth was faster in size than in weight in both species. It could be explained by the mobilization of nutrient reserves for the needs of reproduction, leading to weight loss in individuals. According to some authors, periods of weight loss correspond to active periods of reproduction (Atsé *et al.*, 2009; Traoré *et al.*, 2020) ^[10, 2]. Many cichlid species reproduce continuously with an intense period during the rainy season (Sanogo *et al.*, 2022) ^[3]. This could affect growth speed in favor of height at the expense of weight.

However, the condition factor values obtained are higher than the theoretical value 1. This indicates that the fish are in an environment conducive to their well-being and are in good condition. In the present study, body condition was better in *Coptodon dageti* than in *Sarotherodon galilaeus*. In Lake Sélingué, many species were in good condition, *Clarias anguillaris* and *Clarias* sp. (Diop *et al.*, 2020) ^[33], *Hemichromis fasciatus* (Traoré, 2020) ^[2], *Coptodon zillii* (Dembélé *et al.*, 2022) ^[13], *Chrysichthys auratus* and *Auchenoglanis biscutatus* (Konaté, 2022) ^[23].

The results show that the height-weight relationship gives a decreasing allometric growth with good body condition in both species in the rainy season.

5. Conclusion

The study shows that there is a strong correlation between standard length and total length and between total weight and gutted weight. However, small individuals are caught. The growth resulting from the height-weight relationship is allometric decreasing during the rainy season. Both species were in good physical condition, reflecting an aquatic environment conducive to their development.

The results of the study could be used as reference data in development and management programs for Lake Sélingué. Regulatory measures must be applied to prevent the capture of small specimens.

6. Acknowledgement

The authors thank the National Center for Scientific and Technological Research (CNRST) of Mali and the Executive Secretariat of the Competitive Fund for Research and Technological Innovation (FCRIT) for funding the study. They also thank the fishing communities and the technical fishing service of the municipality of Baya for the frank collaboration in the search for fish samples. They thank the anonymous people who participated in reading the article.

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