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Summary

Length-weight relationships ($W=aL^b$) were estimated for 5 fish species, the pearl stingray *Fontitrygon margaritella* (Compagno & Roberts, 1984), the West African spadefish *Chaetodipterus lippei* (Steindachner, 1895), the East Atlantic African spadefish *Ephippus goreensis* (Cuvier, 1831), the law croaker *Pseudotolithus senegallus* (Cuvier, 1830) and the Guinean sole *Dagetichthys cadenati* (Chabanaud, 1948). Fishes were collected during several scientific fishing surveys using purse seine (length 250 m, height 20 m, 14 mm mesh size) and beach seine (180 m length, 9 m height and 25 mm mesh net) conducted from April 1990 to October 2012 in the Sine Saloum estuary, Senegal. They were weighed to the nearest g and measured to the nearest mm (disc width for *Fontitrygon margaritella* and total length for the 4 other species). The values of parameter b in the LWR equations varied from 3.048 (*Chaetodipterus lippei*) to 3.274 (*Dagetichthys cadenati*) and the coefficient of determination (r^2) varied between 0.969 (*Fontitrygon margaritella*) and 0.998 (*Chaetodipterus lippei)*. In addition, new maximum lengths are proposed for *Fontitrygon margaritella*, *Chaetodipterus lippei* and *Dagetichthys cadenati*.

Key words: Length–weight relationships, fish species, Sine Saloum, estuary, Senegal
Running Head: Fish Length–weight relationships in Senegal

INTRODUCTION

Length–weight relationships (LWR) contribute together with the monitoring of several other essential parameters (e.g. sex ratio, age of first maturity, fecundity, recruitment, natural and fishing mortality, growth patterns, estimation of biomass, population dynamics) to the required stock assessment for proper population management (Le Cren, 1951; Hampton, 2000; Fromentin & Fonteneau, 2001; Froese, 2006). They help to describe a specific population, to compare fish species populations or fish life histories between seasons, years, zones and regions, provided all investigators use the same standardized sampling methodology (De La Cruz Agüero et al., 2011; Gonçalves et al., 1997; Moutopoulos & Stergiou, 2002). In this study, we assessed length-weight relationships for 5 fish species from the Sine Saloum estuary. This work complements those of Ecoutin and Albaret (2003) and Ndiaye et al. (2015) on LWR of fish species in the Saloum estuary.

MATERIALS AND METHODS

The Sine Saloum estuary is located 100 km south of Dakar, in Senegal, between 13°55' and 14°10' North and 16°03' and 16°50' West. The Sine Saloum is an inverse estuary characterized by an increase in salinity from downstream to upstream in all seasons. Mangrove forests cover almost the entire southern portion of the system and progressively diminish in the North (Diouf, 1996; Simier et al., 2004). Data were collected during two research programs covering the whole Sine Saloum estuary in 1990-1993 and then in 2002-2003 (Diouf, 1996; Ecoutin et al., 2010) and the biological monitoring of the Bamboung MPA and its surroundings from 2003 to 2012 (Ecoutin et al., 2014; Sadio et al., 2015). All the sampling was carried out over the three main hydro-climatic seasons of the region (Simier et al., 2004). 166 fishing hauls were made using a purse seine (length 250 m, height 20 m, 14 mm mesh size; see Simier et al., 2004) and 11 using a beach seine (180 m length, 9 m height and 25 mm mesh net; see Diouf, 1996). Fish were measured to the nearest mm (disc width for *Fontitrygon margaritella* and total length for the 4 other species) and weighed to the nearest g. All data are available in PPEAO database (Simier, Ecoutin, & Tito de Morais, 2019). Linear regressions of log(W) *vs*. log(L), where W is total weight in g and L is total length or disc width in cm, were calculated to obtain the length-weight relationship of the form $W = aL^b$, where a and *b* are regression parameters (Froese, 2006).

RESULTS

Five fish species belonging to 4 families were considered in this study. Sample size, length and weight ranges, parameters of the LWR equations with 95% confidence limits and values of the determination coefficient (r^2) were computed for the 5 fish species (Table 1). All regressions of LWRs were statistically significant ($p < 0.001$).

DISCUSSION

All the fishes in this study were collected over a long period of time, during several scientific surveys of the fish assemblages in the Sine Saloum estuary. The sampling protocols were designed to cover the entire hydroclimatic cycle and to explore various habitats, thus providing a spatial and temporal overview of estuarine fish assemblages. The five species

presented here are not however among the most frequent in these assemblages. Except *Fontitrygon margaritella* and *Pseudotolithus senegallus* which are an "estuarine species from marine origin" and a "marine-estuarine species" respectively, the 3 others are "marine species, occasionally or accidentally found in estuaries" (Albaret, 1999). Thus, for *Ephippus goreensis* the sample size is limited and the maximum length is only 20.8 cm (for a known maximum size of 30 cm) and for *Pseudotolithus senegallus* the maximum length is 101 cm (for a known maximum length of 230 cm). Consequently, the parameters estimated here, especially for these two species, should be considered as tentative. Despite these limitations, the coefficients of determination (r^2) were very high for the five species, indicating a good predictive power. All species had *b* value comprised between 2.5 and 3.5 as expected (Froese, 2006). Regression results suggest that the data from this study and the results presented here are reliable and can enriched length-weight relationships in FishBase (Froese & Pauly, 2020) for the Senegal.

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Data availability statement: Data are available at http://ppeao.ird.fr or upon request to ppeao@ird.fr

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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*Table 1. Descriptive statistics and estimated parameters of length-weight relationships ($W = aL^b$) for five species from the Sine Saloum estuary, Senegal, captured from 1990 to 2012. n, sample size; Max, maximum; Min, minimum; a and b, parameters of LWR; CL, confidence limits; r^2, coefficient of determination. Length = Total Length except for Fontitrygon margaritella (Disc Width). *, indicates that the LWR includes a new not yet reported maximum total length.*

Family	Species	n	Length (cm)	Weight (g)	Relationship parameters		
			Min – Max	Min – Max	a (95%CL)	b (95%CL)	r^2
Dasyatidae	*Fontitrygon margaritella* (Compagno & Roberts, 1984)*	139	10.7 – 47.0	54 – 5175	0.025 (0.018 – 0.033)	3.177 (3.081 – 3.274)	0.969
Ephippidae	*Chaetodipterus lippei* Steindachner, 1895*	73	4.4 – 32.3	3 – 1114	0.029 (0.027 – 0.033)	3.048 (3.013 – 3.082)	0.998
	Ephippus goreensis Cuvier, 1831	15	5.5 – 20.8	5 – 316	0.024 (0.017 – 0.032)	3.141 (3.014 – 3.269)	0.995
Sciaenidae	*Pseudotolithus senegallus* (Cuvier, 1830)	118	11.1 – 101.0	9 – 8250	0.006 (0.005 – 0.006)	3.079 (3.047 – 3.112)	0.997
Soleidae	*Dagetichthys cadenati* (Chabanaud, 1948)*	20	8.3 – 38.0	3 – 457	0.003 (0.002 – 0.005)	3.274 (3.054 – 3.494)	0.982