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RESEARCH ARTICLE

Length-weight relationships of some fish species from the Bandiala River in Saloum Delta, Senegal

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Abstract

This study describes the length-weight relationships (LWRs) of some fish species of ecological and economic importance found in Saloum Delta area, Senegal (October - December 2014). Specimens were caught with gillnets with one mesh size (36). They were sorted to the lowest taxonomy level and identified using identification manuals. The morphometric data such as fish's total length (TL) was determined using measuring board and measuring total weight (TW) from a digital balance to an accuracy of 0.01 g. The growth coefficients of the LWRs were determined using Microsoft office Excel software. The fish assemblages consisted of 3684 individuals belonging to 15 families, 22 genera and 31 species of freshwater and marine origins. The fish size varied between 9.7 cm TL in *Gerres nigri* and 67.3 cm TL in *Strongylura senegalensis* and the weight ranged from 10.9 g TW for *Gerres nigri* to 578.3 g TW for *Ephippion guttifer*. The allometric coefficient b ranged from 1.23 (*Trachurus trecae*) to 3.60 (*Pseudotolithus typus*). The thirty (30) species exhibited allometric ($b < 3 < b$) and one (1) isometric ($b = 3$) growth patterns. These values of "b" shows that most of the fishes collected from the Saloum Delta area displayed negative allometric growth pattern. The results further indicated that LWRs were highly correlated ($r^2 > 0.92$; $p = 0.001$). There were variations in the species morphometry. This information provides important tool in fishery management and modeling of aquatic ecosystem.

INTRODUCTION

Senegal is located at the edge of two of the most productive fishing zones in the world, the Canary Current Large Marine Ecosystem and the Gulf of Guinea Large Marine Ecosystem, between 14°40'N and 17°25'W. This, along with a strong seasonal upwelling and a relatively wide continental shelf of 23,800 km^2, has made Senegal one of the countries with the largest fisheries in West Africa, and consequently in the world (Goffinet, 1992; Ganapathiraju and Pitcher, 2006). Fisheries gained a key role in Senegal in rebalancing the economy after the decline of groundnut and phosphate exports since the 1970s (Ganapathiraju and Pitcher, 2006). The sector now uses approximately 20,000 pirogues, i.e., large wooden canoes (Fontana and Weber, 1982) and 100 large-scale industrial fishing vessels, employs over 600,000 people (about one-fifth of the working population of Senegal) and provides over 75% of animal protein intake of the local population (York and Gossard, 2004). With 36 kg yr^{-1}, Senegal has the second highest per capita fish consumption in Africa (York and Gossard, 2004). The motorization of the small-scale artisanal sub-sector, then controlled issuance of fishing licenses, expanding market and fishing subsidies at first contributed to raising fish catches and trade (Lenselink, 2002). However, these factors now combine to intensify the decline of Senegalese fisheries (Dahou et al., 2001). Over-expansion in fisheries capacity resulted in the over-exploitation of many fish stocks in Senegal and drove some high-value species, such as groupers to commercial extinction (Thiao et al., 2012). The Saloum Delta is at the northern side of the Western Africa Coastal Rivers landscape.

Length and weight data are useful standard results of fish sampling programs (Morato et al., 2001). In fish, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than age-dependent. Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics (Erzini, 1994). Length-weight relationship (LWR) is an important tool in fishery management; its importance is pronounced in estimating the average weight at a given length of a fish. Length weight regressions have been used frequently to estimate weight from length because direct weight measurements can be time consuming in the field (Sinovcic et al., 2004). One of the most commonly used analyses of fisheries data is length-weight relationship (Mendes et al., 2004). LWRs explain mathematically the correlation between fish length and weight and are useful for converting length observations into weight estimates to provide some measure of biomass (Froese, 1998). In fish studies, the length of a fish is often more rapidly and easily measured than is its mass, therefore it is opportune to be able to determine mass where only the length is known (Harrison, 2001). The morphometric relationships between fish length and weight can be used to assess the well being of individuals and to determine possible differences between separate stocks of the same species (King, 1996). LWR is important in fisheries management for comparative growth studies (Mendes et al., 2004; Moutopoulos and Stergiou, 2002); it provides valuable information on the aquatic habitat (Pauly, 1993) and in aquatic ecosystem modeling (Kulbicki et al., 2006). It is often used as an indication of fatness and general well being (Le Cren, 1951), in gonad development of fish (Wootton, 1998) and in the estimation of standing stock biomass and comparing the ontogeny of fish population from different regions (Petrakis and Stergiou, 1995). According to Froese (2006), the length-weight relationship is an important indicator in fishery management and conservation. It is very useful for fisheries research because it: (i) allows conversion of growth-in-length equations to growth-in-weight for use in stock assessment models, (ii) allows the estimation of biomass from length observations, (iii) allows an estimate of the condition of the fish, and (iv) is useful for between-region comparisons of life histories of certain species (Froese and Pauly, 1998; Moutopoulos and Stergiou, 2002).

To the best of the knowledge, there is no previous information on LWRs of these species from the Saloum Delta in Senegal, except a brief studies by Ecoutin and Albaret (2003).

Subsequently, the aim of the present paper was to carry out the first complete and comprehensive description of the LWR of these species from the Saloum Delta.

Materials and methods

Study area

The Saloum Delta (13°35' and 14°10'N, 16°50' and 17°00'W) is located on the coast of Senegal about 100 km south of Dakar (Fig. 1). The Saloum Delta covers an area of about 180,000 ha that integrates several types of wetlands (Schepers et al., 1998). The watershed which hosts the Sine-Saloum estuary covers an area of about 80,000 ha. The river system is made up of three main tributaries: the Saloum (110 km long) in the north and north-east, the Bandiala (18 km) in the south and south-east and the Diomboss (30 km) between the two. The delta was formed by the confluence of the three rivers flowing south west into the Atlantic. Freshwater inflows are recorded in the rainy season from July to September. Freshwater inflows do not compensate for the intense evaporation. As a result, the salinity is higher than that of the sea water in all three estuaries. It can even reach and exceed 100‰ upstream of the Saloum late in the dry season (Le Reste, 1994). Nevertheless, these tributaries are surrounded by a network of very dense bolongs bordered by intertidal mudflats that are colonized by mangroves. The three hydrological systems Saloum, Diomboss and Bandiala are inter-connected by large channels of tide which create two groups of quite distinct islands; in north islands of Gandoul, the south the Bétenti islands. From the climatic point of view, the field "saloumien" (Moral, 1965 and 1966) prolongs the field Libero-Guinean (Leroux, 1983).

The river estuaries in the study area attract marine fish species for feeding and spawning and, as a consequence, the estuarine reaches of the rivers in this zone are rich in marine fish species of high economic importance. The upwelling process provides nutrients for fish and marine species.

Sampling and data analysis

This study was carried out on the Saloum Delta. Fish were captured by gillnets with one mesh size (36) during one period (October - December 2014). After fish were collected, this fish samples were temporarily placed in cooling box filled with ice and transported to the research laboratory. In the laboratory, fish were identified. The total length (TL) of each fish was taken from tip of snout to longest ray of caudal fin. Then, for each individual, standard length (SL) was measured from the snout to the end of vertebral column. Caudal fork length (CFL) measured from the tip of the snout to the end of the middle caudal fin rays. The TL, SL and CFL were measured in centimeters using a measuring board. Lastly, the total weight (TW) in grams was measured to the nearest 0.1 gram using electronic weighing balance.

The length-weight relationship of combined sex fish was estimated by using the expression: $TW = a.TL^b$, where TW = total weight (g), TL = total length (mm), a and b are the intercept and the slope of the regression line, respectively. The value of b gives information on the kind of growth of fish. Additionally, the statistical significance level of r^2 was estimated, and the b-value for each species was tested by t-test to verify if it was significantly different from the isometric ($b = 3$). The growth is isometric if $b = 3$ and the growth is allometric if $b \neq 3$ (negative allometric if $b < 3$ and positive allometric if $b > 3$). All the statistical analyses were considered at significance level of 5% ($p < 0.05$).

Results

A total of 3684 specimens of fish species were collected from the Saloum Delta during the present study. The estimated parameters and length characteristics of the length-weight relationship are given in Table 1. The families with the highest genres number were Mugilidae (n = 6), Carangidae (n = 6), Haemilidae (n = 3) and Belonidae (n = 3). The most abundant species in the catches were *Ethmalosa fimbriata* (n = 260), *Chloroscombrus chrysuris* (n = 258), *Liza falcipinnis* (n = 230), *Mugil cephalus* (n = 211), *Monodactylus sebae* (n = 210), *Gerres nigri* (n = 205) and *Caranx hippos* (n = 145). The fish assemblages of Saloum Delta comprised 3684 individuals from 15 families, 22 genera and 31 species. All species considered in this study were commercially important to residents of this region. The total length ranged from a minimum of 9.7 cm for *Gerres nigri* to a maximum of 67.3 cm for *Strongylura senegalensis* with mean of 20.1 cm and weight ranged from 10.9 g for *Gerres nigri* to 578.3 g for *Ephippion guttifer* with mean of 82.4 g.

In the present study, the values of the growth parameter b varied from the lowest (b = 1.23) for *Trachurus trecae* to the highest (b = 3.60) for *Pseudotolithus typus* in the Saloum Delta. The mean b-value for all species was 2.02. The coefficient of determination (r^2) ranged from 0.72 for *Liza grandisquamis* to 0.99 for *Lobotes surinamensis* with a median value of 0.92. All relationships were highly significant ($p < 0.05$) with r^2 values being greater than 0.72. Species exhibited both allometric ($b < 3$, $b > 3$) and isometric ($b = 3$) growth types. One of the studied specimens showed isometric growth (b = 3.0). The Student's t-test showed that the b (b = 3.01 - 3.60; p = 0.001, t-test) was significantly higher than the theoretical value of 3 indicating positive allometric growth for twenty eight species, while the Student t-test for *Trachinotus goreensis* and *Pseudotolithus typus* showed significant lower values (b = 1.23 - 2.98; p = 0.002, t-test) indicating negative allometric growth. However, *Lishia amia* exhibited isometric growth (b = 3; p = 0.07, t-test), with no significant difference from the theoretical value of 3. In simple words, *L. amia* increase in his length with the increasing weight in cubic form.

In the present study, overall growth parameter, r^2 values were positive and highly correlated with $r^2 > 0.60$ between fish total length and body weight measurements. All relationships were highly significant ($p < 0.05$) with $r^2 > 0.90$ in twenty four (24) different species and $r^2 = 0.72 - 0.89$ in seven (7). The least, $r^2 = 0.72$ was in exhibited by *Liza grandisquamis* and the highest value of $r^2 = 0.99$ by *Ephippion guttifer*, *Lobotes surinamensis*, *Pomadasys jubelini* and *Strongylura senegalensis*.

Discussion

The length-weight relationship in fish is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat (Petrakis and Stergiou, 1995), none of which is taken into consideration in the present study. This study covers the recent information on the length-weight relationship of 31 species living in the Saloum Delta of Senegal. The results obtained from this study are useful to fisheries scientist. Despite the small sample sizes and narrow size ranges for some species studied, these data represent an important background data for fisheries in the Senegalese coast. Furthermore, species studied in this paper included a wide range of body shapes and life history dynamics; this diversity in body size and shape is reflected in the estimated parameters. The sample size varied with fish species. The variation in fish sizes indicate that the fish population ranged from immature specimens to fully matured one. Several works have been carried out on estimation of length weight relationship in different fish species. The present study showed there were variations in length and weight data of fish from Saloum Delta. Captured fish varied in size between 9.7 cm TL in *Gerres nigri* and 67.3 cm TL in *Strongylura senegalensis*. The weight ranged from 10.9 g TW in *G. nigri* to 578.3 g TW for *Ephippion guttifer*. The fish assemblages were mainly populations of juvenile fish. The absence of fish below 9.7

cm total length may be associated with fish gear selectivity rather than implying the absence of small sized individuals.

The parameter b values of LWRs vary generally between 2.5 to 3.5 are more common (Froese, 2006). Normally, b is close to 3, indicating fish grow isometrically; values significantly different from 3.0 indicate allometric growth (Tesch, 1971). Growth is isometric when the length exponent equal to 3 and allometric when length exponent is less than or greater than 3. The value of b greater than three indicates that the fish become plump as they increase in length and b value lower than three shows that the fish more slimmer with increasing length (Jobling, 2002). There were many factors affecting the value of b throughout the fish life history. Froese (2006) stressed that the value of b can be used to compare the condition of fish at temporal and spatial level. The b value reflects the pattern of change in body form and condition with increase in size, but the value of b may also be affected by the size range catcher in the area during the sampling period (Kimmerer et al., 2005, Kulbicki et al., 2005, Froese 2006). Values of Length exponent in the length weight relationship of most of the fish studied increase in length faster than the weight. The growth parameter value of b = 1.23 (*Trachurus trecae*) is outside the limits of 2 to 4. For others species in this study, the values of b are inside the limits of 2 to 4.

The coefficient of determination (r^2) for length-weight relationships is high for all fish species ($r^2 = 0.72 - 0.99$) which indicates that the length increases with increase in weight of the fish. All these values are very near to unity. The high coefficient of determination r^2 obtained in this study showed that there was strong association between length and weight. It indicated very high positive correlation between total length and total weight in this species. This is in agreement with previous studies on different fish species from various water bodies: (Konan et al., 2007; Tah et al., 2012; Koffi et al., 2014).

This present study therefore highlights the length-weight relationships for eleven (31) fish species from Saloum Delta and it is the first documented report on biological aspects of any fish species from this water body. Report also serves as an additional research work to what had been reported by workers in the adjourning waters. It is a useful source of information in fisheries management, especially in fish sampling programs, to estimate growth rates, length structures and other components of fish population dynamics and fish stock assessment. Finally, it is important for assessment of well being of the individuals and possible differences between separate unit stocks of the fish.

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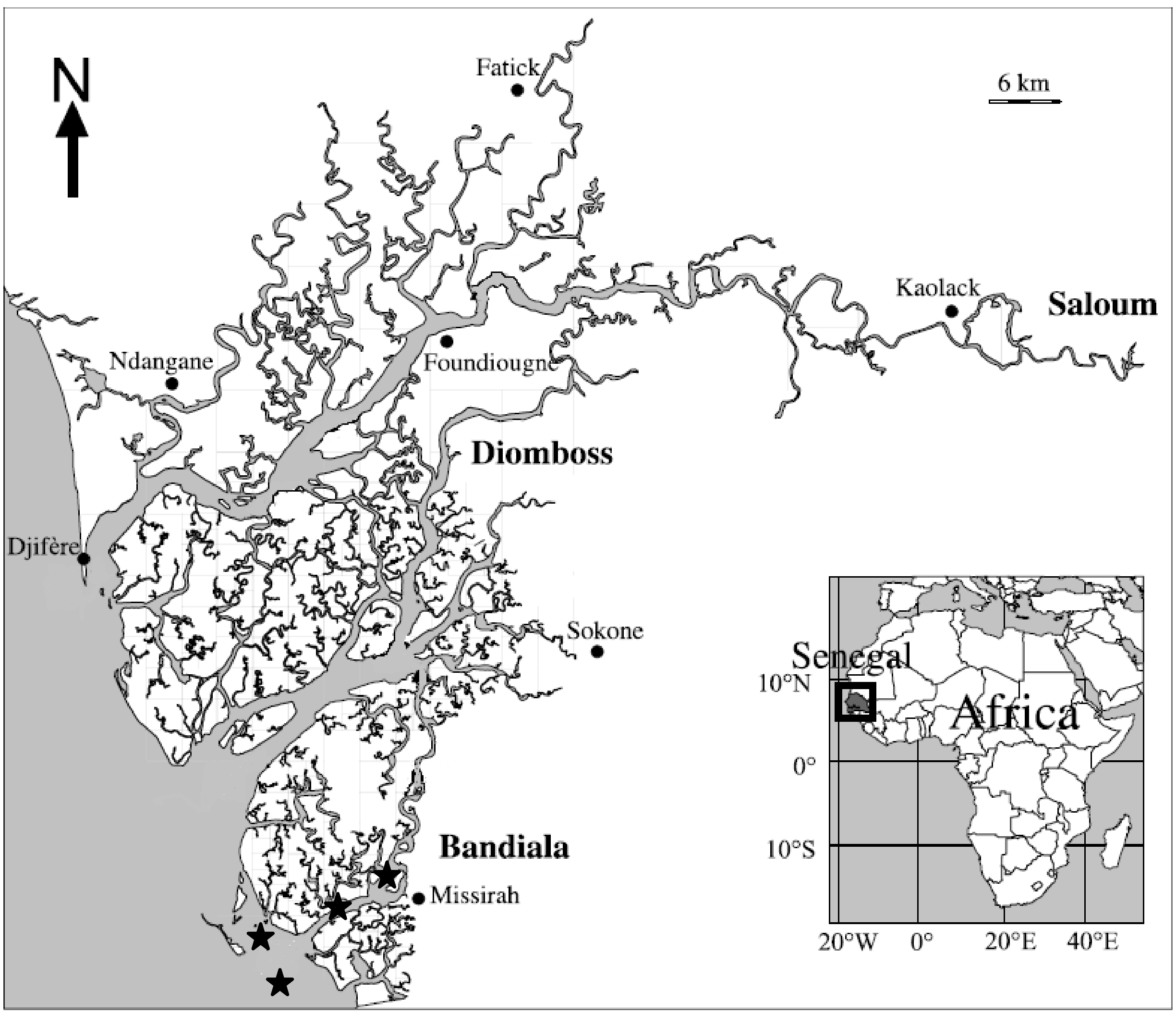
Table 1 Estimated parameters of length-weight relationship for some fish species from Saloum Delta (Senegal). N: sample size; TL: total length; TW: total weight; a: intercept; b: slope; r^2: determination coefficient; I: isometric growth; A^+: positive allometric growth; A^-: negative allometric growth.

Family	Species	N	TL range (cm)	TW range (g)	a	b	r^2	Growth
Mugilidae	*Liza dumerili*	201	18.3 - 23.7	49.2 - 101.0	0.040	2.45	0.89	A^-
	Liza falcipinnis	230	16.0 - 24.0	36.9 - 112.0	0.088	2.17	0.83	A^-
	Liza grandisquamis	118	15.0 - 29.9	20.1 - 140.8	0.094	2.19	0.72	A^-
	Mugil cephalus	211	19.0 - 24.0	54.7 - 118.0	0.016	2.76	0.78	A^-
	Mugil bananaensis	90	19.2 - 38.2	54.4 - 268.9	0.097	2.18	0.97	A^-
	Mugil curema	93	20.4 - 21.8	60.4 - 66.5	0.010	2.92	0.98	A^-
Clupeïdae	*Ethmalosa fimbriata*	260	12.1 - 28.2	19.6 - 546.8	0.014	2.87	0.83	A^-
Polynemidae	*Galeoides decadactylus*	140	12.9 - 18.0	23.1 - 52.0	0.034	2.51	0.91	A^-
Gerreidae	*Gerres nigri*	205	9.7 - 18.2	10.9 - 73.0	0.020	2.79	0.95	A^-
Monodactylidae	*Monodactylus sebae*	210	10.1 - 15.2	27.6 - 86.0	0.106	2.45	0.96	A^-
Haemulidae	*Pomadasys jubelini*	98	13.0 - 28.0	35.2 - 269.8	0.029	2.73	0.99	A^-
	Pomadasys peroteti	57	15.1 - 32.2	37.8 - 286.2	0.032	2.75	0.97	A^-
	Plectorhinchus macrolepis	16	16.0 - 31.5	42.5 - 295.4	0.030	2.83	0.96	A^-
Belonidae	*Strongylura senegalensis*	32	38.5 - 67.3	79.9 - 273.4	0.022	2.25	0.99	A^-
	Tylosurus acus	56	57.2 - 67.2	125.6 - 212.3	0.032	2.18	0.87	A^-
	Tylosurus crocodilus	101	54.5 - 58.1	135,6 - 202.3	0.025	2.32	0.92	A^-

Cynoglossidae	*Cynoglossus senegalensis*	82	24.0 - 37.2	66.0 - 217.4	0.007	2.84	0.98	A^-
Ariidae	*Arius latiscutatus*	130	20.5 - 28.4	52.4 - 72.6	0.025	2.54	0.92	A^-
	Arius heudelotii	104	18.5 - 26.0	48.3 - 70.4	0.023	2.65	0.81	A^-
Sciaenidae	*Pseudotolithus typus*	142	18.0 - 26.8	35.5 - 148.4	0.001	3.60	0.98	A^+
	Pseudotolithus senegalensis	78	18.5 - 28.0	52.1 - 166.2	0.015	2.79	0.98	A^-
Carangidae	*Chloroscombrus chrysurus*	258	11.5 - 23.7	13.3 - 98.9	0.012	2.84	0.97	A^-
	Caranx hippos	145	18.6 - 27.0	55.5 - 110.8	0.029	2.61	0.90	A^-
	Chloroscombrus typus	110	12.5 - 24.2	32.6 - 98.5	0.023	2.98	0.98	A^-
	Trachurus trecae	95	15.2 - 32.3	46.8 - 108.4	0.027	1.23	0.97	A^-
	Trachinotus goreensis	53	12.4 - 28.2	29.3 - 89.5	0.025	3.01	0.92	A^+
	Lichia amia	16	14.3 - 31.5	35.4 - 107.1	0.026	3.00	0.96	I
Tetraodontidae	*Ephippion guttifer*	58	13.5 - 30.5	51.5 - 578.3	0.025	2.92	0.99	A^-
Pristigasteridae	*Ilisha africana*	135	20.4 - 21.8	60.4 - 63.9	0.020	2.82	0.91	A^-
Cichlidae	*Sarotherodon galileus*	76	13.1 - 18.7	42.5 - 78.3	0.024	2.86	0.95	A^-
Lobotidae	*Lobotes surinamensis*	84	16.7 - 35.6	48.7 - 102.5	0.023	2.98	0.99	A^-

Fig. 1 Map of the study area showing the location of fishing sites (black stars)



References

Dahou, K., Déme, M. and Dioum, A. (2001): Socio-economic and environmental impact of Senegalese fishery support mechanisms. UNEP Fisheries Workshop, Geneva, p. 34.

Ecoutin, J.M. and Albaret, J.J. (2003): Relation longueur-poids pour 52 espèces de poissons des estuaires et lagunes de l'Afrique de l'Ouest. Cybium, 27(1): 3-9.

Erzini, K. (1994): An empirical study of variability in length at age of marine fishes. J. Appl. Ichthyol., 10: 17-41.

Ezekiel, M.O. (2013): Fecundity, food and feeding habits and growth pattern of *Galeoides decadactylus* in Nigeria coastal waters. Int. J. Nat. Sci. Res., 1(1): 1-13.

Fontana, A. and Weber, J. (1982): Aperçu de la situation de la pêche maritime sénégalaise. CRODT-ISRA, Dakar, p. 34.

Froese, R. (1998): Length-weight relationships for 18 less-studied Fish species. J. Appl. Ichthyol., 14: 117-118.

Froese, R. and Pauly, D. (1998): Concepts, design and data sources. ICLARM, Manila, Philippines, p. 324.

Froese, R. (2006): Cube law, condition factor a weight-length relationships: history, meta-analysis and recommendations. J. Appl. Ichthyol., 22: 241-253.

Ganapathiraju, P. and Pitcher, T.J. (2006): An estimation of compliance of the fisheries of Senegal with Article 7 (Fisheries Management) of the UN Code of Conduct for responsible fishing. In: Pitcher TJ, Kaliloski D, Ganapathiraju P (eds) Evaluations of compliance with FAO (UN) Code of Conduct for responsible fisheries. University of British Columbia, Vancouver, Canada. Fisheries Centre Research Reports, p. 78-79.

Goffinet, T. (1992): Development and fisheries management: the case of north-west Africa. Ocean & Coastal Management, 17 (2): 105-136.

Harrison, T.D. (2001): Length-weight relationships of fishes from South African estuaries. J. Appl. Ichthyol., 17: 46-48.

Jobling, M. (2002): Environmental factors and rates of development and growth. In: Hart PJB, Reynolds JD (eds) Handbook of Fish Biology and Fisheries. Blackwell Publishing, p. 107-109.

Kimmerer, W., Avent, S.R., Bollens, S.M., Feyrer, F., Grimaldo, L F., Moyle, P.B., Nobriga, M. and Visintainer, T. (2005): Variability in length–weight relationships used to estimate biomass of estuarine fish from survey data. Trans. Am. Fish. Soc., 134: 481–495.

King, R.P. (1996): Population dynamics of the mudskipper, *Periophthalmus barbarus* (Gobidae) in the estuarine swamps of Cross River Nigeria. J. Appl. Ichthyol., 11: 31-34.

Koffi, B.K., Berté, S. and Koné, T. (2014): Length-Weight Relationships of 30 Fish Species in Aby Lagoon, Southeastern Côte d'Ivoire. Curr. Res. J. Biol. Sci. (Sous presse).

Konan, A.K F., Ouattara, M., Ouattara, A. and Gourène, G. (2007): Weight-length relationship of 57 fish species of the coastal rivers in south-eastern of Ivory Coast. Ribarstvo, 65(2): 49-60.

Kulbicki, M., Guillermot, N. and Amand, M. (2005): A general approach to length-weight relationships for New Caledonian lagoon fishes. Cybium, 29: 235-252.

Le Cren, E.D. (1951): The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). J. Anim. Ecol., 20: 201-219.

Le Reste, L. (1994): Variations spatio-temporelles des prises et de la taille des crevettes *Penaeus notialis* dans l'estuaire sursalé du Saloum (Sénégal). Rev. Hydrobiol. Trop. 27: 129-142.

Lenselink, N.M. (2002): Participation in artisanal fisheries management for improved livelihoods in West Africa. A synthesis of interviews and cases from Mauritania, Senegal, Guinea and Ghana. FAO Fisheries Technical Paper. No. 432, Rome, p. 72.

Leroux, M. (1983): Le climat de l'Afrique tropicale, 351 illustrations + un atlas de 250 cartes. Edition Champion, Paris, p. 650.

Mendes, B., Fonseca, P. and Campos, A. (2004): Weight-length relationships for 46 fish species of the Portuguese west coast. J. Appl. Ichthyol., 20: 355-361.

Moral, P. (1965): Le climat du Sénégal: le schéma climatique; les saisons. Rev. Géo. Afr. Occident., 1(2): 44-70.

Moral, P. (1966). Le climat du Sénégal : les types de temps, les régions climatiques. Rev. Géo. Afr. Occident., 3: 3-25.

Morato, T., Afonso, P., Loirinho, P., Barreiros, J.P., Sanstos, R.S. and Nash, R.D.M. (2001): Length-weight relationships for 21 costal fish species of the Azores, North-eastern Atlantic. Fish. Res., 50: 297-302.

Moutopoulos, D.K. and Stergiou, K.I. (2002): Length-weight and length-length relationships of fish species from Aegean Sea (Greece). J. Appl. Ichthyol., 18: 200-203.

Pauly, D. (1993): Editorial, Fish byte section. Naga, ICLARM Quarterly, 16(2-3): 26-27.

Petrakis, G. and Stergiou, K.I. (1995): Weight length relationships for 33 fish species in Greek waters. Fish. Res., 21(3-4): 465-469.

Schepers, F.J., Keijl, G.O., Meininger, P.L. and Rigoulot, J.B. (1998): Oiseaux d'eau dans le Delta du Sine-Saloum et la Petite Côte, Sénégal. Groupe International de Recherches sur des Oiseaux d'Eau et des Zones Humides (Fondation WIWO). Direction Parcs Nationaux du Sénégal. WIWO-report 60. Zeis U Dakar.

Sinovcic, G., Franicevic, M., Zorica, B. and Ciles-Kec, V. (2004): Length-weight and length-length relationships for 10 pelagic fish species from the Adriatic Sea. (Crotia). J. Appl. Ichthyol., 20: 156-158.

Tah, L.G., Gooré Bi, G. and Dacosta, K.S. (2012): Length-weight relationships for 36 freshwater fish species from two tropical reservoirs: Ayamé I and Buyo, Côte d'Ivoire. Int. J. Trop. Biol. Cons., 60(4): 1847-1856.

Tesch, F.W. (1971): Age and growth. In W.E. Ricker (Ed.). Methods for Assessment of Fish production in Fresh Waters. Blackwell Scientific Publications, Oxford.

Thiao, D., Chaboud, C., Samba, A., Laloë, F. and Cury, P.M. (2012): Economic dimension of the collapse of the 'false cod' *Epinephelus aeneus* in a context of ineffective management of the small-scale fisheries in Senegal. Afr. J. Mar. Sci. 34 (3): 305-311.

Wootton, R.J. (1998): Ecology of Teleost fishes (2nd ed.). Springer Verlag, New York, USA.

York, R. and Gossard, M.H. (2004): Cross-national meat and fish consumption: exploring the effects of modernization and ecological context. Ecol. Econom., 48 (3): 293-302.