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Length–weight relationships for estuarine fishes in subtropical estuary

Barbara Maichak de Carvalho^{1*}, Renato Bot² and Henry Louis Spach²

¹Laboratório de Ecologia e Conservação, Centro Politécnico, Universidade Federal do Paraná, Av. Coronel Francisco Heráclito dos Santos, 100, 81531-970, Bairro Jardim das Américas, Curitiba, Paraná, Brazil. ²Programa de Pós-graduação em Ecologia e Conservação, Universidade Federal do Paraná, Curitiba, Paraná, Brazil. *Author for correspondence. E-mail: bmaicarvalho@gmail.com

ABSTRACT. The present study describes the length/weight ratio (LWR) of 20 fish species caught in an intertidal area of the Paranaguá Estuarine Complex, southern Brazil. Fish were caught with three beach seine nets, with 2m high, 70m long and distance between knots of 2.5; 4 and 5cm. A total of 880 individuals of 21 species belonging to 11 families were captured, ranging from 5 to 75.5cm in total length. All species analyzed are widely distributed throughout the Southwestern Atlantic. Positive allometric growth ($b > 3$) was predominant, occurring in 60% species, 35% presented negative allometry ($b < 3$) and only 5% had isometric growth ($b = 3$). Many factors could be influencing the distinct growth patterns observed between the literature and the present study, such as the environmental influences, the reduced number of specimens, the sampling methods, the sampling periods and the estimation of the LWR with grouped sexes.

Keywords: b coefficient; fish growth; LWR; Paranaguá Bay; subtropical estuary.

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Introduction

The length-to-weight ratio (LWR) is an important parameter that allows biomass estimates (Le Cren, 1951; Froese, 2006), assisting in the elaboration of stock and growth models (Haimovici & Velasco, 2000), enabling the identification of animal health state. (Possamai, Zanlorenzi, Machado, & Fávaro, 2019) and, through the allometric coefficient (b) of the LWR, verifying the type of fish growth (allometric/isometric; Carvalho, Barradas, Fontoura, & Spach, 2017). The allometric coefficient also allows to identify the influence of environmental parameters on the growth pattern of species with wide geographical distribution (Froese, 2006).

The present study showed the LWR of 21 species widely distributed on the southwest coast of the South Atlantic (Cervigón, 1993), which use the estuary for breeding and growth and are part of the bycatch in artisanal fisheries (Cattani, Santos, Spach, Budel, & Gondim Guanais, 2011; Santos, Cattani, & Spach, 2016). These species are also reported in the literature as prey for ichthyophagous species (Miotto, Carvalho, & Spach, 2017; Rupil, Barbosa, Marcondes, Carvalho, & Farro, 2019).

Material and methods

Fish were caught on an estuarine beach located near the mouth of the Paranaguá Estuarine Complex, State of Paraná, Brazil (25°28' – 25°36'S; 48°20' – 48°28'W, Figure 1). Paranaguá Estuarine Complex, due to its continuous cover of the Atlantic Forest, is considered a Natural Heritage of Humanity (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2019). However, it is an environment greatly impacted by the domestic sewage and the port terminals of the region (Barletta & Lima, 2019). It is located on the coast of the State of Paraná, occupying an area of 612 km², divided into two main axes, north-south (Laranjeira and Pinheiro Bay) and east-west (Paranaguá Bay) (Lana, Marone, Lopes, & Machado, 2001). This estuary is dominated by tidal, characterized as semi-diurnal tides with a salinity range between 0 and 33.2°C and a temperature range between 17 and 31°C (Dias et al., 2016).

Bimonthly samplings were performed between August 2015 and February 2016. For the capture were used beach seine nets, with 2 m high, 70 m long, and mesh sizes of 2.5 cm, 4 and 5 cm between opposite

knots, dragged by two people, parallel to the coast by about 5 minutes. The collected specimens were identified to the lowest possible taxonomic level using specific literature (Menezes, Buckup, Figueiredo, & Moura, 2003), afterwards the specimens were measured for total length (Lt, in cm) and weighed (Wt, in g). Fish from each species were fixed and kept in the collection of the Fish Laboratory of the *Centro de Estudos do Mar* – UFPR. The capture complied with animal welfare laws, guidelines and policies, approved by the national licensing authority the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*, IBAMA, with license number 47571-1.

The LWR was adjusted through the equation (Huxley, 1924): $Wt = a Lt^b$ where a is the proportionality coefficient and b is the allometric coefficient (Carvalho et al., 2017; Possamai et al., 2019).

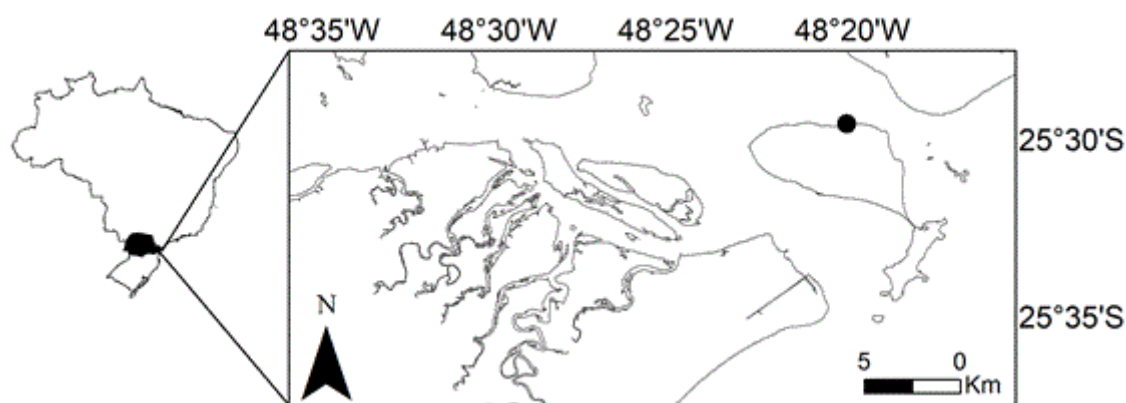


Figure 1. Sampling site of specimens in an estuarine area (black circle) in the Paranaguá Estuarine Complex, Southwestern Atlantic.

Results

We caught 880 individuals from 21 different species belonging to 11 families. The allometric coefficient ranged from 1.95 to 4.08 with a mean of 3.21 (SD \pm 0.32). The three different growth types were identified, 60% of the species showed positive allometric growth ($b > 3$), 35%, negative allometric growth ($b < 3$) and 5% presented isometric growth ($b = 3$), with values between 2.5 and 3.4 being more frequent. The coefficient of determination ranged from 0.47 to 0.99 (Table 1).

Table 1. Number of specimens (n), total length range (mean Lt, min and max), mean and standard deviation of the allometric coefficient, coefficient of determination, growth pattern from mean allometric coefficient (a- = negative allometric; i = isometric; a+ = positive allometric) of specimens collected in the Paranaguá Estuarine Complex, Southwestern Atlantic.

Species	n	Lt min	Man Lt \pm SD	Ltmax	Mean b	r ²	Growth
<i>Achirus lineatus</i>	11	8.2	10.0 \pm 2.06	13.6	3.60 \pm 0.07	0.95	a+
<i>Atherinella brasiliensis</i>	13	13.2	14.69 \pm 0.98	16.3	2.90 \pm 0.06	0.55	a-
<i>Centropomus parallelus</i>	15	15.5	21.33 \pm 3.00	27.5	3.15 \pm 0.04	0.94	a+
<i>Citharichthys spilopterus</i>	34	5.0	9.36 \pm 2.84	14.6	2.83 \pm 0.11	0.93	a+
<i>Diapterus rhombeus</i>	13	11.7	14.45 \pm 1.21	16.7	4.04 \pm 0.03	0.95	a+
<i>Diplectrum radiale</i>	12	11.5	16.36 \pm 0.67	20.8	3.28 \pm 0.05	0.55	a+
<i>Etropus crossotus</i>	53	4.2	9.39 \pm 2.30	13.2	2.96 \pm 0.08	0.95	a-
<i>Eucinostomus melanopterus</i>	30	8	12.58 \pm 1.78	17.7	2.91 \pm 0.10	0.69	a-
<i>Hyporhamphus unifasciatus</i>	21	16.1	18.42 \pm 1.41	21.6	3.77 \pm 0.05	0.8	a+
<i>Lycengraulis grossidensis</i>	21	11.9	18.80 \pm 2.32	21.3	3.16 \pm 0.03	0.95	a+
<i>Menticirrhus americanus</i>	256	12.0	19.43 \pm 4.61	31.2	3.22 \pm 0.04	0.97	a+
<i>Menticirrhus littoralis</i>	30	10.9	16.60 \pm 3.62	26.5	3.29 \pm 0.02	0.99	a+
<i>Micropogonias furnieri</i>	12	12	14.99 \pm 2.93	19.5	2.57 \pm 0.24	0.47	a-
<i>Mugil curema</i>	17	14.8	14.99 \pm 2.93	26.5	2.68 \pm 0.04	0.99	a-
<i>Mugil curvidens</i>	13	18	22.25 \pm 3.23	26.8	2.99 \pm 0.02	0.99	i
<i>Mugil liza</i>	46	5.4	16.64 \pm 5.65	28.8	3.16 \pm 0.05	0.99	a+
<i>Oligoplites saurus</i>	75	11.2	15.17 \pm 3.85	35.8	3.21 \pm 0.06	0.94	a+
<i>Selene vomer</i>	31	7.4	12.40 \pm 1.89	15.1	3.04 \pm 0.03	0.97	a+
<i>Strongylura marina</i>	38	26.4	49.67 \pm 9.42	75.5	3.72 \pm 0.03	0.97	a+
<i>Strongylura timucu</i>	87	23.4	42.82 \pm 4.10	52.5	3.47 \pm 0.03	0.93	a+
<i>Trachinotus carolinus</i>	52	6.3	11.72 \pm 4.50	23.0	3.15 \pm 0.10	0.95	a+

Discussion

All species analyzed in the present study had their LWRs described in other studies (Haimovici & Velasco, 2000; Frota, Costa, & Braga, 2004; González Acosta, La Cruz Agüero, & La Cruz Agüero, 2004; Macieira & Joyeux, 2009; Joyeux, Giarrizzo, Macieira, Spach, & Vaske, 2008; Santos & Gris, 2016; Viana et al., 2016; Carvalho et al. 2017; Silva, Teixeira, Batista, & Fabr , 2017). However, the species presented distinct growth patterns between the present study and the other studies. *E. crossotus*, *E. melanopterus*, *M. furnieri* showed negative allometric growth in this study while in other studies, they showed positive allometric growth (Passos, Schwarz Jr., Cartagena, Garcia, & Spach, 2012; Santos & Gris, 2016). Differences were also observed for *M. curvidens*, *T. carolinus* and *O. saurus*, the first with negative allometric growth in a previous study (Silva et al., 2017) and isometric growth in the present study, and the two other species presented in this study positive allometric growth in contrast to negative allometric growth presented in other studies (Mazzei, Joyeux, & Simon, 2011). This variation in allometric coefficient values is probably a result of the latitudinal distribution of the studies, evidencing the importance of environmental influences as determinant factors in the growth patterns of species distributed along a latitudinal gradient (Froese, 2006).

In addition to the variation in environmental influences, other factors may also be influencing the distinct growth patterns observed between the literature and the present study, such as the reduced number of specimens (Dias, Fernandez, & Schmidt, 2014), sampling methods and sampling period (Santos & Gris, 2016; Carvalho et al., 2017) and the estimation of the LWR with grouped sexes and stage of life (Possamai et al., 2019).

Conclusion

The length-to-weight ratio of the estuarine fishes in the Paranagu  Estuarine Complex is 60% of the species showed positive allometric growth, 35%, negative allometric growth and 5% presented isometric growth. Many species demonstrated variation in the LWR in this study and the others, this difference is caused by environmental influences or/and life stage.

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