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Size distribution, weight-length relationship and condition factor of *Sarotherodon melanotheron melanotheron* (Rüppell, 1852) from three aquatic ecosystems, Côte d'Ivoire

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Abstract
343 specimens of *Sarotherodon melanotheron melanotheron* are sampled from March 2017 to February 2018 with carp nets. They are sexed, weighed and measured. This operation made it possible to obtain size distribution frequency, allometric coefficient (b) and condition factor (k) modal class is [17.78-19.03] for each of the two sexes in sector VI. In the females of Ayame 1 artificial lake and Aby lagoon, modal class is [19.04-20.29] while in the males it is [20.30-21.55]. Only in lagoon males, cases of positive and isometric allometric growth appeared. Positive allometric growth is obtained in males during short dry season (b=3.23) and short rainy season (b=3.07) in Aby lagoon. In sector VI, males of the flood season had a positive allometric growth (b=3.04) while it was isometric in rainy season (b=2.99). As for condition factor, it was greater than 1. In conclusion, species adapts to any environment but with growth favorable to weight in males in lagoon.

Keywords: *Sarotherodon melanotheron melanotheron*, allometric coefficient, condition factor, Ivory Coast

1. Introduction
The black-chinned tilapia, *Sarotherodon melanotheron* (Rüppell, 1852) endemic to Africa, occurs naturally in estuaries, lagoons and lower parts of rivers from Senegal to Angola [1]. This taxon is a euryhaline [2] and eurytherm fish species [3]. Trewavas [4] had subdivided *S. melanotheron* into five subspecies. Currently, three subspecies of this fish are clearly distinguished as separate taxa through morphometric and molecular data [5] among which, we can cite *S. m. melanotheron* known from Côte d'Ivoire to Cameroon [6]. This fish is found in estuaries and brackish waters in Côte d'Ivoire from the Cavally River in the West to Aby lagoon in the East and also in various ecosystems of the Bia basin [7]. According to earlier studies, *S. m. melanotheron* constitutes more than 50% *of* the commercial catches in the man-made Lake Ayame [8]. Now, the Nile tilapia *O. niloticus* by far, is the most important farmed tilapia species, representing more than 80% of total tilapia production [9]. Despite of its potential for aquaculture in freshwaters, *O. niloticus* does not tolerate high salinity waters [10]. So, *S. m. melanotheron* could be a good candidate for the aquaculture in the areas where freshwaters are scarce [11]. For a successful culture operation of a fish, the knowledge of some biological parameters including its growth and wellbeing are required [12]. As reported by few studies, length-weight relationships (LWRs) and condition factors are of great importance in fishery assessment studies [13]. These parameters provide information about the growth of the fish, its general wellbeing and fitness [14]. This study aimed at determining the size distribution, the allometric growth patterns and condition factor of *S. m. melanotheron* in different aquatic ecosystems of Côte d'Ivoire. The sites were selected according to the availability of the resource and the water salinity.

Material and methods

Study area

Specimens of *S. m. melanotheron* were collected in the sector VI of the Ebrie lagoon, Ayame Lake 1 and northern area of Aby lagoon (Figure 1). The Ebrié lagoon system, located between 2°50' and 5°25' West of Côte d'Ivoire, is permanently connected to the Atlantic through the Vridi canal. This elongated lagoon system (130 km in length and 0.4-7 km in width) with a total area of 566 km^2 [15]. The Ebrie lagoon system is affected by three seasons: the dry season (DS) which extends from January to April, the rainy season (RS) observed from May to August and flood season (FS) from September to December. The sector VI of the Ebrie lagoon, characterized by stable and homogeneous waters all year round, is oligohaline with a maximum salinity of ~ 3 [16]. The Ayamé Lake 1 (5° - 7° 5' N and 2° 6' - 3° 3' W) is an artificial freshwater lake located in the south-east region of the country resulting from the hydroelectric dam built across the Bia River in 1959 [17]. It has an average surface of 180 km^2, 80 km long, 27 km wide. The lake is affected by four seasons: the long dry season (LDS) extending from December to March, the long rainy season (LRS) from April to July, the short dry season (SDS) from August to September and the short rainy season (SRS) starts from October to November. The Aby lagoon system is located between longitude 2°51' and 3°21' on the one hand and latitude 5°01' and 5°22' on the other. It is the second largest of lagoon of Côte d'Ivoire, after Ebrie lagoon complex. With an area of 424 km^2 and located in the far east of the country. It consists of the main Aby lagoon, the Tendo lagoon, and the Ehy lagoon and receives freshwater from the Bia River in the Northwest and the Tanoé River in the East [18]. The Aby lagoon lagoon system is also affected by the same four seasons observed for Ayame Lake 1.

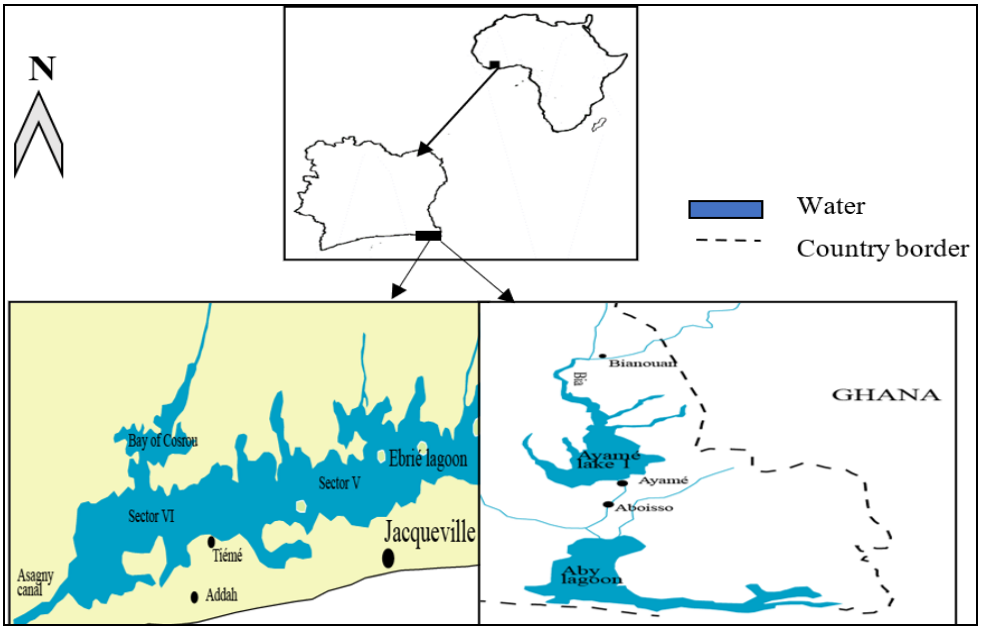

Fig 1: Map showing the sector VI of Ebrie lagoon, man-made Ayame lake 1 and northern area of Aby lagoon.

Sampling of specimens

Specimens of *S. m. melanotheron* were collected on monthly basis between March 2017 and February 2018 using carp gillnets (mesh size: 80 to 100 mm). A total of 110, 116 and 117 fish were collected in the Ebrie lagoon, Ayame Lake 1 and northern area of Aby lagoon, respectively. During each gillnet survey, fish collected were kept in a cooler filled with ice and then transported to the laboratory for analysis. In the laboratory, each fish was identified, weighed (in g) using electronic balance (Scale House, 0.01 g precision) and measured using an ichtyometer (± 0.01 cm). The sex of each sample was identified

Parameters

Number of classes and class interval

The class interval and the number of classes were determined following the formula of Sturges:

Class interval= maximum size-minimum size/k, where k is the number of classes;

$k=1+(3{,}3\ \log n)$; Where n the number of individuals.

Length-weight relationship and fish condition factor

The weight-length relationship was done according to Le Cren [19]:

$$W = aL^b$$

Where W = weight (g), L = total length (cm), b = the regression coefficient and a = the intercept of the regression curve. The "b" value represents the relative growth constant (b = 3 means isometric growth; b > 3 means positive allometric growth; and b < 3 means negative allometric growth). The condition factor (K) of the fish specimens was estimated from the relation [20]:

$$K = 100\ W/L^b$$

Where K = condition factor, W = weight of fish (g), L = length of fish (cm).

Statistical analyses

The statistical significance of the "b" for the isometry (Ho: b = 3) was tested using the Student's *t*-test ($\alpha = 0.05$). When the ANOVA has revealed a significant seasonal effect ($P \leq 0.05$) on the condition factor (K), the Tukey's HSD test was used to

determine significant differences between means.

Results

Size distribution

A unimodal TL distribution was observed in the population, for each sex in the 3 hydrosystems. It is [17.78-19.03[cm in sector VI (figure 2). In Lake Ayame 1, the nodal class changes according to sex (Figure 3). Males modal class is [20.30-21.55] cm while of females and population it was [19.04-20.29]. In Aby Lagoon, fish showed two different modal distributions of TL by sex (Figure 4). The modal class of TL of males is [20.30-21.55] cm while that of females was [19.04-20.29] and identical to that of the population.

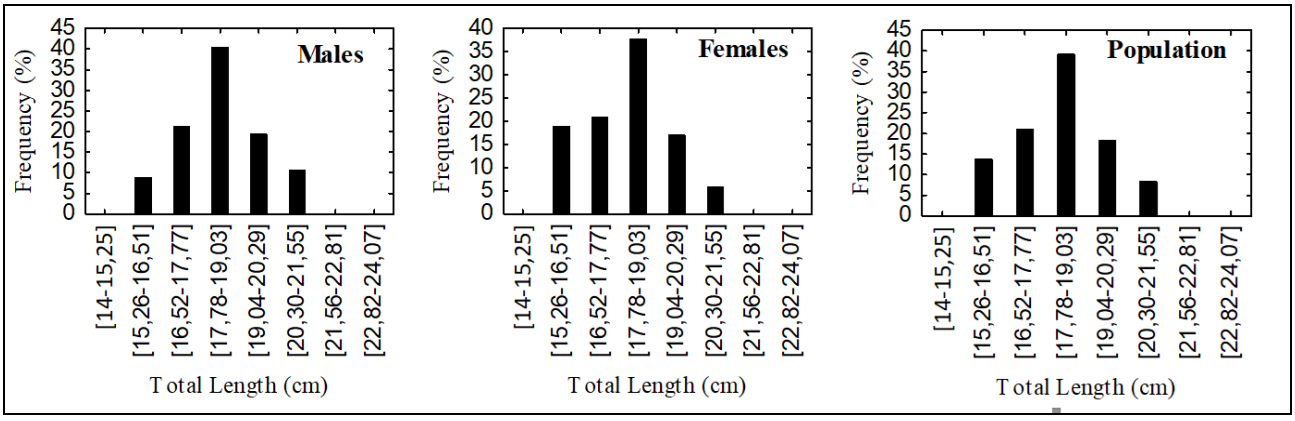

Fig 2: Frequency distribution of *S. m. melanotheron* in males, females and population sampled in the sector VI of Ebrie lagoon

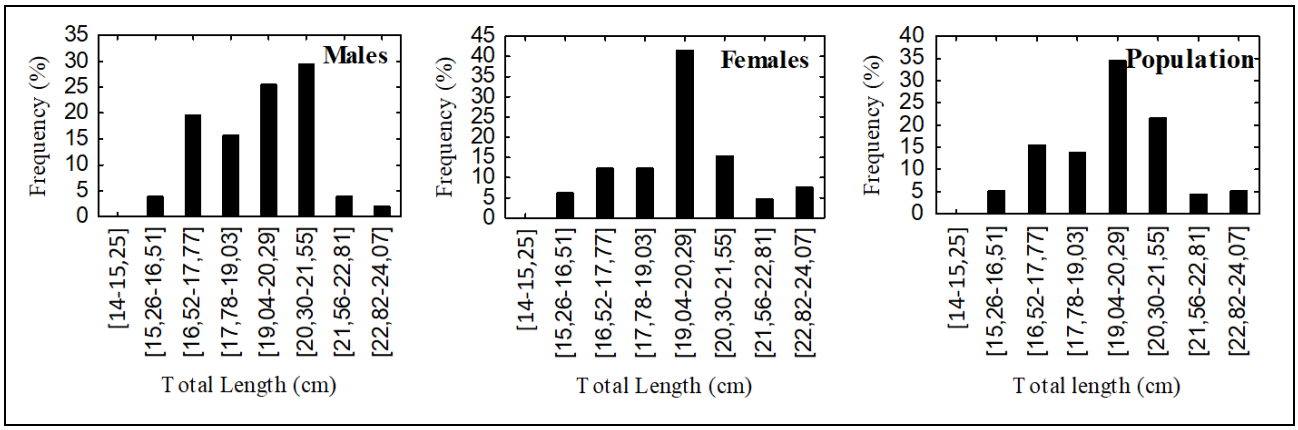

Fig 3: Frequency distribution of *S. m. melanotheron* in males, females and population sampled in the man-made Ayame lake 1

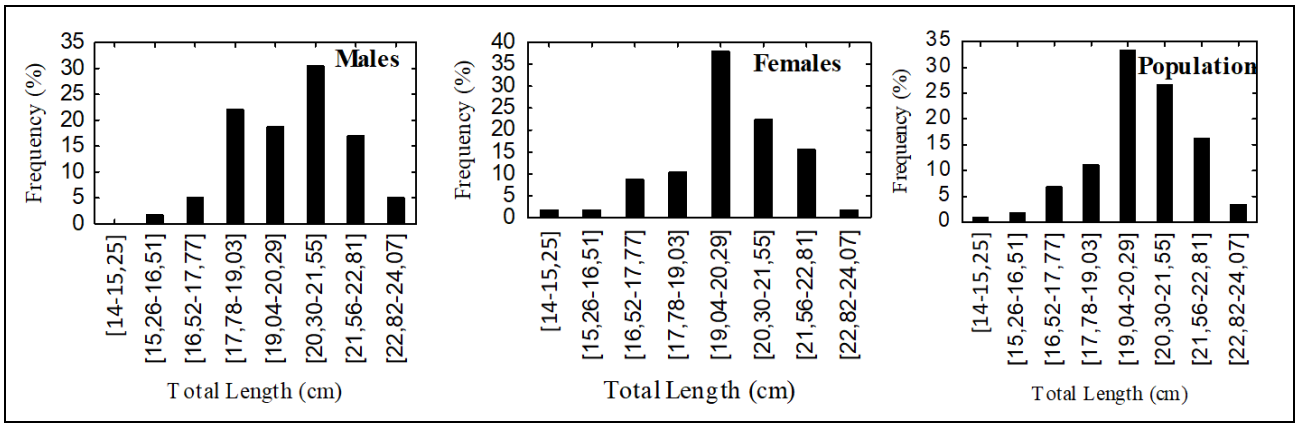

Fig 4: Frequency distribution of *S. m. melanotheron* in males, females and population sampled in the Aby lagoon

Weight- length relationship

Table 1 summarizes the seasonal variations in the differents parameters compunted from the power function ($W = aL^b$) used to study the lenght-weight relationship (LWR) in *S. melanotheron*. In the sector VI of the Ebrie lagoon, a negative ($b < 3$) allometric growth was observed in females in all seasons, while males presented negative ($b < 3$), isometric ($b = 3$) and positive allometric growths during the dry season (DS), rainy season (RS) and flood season (FS), respectively.. In the man-made lake Ayame 1, *S. melanotheron* exhibited a negative allometric growth ($b < 3$) for both sexes in all seasons. In the Aby lagoon, female fish presented a negative allometric growth ($b < 3$) in all seasons, but not for males showing a negative allometric growth ($b <3$) in high dry season (HDS) and high rainy season (HRS) and a positive allometric growth ($b > 3$) in Small dry season (SDS) and

small rainy season (SRS).
In the 3 study areas, for both sexes in all seasons R^2 values recorded are between 0.67 and 0.99.

Table 1: Seasonal variations in Weight-total length relationship ($W= aL^b$) parameters for *S. m. melanotheron* caught in the Ebrie lagoon, man-made Ayame lake 1 and Aby lagoon

Sites	Sex	Seasons	R^2	b	Allometric growth patterns
Secteur VI of Ebrie lagoon	M	DS	0.83	2.41	A-
		RS	0.89	2.99	I
		FS	0.89	3.04	A+
	F	DS	0.92	2.2	A-
		RS	0.92	2.77	A-
		FS	0.92	2.87	A-
Man-made Ayame lake 1	M	HDS	0.74	2.49	A-
		HRS	0.95	2.81	A-
		SDS	0.98	2.46	A-
		SRS	0.81	2.81	A-
	F	HDS	0.72	2.00	A-
		HRS	0.93	2.58	A-
		SDS	0.81	2.56	A-
		SRS	0.93	2.88	A-
Aby lagoon	M	HDS	0.85	2.7	A-
		HRS	0.69	1.81	A-
		SDS	0.67	3.23	A+
		SRS	0.99	3.07	A+
	F	HDS	0.94	2.42	A-
		HRS	0.70	2.61	A-
		SDS	0.86	2.62	A-
		SRS	0.81	2.81	A-

M : males, F : females; HDS : High dry season ; HRS : High rainy season; SDS : Small dry season ; SRS : Small rainy season; DS : Dry season ; RS : Rainy season ; FS : Flood season. A+: Positive allometry; A- : Negative allometry; I : isometry.

3.3. Condition factor

Sampling period of had a significant ($P< 0.05$) effect on condition factor (k). In the sector VI of Ebrie lagoon, k value was higher in females (2.17±0.15) sampled in the dry season (DS) than those collected (k =2.06 ± 0.12) during the rainy season (RS) and the flood season (FS) (k = 2.05±0.14). In male fish, k was slightly high in the RS and low (k = 1.96±0,17) in FS. In the man-made Ayame Lake 1 and in the Aby lagoon, no statistical difference between the sexes was detected for the condition factor k (Table 2).

Table 2: Seasonal variations in condition factor (k) of *S. m. melanotheron* sampled in the Ebrie lagoon, man-made Ayame lake 1 and Aby lagoon

	Sexes	**DS**	**RS**	**FS**	
Secteur VI of Ebrie lagoon	M	$2.03±0.15^{ab}$	$2.13±0.12^{b}$	$1.96±0.17^{a}$	
	F	$2.17±0.15^{b}$	$2.06±0.12^{a}$	$2.05±0.14^{a}$	
	Sexes	**HDS**	**HRS**	**SDS**	**SRS**
Man-Made Ayame Lake 1	M	$1.90±0.19^{a}$	$2.02±0.13^{a}$	$1.94±0.1^{a}$	$2.04±0.16^{a}$
	F	$2.03±0.20^{a}$	$1.98±0.18^{a}$	$2.00±0.17^{a}$	$2.00±0.13^{a}$
	sexes	**GSS**	**GSP**	**PSS**	**PSP**
Aby Lagoon	M	$2.04±0.18^{a}$	$2.06±0.20^{a}$	$1.99±0.18^{a}$	$2.00±0.04^{a}$
	F	$2.03±0.20^{a}$	$2.04±0.18^{a}$	$2.11±0.14^{a}$	$1.93±0.20^{a}$

M : males, F : females; HDS : High dry season ; HRS : High rainy season; SDS : Small dry season ; SRS : Small rainy season; DS : Dry season ; RS : Rainy season ; FS : Flood season., (a, b): numbers with the same letters on the same line are not significantly different ($p>0.05$)

Discussion

The existence of a unimodal distribution with an adult tendency could affirm that the subspecies *S. m. melanotheron* is spared from extinction, because for Lye Koh *et al.* [21], a population threatened with extinction has a bimodal size distribution, one of which corresponds to juvenile specimens and the other to adult specimens. The probability of capturing individuals increases according to the size of the species [22], which is why the membership of males in a higher modal class than that of females in the Ayamé 1 and Aby-north show that they are larger. Seasonal values of b coefficient are within limits (2-4) established by Tesch [23] except for aberrant b value of Aby-north lagoon males caught during hight rainy season. Outlying values of b according to Hazoume *et al.* [24] are due to species overexploitation. Effectively, this b value coincides with final phase of a long and intense fishing period that began in October and preceded biological rest. Biological rest results in the suspension of high-capacity fishing gear, in particular the Aly net, over a period of two to three months (June-September) depending on the lagoon sector [25]. Negative allometry coefficients obtained in the females mean that the growth is in favor of length. Water quality or food availability are factors influencing b coefficient [26]. In this vein, Dembe *et al.* [27] support the hypothesis that food is more abundant in rainy season and fish increase in weight. But absence of change in growth type, which remains negative allometric in females despite different seasons and hydrosystems diversity, leads to minimizing impact of environmental factors and those related to food availability. Moreover, little [28] studies have shown existence of strong correlation between weight loss and duration of oral incubation in female Tilapia. In fact, it can happen that after spawning, *S. melanotheron* female practices oral incubation when all the eggs are not taken care of by male and feeds less during this phase [29]. In addition, in fishes during spawning period, growth of genital glands puts pressure on digestive tract, which leads the latter to eat little or not at all [30] (Koné *et al.*, 2014). In view of above, reproduction in Tilapia female has a high energy cost as mentioned by Toguyeni [31] (1996). This would therefore have a negative impact on b coefficient, especially since reproduction is spread over whole year and

the average spawning frequency and average incubation period are 14 days [32]. The existence only in males of the types of positive and isometric allometries confirms sexual dimorphism in favor of males already mentioned by Toguyeni [31] and Tiogue *et al.* [33]. Thus Toguyeni [31] explains this state of affairs by higher energy cost of reproduction in females and by difference in hormonal status, leading in particular to an anabolic effect of androgens in males. Notwithstanding this status, there is negative allometric growth in males of all seasons on Lake Ayame 1, in those of the high dry season and the high rainy season of Aby-north lagoon and in males of the dry season of Ebrié lagoon. Certainly during oral incubation, the males of *Sarotherodon melanotheron* do not feed [34] and lose weight, but fishery resources overexploitation could also be a factor according to Adebola *et al.* [35] responsible for poor growth in fish. Indeed, in sector VI, sampling area is called by local populations, "reserve". This water body is allocated at the end of dry season to an economic operator who alone has right to set up acadjas there and carry out small fishing operations intermittently. The acadjas are lifted at end of the year and fishing is open to population at the end of flood season and throughout the dry season. This season during which we recorded the fish growing in favor of the length, population resorts to all fishing gear and even toxic products. Positive allometric growth in males would be supported in Aby-Nord lagoon by biological rest, which would considerably reduce catches and also stress linked to fishing operations. Thus Brown [36] suggests that stress suffered by fish induces an increase in energy expenditure and, consequently, decreases energy available for growth. The seasonal condition factor of *Sarotherodon melanotheron* of the 3 hydrosystems was greater than 1, which shows that the species adapts to its habitat which provides it with the physico-chemical and biological conditions necessary for its development [37]. Periodic flood-low water alternations have a major impact on the biology, physiology and ecology of fish populations [38]. In addition, several other factors including the size of the gonads, the sex, the stomach content and the availability of food, the specific morphology of the individual, the state of fattening and the specific density influence the condition factor [39; 40].

Conclusion

The study clearly shows that *S. m. melanotheron* subspecies wild stock is far from extinction and is overweight in both fresh and brackish water. In both types of hydrosystem, growth is generally in favor of length to the detriment of weight. However, in the brackish environment, the males only have a growth in favor of the weight when fishing pressure decreases with the biological rest established in Aby-north lagoon and restriction of fishing in sampling zone of sector VI. Environmental and trophic factors in brackish and freshwater environments would not be an obstacle to species development. The two factors that negatively impact weight growth of species are the cost of reproduction and overfishing which could be controlled in intensive and extensive aquaculture.

References

1. Kone T, Teugels GG. Food habits of brackish water tilapia (*Sarotherodon melanotheron*); in riverine and lacustrine environments of a West African coastal basin. Hydrobiologia. 2003;490(1):75-85.
2. Dugue R, Baras E, Gueye M, Avarre J-C, Combes Y, Cochet C, *et al*. Egg production in the euryhaline tilapia, *Sarotherodon melanotheron heudelotii*, experimentally maintained in fresh, sea and hypersaline waters. Aquatic Living Resources. 2014;27(2):63-72.
3. Albaret JJ. Les peuplements de poissons de la Casamance (Sénégal) en période de sécheresse. Revue d'hydrobiologie tropicale. 1987;20(3-4):291-310.
4. Trewavas E. Tilapiine fishes of the genera Sarotherodon, Oreochromis and Danakilia. Bulletin of the British Museum (Natural History), London, 1983, 583.
5. Falk TM, Teugels GG, Abban EK, Villwock, W, Renwrantz, L. "Phylogeographic patterns in populations of the black-chinned tilapia complex (*Teleostei*, *Cichlidae*) from coastal areas in West Africa: support fort the refuge zone theory". Molecular Phylogenetics and Evolution. 2003;27(1):81-92.
6. Lederoun D, Amoussou G, Baglo IS, Adjibogoun H, Vodougnon H, Moreau J, *et al*. Growth, mortality and yield of *Sarotherodon melanotheron melanotheron* (Rüppell, 1852) in the Lake Nokoué and Porto-Novo Lagoon complex Benin, West Africa. Aquatic Living Resources. 2020;33:18.
7. Gourène G., Teugels GG, Hugueny B, Audenaerde ADFE. Evaluation de la diversité ichtyologique d'un basin ouest-africain. Cybium. 1999;23(2):147-160.
8. Vanga AF, Gourène G, Ouattara M. Impact de la pêche sur la disposition en poisson dans les régions des lacs d'Ayamé et de Buyo (Côte d'Ivoire). Archives Scientifiques CRO, Abidjan. 2002;12(2):1-12.
9. Fessehaye Y. Natural mating in Nile tilapia (*Oreochromis niloticus* L.) Implications for reproductive success, inbreeding and cannibalism. PhD thesis, Wageningen University, Netherlands, 2006, 146.
10. Prabu E, Rajagopalsamy CBT, Ahilan B, Jeevagan IJMA, Renuhadevi M. Tilapia – An Excellent Candidate Species for World Aquaculture: A Review. Annual Research & Review in Biology, 2019, 1-14.
11. Ouattara N, Ouattara S, Bamba Y, Yao K. Influence de la salinité sur la structure des branchies et l'ultrastructure des ionocytes chez le tilapia *Sarotherodon melanotheron heudelotii* provenant d'un estuaire hypersalé (Saloum, Sénégal). Journal of Applied Biosciences. 2014;79:6808-6817.
12. Obayemi OE, Komolafe OO, Okunola OV, Asafa ST, Ayoade MA. Length-Weight Relationships and Condition Factors of Three Tilapine Species in an Abandoned Gold Mine Reservoir, Igun, Southwestern Nigeria. Notulae Scientia Biologicae. 2019;11(2):205-209.
13. Mortuza MG, Misned AA. Length-weight Relationship, condition factor and sex ratio of Nile Tilapia, Oreochromis niloticus in Wadi Hanifar, Riyadh, Saudi Arabia. World Journal of Zoology. 2013;8(1):106-109.
14. Jisr N, Younes G, Sukhn C, El-Dakdouki MH. Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. The Egyptian Journal of Aquatic Research. 2018;44:299-305.
15. Koné YJM, Abril G, Kouadio KN, Delille B, Borges AV. Seasonal Variability of Carbon Dioxide in the Rivers and Lagoons of Ivory Coast (West Africa). Estuaries and Coasts. 2009;32(2):246–260.
16. Durand J-R, Guiral D. Hydroclimat et Hydrochimie (pp 60-90). In Durand J.R, Dufour P., Guiral D. et Zabi

S.G.F. Environnement et Ressources Aquatiques de Côte d'Ivoire : Les Milieux Lagunaires,. Orstom, 2, La Fayette, Paris (France), 1994, 543.
17. Blahoua KG, Adou YE, Etilé RN, Tiho S. Parasite community of Oreochromis niloticus from man-made Lake Ayame I, Côte d'Ivoire. International Journal of Biosciences. 2020;16(4):193-205.
18. Seu-Anoï NM, Ouattara A, Koné YJ-M, Gourène G. Seasonal distribution of phytoplankton in the Aby lagoon system, Ivory Coast, West Africa. African Journal of Aquatic Science. 2011;36(3):321-330.
19. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology. 1951;20:2-19.
20. Pauly D. Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical paper, FAO, Rome, Italy. 1983;234:52.
21. Lye Koh H, Hallam TG, Lee HL. Combined effects of environmental and chemical stressors on a model of Daphnia population. Ecological Modelling. 1997;103(1):19-32.
22. Koné N, N'Da AS, Boguhé GFH, Berté S. Relation longueur-masse et paramètres de population de *Synodontis bastiani* Daget, 1948 (Mochokidae) dans le fleuve Bandama en aval du barrage de Taabo (Côte d'Ivoire). Journal of Animal & Plant Sciences. 2022;51(3):9284-9296.
23. Tesch FW. Age and Growth. In: Ricker, W.E. (Ed.), Methods for Assessment of Fish Production in Freshwaters.. IBP Handbook 3. Blackwell Scientific Publications, Oxford, UK, 1971, 93-123
24. Hazoume US, Chikou A, Koudenoukpo C, Houndonougbo P, Adite A, Bonou CA, *et al*. Length-weightrelationships of 30 species of fish of the river Sô in Benin. International Journal of Fisheries and Aquatic Studies. 2017;5(3):514-519.
25. Zran GM. Gestion des baies en lagune Aby et développement durable des pêches à Adiaké (Côte d'Ivoire). Revue Ivoirienne de Géographie des Savanes. 2019;6:110-124.
26. Henderson PA. The Growth of Tropical Fishes.In A. Val, V. Val and D. Randall (eds.), 2005, 85-101.
27. Dembe LTH, Ibala ZA, Goma-Tchimbakala J, Batiabo ML, Ngo HFP, Mamonekene V. Effets saisonniers sur les relations poids-longueurs et coefficients de condition pour 16 espèces de poissons de la Lagune Mvassa, basse Guinée, République du Congo. Journal of Animal and Plant Sciences. 2020;44(1):7540-7552.
28. Little DC. An evaluation of strategies for production of Nile tilapia (*Oreochromis niloticus* L.) fry suitable for hormonal treatment. PhD thesis. Institute of Aquaculture; c1989.
29. Koné T. Régime alimentaire et reproduction d'un tilapia lagunaire (*Sarotherodon melanotheron* Rüppell, 1852) dans la rivière Bia et le lac de barrage d'Ayamé (Côte d'Ivoire). Thèse de Doctorat. Katholieke Universiteit Leuven, 2000, 253.
30. Kone T, Kouakou IKF, Agnissan J-PA, Soro Y, N'Da K. Régime et éthologie alimentaires de *Pseudotolithus elongatus* (Bowdich, 1825) de la lagune Ebrié, Côte d'Ivoire. International Journal of Innovation and Applied Studies. 2014;14(3):668-676.
31. Toguyeni A. La croissance différentielle liée au sexe chez le tilapia (Pisces: cichlidae), *O. niloticus* (linnaeus, 1758): contribution des facteurs genetiques, nutritionnels, comportementaux, et recherche d'un relais endocrinien. Thèse de Doctorat (Option : Biologie et Agronomie) de l'Université de Reims, France, 1996, 158.
32. Lazard J, Legendre M. La reproduction spontanée du tilapia: une chance ou un handicap pour le développement de l'aquaculture africaine? 1996, 82-98. /n R.S.V, Pullin, J. Lazard, M. Legendre, J.B. AmonKothias et D. Pauly (éds.) Le Troisième Symposium International sur le Tilapia en Aquaculture. ICLARM. Conf. Proe. 41, 630.
33. Tiogue CT, Tomedi MT, Eyango DN, Tchoumboue J. Caracteristiques de morphologie générale et de croissance du Cyprinidae africain *Labeobarbus batesii* dans la plaine inondable des Mbô, Cameroun. International Journal of Biological and Chemical Sciences. 2010;4(6):1988-2000.
34. Lacroix E. Pisciculture en Zone Tropicale. Rapport GTZ - GFA terra systems, Hamburg, Allemagne, 2004, 225.
35. Adebola TO, Bello-Olusoji OA, Fagbenro AO, Sabejeje TA.-Length Weight Relationship and Condition Factor of Four Commercially Important Fish Species at ERO Reservoir, Ekiti State, Nigeria. International Journal of Inovative Research and Development. 2016;5(9):324-328.
36. Brown ME. The growth of brown trout (*Salmo trotta* Linn.).1. Factors influencing the growth of trout fry. Journal of Experimental Biology. 1946;22(3-4):118-129.
37. Abba E, Belghyti D., Benabid ME, Ibaoui H. Relation taille-poids et coefficient de condition de la truite commune (*Salmo trutta macrostigma*, Dumeril. 1858) de l'Oued Sidi Rachid (Moyen Atlas) Maroc. Afrique Science. 2010;06(2):60-70.
38. Albaret, JJ. Les peuplements des estuaires et des lagunes. In : Lévêque Christian (ED.), Paugy Didier (ED.). Les poissons des eaux continentales africaines : diversité, écologie, utilisation par l'homme, Paris : IRD, 1999, 325-349.
39. Freon P. Relations tailles-poids facteurs de condition et indices de maturité sexuelle : rappels bibliographiques, interprétation, remarques et applications. 1979, 29.
40. Hossain, MY, Ahmed ZF, Leunda PM, Jasmine S, Oscoz J, Miranda R, *et al*. Condition, length-weight and length-length relationships of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Mathabhanga River, Bangladesh. Journal of Applied Ichthyology. 2006;22(4):304-307.