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Size-weight relationship of *Hemichromis bimaculatus* (Gill, 1862) from Lake Sologo, Korhogo, Ivory Coast

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Abstract

The aim of this study is to investigate the effect of anthropogenic pressures on the species *Hemichromis bimaticulatus* (Gill, 1862) caught in the Sologo dam lake. Sampling for this study to determine the status of *Hemichromis bimaticulatus* took place from May to July 2022, and the fish collected came from commercial fisheries. A total of 172 individuals grouped into mature (male and female) and immature specimens with standard lengths ranging from 3.5 cm to 10 cm and masses that varied from 2.1 g to 26.41 g were recorded. Length-mass relationships were determined by the equation $P = aSL^b$ and the condition factor by the relationship K = 100*W/SL. The coefficient of determination (r^2) recorded for all individuals was 0.937, ranging from 0.894 to 0.954. The coefficient of allometry b and the average condition factor for this species ranged from 1.99 to 2.18 and from 3.02 ± 0.54 to 3.44 ± 0.8 respectively. The size frequency distribution showed that 64 % of species have a size between 7.75 cm and 9.05 cm. This study contributes to our knowledge of the biology of *Hemichromis bimaticulatus* and provides a database of particular growth and condition factors of the species *Hemichromis bimaticulatus* from the Sologo dam lake.

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Introduction

Fishing is the main source of animal protein for mankind, and fish remains the most accessible and least expensive animal protein (Adjanke, 2011). In Côte d'Ivoire, fish provides nearly 70 % of the animal protein consumed by Ivorians (Anoh and Koffié-bikpo, 1999). However, national fisheries production covers only 20 % of national needs, which amount to over 300,000 tonnes per year. This low productivity is essentially due to the degradation of aquatic ecosystems and intensive fishing (Coulibaly, 2012). This is the case of the small dams in Korhogo, which were built for agropastoral activities, but are now heavily influenced by intensive fishing activities (Koudou *et al.*, 2020). This situation needs to be monitored. To do this, it is imperative to determine the overweight of fish species in these reservoirs. This requires knowledge of the length-mass relationship and the fish condition factor. These parameters are good indicators of stock composition, lifespan, mortality, growth and production (King, 1996). Thus, knowledge of these parameters is necessary for understanding the life cycle of fish, especially in regions where fishing represents one of the most important economic sectors where fish stocks are the main source of food (Freitas *et al.*, 2017). Today, the major interest is to have information on the condition of *Hemichromis bimaticulatus* in the Sologo dam lake. This means knowing the weight relationship and condition factor of *Hemichromis bimaticulatus* in this body of water.

In addition, the data from this study will contribute to better planning of the management strategy for the fishery resources of the Sologo dam lake.

Materials and methods

Study area

This study was carried out on the Sologo dam lake in the Tioroniaradougou sub-prefecture, 16 km from Korhogo in northern Côte d'Ivoire, between 9°33 N and 5°65 W (Fig. 1). Lake Sologo was created in 1972 by CIDT with EDF funds, and rehabilitated with GIZ21 funding in 1996 on a left-bank tributary of the Solomougou, itself a tributary of the Bandama River (Traoré, 1996). This agro-pastoral dam lake covers an area of 95 ha. The lake's climate emanates from that of the Korhogo department, which is of the Sudanese type with two seasons: a dry season from November to March and a rainy season from April to October (Boko-Koiadja *et al.*, 2016).

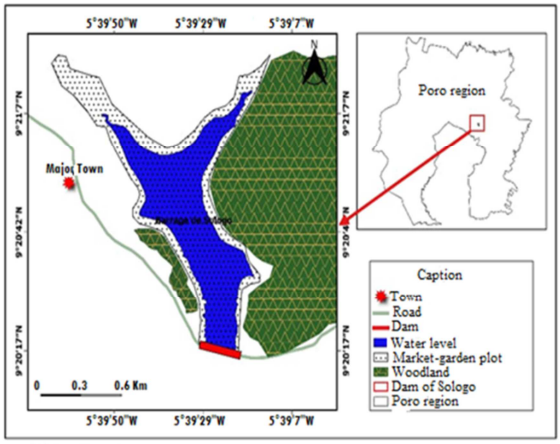

Fig. 1. Location of the Sologo dam lake

Data collection

Fish sampling took place from May to July 2022. The fish used in this study came from commercial fisheries. Fish were identified using the dichotomous key of Paugy *et al.* (2003). The standard length of each specimen was determined to the nearest centimetre using an ichthyometer, and the total mass in grams using a 0.01 g precision balance. The specimens were dissected and macroscopic observation of the gonads enabled classification into three groups (immature, mature male and mature female).

Data analysis

Determination of size ranges

The standard lengths of each group were organized into size classes. The number and lengths of size classes were determined according to the Sturge rule used by Kouamélan *et al.* (2000) below:

Number of classes = 1 + (3.3 log10 n)

Class interval = (SLmax - SLmin) / Number of classes

Or: n = total number of specimens examined, SL max = maximum standard fish length and SL min = minimum standard fish length.

Determining the length-weight relationship

The length-weight relationship was determined using the linear model of Ricker's (1975) formula $P = aSL^b$,

transformed into a logarithm expressed by the following equation:

$\log W = \log a + b \log SL$

With P: fish mass in g and LS: standard fish length in cm. The constant "a" represents the intercept of the regression line and b the slope of the relationship.

Student's t-tests (ts) were used to check whether the slope "b" was significantly different from the theoretical value of 3 ($p < 0.05$). Thus, the ts value for each species was calculated according to the following expression (Zar 1984):

$ts = \frac{b-3}{sb}$

With b the slope and sb the standard error of the slope.

$S = \sqrt{\frac{\left(\frac{SW}{SLS}\right)-b^2}{n-2}}$

With SW: variance in body weight, SLS: variance in standard length and n: sample size.

In addition, ts must be compared with the table value of t for n-2 degrees of freedom to make inferences about the null hypothesis (Kuriakose, 2017). If t > ts ($p > 0.05$), accept the null hypothesis that b = 3, growth is isometric; if t < ts ($p > 0.05$), b ≠ 3, growth is allometric (negative allometric if b < 3 and positive allometric if b > 3). The coefficient of determination r^2 was used as an index of the degree of correlation between length and mass.

Determining the condition factor

The condition factor (K) is used to determine the overweight of fish in an environment. This Fulton's condition factor (K) (Fréon, 1979) was estimated from the relationship: $K = 100 \times W_T / SL^3$ with W_T the total weight of the individual (g) and SL the standard length (cm).

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According to Morton & Routledge (2006), condition coefficient K can be divided into five categories: Very poor (0.8-1.0), Poor (1.0-1.2), Balanced (1.2-1.4), Good (1.4-1.6) and Very good (>1.6).

Results

A total of 172 *Hemichromis bimaculatus* individuals were recorded. The population comprised 126 immature and 46 mature individuals, including 24 males and 22 females. The size of these sampled individuals ranged from 3.5 cm to 10 cm, while weights ranged from 2.1 g to 26.41 g. A general analysis of size structure enabled us to group *Hemichromis bimaculatus* individuals into 8 classes. The most dominant classes are those ranging in size from 7.75 cm to 8.4 cm, then from 8.4 cm to 9.05 cm, accounting for 64 % of the population (Fig. 2).

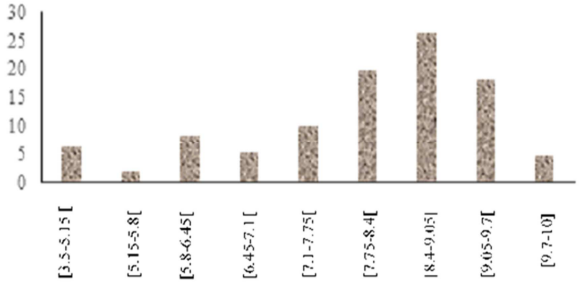

Fig. 2. General size range of *Hemichromis bimaculatus* in the Sologo dam lake from October 2021 to November 2022

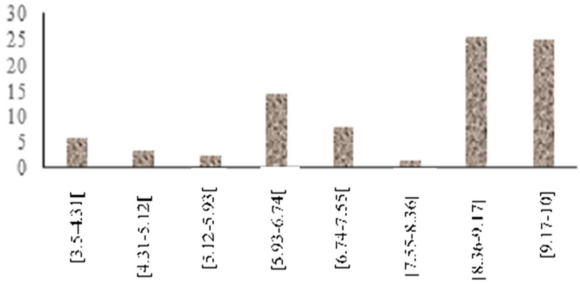

Fig. 3. Size range of immature *Hemichromis bimaculatus* in the Sologo dam lake from October 2021 to November 2022

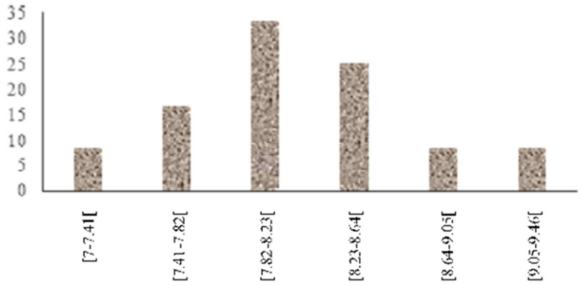

Fig. 4. Size range of male mature *Hemichromis bimaculatus* in the Sologo dam lake from October 2021 to November 2022

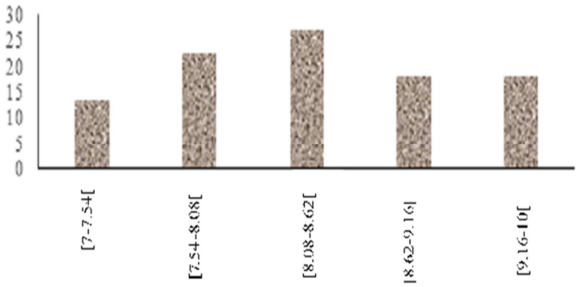

Fig. 5. Size range of mature female *Hemichromis bimaculatus* in the Sologo dam lake from October 2021 to November 2022

In immature individuals, sizes ranged from 3.5 cm to 10 cm, with the most represented class being those between 8.36 cm and 9.17 cm (Fig. 3). Among mature males, the most dominant size class was between 7.82 cm and 8.23 cm (Fig. 4). In females, the most represented size class is between 8.08 cm and 8.62 cm (Fig. 5).

The results of the length-weight relationship for *Hemichromis bimaculatus* are shown in Table 1. These results show that the coefficient of determination (r^2) varies from 0.894 for mature males to 0.954 for immature individuals. The coefficient of allometry (b) ranged from 1.99 to 2.18 for mature males and females respectively. All these recorded allometry coefficients differ by less than 3 (Student's t-test: $p < 0.05$). Analysis of the coefficient of allometry b values shows that *Hemichromis bimaculatus* has a so-called negative allometric growth.

Table 2. Different values of the condition factor (K) of *Hemichromis bimaculatus* landed at the Sologo dam lake from October 2021 to November 2022

		Condition factor		
Categories	Numbers	Min.	Max.	Mean
Immature	126	1.55	5.33	3.02 ± 0.54
Male	24	2.66	4.13	3.44 ± 0.8
Female	22	2.91	3.79	3.33 ± 0.55

Condition factor (K) values range from 3.02 to 3.44, with the lowest mean for immature individuals (3.02±0.54) and the highest mean for mature males (3.44±0.8) (Table 2). The classification of these condition factors shows that *Hemichromis bimaculatus* grows very well.

Discussion

The size of the individuals caught shows a wide range of variation. This variation could be explained by the fact that fishermen on this lake use nets with different mesh sizes and also that the other fishing gear they use is non-selective. Furthermore, the most preponderant class sizes are practically similar for all three categories of individuals (immature and mature males or females). The high number of size classes observed in this species shows that this population is heterogeneous. However, the presence of a large number of undersized individuals is thought to be the result of overfishing, following the use of very small-mesh nets. Similar results were observed by Cissé (2022) at the Ayamé 1 dam lake.

In this study, the coefficient of determination showed high values (0.894 to 0.954). These high values show that there is a close relationship between fish mass and weight. Indeed, the high value of the coefficient of determination suggests that growth in size induces an increase in weight in fish (Mikembi *et al.*, 2019). Moreover, the values of the coefficient of determination range from 0.717 to 0.979, showing that *Hemichromis bimaculatus* is a species with low weight growth (Koffi *et al.*, 2014).

Growth coefficient values for this species ranged from 1.99 to 2.18. These values fall within the limit range (2-4) defined by Montchowui *et al.* (2009). The value below 2 observed in mature males is due to the class intervals. In fact, the growth coefficient (b) can be influenced by water quality, food availability for fish growth (Henderson, 2005), sex, growth phase, stomach contents, level of gonad development (Hossain *et al.*, 2006), hydrological conditions N'Dri *et al.* (2020) and by unfavorable environmental conditions linked to fishing activities (Kamelan *et al.*, 2021). In this study, it is linked to water quality on the one hand, and to anthropogenic pressures such as fishing on the other. In addition, b values all below 3 indicate that the fish is growing faster than it is putting on weight. This negative allometric growth is linked to the evolutionary stages of the gonads, on the one hand, and to the reduction in food resources due to anthropogenic pressures, on the other. Similar results were observed by Cissé (2022) at the Ayamé 1 dam lake.

The mean condition factor recorded in this study ranged from 3.02 ± 0.54 to 3.44 ± 0.8. These mean values were

all above 1.6, indicating a state of well-being for this species in the Sologo dam lake. This state of well-being is linked to the species' good adaptation to environmental conditions. According to Abba *et al.* (2013), N'Dri *et al.* (2020) and Cissé (2022), operating and environmental factors are limiting factors for the overweight of a species.

Conclusion

Following this study on the growth parameters and condition factor of *Hemichromis bimaculatus* from the Sologo dam lake, it appears that this species has a greater growth in length than in weight. A condition factor greater than 1 would indicate favorable conditions for this species. However, the presence of a large number of small individuals in the stock indicates that the species is overexploited.

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References

Abba E, Belghyti D, Benabid M, EL Adel N, EL Idrissi H, Chillasse L. 2013. Relation entre poids, taille et fécondité chez la truite arc-en-ciel (*Oncorhynchus mykiss*) de la station de salmoniculture de Ras Al Ma (Azrou-Ifrane) [Relationship between weight, size and fecundity in trout (*Oncorhynchus mykiss*) (Ifrane, Morocco)]. Journal of Materials and Environmental Science **4(3)**, 482-487.

Adjanke A. 2011. Production d'alevins et gestion de ferme piscicole. Rapport, 37p.

Anoh KP, Koffie-Bikpo CY. 1999. Le rôle des femmes dans la communauté de pêcheurs-artisans dans l'agglomération d'Abidjan: le cas de Vridi Zimbabwe, in Géographie ivoirienne, Cahiers Nantais, Abidjan, 47-60p.

Boko-Koiadja A, Gueladia C, Brama K, Deby S. 2016. Variabilité climatique et changement dans l'environnement à Korhogo en Côte d'Ivoire : Mythe ou Réalité. European Scientific Journal **12(5)**, 158-176. https://doi.org/10.19044/esj.2016.v12n5p158

Cissé M. 2022. Evaluation de la pression de la pêche sur le niveau de stock des espèces à intérêt économique après le retour des pêcheurs allogènes sur le lac de barrage d'Ayamé 1. Thèse de doctorat, Université Felix Houphouët Boigny de Côte d'Ivoire, 192p.

Coulibaly K. 2012. Analyse des facteurs de variabilité des performances agronomiques et économiques des cultures et de l'évolution de la fertilité des sols dans les systèmes agropastoraux en milieu soudanien du Burkina Faso : approche expérimentale chez et par les paysans. Thèse de Doctorat, Université polytechnique de Bobo Dioulasso, 165p.

Freitas TM da S, e Souza JB de S, Prudente B da S, Montag LF de A. 2017. Length-weight relationship in ten fish species from the Nhamundá River, the Amazon Basin, Brazil. Acta Amazonica **47(1)**, 75-78.

Fréon P. 1979. Height-weight relationships, condition factors and sexual maturity indices: bibliographic reminders, interpretations, remarks and applications. In: The Reproduction of the Species Exploited in the Gulf of Guinea, Pierre P., ISRA, Pakistan, 144-171.

Henderson PA. 2005. The growth of tropical fishes. In: Val AL, Vera MR, Randal DJ (Eds.). The Physiology of Tropical Fishes. Academic Press USA, **21**, 85-99.

Hossain MY, Ahmed ZF, Leunda PM, Jasmine S, Oscoz J, Miranda R, Ohtomi J. 2006. Condition, length-weight and length-length relationships of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Mathabhanga River, Southwestern Bangladesh. Journal of Applied Ichthyology **22**, 304-307.

Kamelan TM, Cissé M, Konan YA, Kouamelan EP. 2021. Size range and length-weight relationships of 17 fish species from Lake Ayame 1 (Côte d'Ivoire, West Africa). Journal of Applied Biosciences **168**, 17494-17506.

King RP. 1996. Length-weight relationships of Nigerian coastal water fishes. Fishbyte **19(4)**, 54-58.

Koffi KB, Berté S, Koné T. 2014. Length-weight relationships of 30 fish species in Aby Lagoon, Southeastern Côte d'Ivoire. Current Research Journal of Biological Sciences **6(4)**, 173-178.

Kouamélan EP, Teugels GG, Gourène G, Thys Van Den Audenaerde DFE, Ollevier F. 2000. Habitudes alimentaires de *Mormyrops anguilloides* (Mormyridae) en milieux lacustre et fluvial d'un bassin Ouest-africain. Cybium **24(1)**, 67-79.

Koudou D, Kakou YSC, Sékongo LG. 2020. Pêche dans le lac de Korhogo (Côte d'Ivoire) : acteurs, exploitation incontrôlée et signes de dégradation de la ressource halieutique. DALAGEO **19(002),** 8-19.

Kuriakose S. 2017. Estimation of length weight relationship in fishes. In: Summer School on Advanced Methods for Fish Stock Assessment and Fisheries Management, Gopalakrishnan A., CMFRI Lecture Note Series, UK: 215-220.

Mikembi ALB, Zamba AI, Mamonekene V, Hélène Dembe Louvinguila Tenda H DL, Ngot FHP, Vouidibio J. 2019. Relations longueurs-poids et coefficients de condition pour 13 espèces de poissons de la rivière Dzoumouna, affluent du cours inférieur du fleuve Congo (République du Congo). Journal of Animal & Plant Sciences **39(1)**, 6384-6393.

Montchowui E, Lalèyé P, Moreau J, Philippart JC, Poncin P. 2009. Population parameters of African carp: *Labeo parvus* Boulenger, 1902 (Pisces: Cyprinidae) in the Ouémé River in Bénin (West Africa). North-Western Journal of Zoology **5(1)**, 26-33.

Morton A, Routledge RD. 2006. Fulton's condition factor: is it a valid measure of sea lice impact on juvenile salmon? North American Journal of Fisheries Management **26**, 56-62.

N'dri OR, Konan YA, Bamba M, Monney AI, Kone T. 2020. Length-weight relationships and condition factor of twenty-four freshwater fish species from lake Buyo, Côte d'Ivoire. Journal of Fisheries and Aquatic Science **15**, 27-34.

Paugy D, Lévêque C, Teugels GG. 2003. Faune des poissons d'Eaux douces et saumâtres de l'Afrique de l'Ouest. Tome 2. IRD (Paris), MNHN (Paris), MRAC (Tervuren), 815p.

Traoré K. 1996. Etat des connaissances sur les pêcheries continentales ivoiriennes. Rapport de consultation, avril 1996. FAO, 140p.

Zar JH. 1984. Biostatistical Analysis. 2nd Edn., Prentice-Hall Inc., Englewood Cliffs, New Jersey, USA, 718.