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Size range and length-weight relationships of 17 fish species from Lake Ayame 1 (Côte d'Ivoire, West Africa)

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ABSTRACT
Objective: Fish growth and size can be influenced by several ecological and environmental factors. Thus, this work describes the length-weight relationships and condition factors of 17 fish species to assess fishing pressure on the fish fauna of Lake Ayamé 1 with the return of non-native fishermen.
Methodology and Results: A total of 8346 individuals from experimental and commercial fisheries were sampled from July 2017 to June 2018. The size of the individuals caught from 6.0 cm to 71.3 cm and the majority of the fishes (70%) were concentrated between 5 cm and 15 cm. Length-weight relationships were calculated using the equation $W = aTL^b$ and condition coefficients were determined using the equation $K = 100 X W_T /TL$. The coefficient of determination (R^2) varied from 0.548 in *Brycinus longipinnis* to 0.973 in *Sarotherodon melanotheron*. The coefficient of allometry b varies from 2.409 in *Brycinus nurse* and 3.207 in *Clarias anguillaris*. Twelve species had negative allometry, three species had positive allometry and two species had isometry. These allometry coefficients indicated changes for *Hepsetus odoe*, *Clarias anguillaris*, *Schilbe mandibularis* and *Hemichromis fasciatus* compared to previous work. The average condition factor varied from 0.75 ± 0.41 in *Schilbe mandibularis* to 1.98 ± 0.60 in *Sarotherodon melanotheron*.
Conclusion and Application of results: The massive presence of small individuals expresses an overexploitation of the stock. These results highlighted the effect of fishing pressure on the fish fauna of Lake Ayamé 1.
Keywords: Allometry, fishing, threat, fish, conservation

INTRODUCTION

The Lake Ayamé 1 forty years after its installation, observed a gradual drop in its production and a decline in the income of its fishermen in 1990, because of continuous and uncontrolled exploitation of fishery resources (Vanga, 1994). The scarcity of fishery resources in this lake resulted in a conflict between indigenous and non-indigenous fishermen. This conflict led to the closure of the lake to fishing and the expulsion of non-national fishermen from the lake (Vanga, 2001). In 2012, the work of Tah (2012) after the reopening of the lake revealed a state of equilibrium of the stocks of the exploited communities. After a decade of exploitation marked by the return of non-national fishermen, no scientific data exist to assess the stock status of the main exploited communities. The only data available are those of Tah (2012), which refer to the state of the fish fauna of the Lake Ayamé 1 in the absence of fishermen. It is this concern that motivates this study. In order to deal with fishing pressure on the reservoirs, researchers and fisheries managers use numerous parameters, namely length-weight relationships and the condition factor. These parameters are real tools that allow a better understanding of the evolution of fish stocks according to the modifications made in its exploitation (Tchouante *et al.*, 2019). As for the condition factor, it provides information on the overweight status of a fish (Paugy & Lévêque, 2017). It is an instrument often used to compare the overall physiological state of populations during a seasonal cycle or between ponds with similar or different ecological conditions (Lizama & Ambrósia, 2002). Thus, the condition factor can be used as an index to assess the level of disturbance in an aquatic ecosystem (Baby *et al.*, 2011). Therefore, the present study describes the length-weight relationships and condition factors of 17 ichthyological species of economic interest at Ayamé 1 dam Lake in order to understand the effect of fishing pressure on fishery resources. The data obtained will serve as a reference for a sustainable management of the fishery resources of this water body.

MATERIAL AND METHODS

Study area: The present study is conducted on the Lake Ayamé 1. This lake is located in south eastern Côte d'Ivoire between longitudes 3 and 3.5° West and latitudes 5.3 and 6° North (Figure 1) and has been constructed on the Bia River, since 1959 (Tah, 2012). This lake has an average area of 9320 ha (Laë *et al.*, 1999). It is about 80 km long and 27 km wide with a maximum depth of 30 m (Ouattara, 2004). The lake has an attiean climate characterized by the succession of 4 seasons (2 dry seasons and 2 rainy seasons) (Savané & Konaré, 2010).

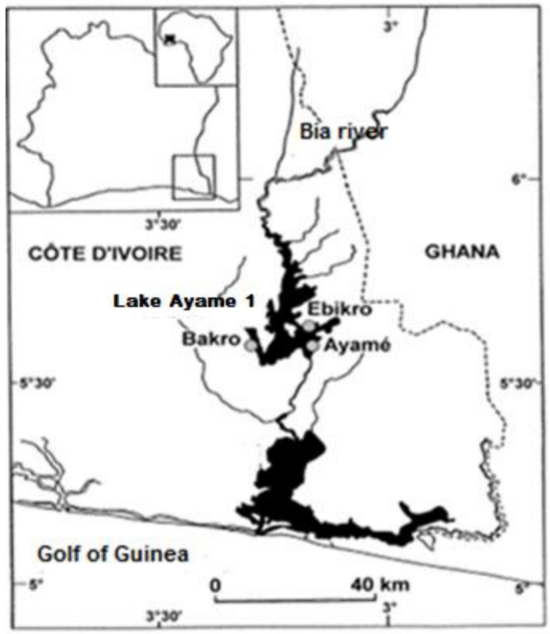


Figure 1: Geographic location of sampling stations (◯) on Lake Ayame 1

Data collection: The fish sampling was done monthly from July 2017 to June 2018. The fish studied were from commercial and experimental fisheries. These fish were identified according to Paugy *et al.* (2003a and 2003b) and the species names were updated in Fishbase (Froese & Pauly, 2019). The total length (TL) and total weight (W_T) were determined to the nearest centimetre using an ichthyometer and to the nearest gram using a 0.01g precision scale, respectively.

Data analysis

Determination of size spectrum : The total lengths were grouped into size classes. Thus, the determination of the number and lengths of the size classes was done based on the Sturge rule as used by Kouamélan *et al.* (2000) below:

Number of classes = 1+ (3.3 log10 n)

Class interval = (TLmax-TLmin)/Number of Classes)

n: total number of specimens examined;

TLmax**:** maximum total length of fish;

TLmin: minimum total length of fish.

In addition, the coefficient of variation (CV) of the sizes of each species was calculated using the following formula:

CV = (Standard deviation)/mean × 100

When: CV < 2%, the structure is said to be very homogeneous; 2% ≤ CV ≤ 30%, the structure is said to be homogeneous; CV > 30%, the structure is said to be heterogeneous.

Determination of the length-weight relationship: The length-weight relationship was performed using the log-transformed linear model expressed by the following equation:

Log W = log a + b log TL (Lévêque, 2006)

With W: the weight of the fish in g and TL: the total length of the fish 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 test 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 = (b-3)/sb

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

$$S = \sqrt{((SW/STL) - b^2)/(n-2))}$$

With SW: the variance of the body weight, STL: the variance of the total length and n: the sample size.

In addition, ts must be compared to 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 indicator of the degree of correlation between length and weight.

Determination of the condition factor: The condition factor (K) is used to determine the overweight of fish in an environment. This condition factor Fulton's (K) (Freon, 1979) was estimated from the relationship:

$$K = 100 \times W_T / TL^3$$

According to Morton and Routledge (2006), the condition factor K can be divided into five categories that 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). The statistical analysis was performed by combining the data collected monthly and for all stations combined. Thus, the correlation between standard length and body weight were analysed using the Spearman rank correlation test and the data were processed using STAISTICA software version 7.1.

RESULTS

A total of 8346 specimens grouped in 17 species, 9 genera, 7 families and 5 orders were recorded in this study. In numbers of individuals, the family Alestidae (42.15%) is proportionally the most representative. It is followed by Cichlidae (39.97 %), Claroteidae (14.10 %), Schilbeidae (4.96 %), Mormyridae (4 %), Hepsetidae (2.48 %) and Clariidae (1.40 %). The size of the fish sampled varied from 6.0 cm to 71.3 cm with the smallest length in *Sarotherodon melanotheron* and *Brycinus longipinnis*, the largest length in *Clarias anguillaris*. While the weight is between 2.22 g and 4700 g respectively in *Schilbe mandibularis* and *Clarias anguillaris*. For these species studied the average sizes varies from 8.35 ± 0.86 cm and 26.67 ± 8.71 cm respectively for *Brycinus longipinnis* and *Clarias anguillaris*. Analysis of Figure 2 shows that the most dominant size classes are 10-12 cm with *Coptodon guineensis* and *Schilbe mandibularis*, 10-15 cm for *Coptodon zillii* and *Brycinus macrolepidotus*, 12-14 cm for *Coptodon hybrid* (*Coptodon zillii x C. guineensis*) and *Hemichromis fasciatus*, from 14 to 16 for *Chrysichthys maurus* and *Marcusenius furcidens*, 15 to 20 cm for *Sarotherodon melanotheron* and *Chrysichthys nigrodigitatus*, from 25 to 30 for *Clarias anguillaris* and *Oreochromis niloticus*, 8 to 9 cm for *Brycinus longipinnis*, 9 to 10 for *Brycinus imberi*, 11 to 12 cm for *Brycinus nurse*, 16 to 18 cm for *Marcusenius ussheri* and 20 to 25 for *Hepsetus odoe*. Overall, the majority of individuals exploited (70%) are between 5 and 15 cm in size.

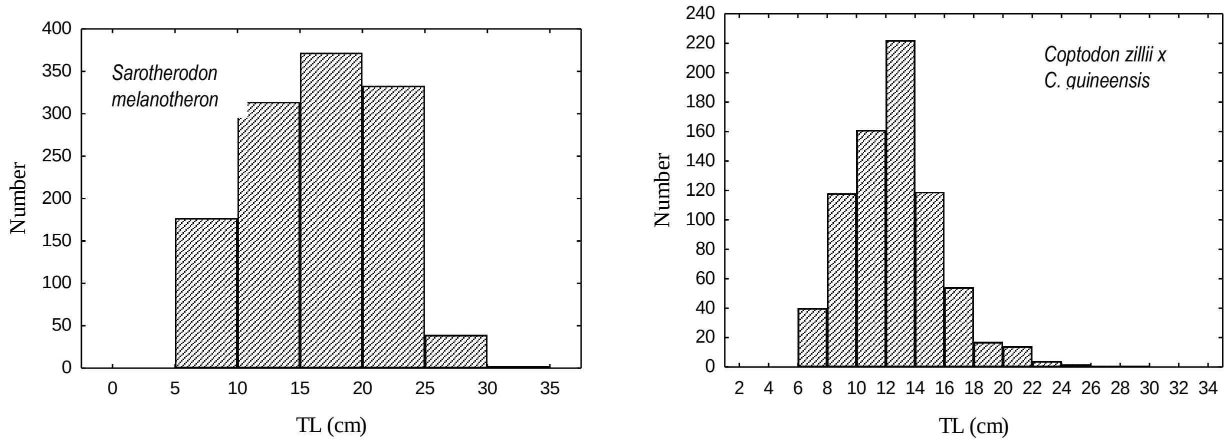
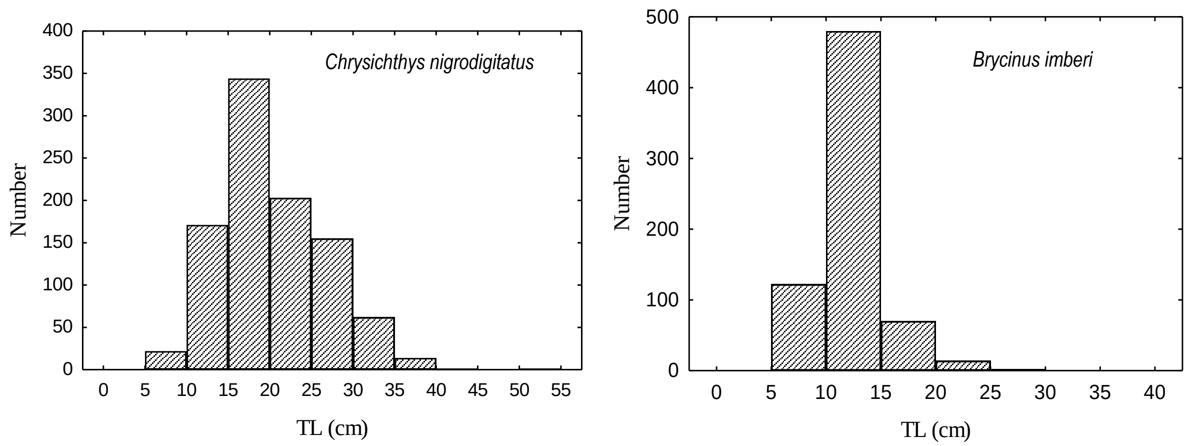
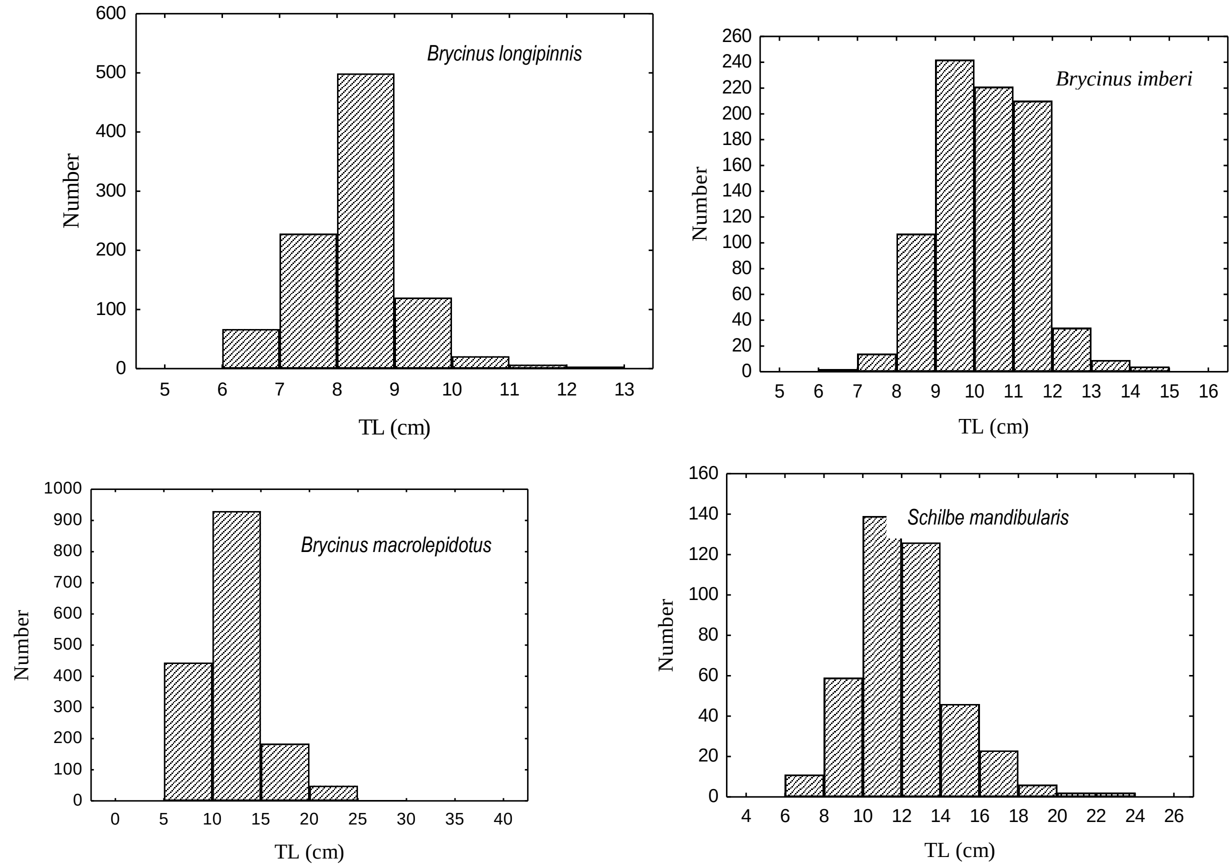


Figure 2: Size range of fish species from the Lake Ayamé 1 between July 2017 and June 2018





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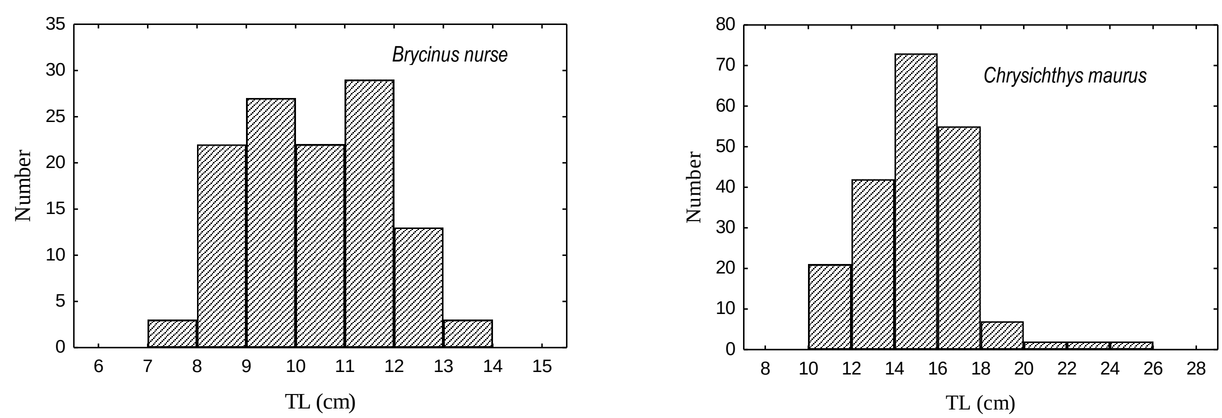

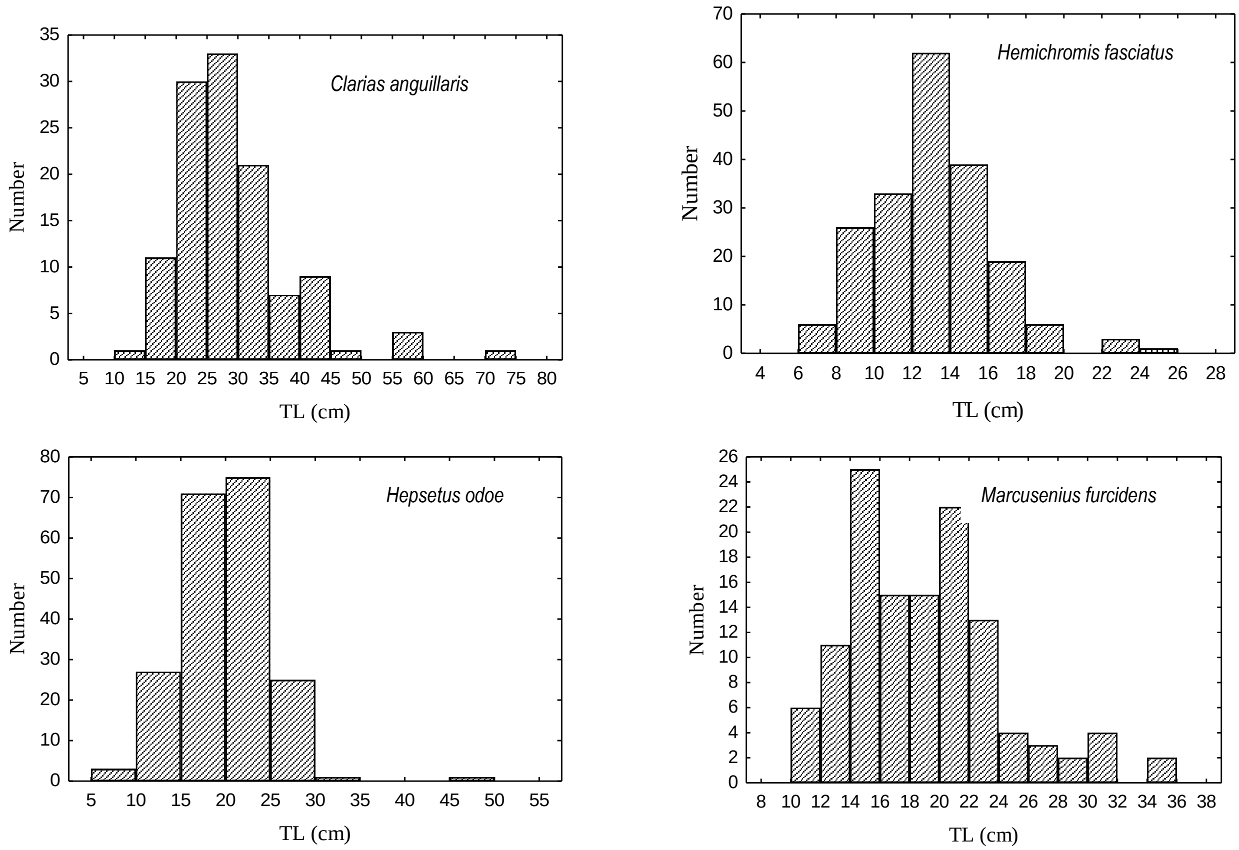

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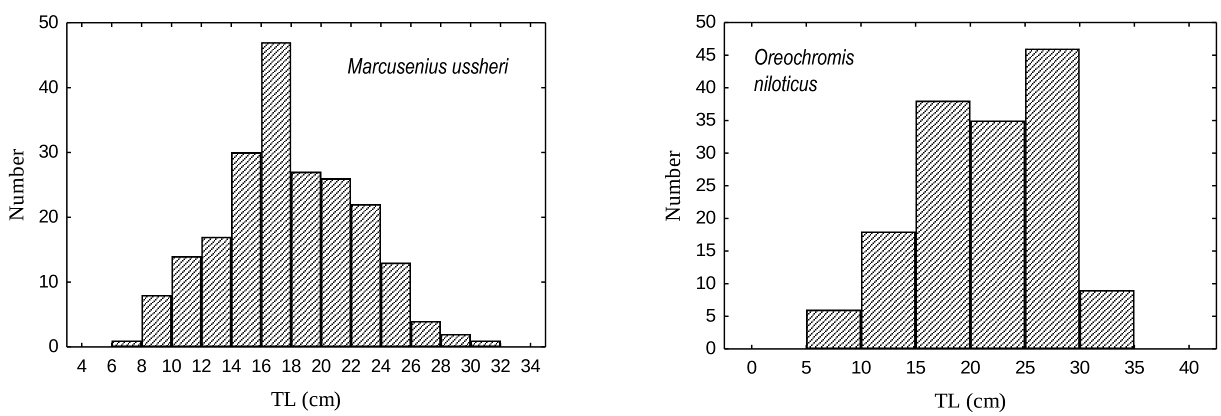

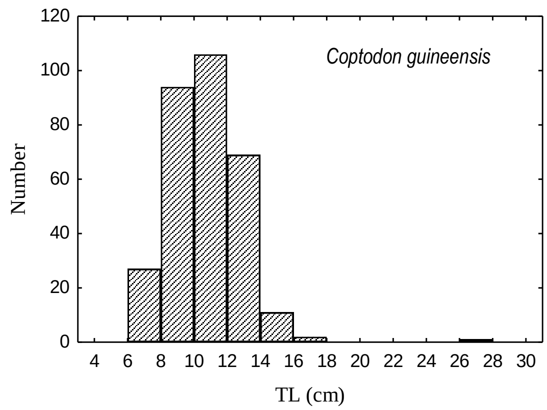

Figure 2: Size range of fish species from the Lake Ayamé 1 between July 2017 and June 2018

Moreover, the analysis of the coefficient of variation of these species allowed to classify them in two groups. Those that have a homogeneous structure are *Brycinus nurse* (13.65 %), *Brycinus longipinnis* (10.30 %), *Schilbe mandibularis* (20.13 %), *Marcusenius furcidens* (26.13 %), *Marcusenius ussheri* (24.92 %), *Brycinus imberi* (11.70 %), *Brycinus macrolepidotus* (26, 86%), *Hepsetus odoe* (25.33%), *Chrysichthys maurus* (16.42%), *Hemichromis fasciatus* (23.42%), *Coptodon guineensis* (20.11%), *Brycinus nurse* (13.65%), *Coptodon zillii* (23.00%), *Oreochromis niloticus* (28.67%) and *Coptodon hydrid* (*Coptodon zillii x C. guineensis*)(25.04%) and those with a heterogeneous structure are *Chrysichthys nigrodigitatus* (31.49%), *Sarotherodon melanotheron* (31.01%) and *Clarias anguillaris* (31.09%). The results of the length-weight relationship of the 17 species studied are mentioned in Table 1. These results showed that the coefficient of determination (r^2) ranged from 0.548 for *Brycinus longipinnis* to 0.973 for *Sarotherodon melanotheron*. Of the 17 species in the table, 8 species (*Brycinus imberi*, *Brycinus longipinnis*, *Brycinus nurse*, *Brycinus macrolepidotus*, *Chrysichthys maurus*, *Coptodon guineensis*, *Schilbe mandibularis*, and *Coptodon hybrid* (*Coptodon zillii x C. guineensis*) have a coefficient of determination $r^2 < 0.90$, while the coefficients of determination r^2 of the other 9 species are greater than 0.90. The coefficient of allometry b varies from 2.409 for *Brycinus longipinnis* to 3.207 for *Clarias anguillaris*. The values of this allometry coefficient (b) obtained allowed us to classify the species into three groups (Figure 3). Those with isometric type growth ($b = 3$; $p > 0.05$), are *Hepsetus odoe* and *Schilbe mandibularis*. Those showing negative allometric growth ($b < 3$; $p < 0.05$): *Brycinus nurse*, *B. imberi*, *B. macrolepidotus*, *Coptodon guineensis*, *Coptodon zillii x C. guineensis*, *Chrysichthys maurus*, *C. nigrodigitatus*, *Marcusenius furcidens*, *M. ussheri*, *Oreochromis niloticus*, *Sarotherodon melanotheron*, and *Brycinus longipinnis*. Those showing positive allometric growth ($b > 3$; $p < 0.05$): *Clarias anguillaris*, *Hemichromis fasciatus*, and *Coptodon zillii*. The condition factor (Kc) values range from 0.75 to 1.98 with the smallest average for *Schilbe mandibularis* (0.75 ± 0.41) and the largest average for *Sarotherodon melanotheron* (1.98 ± 0.60). Classification of K values shows that 41.18 of the species have poor growth, 23.53% have balanced growth and 35.29% have good growth.

Table 1: Length-weight relationship parameters of 17 fish species caught on Lake Ayamé 1 from July 2017 to June 2018

Orders and families	Species	N	Length (cm)			Weight (g)			r^2	a	b	Sb	t	Growth	K
			min	max	mean	min	max	mean							
Osteoglossiformes															
Mormyridae	*Marcusenius furcidens*	122	10.7	34.6	19.06	15.14	406.07	70.40	0.940	0.031	2.571	0.122	-1.151	A-	0.88 ± 0.16
	Marcusenius ussheri	212	8.0	30.2	17.90	7.12	223.67	58.95	0.935	0.015	2.822	0.095	-1.473	A-	0.91 ± 0.21
Characiformes															
Alestidae	*Brycinus imberi*	843	6.6	14.9	10.34	5.07	49.72	15.40	0.750	0.023	2.776	0.049	-2.864	A-	1.37 ± 0.32
	Brycinus longipinnis	946	6.0	12.3	8.35	3.00	15.32	7.51	0.548	0.046	2.409	0.029	-4.864	A-	1.23 ± 0.27
	Brycinus nurse	119	7.1	14.0	10.40	4.10	53.53	16.03	0.640	0.034	2.584	0.079	-1.772	A-	1.38 ± 0.30
	Brycinus macrolepidotus	1610	6.1	35.7	12.06	2.26	1100	27.16	0.734	0.020	2.790	0.080	-1.761	A-	1.23 ± 0.67
Hepsetidae	*Hepsetus odoe*	203	9.0	47.5	19.90	8.18	232.21	70.81	0.943	0.007	3.033	0.086	-1.621	I	0.97 ± 0.25
Siluriformes															
Clariidae	*Clarias anguillaris*	117	12.4	71.3	29.40	48.45	4700	314.60	0.958	0.004	3.207	0.509	-0.275	A+	0.90 ± 0.39
Claroteidae	*Chrysichthys nigrodigitatus*	973	7.3	50.6	20.26	6.70	2100	97.97	0.903	0.017	2.748	0.276	-0.508	A-	1.02 ± 0.69
	Chrysichthys maurus	204	10.1	26.0	14.98	6.51	113.08	35.40	0.706	0.042	2.438	0.069	-2.025	A-	1.01 ± 0.30
Schilbeidae	*Schilbe mandibularis*	414	7.0	23.3	12.32	2.22	81.01	14.60	0.897	0.007	2.999	0.046	-3.033	I	0.75 ± 0.41
Perciformes															
Cichlidae	*Coptodon guineensis*	310	7.0	26.1	10.74	4.33	94.28	23.21	0.727	0.023	2.876	0.062	-2.267	A-	1.74 ± 0.40
	Coptodon zillii	689	7.0	32.9	12.74	3.91	498	42.47	0.927	0.013	3.114	0.162	-0.865	A+	1.87 ± 0.86
	Coptodon zillii x C. guineensis	753	6.3	30.0	12.66	4.46	400	44.23	0.852	0.040	2.699	0.148	-0.948	A-	1.84 ± 0.40
	Hemichromis fasciatus	195	7.4	25.9	13.15	4.64	229.56	39.20	0.959	0.010	3.157	0.103	-1.364	A+	1.52 ± 0.36
	Oreochromis niloticus	152	7.5	32.7	21.66	7.46	578,3	229.35	0.925	0.028	2.881	0.251	-0.558	A-	1.92 ± 0.75
	Sarotherodon melanotheron	1237	6.0	31.6	16.61	3.31	480	113.75	0.973	0.022	2.912	0.140	-1.001	A-	1.98 ± 0.60

N: number, **min:** minimum, **max:** maximum, r^2**:** coefficient of determination, **a:** constant, **b:** slope, **sb:** Standard error of the slope, **t** = Student's t test (p < 0, 05), **A-:** negative allometric growth, **A+**: positive allometric growth, **I**: Isometric growth, K: condition factor

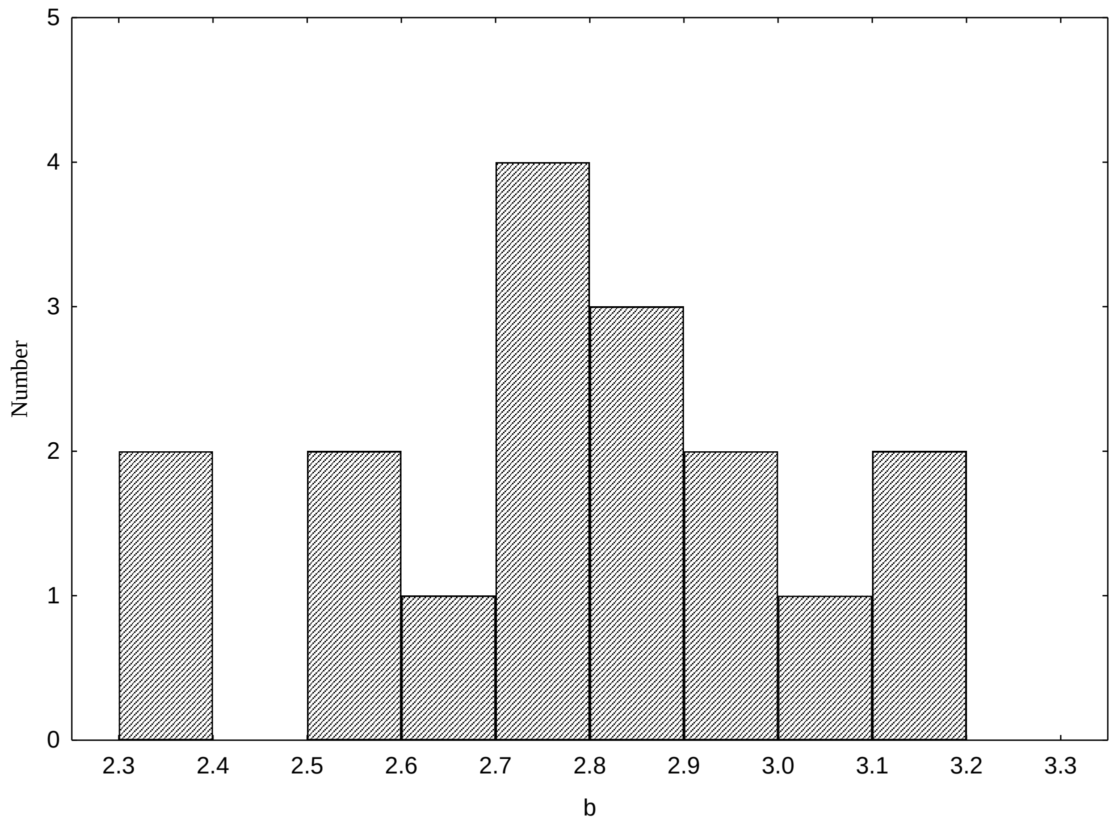

Figure 3: Distribution of allometry coefficient b for the 17 ichthyological species of economic interest in Lake Ayamé 1 from July 2017 to June 2018

DISCUSSION

The specimens collected in the Lake Ayame 1 showed sizes ranging from 6.0 cm to 71.3 cm. This wide range of sizes shows the non-selectivity of the fishing gear used by the fishermen on the lake. Thus, of 14 species (*Marcusenius furcidens*, *Marcusenius ussheri*, *Brycinus imberi*, *Schilbe mandibularis*, *Brycinus nurse*, *Brycinus macrolepidotus*, *Hepsetus odoe*, *Clarias anguillaris*, *Chrysichthys nigrodigitatus*, *Chrysichthys maurus*, *Hemichromis fasciatus*, *Oreochromis niloticus*, *Sarotherodon melanotheron*, and *Coptodon zillii*) studied by Tah (2012), 9 species have a maximum size larger than that observed by Tah (2012). This reflects that this environment would still be favourable for their development. However, analysis of the size spectra shows that more than 70% of the species have a concentrated size between 5 cm and 15 cm and this population is heavily dominated by species such as *Brycinus longipinnis*, *Coptodon zillii x C. guineensis*, *Chrysichthys maurus*, *Hemichromis fasciatus*, *Coptodon zillii*, *Brycinus imberi*, *Coptodon guineensis*, *Schilbe mandibularis*, *Brycinus nurse*, *Brycinus macrolepidotus*, *Hepsetus odoe*, *Marcusenius furcidens* and *Marcusenius ussheri*, which all present a homogeneous structure. The strong presence of this homogeneous structure in the exploited stock shows that the fishing gear used by the fishermen at the level of Lake Ayamé jeopardizes the monitoring of these fish. In addition, this high proportion of small-sized individuals in the catches would be the consequences of a strong fishing pressure. In this study, the coefficient of determination (0.548-0.973) of the exploited species is relatively high. This shows that there is a close relationship between the length and weight of the fish. Thus, the positive and high values of the coefficient of determination for these species suggest that growth in size induces an increase in weight in them, reported by Mikembi *et al.* (2019). Furthermore, the coefficient of allometry for the species ranged from 2.409 to 3.207. This value falls within the range of limit (2-4) defined by Montchowui *et al.* (2009). Indeed, the allometry coefficient b can be influenced by sex, growth stage, stomach contents, level of gonad development (Hossain *et al.,* 2006), water quality, food availability for fish growth (Henderson, 2005) and hydrological conditions as demonstrated by N'Dri *et al.* (2020) in lake Buyo. In contrast, in this study, it would be more influenced by fishing activities. Thus, the analysis of the value of b allowed to classify the species in three groups. Those with isometric growth (b = 3) i.e. the growth in weight and length are in one direction (*Hepsetus odoe* and *Schilbe mandibularis*), those with positive allometric growth (b > 3), i.e.: they grow faster than they grow. These are *Clarias anguillaris, Hemichromis fasciatus* and *Coptodon zillii*. On the other hand, the other species show a negative allometry. This implies that these fish grow faster than they get bigger. This same finding was made by Falaye *et al.* (2015) on fishes from Erelu Reservoir in Nigeria. However, the growth patterns obtained for *Hepsetus odoe*, *Clarias anguillaris*, *Hemichromis fasciatus* and *Schilbe mandibularis* differ from those previously obtained by the work of Tah (2012) in the same lake. The latter reported negative allometry for *Hemichromis fasciatus* and *Schilbe mandibularis*, positive allometry for *Hepsetus odoe* and isometry for *Clarias anguillaris*. Indeed, these growth changes for these species could be a response to fishing pressure. The Fluton condition factor (K) generally used to assess fish health and productivity (Froese, 2006) ranged from 0.75 to 1.98. This condition factor indicates that 41.18% of the fish had a K below 1.2 reflecting poor growth condition, 23.53% had balanced growth condition and 35.29% had good growth. Overall, the species with a good growth condition belong to the Cichlidae family. Indeed, the high growth of the species would be the proof of their good adaptation in this environment.

CONCLUSION

At the end of this study, it appears that the majority of these species have a negative allometry. This implies that the growth in size is more important than the growth in weight. The rate of condition factor being lower than the equilibrium value would translate a condition unfavourable to the studied species. In addition, the presence of a large number of small individuals reflects an overexploitation of the resources.

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REFERENCES

Baby F, Tharian J, Abraham KM, Ramprasanth MR, Ali A, Ranghavan R, 2011. Length-weight relationship and condition factor of an endemic stone sucker, *Garra gotyla stenorhynchus* (Jerdon, 1849) from two opposite flowing rivers in southern Western Ghats. Journal of threatened taxa **3** (6): 1851-1855.

Falaye AE, Ajani E K, Kareem OK, Olanrewaju AN, 2015. Assessment of Ichthyofaunal Assemblage of Erelu Reservoir, Oyo, Nigeria. Ecologia, **5** (2): 43-53.

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.

Froese R, 2006. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology, **22** (4): 241-253.

Froese R, Pauly D, 2019. FishBase. World Wide Web electronic publication. www.fishbase.org.

Henderson PA, 2005. The growth of tropical fishes. In: val, A.L, vera, M.R. and Randal, D.J. (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.

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.

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.

Laë R, Lek S, Moreau J, 1999. Predicting fish yield of African lakes using neural networks. Ecological Modelling, 120: 325-335.

Lévêque C, 2006. Croissance et ontogénie. In: Les poissons des eaux continentales africaines: Diversité, écologie, utilisations par l'homme (Lévêque C & Paugy D, eds). IRD, Paris. 177-190.

Lizama MAP, Ambrósia AM, 2002. Condition factor in nine species of fish of the Characidae family in the upper Paraná River floodplain. *Brazilian Journal of Biology*, **62** (1): 113-124.

Mikembi ALB, Zamba AI, Mamonekene V, Hélène Dembe Louvinguila Tenda HDL, 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 RO, Konan YA, Bamba M, Monney AI, Koné 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** (1): 27-34.

Ouattarra NI, 2004. Étude du potentiel aquacole d'une population du Coptodon estuarien *Sarotherodon melanotheron* (Rüppell, 1852) isolée dans le lac de Barrage d'Ayamé (Côte d'Ivoire). Thèse de Doctorat Université de Liège, (Belgique), 288 p.

Paugy D, Leveque C, 2017. Impacts of human activities. In: Paugy D, Leveque C, Otero O. (Eds): The inland water fishes of Africa: Diversity, Ecology and Human use, Institut de Recherché pour le Développement (IRD), Royal Museum for Central Africa (RMCA). 459-478.

Paugy D, Lévêque C, Teugels GG, 2003a.- Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest. Tome 1. IRD (Paris), MNHN (Paris), MRAC (Tervuren), 457 p.

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

Savané I, Konaré A, 2010. Climat. In: Biodiversity Atlas of West Africa, Volume III Edité par S. Konaté and D. Kampmann (eds.), Abidjan & Frankfurt/Main, Côte d'Ivoire: 124-125.

Tah L, 2012. Exploitation du lac d'Ayamé I (Côte d'Ivoire) après le départ des pêcheurs «bozo» en 1998 et impact sur les structures démographiques des populations ichtyologiques. Thèse de Doctorat, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire, 177 p.

Tchouante TC, Efole ET, Tchoumboue J, 2019. Caractéristiques de la croissance et facteur de condition k de *Clarias jaensis* (Boulenger, 1909) pêchée dans les rivières de la plaine inondable des Mbô (Cameroun). International Journal of Innovation and Scientific Research, **43** (1): 1-9.

Vanga AF, 1994. La pêche au lac d'Ayamé. Mémoire de DEA, Université de Cocody, Abidjan, 50 p.

Vanga AF, 2001. Conséquences socio-économiques de la gestion des ressources naturelles: cas des pêcheries dans les lacs d'Ayamé et de Buyo (Côte d'Ivoire). Thèse de Doctorat en sciences et gestion de l'environnement, Université d'Abobo-Adjamé, Abidjan, Côte d'Ivoire, 210 p.

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