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Growth parameters of *Chrysichthys nigrodigitatus* (Lacépède, 1803) and *Chrysichthys maurus* (Valenciennes, 1840) in Buyo Lake (Middlee - West: Côte d'Ivoire)

Moussa Ouattara [1,*], AwaTraore [2], Koffi Charles Boussou [1] and Kouakou Severin Attoungbre [1]

[1] *Department of Environment, Jean Lorougnon Guédé University, Daloa city (Côte d'Ivoire) P.O. Box 150 Daloa, Côte d'Ivoire.*
[2] *Department of Agrororestry, Jean Lorougnon Guédé University, Daloa city (Côte d'Ivoire) P.O. Box 150 Daloa, Côte d'Ivoire.*

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Abstract

The growth parameters of *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* were estimated in Buyo Lake. The study covered 1070 individuals collected monthly between August 2019 and July 2020, including 630 *Chrysichthys nigrodigitatus* with sizes between 4 cm Ls and 55 cm Ls and 440 *Chrysichthys maurus* individuals with sizes between 12 cm Ls and 59 cm Ls. The values of L∞, K and Φ' are 69.35 cm; 0.78 yr^{-1} and 3.57 yr for *Chrysichthys nigrodigitatus* respectively. The longevity is 3.84 years with a To equal to -0.16 while in *Chrysichthys maurus*, the longevity is 4.68 years with a To equal to -0.21. The values of L∞, K and Φ' for this species are 61.42 cm; 0.68 yr^{-1} and 3.38 yr, respectively. Both species exhibit long lifetimes.

Keywords: *Chrysichthys nigrodigitatus*; *Chrysichthys maurus*; Growth parameters; Buyo Lake; Côte d'Ivoire.

1. Introduction

In many developing countries, fishery products, particularly fish, represent the main source of animal protein in the human diet [1]. In some developing countries, fishing is the only source of animal protein [2, 3]. Indeed, the nutritional and socio-economic importance of fishery resources in Côte d'Ivoire is no longer in question. The national consumption of fishery products represents 70% of the animal protein consumption. It was estimated at 16.50 kg/inhab/yr in 2007 [1]. The national fisheries production is essentially ensured by fishing in general, and artisanal fishing in particular, with an annual quantity of about 25,653 tons [4]. Fishery products such as fish of the genus *Chrysichthys* are prized products by the population. Commonly called jadefish, the interest given to the fish of the genus *Chrysichthys* has given rise to several research works on different aspects of this family. In Côte d'Ivoire, fish of the genus *Chrysichthys* are also appreciated by the populations and are therefore of significant economic interest fishermen. For this reason, this genus is under strong exploitation pressure [5]. In Lake Guessabo this genus occupies the second place in all fishermen's landings after Tilapia [6]. Despite the importance of this genus, the study conducted is that of [7] in Lake Buyo. This study comes to update that of Goli Bi and collaborators for the species *Chrysichthys nigrodigitatus* and for the first time for the species *Chrysichthys maurus* in Lake Guessabo. Thus, the objective of this study is to estimate the growth parameters of these two species of Chrysichthys exploited in Lake Guessabo in order not only to update the data on *Chrysichthys nigrodigitatus* and to provide the first data for the species *Chrysichthys maurus* in the Sassandra River to the fisheries managers for a more rational use of these species.

*Corresponding author: Moussa Ouattara

2. Material and methods

2.1. Study zone and data collection

The Buyo lake is the result of the construction of the hydroelectric dam of Buyo in 1981 which extended to the locality of Guessabo with coordinates 06°43'56''N and 06°58'48''W. The lake is located upstream of the Buyo hydroelectric dam on the Sassandra River.

Data collection was conducted between August 2019 and July 2020 with one survey per month at the main landing site (Figure 1) on the Buyo Lake near Guessabo. Fish specimens surveyed came from the commercial fishery. The identification of the specimens was done at the specific level using the identification keys proposed by [8,9]Paugy *et al.*(2003a and 2003b), [10] Froese and Pauly (2014). Total length and standard length were measured using an ichthyometer and the weight of the specimens was taken out using an electronic scale of COSYLIFE brand (precision = 1 g and range 5 kg).

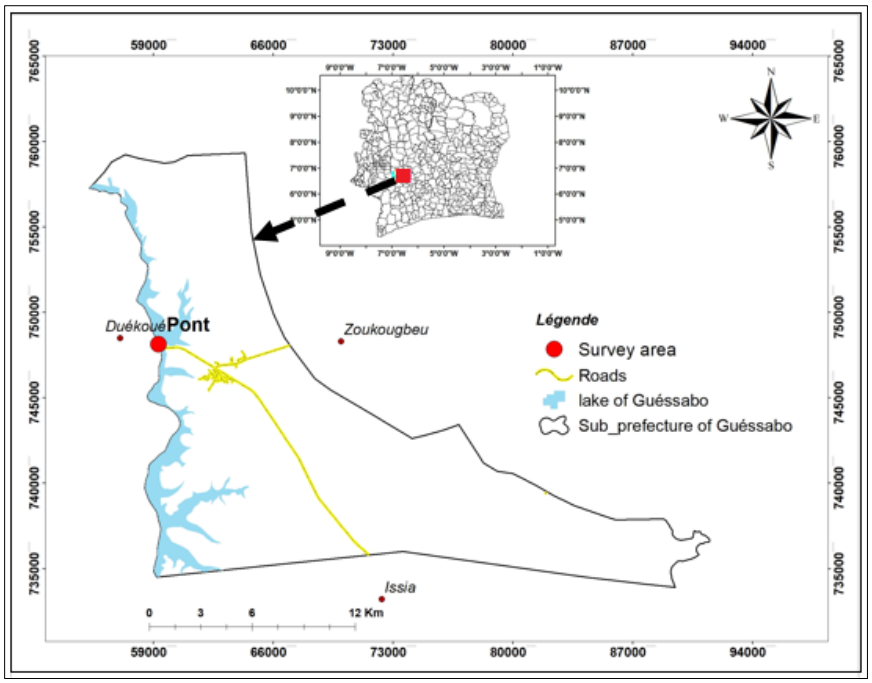


Figure 1 Map showing the location of the fish collection site

2.2. Frequency distribution in size

The size classes were determined using the [11]. They are obtained by the following formula:

$$K = 1 + (3.332 \times \log10(n))$$; where n = total number of individuals and K: the number of classes.

Concerning the class interval, it is calculated as follows:

$$IC = (Ls\ max - Ls\ min) / (Number\ of\ class)$$; with

Ls: standard length IC: the amplitude of each class interval.

2.3. Length -Weight Relationships

Length-weight relationships in fish are considered as allometric growth models [12] because they allow to verify the growth type of a fish. Thus, there is a close relationship between the length (L) of a fish and its weight (P) and it is obtained according to the following equation [13].

$P = a \times Ls^b$; where P is the weight of the fish (g); Ls, the standard length (mm); a = constant of proportionality and b = allometry coefficient. This equation being of exponential type; it is linearised after logarithmic transformation in order to determine the constants a and b as follows;

$$\text{Log } (P) = \text{Log } a + b \text{ Log } (Ls). \text{ [14].}$$

The Length-Weight relationship reflects isometric growth when b = 3 and allometric growth when b ≠ 3. Hence, positive allometric growth is observed when b > 3 and negative allometric growth when b < 3 [15].

Student's t-test was used to compare the slope b of the length-weight relationship to the value 3 (reference value) [16,17,18].

2.4. Linear growth parameters according to Von Bertalanffy

Growth parameters were determined on the basis of size frequency histograms [19, 20].

The Fisat II program ELEFAN I [21] was used to determine the asymptotic length (L∞) and the growth coefficient (K). Thus, the mathematical model that was used in this study to estimate the growth parameters is that of [22] whose equation is as follows:

$$L(t) = L\infty \ (1 - e^{-K(t-t0)}) \text{ ; avec}$$

L(t) : Length of the fish at the time considered; L∞: length to infinity which is the length the fish could reach if it were allowed to live until an indefinite date; K: the growth coefficient characterizing the speed with which the species grows towards L∞ and to: theoretical age of the fish when its length is assumed to be zero.

The parameter *to* was obtained from the empirical equation of [23].

$$\log_{10} (-to) = - 0{,}392 - 0{,}275 \log_{10} L\infty - 1{,}038 \log_{10} K$$

The growth performance index in both fish species was determined by the equation of [24]:

$$\Phi' = \log K + 2\log L\infty.$$

The longevity or maximum age (Tmax) was calculated with the formula of [25]:

$$Tmax = 2, 9957 / K$$

3. Results

3.1. Frequency distribution of size

630 specimens of *Chrysichthys nigrodigitatus* composed of individuals without distinction of sex whose standard length is between 4 cm and 55 cm with an average of 25.43 ± 12.68 cm were used in this study. In *Chrysichthys maurus* 440 specimens including individuals without distinction also of sex for standard lengths going from 12 cm to 59 cm with an average of 41, 01 ± 8,39 cm were considered. Figure 2 is a histogram representating the size frequency distributions. These histograms show an unimodal size distribution in *Chrysichthys nigrodigitatus* while in *Chrysichthys maurus*, the histograms show an bimodal distribution. The size class of 29.5 to 34.6 cm Ls has the highest number of individuals in *Chrysichthys nigrodigitatus* while the highest number of individuals in *Chrysichthys maurus* are present in the classes of 35.5 to 40.2 cm Ls and 44.9 to 49.6 cm Ls. The histograms reveal that the fishermen's catches are dominated by a high proportion of individuals with a size between 4 and 19 cm Ls (36, 50%°) and between 25 and 39 cm Ls (51.11%) for *Chrysichthys nigrodigitatus*. In *Chrysichthys maurus* are present in the classes of 35.5 to 40.2 cm Ls and 44.9 to 49.6 cm Ls while for the species *Chrysichthys maurus*, 79, 31 % of the individuals caught by the fishermen evolve in the size range between 31 and 50 cm Ls.

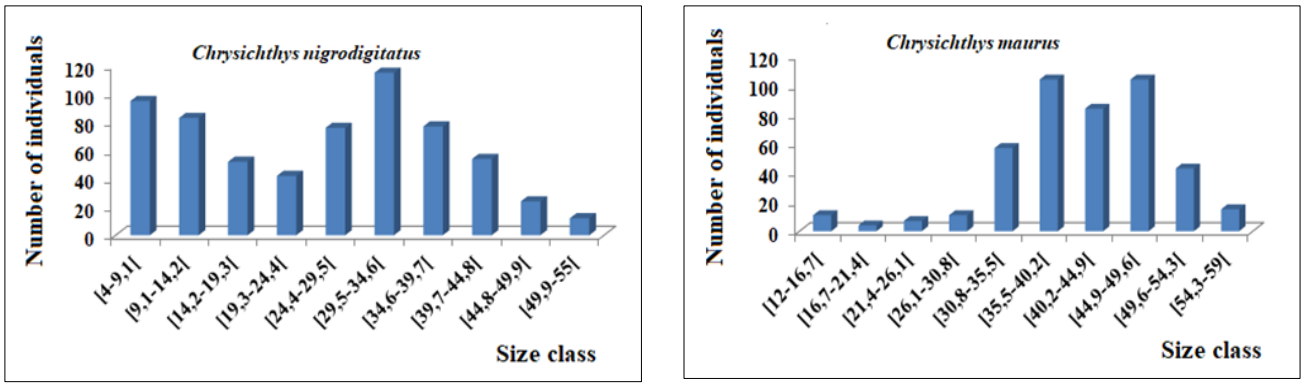


Figure 2 Size frequency distribution of *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* in Buyo Lake at Guessabo level

3.2. Relationship between standard length and fish weight

Table 1 provides information on the growth type of the two fish species studied. The values of the correlation coefficients obtained are respectively 0.96 for *Chrysichthys nigrodigitatus* and 0.87 for *Chrysichthys maurus*. For both species the values of the correlation coefficient obtained are highly significant ($r > 0.7$). The value of b obtained for *Chrysichthys nigrodigitatus* is equal to 2.81 and significantly lesser than 3 (Student'st-test; $p < 0.05$) thus implying a negative allometry for this species while for *Chrysichthys maurus* the value of *b* obtained is 3.17and significantly higher than 3 (Student's t-test; $p < 0.05$) indicating a positive allometry. (Figure 3).

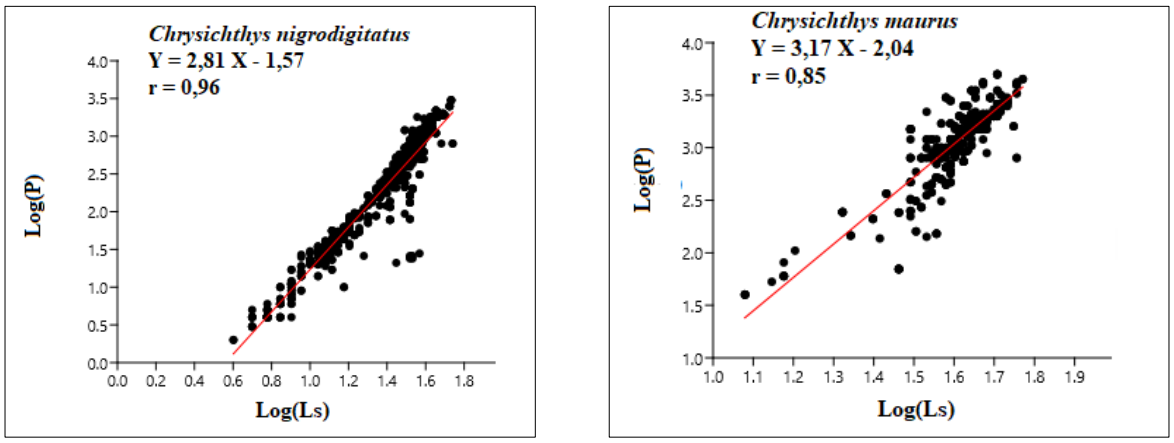


Figure 3 Scaterplots of length-weight regressions in *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* in Buyo Lake at Guessabo

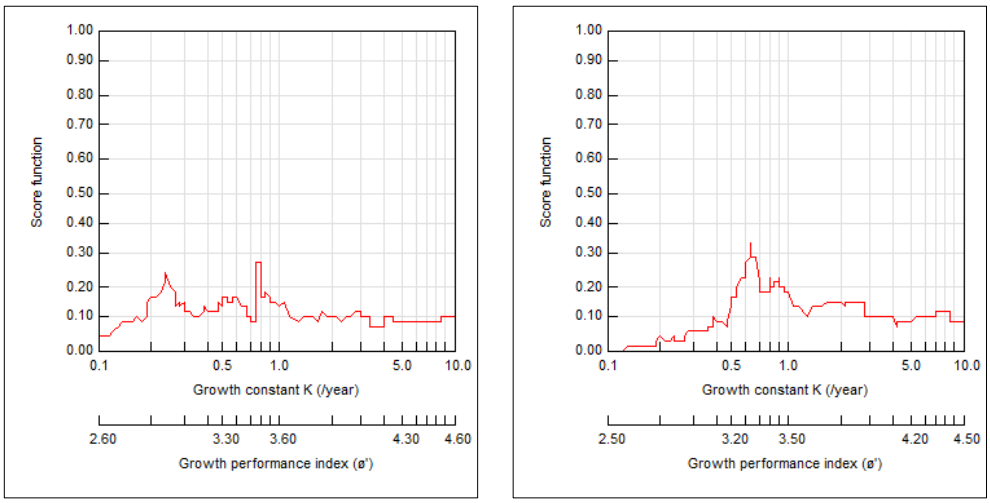
Table 1 Length-weight relationship parameters of *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* in Buyo Lake at Guessabo

		Length (Cm)		Weight (g)				
Species	**N**	**Min**	**Max**	**Min**	**Max**	**r**	**b**	**G.T.**
Chrysichthys nigrodigitatus	630	4	55	2	300	0.96	2.81	AN
Chrysichthys maurus	440	12	59	40	4200	0.85	3.17	AP

N: number; Min: minimum; Max: maximum; r: coefficient of determination; b: slope of the regression line; G.T.: growth type; AN: negative allometry; AP: positive allometry

3.3. Growth parameters according to Von Bertalanffy model

The growth parameters in both species estimated from the size frequency distributions following the Von Bertalanffy model are recorded in Table 2 The graphical representation that allowed the determination of the values of the asymptotic length (L∞), the growth coefficient (K) taken as correct as well as the growth performance index (Φ') is presented by the figure 4. The values of the fitting index (Rn) which allowed to retain the best curves are 0.28 for *Chrysichthys nigrodigitatus* and 0.34 for *Chrysichthys maurus*. The values of L∞, K and Φ' are for *Chrysichthys nigrodigitatus*, 69.35 cm Ls, 0.78 yr^{-1} and 1.84 respectively. The longevity is 3.84 years with a To equal to -0.16 while in *Chrysichthys maurus* the longevity is 4.68 years for a To equal to -0.21. The values of L∞, K and Φ' for this species are 61.42 cm Ls, 0.68 yr^{-1} and 3.38 yr, respectively.



Chrysichthys nigrodigitatus *Chrysichthys maurus*

Figure 4 Variation curve of the adjustment index (Rn) as a function of the growth coefficient (K) and the performance index (Ø') in *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* in Buyo Lake at Guessabo

Table 2 Parameters of Von Bertalanffy growth model for *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* in Buyo Lake at Guessabo

	L∞ (cm)	**K (an-1)**	**Ø'**	**Rn**	**to**	**Tmax(an)**	**Growth model**
Chrysichthys nigrodigitatus	69.35	0.78	3.57	0.28	-0.16	3.84	L(t) = 69.35 [1 – e – 0.78(t +0.16)]
Chrysichthys maurus	61.42	0.68	3.38	0.34	-0.21	4.68	L(t) = 61.42 [1 – e – 0.68(t +0.21)]

4. Discussion

The size frequency distributions reveal that the fishermen's catches are dominated by a high proportion of individuals between 4 and 19 cm Ls (36, 50%) and between 25 and 39 cm Ls (51.11%) for *Chrysichthys nigrodigitatus*. The average standard length recorded in *Chrysichthys nigrodigitatus* (25.43 ± 12.68 cm) show that the fishermen's catches are dominated by both small and large individuals. While for the species *Chrysichthys maurus,* 79, 31 % of the individuals caught by the fishermen evolve in the size range between 31 and 50 cm Ls. Moreover, the average standard length of 41.01 ± 8.39 cm implies that the fishermen's catches are dominated by medium-sized individuals. The study revealed that *Chrysichthys nigrodigitatus* presents a negative allometry (b = 2.81) which implies that in this species the growth in length is faster than that in weight. While in *Chrysichthys maurus* (b = 3.17) reveals a positive allometry indicating that growth in weight is faster than growth in length. These results differ from those obtained by [17] who obtained a negative allometry for *Chrysichthys maurus* (b = 2.784) and an isometry for *Chrysichthys nigrodigitatus* (b = 2.899) in the coastal rivers of southeastern Côte d'Ivoire. Our results also for the species *Chrysichthys nigrodigitatus* (allometry negative, b = 2.81) in this study are different from those obtained by [26] in Buyo Lake (isometry, b = 3.023) but identical to those obtained in Ayamé I for this same species (allometry negative, b = 2.712) for these same authors. For the species *Chrysichthys maurus*, the positive allometry result (b= 3.17) obtained in this study is different from that obtained by [26] (negative allometry, b = 2.705) in Ayamé I. Also, our results for *Chrysichthys maurus* are different from the negative

allometry (b = 2.812) obtained in *Chrysichthys maurus* by [27] in the Aby Lagoon. These variations in b could be due to several factors including, among others, the sampling procedure (sample size and length range) [28], the availability of food on fish growth [29]. In this study L∞ (length to infinity) of *Chrysichthys nigrodigitatus* (69.35 cm Ls) is higher than that of *Chrysichthys maurus* which is (61.42 cm Ls). In addition, the length of *Chrysichthys nigrodigitatus* from this study is higher than that obtained by [5] for *Chrysichthys nigrodigitatus* (L∞ = 58 cm). The growth coefficient results for *Chrysichthys nigrodigitatus* (0.78 yr^{-1}); *Chrysichthys maurus* (0.68 yr^{-1}) show that both species studied grow rapidly toward the asymptotic length. Indeed, according to [30], fish species with a growth coefficient in the range of K (0.20 - 0.50 yr^{-1} and above) would be characterized by rapid growth. In addition, the growth coefficient (K) values obtained for these two species (0.78 yr^{-1} for *Chrysichthys nigrodigitatus* and 0.68 yr^{-1} for *Chrysichthys maurus*) are less than 1 indicating that these two species are long-lived species [31]. This was also reported by [5] for the species *Chrysichthys nigrodigitatus* in the Potou Lagoon (K= 0.33 yr^{-1}). In the present study the growth coefficient for *Chrysichthys nigrodigitatus* (K = 0.78 yr^{-1}) is similar to that obtained by [7]; K = 0.76 yr^{-1}) in Buyo Lake but greater than that obtained by [5] in the Aghien Lagoon. However, for *Chrysichthys maurus* (K = 0.68 yr^{-1}) is similar to that obtained by [32] for the species *Chrysichthys auratus* (K = 0.69 yr^{-1}) in the OUME valley in Benin. But growth in *Chrysichthys nigrodigitatus* (K = 0.78 yr^{-1}) is faster than growth in *Chrysichthys maurus* (0.68 yr^{-1}). The growth performance indices of the two species are 3.57 and 3.38 for *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* respectively. These values are not within the range of values (2.65 - 3.32) recommended by [33] for African fish. However, these two values of the performance index are significantly close. This result could be due to the fact that these two species are of the same family [34] Moreover, it appears from this study that the species *Chrysichthys maurus* has a longer lifespan (Tmax = 4.68 years) than *Chrysichthys nigrodigitatus* (Tmax = 3.84 years) in Buyo Lake.

5. Conclusion

The growth parameters of *Chrysichthys nigrodigitatus* and *Chrysichthys maurus* were determined in Buyo Lake, precisely in the Guessabo area. In this study it was found that *Chrysichthys nigrodigitatus* has a negative allometric growth while *Chrysichthys maurus* has a positive allometric growth. The length to infinity of *Chrysichthys nigrodigitatus* is higher than that of *Chrysichthys maurus*. However, the growth coefficient revealed that both species are fast-growing and long-lived species.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Anonymous 1. ICCAT (International Commission for the Conservation of Atlantic Tunas). 2007- Report of the biennial period 2006-2007, Part I French version COM 1: 86p.

[2] Hall SJ. The effects of fishing on marine ecosystems and communities.1999. Ser. Fish Biology and Aquatic Resources. Oxford Blackell Science, 274p.

[3] Ticheler A. Conservation of fish biodiversity in West African wetlands - Regional Action Plan. 2000. Wetlands International, 79p.

[4] Anonymous 2. Côte d'Ivoire, Ministry of Agriculture and Animal Resources (MINIGRA). (2005). Yearbook of Aquaculture and Fisheries Statistics. Department of Aquaculture and Fisheries, Abidjan, 150 p.

[5] Bédia AT, N'doua ER, Gooré GI, Kouamelan EP, N'douba V. Growth and exploitation parameters of *Chrysichthys nigrodigitatus* (Lacépède, 1803) (Siluriformes, Bragridae) in a tropical lagoon: Ebrié lagoon (Sector I: Potou lagoon, Ivory Coast). (2017). *Tropicultura*. 35, 4, 253-261

[6] Kra KS. The development of fishing in Côte d'Ivoire: the case of inland fishing in the sub-prefecture of Guessabo. (2016). *Journal of Tropical Geography and Environment*, 1: 37-45.

[7] Goli Bi EP, Kamelan TM, Berté S, Kien KB, N'Diaye S,Kouamelan EP. The first data on the population parameters of the main fish species in man-made Lake Buyo (River Sassandra, Côte d'Ivoire). (2019). Egyptian Journal of aquatic Biology et Fisheries Zoology Department, Faculty Of Sciences Ain Shams University, Cairo, Egypt. ISSN 11.10-6131. 23, (2), 586-597

[8] Paugy D, Lévêque C, Teugels GG. Fresh and brackish water fish fauna of West Africa. Volume I, Editions IRD – MNHN – RMCA, Paris - Tervuren (France), (2003a). 457p.

[9] Paugy D, Lévêque C, Teugels GG. Fresh and brackish water fish fauna of West Africa. Volume II, Editions IRD – MNHN – RMCA, Paris - Tervuren (France), (2003b). 815p.

[10] Froese R, Pauly D. (eds.) (2014). Fishbase. World Wide Web electronic publication.www.fishbase.org (consulté le 12 Août 2019).

[11] Sturge H. The choise of a class-interval. (1926). *Journal of the American Statistical Association*, 2, (153): 65 - 66.

[12] Palomares MLD, Entsua-Mensah M, Osei-Abunyewa A. Length-weight relationships of fishes from tributaries of the Volta River, Ghana: part 2 and conclusion. (1996). NAGA, ICLARM Quat., 19 (1): 45-47.

[13] [13] Lévêque C. Growth and ontogeny. In: Fishes of African continental waters: diversity, ecology, human use. (2006). Editions IRD, Paris (France). 177-190.

[14] [14] Lévêque C, Paugy D. Fishes of African continental waters. (2006). Research Institute for Development. IRD Publishing, Paris.

[15] Shingleton AW. Allometry: the study of biological Scaling. (2010). Nature Education Knowledge 3(10): 2.

[16] Zar JH. Biostatistical Analysis. 4ème edition, Prentice - Hall, Englewood Cliffs, New Jersey, (1999). 662p.

[17] Konan KF, Ouattara A, Ouattara M, Gourène G. Weight-length relationship of 57 fish species of Coastel Rivers in South eastern of Ivory Coast. (2007). Ribarstvo, 65, (2), 49 - 60.

[18] Boussou KC. Morphometric variations, biology and ecology of the Cichlidae *Chromidotilapia guntheri* (wild, 1882) in the hydrosystems of eastern and southern Côte d'Ivoire. Doctoral thesis, Department of Environmental Sciences and Management, Nangui Abrogoua University (Abidjan, Ivory Coast), (2013), 161 p.

[19] Thiam D. Size frequency analysis. In: Fish stock assessment methods. International Center for Ocean Development, Halifax: (1990). 329 - 394

[20] Dadzie S, Abou-Seedo FS, Moreau J. Population dynamics of *Parastromateus niger* in Kuwaiti waters as assessed using length-frequency analysis. *Journal of Applied Ichthyology*, (2007). 23: 592-597.

[21] Gayanilo FCJR, Sparre P, Pauly D. The FAO-ICLARM Stock Assessment Tools II (FiSAT II Version 1.2.2). (2002). FAO, Available at: http://www.fao.org/fi/statist/fisoft/fisat

[22] Bertalanffy LV. A quantitative theory of organic growth (Inquiries on growth Laws II). *Human Biology*, (1938). 10 (2): 181-213.

[23] Pauly D. Theory and management of tropical multispecies stocks: a review with emphasis on the Southeast Asian demersal fisheries. ICLARM Studies Review, (1979). 1: 35.

[24] Pauly D. Tropical fishes: patterns and propensities. *Journal of Fish Biology*,(1998). 53: 1-17.

[25] Pauly D. Population dynamic of short lived species with emphasis on squids. NAFO Science Council Studies, (1985). 9: 143 – 154.

[26] Tah L, GOORE Bi G,Da Costa KS. Length-Weight relationships for 36 freshwater fish species from two tropical reservoirs: Ayamé I and Buyo, Côte d'Ivoire. *Revista de Biologia Tropical,* (2012), 60, (4), 47-56.

[27] Koffi BK, Berté S, Koné T. Length-weight Relationships of 30 Fish Species in Aby Lagoon, Southeastern Côte d' Ivoire. Curr. Res. J. Biol. Sci. (2014). 6, (4): 173-178.

[28] Ecoutin JM, Albaret JJ. Length–weight relationship for 52 fish species from West African estuaries and lagoons. *Cybium*, (2003), 27: 3-9.

[29] Henderson, P.A. The Growth of Tropical Fishes, In A. Val, V. Val & D. Randall (eds.). The Physiology of Tropical Fishes. Academic, New York, USA. (2005), p.85-101.

[30] Branstetter S. Age and growth estimates for blacktip, *Carcharhinus limbatus,* and spinner, *C. brevipinna,* sharks from the Northwestern Gulf of Mexico. Copeia, (1987). 4: 964 - 974.

[31] Ikongbeh OA, Ogbe FG, Solomon SG,Ataguba GA Age, growth and mortality of *Chrysichthys nigrodigitatus* (Lacépède, 1803) from Lake Akata, Benue State, Nigeria, Asian J. Conserv. Biol., (2015). 4, 1, 81-88.

[32] Dossou DH. Estimation of the demographic parameters of *Chrysichthys auratus* populations: Case of the commune of Dangbo in the OUME valley in Benin. Research master's degree in population analysis of wildlife and fishing areas. Polytechnic University of Bobo-Dioulasso. (2013). 33p.

[33] Bajot E, Moreau J. Biology and demographic status of main fish species in the reservoirs of Burkina Faso. In: Hydrological Aspects of Fisheries in Small Reservoirs in Region (Bajot E., Moreau J. & Bouda S. éds). Technical Centre for Agricultural and Rural Cooperation, Commission of the European Communities, Wageningen, Netherlands, (1997). 79-109.

[34] Moreau J, Bambino C, Pauly D. Indices of overall fish growth performance of 100 tilapia (Cichlidae) populations, In: J. L. Maclean, L. B. Dizon and L. V. Hosillos (eds.), The First Asian Fisheries Forum, Manila, Philippines: Asian Fisheries Society, (1986), 201–206.