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Length-length, length–weight relationships and condition factor of Nile perch, *Lates niloticus* (Linnaeus, 1762) in the Pendjari River, West Africa

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ABSTRACT

This study is the first of its kind on the population of *Lates niloticus* from the Pendjari River (West Africa). It provides information on length frequency distributions, length-length, weight-length relationships and condition factor of the species. A total of 781 specimens were used for this study and were caught by artisanal fishing gears between Februay 2006 and January 2007. The length frequency distributions were unimodal. Individuals larger than 20.0 - 22.5 cm (modal class) were more abundant (71.06 %). Monthly, the coefficient b and the condition factor (K) ranged from 2.83 to 3.31 (mean = 3.14) and from 0.44 to 2.44 (1.14), respectively. The growth was in favour of the body weight (b>3, positive allometric growth) during the low water season and in favour of the length (b<3, negative allometric growth) during the high water season. Whenever possible, the b values for the species obtained both in this study and in some of the previously reported ones were compared. Generally, b values indicate a positive allometric growth for the species.

Keywords: *Lates niloticus*, length-weight relationships, condition factor, Pendjari River.

INTRODUCTION

The Nile perch, *Lates niloticus* (Linnaeus, 1762) is widespread in central, eastern and western Africa. It occurs commonly in all the major river basins including Nile, Niger, Senegal, Volta, Tana and in Lakes such as Chad, Albert, Turkana, and brackish Lake Mariot (Greenwood, 1966; Loubens, 1974; Paugy et al., 2003). The species is found almost everywhere in West Africa, except in Gambia (Paugy et al., 2003). It had been introduced in Lakes Kyoga, Nabugabo, Victoria, Congo, Cuba, Morocco, Texas (Fryer, 1960; Anderson, 1961; Hamblyn, 1962; Gee 1964; Okemwa, 1984; Welcomme, 1988; Pringle, 2005). Wherever the species is introduced, it has become invasive. According to Satia and Bartley (1998), Schofield and Chapman (1999), the explosion of the Victorian population of the Nile perch in the 1980s closely coincided both with a fivefold increase in the economic value of the fishery and with a halving of the lake's 500-species haplochromine cichlid flock. It is an ecological disaster (Achieng, 1990; Satia and Bartley, 1998; Bwanika, 2006) that initiated several studies to be conducted on *L. niloticus*.

This species is reported from Benin and is found in the Ouémé (Lalèyè et al., 2004), Niger (Moritz et al., 2006), Mono and the Pendjari River basins where very little is known about its biology and natural populations. This paper provides some information on length, weight, size frequency distributions, length-length and length-weight relationships parameters and condition factor of the species from the Pendjari River.

MATERIALS AND METHODS

Study area

The Pendjari River is located in West Africa (Figure 1) and has a total length of 380 km. It is the easternmost tributary of the Volta basin. It has its source in the Atacora hills in Benin between Tanguiéta and Natitingou (10°24 N, 1°21 E). It forms a curl oriented SSW-NNE, E-W, NE-SW and constitutes the border between Benin (Pendjari National Park) and Burkina Faso (Arli National Park) for a length of 150 km. It then flows through Togo, bearing the name Oti, and finally discharges into the Lake Volta in Ghana. It runs through the National Park of Pendjari (2660.4 km^2), the Pendjari hunting zone (1750 km^2) and the hunting zone of Konkombri (251 km^2) (Delving et al., 1989). The river has some small streams (Magou, Bori, Yapiti, Podiega) as tributaries. All the tributaries are temporary, only flowing during the rainy season, drying up in November.

The river is located in the Sudanian zone with one rainy season (Djossa et al., 2008). The rainfall ranges from 750 mm to 1100 mm per year with 60% falling between July and September (Sinsin et al., 2002). These climatic conditions marked the hydrological seasonality in the Pendjari River leading to the definition of three main hydrological seasons. Thus, its flow is strong during the rainy season (June to October), low or even zero in the first half of the dry season (November-January) and it dries up in places in the second half of the dry season (February-April). The river has a pure tropical regime.

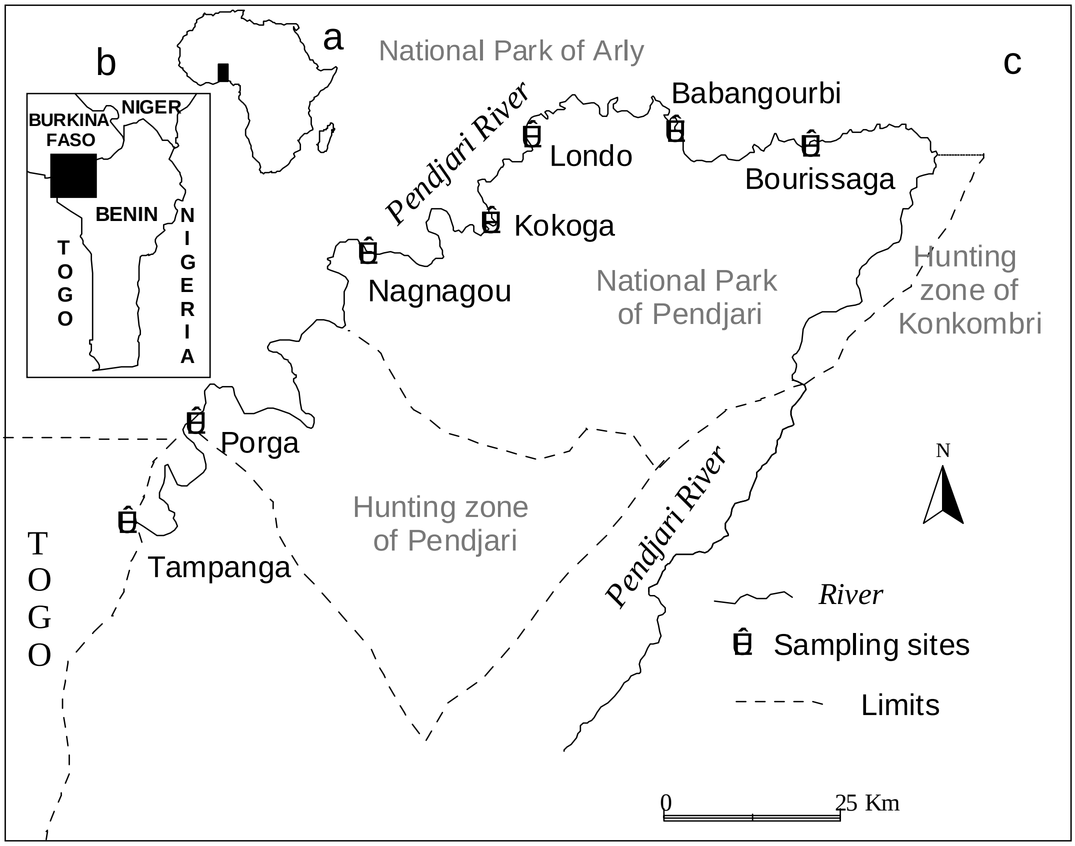

Figure 1: Study area, a- in Africa (■), b- between Benin - Burkina Faso - Togo (■), c- Sampling sites (★).

Data sampling and analysis

The data collection was based on artisanal fishing (gill nets and seine nets) examined at two jetties (Tampanga, 10°54 N 0°54 E; Porga, 11°03 N 0°58 E) outside the parks and 5 jetties (Nagnagou, 11°17 N 1°16 E; Kokoga, 11°24 N 1°23 E; Londo, 11°24 N 1°54 E; Babangourbi 11°24 N 1°35 E and Bourissaga 11°25 N 1°45 E) inside the parks (Figure 1) for 12 months (February 2006-January 2007).

Fishes were measured for total length (horizontal distance from tip of snout to hinge tip of caudal fin) and for standard length (horizontal distance from tip of snout to base or articulation of caudal fin) to the nearest 0.1 cm, the total weight was measured to the nearest 0.1 g. Some environmental factors were also investigated to determine the influence on fish growth and its condition**.** Thus, monthly, the depth of the river was measured and rainfall/river hydrology data for the period were considered.

The weight-length relationships established in the form $W = aTL^b$ (Le Cren, 1951) was fitted by linear regression with a, the regression constant; b, the regression coefficient. TL = total length (cm) and W = body weight (g). The value of *b* gives the information on the kind of growth of fish: the growth is isometric if b = 3 and the growth is allometric if b≠3 (negative if b<3 and positive if b>3). Standard length (SL) and total length (TL) were used to establish the relationships TL vs SL by linear regression. The condition factor K was calculated according to Tesch (1971). $K = \frac{100 \times W}{TL^{b}}$.

ANOVA has been used to compare b to 3 and to test the significance of all regressions. All the analyses were performed using the StatView Software (Version, 1992 SAS Institute INC).

RESULTS

Morphometric characteristics

The total length (TL) of *L. niloticus* specimen collected from the Pendjari River ranged from 12.6 to 176.4 cm with corresponding standard length (SL) of 9.6 to 150.1 cm and weight (W) ranged from 7.1 to 92200 g. The weight of largest specimen recorded by fishermen for the study period was 120 kg. The length frequency distributions of the population of the species (without the unusual big specimen, TL more than 100 cm) obtained were shown in figure 2. The distribution was unimodal with a modal class interval of 20.0 - 22.5 cm.

Length-length relationships

The total length-standard length relationships for *L. niloticus* from the Pendjari River were highly significant (p<0.0001). The regression equation was TL = 1.4235 + 1.1674SL (r^2 = 0.99, N = 781, Figure 3).

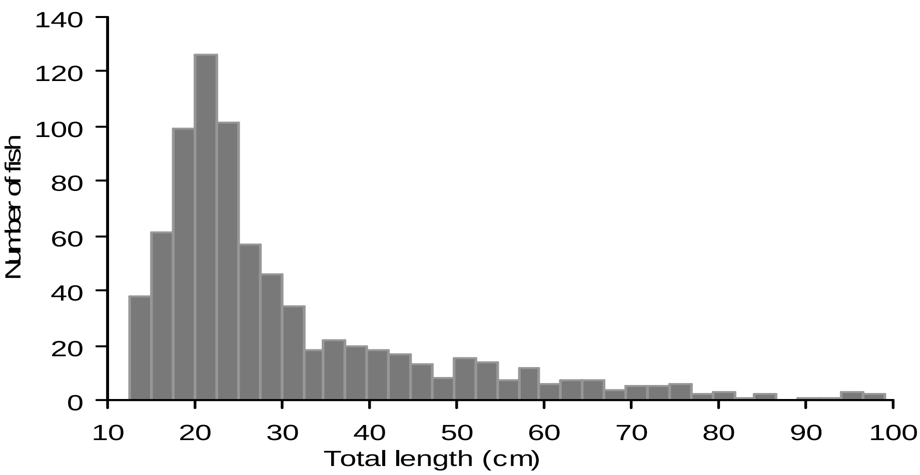

Figure 2: Length frequency distributions of *L. niloticus* from the Pendjari River (February, 2006 - January, 2007), N = 781.

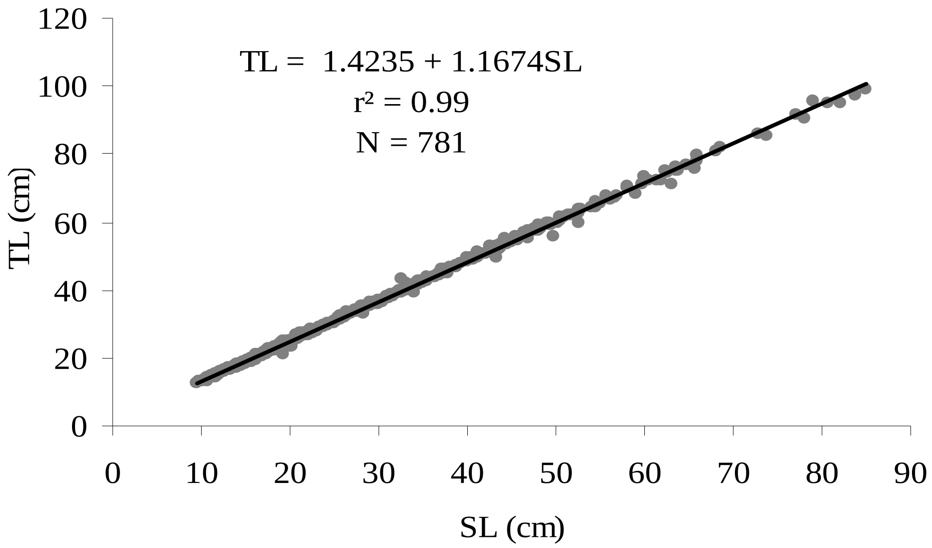

Figure 3: Length-Length relationships for *L. niloticus* between 10 cm and 100 cm from the Pendjari River (February, 2006 - January, 2007). TL = total length, LS = standard length, N = number of fish.

Length-weight relationships

The total length-weight relationships ($W = aTL^b$, Figure 4) for *L. niloticus* from the Pendjari River were highly significant ($p<0.0001$). The months, the sample size (n), the coefficient of determination (r^2), the estimated parameters a and b, the confidence interval (CI) of b and the growth type are presented in Table 1. According to the confidence intervals (95%), the slope (b values) of the length-weight relationships of the population was significantly higher than 3 ($p<0.05$). The b values vary between 2.717 and 3.545 during the year (Table 1). The growth pattern varies gradually from the positive allometric (b>3, January to June, Low water) to the negative allometric (b<3, October to November, high water). The isometric values of b (b=3) is obtained in July, August, September and December.

Condition factor

The condition factor K values are presented in Table 1. The values of K range from 0.43 to 2.44 (average: 1.136±0.490). The figures 5 and 6 illustrate its variation by size classes and synchronisation with the river water level. The highest means of K are recorded during the flood season on the one hand and with the smaller sizes on the other hand. The values decreased progressively when the size increased.

DISCUSSION

Lates niloticus is a large-growing predator (Witte et al., 2000). It grows to very large sizes (up to two metres; Pringle, 2005). The weight of the largest specimen from the Pendjari River recorded by fishermen for the study period was 120 kg corresponding to about 187.8 cm (extrapolated TL). From many lakes and rivers, the high sizes were recorded (Table 2). But, precisely from Lake Victoria, specimens of 190 cm and 200 cm TL have been registered by Acere (1985) and Okemwa (1984) respectively.

The length frequency distributions showed that the individuals larger than 20.0 - 22.5 cm (modal class) were more abundant (71.06%).

Although many studies provide length - weight relationships, few present factors of conversion allow calculating total or standard length from one of them. In the present study, length–length relationships permits firstly to determine conversion factors for “total length–standard length” of *L. niloticus* of Pendjari River and secondly to serve as base of comparison for those studies based on total or standard lengths.

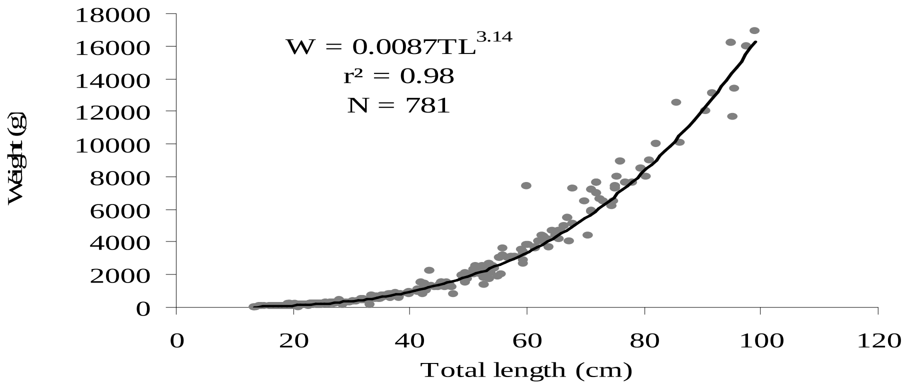

Figure 4: Length-Weight relationships of *L. niloticus* between 10 cm and 100 cm TL from the Pendjari River. W = weight, TL = total length, r^2 = coefficient of determination, N = number of fish.

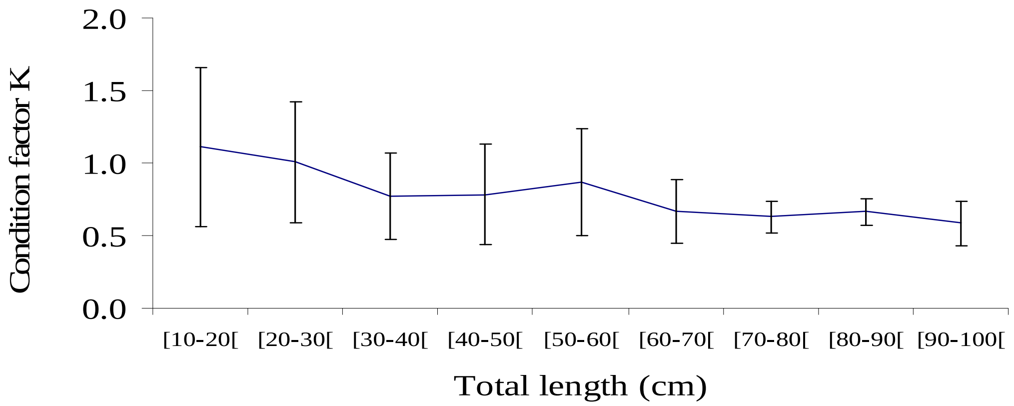

Figure 5: Mean condition factor (K) in relation to the size of *L. niloticus* from the Pendjari River (February, 2006 - January, 2007). Vertical bars indicate 95% confidence intervals.

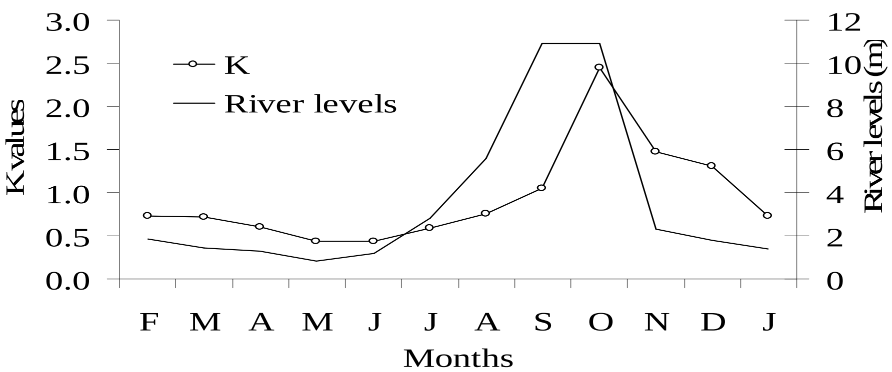

Figure 6: Monthly variation of K in *L. niloticus* and water level in the Pendjari River.

Table 1: Length-weight relationships parameters and condition factor (K) in *L. niloticus* of the Pendjari River.

Months	N	r^2	a	b (CI)	Growth type	k
February	41	0.98	0.007	3.20 (3.019 - 3.384)	Allometric positive	0.730 ± 0.185
March	60	0.98	0.007	3.19 (3.106 - 3.279)	Allometric positive	0.717 ± 0.147
April	53	0.98	0.006	3.25 (3.187 - 3.304)	Allometric positive	0.607 ± 0.058
May	22	0.98	0.004	3.31 (3.194 - 3.416)	Allometric positive	0.440 ± 0.063
June	11	0.98	0.004	3.31 (3.065 - 3.545)	Allometric positive	0.430 ± 0.068
July	10	0.92	0.017	2.94 (2.835 - 3.240)	Isometric	0.595 ± 0.139
August	19	0.98	0.008	3.11 (2.990 - 3.225)	Isometric	0.757 ± 0.056
September	11	0.98	0.010	3.04 (2.962 - 3.126)	Isometric	1.056 ± 0.035
October	41	0.98	0.025	2.83 (2.717 - 2.937)	Allometric negative	2.443 ± 0.157
November	141	0.96	0.028	2.95 (2.831 - 3.040)	Allometric negative	1.469 ± 0.461
December	350	0.88	0.013	3.03 (2.866 - 3.203)	Isometric	1.305 ± 0.366
January	22	0.98	0.007	3.20 (3.137 - 3.264)	Allometric positive	0.725 ± 0.154
Overall	781	0.98	0.008	3.14 (3.110 - 3.190)	Allometric positive	1.136 ± 0.490

Values in parenthesis (CI) are lower and upper 95% confidence intervals for regression coefficients of b. N = sample size, r^2 = coefficient of determination, a and b = estimated parameters of the length-weight relationships.

The body weight is closely proportional to the total length ($p<0.0001$) for *L. niloticus* from the Pendjari River. The slope of the length-weight relationships from this study and from other works had been reported in table 2. Globally, the growth is in favour of the body weight ($b>3$) or the growth is isometric ($b = 3$). When the monthly data were considered (Table 1), b value indicated an isometric growth during the onset and the end of the flood season, a negative allometric growth during the flood season (rainy season) and a positive allometric growth during the dry season. These observations suggested that the growth pattern of the Nile perch species is synchronised with the Pendjari River hydrology. Thus the positive allometric growth occurred with low water level and the negative allometric growth with high water level.

According to Arslan et al. (2004), the b value in the length-weight relationship of fish can be used as an indicator of food intake and growth pattern, and may differ according to biotic and abiotic factors, food availability and habitat type. The Nile perch, a piscivorous fish (Pringle, 2005; Bwanika et al., 2006) must hunt actively for prey. With the high water season, synonymous with the overflow and therefore the migration and dispersion of fishes in the vegetation, the food (prey) for this species becomes relatively less available. In contrast to this situation, during the low water season, the river is reduced in the small water volume of, therefore there is a high concentration of fish, and a high availability of preys for the fishes. Then, it is normal that the growth is in favour of weight during the lower water season ($b>3$) and in favour of the length during the flood ($b<3$). Similar

Table 2: Comparison of length-weight relationships parameters in *L. niloticus* obtained by several authors.

Lakes/Rivers	Countries	Years	Sample size	Length (cm), type	a	b	Sources
Lake Chad	Tchad	1965 - 72	1874	6.0 - 164.0, TL	0.0125	3.00	Loubens (1974)
Lake Victoria	Kenya			15.0 - 170.0, TL	0.0078	3.12	Asila and Ogari (1987)
Lake Albert	Uganda	1989 – 92	645	20.0 - 100.0, TL	0.0087	3.10	Ogutu-Ohwayo (1999)
Lake Victoria		1964 – 67	2938	20.0 - 100.0, TL	0.0051	3.26	Ogutu-Ohwayo (1999)
Lake Victoria		1968 – 77	419	20.0 - 100.0, TL	0.0062	3.22	Ogutu-Ohwayo (1999)
Lake Victoria		1982	658	20.0 - 100.0, TL	0.0035	3.34	Ogutu-Ohwayo (1999)
Lake Victoria		1988 – 92	2876	20.0 - 100.0, TL	0.0079	3.12	Ogutu-Ohwayo (1999)
Lake Nabugabo	Uganda	1991 – 93	602	20.0 - 100.0, TL	0.0076	3.12	Ogutu-Ohwayo (1999)
Lake Kyoga	Uganda	1967 – 68	272	20.0 - 100.0, TL	0.0059	3.15	Ogutu-Ohwayo (1999)
Lake Kyoga	Uganda	1978 – 80	1288	20.0 - 100.0, TL	0.0098	3.05	Ogutu-Ohwayo (1999)
Lake Kyoga	Uganda	1988 – 90	1807	20.0 - 100.0, TL	0.0115	3.01	Ogutu-Ohwayo (1999)
Lake Kyoga	Uganda	1991 – 93	2081	20.0 - 100.0, TL	0.0104	3.03	Ogutu-Ohwayo (1999)
Lake Victoria	Uganda		1488	8.0 - 96.0, TL	0.0095	3.09	Acere and Pauly (1988)
Lake Victoria	Uganda		960	12.0 - 185.0, TL	0.0082	3.12	Acere and Pauly 1988)
Lake Turkana	Kenya			6.0 - 190.0, TL	0.0071	3.13	Hughes (1992)
Lake Victoria,	Tanzania	1988 - 90	2014	12.6 - 153.0, TL	0.0066	3.16	Witte and Winter (1995)
Comoé River	Burkina Faso	2005 - 06	195		0.0289	2.88	Kuela (2002)
Kainji Lake	Nigeria	1995 - 97	833	13.0 - 52.0, TL	0.0153	2.94	du Feu (2003)
Upper Volta Rivers	Burkina Faso	1980 - 81	38	12.0 -128.0, SL	0.0239	3.00	Coulibaly (2003)
Ouémé River	Benin	1999 - 01	60	6,4.0 - 29.3, TL	0.0127	2.98	Lalèyè (2006)
Pendjari River	Benin + Burkina Faso	2006 - 07	781	12.6 - 176.4, TL	0.008	3.14	Present study

observations were made by Araya et al. (2008). The authors explained that, during the spring, the reduction of the availability of small fishes (preys) can be related to low growth. There are interactions between biotic and abiotic factors in the physiological condition of fishes. These interactions can also be reflected by the condition factor index (Lizama and Ambrósio, 2002). The condition factor of *L. niloticus* from the Pendjari River showed monthly variations (Table 1) and depends on the length of the fish (Figure 5). The condition factor index fluctuates; but a general decreasing trend has been observed with the increasing in size. This tendency was superficially observed at the Lake Victoria (Uganda) with the species in 2004-2005 (NARO-FIRRI, 2005). Seasonal fluctuations in the condition factor have also been observed. From the Pendjari River, the high value of this index coincided with the highest level of the river (Figure 6).

Conclusion

In conclusion, *Lates niloticus* has a negative allometric growth during the rainy season, a positive allometric growth during the dry season and an isometric growth during the onset and the end of the flood. The condition factor index is synchronised with the river water level. Thus, the growth pattern and the condition factor index of the species are quite influenced by the Pendjari River hydrology.

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REFERENCES

Acere TO, Pauly D. 1988. Preliminary report: artisanal fisheries resources study. Project No. 5100.36.47.025, Uganda, UFFRO/ ICLARM, 16 p.

Achieng AP. 1990. The impact of the introduction of Nile perch, *Lates niloticus* (L.) on the fisheries of Lake Victoria. *J. Fish Biol*., **37**: 17-23.

Anderson AM. 1961. Further observations concerning the proposed introduction of Nile perch into Lake Victoria . *E. Afr. Agric. J.*, **26**: 195-201.

Araya PR, Agostinho AA, Bechara JA. 2008. Population structure, growth and fishery yield of *Leporinus acutidens* (Valenciennes, 1837) (Teleostei: Anostomidae) in Yacyretá Reservoir (Argentina). *Neotrop. Ichthyol.*, **6**(1): 57-66.

Arslan M, Yıldırım A, Bekta S. 2004. Length-Weight Relationship of Brown Trout, *Salmo trutta* L., Inhabiting Kan Stream, Çoruh Basin, North-Eastern Turkey. *Turkish J. Fisheries and Aquat. Sci.,* **4**: 45-48.

Asila AA, Ogari J. 1987. Growth parameters and mortality rates of Nile perch (*Lates niloticus*) estimated from length-frequency data in the Nyanza Gulf (Lake Victoria). In *Contributions to Tropical Fisheries Biology*, Venema S, Moller-Christensen J, Pauly D (eds). *FAO Fish Rep.*, **389**: 272-287.

Bwanika GN, Chapman LJ, Kizito Y, Balirwa J. 2006. Cascading effects of introduced Nile perch (*Lates niloticus*) on the foraging ecology of Nile tilapia (*Oreochromis niloticus*). *Ecol. Freshwater Fish*., **15**: 470-481.

Coulibaly ND. 2003. Relation taille-poids de 11 espèces de poisons du Burkina Faso. In *Fish Biology: Local Studies as Basis for Global Inferences*, Palomares MLD, Samb B, Diouf T, Vakily JM, Pauly D (eds). ACP-UE Fisheries Research Report n°14: Bruxelles; 20-22.

Delving W, Heymans JC, Sinsin B. 1989. *Guide du Parc National de la Pendjari*. Communauté Economique Européenne (CEE): Bruxelles.

Djossa BA, Fahr J, Wiegand T, Ayihouénou BE, Kalko EK, Sinsin BA. 2008. Land use impact on *Vitellaria paradoxa* C.F. Gaerten. Stand structure and distribution patterns: a comparison of Biosphere Reserve of Pendjari in Atacora district in Benin. *Agroforest. Syst.*, **72**: 205-220.

Du Feu TA. 2003. Population parameters for the six commercial species in Lake Kainji, Nigeria using length frequency data sampled from artisanal fish catches. In *Fish Biology: Local Studies as Basis for Global Inferences*, Palomares MLD, Samb B, Diouf T, Vakily JM, Pauly D (eds). ACP-UE Fisheries Research Report n°14: Bruxelles; 31-45.

Fryer G. 1960. Concerning the proposed introduction of Nile Perch into Lake Victoria. *E. Afr. Agric. For. J.,* **25**(4): 267-270.

Gee JM. 1964. Nile perch investigations. EAFFRO Annual Report 1964, 13–17.

Greenwood PH. 1966. *The Fishes of Uganda* (2nd edn). The Uganda Society: Kampala.

Hamblyn EL. 1962. Nile perch investigation. In Annual Report 1961, East African Freshwater Fisheries Research Organisation, Jinja, 23-28.

Hughes NF. 1992. Growth and reproduction of the Nile perch, *Lates niloticus*, an introduced predator, Nyanza Gulf, Lake Victoria, East Africa. *Environ. Biol. Fish.,* **33**:299-305.

Lalèyè Ph, Chikou A, Philippart JC, Teugels G, Vandewalle P. 2004. Etude de la diversité ichtyologique du bassin du fleuve Ouémé au Bénin (Afrique de l'Ouest). *Cybium*, **28**: 329-339.

Lalèyè P. 2006. Length-weight and length-length relationships of fishes from the Ouémé River in Bénin (West Africa). *J. Appl. Ichthyol*., **22**: 330-333.

Le Cren ED. 1951. The length weight relationship and season cycle in gonad weight and condition in Perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20**: 179-219.

Loubens G. 1974. Quelques aspects de la biologie de *Lates niloticus* du Tchad. *Cah. ORSTOM, sér. Hydrobiol.*, **8**(1): 3-21.

Moritz T, Lalèyè P, Koba G, Linsenmair E. 2006. An annoted list of fishes from the River Niger at Malanville, Benin, with notes on the local fisheries. *Verhanlungen der Gesellshaft für Ichthyol. Band*, **4**: 95-110.

NARO-FIRRI (National Agricultural Research Organisation - Fisheries Resources Research Institute). 2005. Annual Report 2004-05, 35p.

Ogutu-Ohwayo R. 1999. Deterioration in length–weight relationships of Nile perch, *Lates niloticus* L. in lakes Victoria, Kyoga and Nabugabo. *Hydrobiologia*, **403**: 81–86.

Okemwa EN. 1984. Potential fishery of Nile perch *Lates niloticus* Linne (Pisces: Centropomidae) in Nyanza Gulf of Lake Victoria, East Africa. *Hydrobiologia*, **108**: 121-126.

Paugy D, Lévêque C, Teugels GG. 2003. *Faune des Poissons d'Eaux Douces et Saumâtres de l'Afrique de l'Ouest*. IRD: Paris, France.

Pringle RM. 2005. The Nile perch in Lake Victoria: local responses and adaptations. *Africa*, **75**(4): 2005.

Satia BP, Bartley DM. 1998. The paradox of international introductions of aquatic organisms in Africa. In *Genetics and Aquaculture in Africa*, Agnèse J-F (ed). ORSTOM: Paris; 115-124.

Schofield PJ, Chapman LJ. 1999. Interactions between Nile perch, *Lates niloticus*, and other fishes in Lake Nabugabo, Uganda. *Envir. Biol. Fishes*, **55**: 343-358.

Sinsin B, Téhou AC, Daouda I, Saïdou A. 2002. Abundance and species richness of larger mammals in Pendjari National Park in Benin. *Mammalia*, **66**(3): 369-380.

Tesch FW. 1971. Age and growth. In *Methods for Assessment of Fish Production in Freshwaters*, Ricker WE (ed). IBP Handbook 3, Blackwell: Oxford; 98-130.

Welcomme RL. 1988. International introductions of inland aquatic species. *FAO Fisheries Tech. Paper*, **294**: 1-318.

Witte F, Msuku BS, Wanink JH, Seehausen O, Katunzi EFB, Goudswaard PC, Goldschmidt T. 2000. Recovery of cichlid species in Lake Victoria: an examination of factors leading to differential extinction. *Reviews in Fish Biol. and Fisheries*, **10**: 233-241.

Witte F, De Winter W. 1995. Appendix II. Biology of the major fish species of Lake Victoria.. In *Fish Stocks and fisheries of Lake Victoria*, Witte F, Van Densen WLT (eds). Samara Publishing Limited: Dyfed, Great Britain; 301-320.