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LENGTH-WEIGHT RELATIONSHIPS OF 12 FISH IN A TROPICAL ESTUARY FROM NORTHEAST BRAZIL

Relações comprimento-peso de 12 peixes em um estuário tropical do Nordeste do Brasil

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ABSTRACT

Estuarine environments are highly dynamic supporting a great fish species diversity. The present study was conducted to estimate length-weight relationships for 12 fish species from the Canal de Santa Cruz system using conventional methods and Bayesian analysis. The samples were collected in one day each month between July 2013 and June 2014, obtained using gillnets (100 to 200 × 2.2 m, mesh size 30, 40, and 50 mm). A total of 12 fish species representing 3 orders and 6 families were analyzed. Of the 12 species in the present study, only *Diapterus auratus*, *Diapterus rhombeus* and *Bairdiella ronchus* were analyzed in Pernambuco state, and there is a limited of analysis for the species *Strongylura marina*, *Harengula clupeola*, *Opisthonema oglinum*, *Anchovia clupeoides*, *Anchoa tricolor* and *Oligoplites saurus* in region Northeast Brazil.

Keywords: icthyofauna, allometry, condition factor, bayesian analysis.

RESUMO

Os ambientes estuarinos são altamente dinâmicos e têm uma grande diversidade de espécies de peixes. No presente estudo foram estimadas relações de peso-comprimento para 12 espécies de peixes no complexo estuarino do Canal de Santa Cruz, usando métodos convencionais e análise bayesiana. As amostras foram coletadas em um dia de cada mês, entre julho de 2013 e junho de 2014, e obtidas com redes de emalhar (100 a 200 × 2,2 m, malha 30, 40 e 50 mm). Foram analisadas 12

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espécies de peixes, representando 3 ordens e 6 famílias. Das 12 espécies estudadas, apenas Diapterus auratus, Diapterus rhombeus *e* Bairdiella ronchus *foram analisadas no estado de Pernambuco, e há um número limitado de análises para as espécies* Strongylura marina, Harengula clupeola, Opisthonema oglinum, Anchovia clupeoides, Anchoa tricolor *e* Oligoplites saurus *na região Nordeste do Brasil.*

Palavras-chave: *ictiofauna, alometria, fator de condição, análise bayesiana.*

INTRODUCTION

Estuarine environments are highly dynamic with their biological structure characterized by high spatial and temporal variability, and are very often heavily utilized and impacted by humanity (Mateus; Mateus & Baretta, 2008). The Canal de Santa Cruz system is the biggest estuary of Pernambuco state, supporting a great diversity of fauna and flora, and nursery for several fish species, despite suffering major anthropic impacts (Moura, 2009). There is little information on length-weight relationships (LWRs) in the CSC and the majority are available in gray literature. The LWRs are used basically to convert length to weight and vice versa (Merella *et al*.,1997), but also are very important tools that indicate the population health state, assist in fishery science and management and for understanding the pattern of somatic growth (Froese, 2006). Additionally, the LWRs are an important component of FishBase (Froese & Pauly, 2019). The present study was conducted to estimate LWRs for 12 fish species from the CSC using conventional methods and Bayesian analysis.

MATERIAL AND METHODS

The samples were collected in the estuary from the Canal de Santa Cruz, Pernambuco state, Brazil. The main channel in CSC is a 22 km long and variable width reaching 1.5 km (Moura, 2009). Samplings occurred in one day each month between July 2013 and June 2014, obtained using gillnets (100 to 200 × 2.2 m, mesh size 30, 40, and 50 mm). In the laboratory, the fishes were identified by taxonomic keys (Figueiredo & Menezes, 1978; Carpenter, 2002), and the weight (0.01 g) and total length (0.1 cm) were measured.

The length and weight data were reviewed in scatter diagrams and outliers observed of all species were excluded. The LWRs were determined by two methodology, regular linear regression (conventional analyses) and Bayesian analysis (Froese, 2006; Froese; Thorson & Reyes, 2014). In conventional analyses were considered to follow growth models of the type: $W = aL^b$, where W is the weight (g), L is the standard length (cm), a is a constant and b is the allometric coefficient. In the case of our study, the parameters a and b were determined by linear regression: $logW = loga + b$. The 95% confidence interval (CI) was determined for parameters a and b. The correlation coefficient of Pearson r-squared (r^2) was estimated. The allometric condition factor *Krel* was calculated according to the equation $K_{rel} = \frac{W}{aLb}$ (Le Cren, 1951). The code-to-use, as well as the necessary information f or combining existing knowledge (prior probabilities) with the new data from this study (likelihood function) for Bayesian analysis were employed from Froese and Pauly (2019).

The prior probabilities were taken from data provided for the Pernambuco state and in cases of non-occurrence, other locations in Brazil were used, preferably from the Northeast region. The package R2jags (Su & Yajima, 2015) and the JAGS sampler software (Plummer, 2017) were used for Bayesian analyses. All the analyses were done using the software R Statistical Environment (R Core Team, 2019).

RESULTS

The LWRs of 12 fish species representing 3 orders and 6 families are shown in Table 1. The sample size ranged from eight individuals for *Anchoa tricolor* to 1634 for *Opisthonema oglinum*. The largest ranged of standard length were for *Strongylura marina* and *O. oglinum*, respectively.

The regressions were significative for all species ($p < 0.001$). The allometric coefficient (b) for the LWRs ranged from 2.598 and 3.507 in conventional analyse, while for Bayesian analysis, it was between 2.640 and 3.510 for the species *Anchovia clupeoides* (Clupeiformes/Engraulidae) and *Bairdiella ronchus* (Perciformes/Sciaenidae), respectively. All condition factor values were above or equal to 1,000, except *A. tricolor*.

DISCUSSION

Of the 12 species in the present study, only *Diapterus auratus*, *Diapterus rhombeus* and *Bairdiella ronchus* were analized in Pernambuco state, and there is a limited of analysis for the species *Strongylura marina*, *Harengula clupeola*, *Opisthonema oglinum*, *Anchovia clupeoides*, *Anchoa tricolor* and *Oligoplites saurus* in region Northeast Brazil (Froese & Pauly, 2019). The value of b for all species were within the expected range of 2.5 to 3.5, as suggested by Froese (2006). Condition factor values above 1,000 for most species may be indicative of better nutritional status for fish in CSC (Froese, 2006). In coastal environments, with estuary, it is expected that most species present positive isometric or allometric growth, since these environments are used by most of them as feeding and development areas (Ferraz & Giarrizzo, 2015), corroborates our results. Therefore, this study represents an additional contribution to the knowledge of ichthyofauna in tropical estuary, environments very anthropic impacts, contributing to fisheries management and environmental conservation in the region.

Table I – Descriptive statistics and estimated length–weight relationship parameters determined by linear regression and Bayesian analysis for 12 fish species collected between 2013 to 2014 in Canal de Santa Cruz, Northeast Brazil

Order/Family/Specie	SL (cm)			TW (g)		LW Regression parameters				Bayesian analyses	
	N	Min	Max	Min	Max	a (95 % CI)	b (95% CI)	r^2 (95% CI)	K_{rel} (SD)	Mean $\log_{10}$ a (SD)	Mean b (SD)
Beloniformes/Belonidae											
Strongylura marina (Walbaum, 1792)	15	39.2	49.7	100.1	194.2	0.0029 (0.0004 - 0.0232)	2.8312 (2.2840 - 3.3784)	0.952 (0.858 - 0.984)	1.002 (0.070)	-2.530 (0.0026)	2.830 (0.0018)
Clupeiformes/Clupeidae											
Harengula clupeola (Cuvier, 1829)	26	8.3	13.5	11.5	56.5	0.0114 (0.0069 - 0.0189)	3.2586 (3.0368 - 3.4803)	0.987 (0.971 - 0.994)	1.002 (0.059)	-2.030 (0.0141)	3.280 (0.0185)
Opisthonema oglinum (Lesueur, 1818)	1634	6.1	16	4.3	65.1	0.0244 (0.0217 - 0.0273)	2.8655 (2.8148 - 2.9162)	0.940 (0.934 - 0.945)	1.007 (0.116)	1.620 (0.0605)	2.870 (0.0426)
Clupeiformes/Engraulidae											
Anchovia clupeoides (Swainson, 1839)	99	8.7	13.7	9	31.7	0.0349 (0.0220 - 0.0556)	2.5981 (2.4065 - 2.7898)	0.939 (0.910 - 0.959)	1.002 (0.059)	-1.520 (0.0283)	2.640 (0.0221)
Anchoa tricolor (Spix & Agassiz, 1829)	8	8.7	14.9	9	55.6	0.0112 (0.0038 - 0.0330)	3.0850 (2.5586 - 3.6113)	0.986 (0.920 - 0.998)	0.970 (0.078)	-1.950 (0.0282)	3.080 (0.0200)
Cetengraulis edentulus (Cuvier, 1829)	21	8.5	13.1	9.1	40.1	0.0106 (0.0044 - 0.0255)	3.2009 (2.8225 - 3.5794)	0.971 (0.929 - 0.988)	1.005 (0.102)	-1.980 (0.0286)	3.200 (0.0203)
Lycengraulis grossidens (Spix & Agassiz, 1829)	46	8.1	15.9	8.9	61.1	0.0084 (0.0041 - 0.0172)	3.2071 (2.9180 - 3.4962)	0.959 (0.926 - 0.977)	1.006 (0.108)	-2.070 (0.0291)	3.210 (0.0206)
Perciformes/Carangidae											
Chloroscombrus chrysurus (Linnaeus, 1766)	77	5.6	8.2	3	9.5	0.0340 (0.0221 - 0.0522)	2.6849 (2.4537 - 2.9162)	0.937 (0.902 - 0.959)	1.002 (0.067)	-1.480 (0.0858)	2.690 (0.0612)
Oligoplites saurus (Bloch & Schneider, 1801)	11	11.5	19.1	15.2	79.4	0.0033 (0.0012 - 0.0094)	3.3912 (2.9911 - 3.7912)	0.988 (0.9528 - 0.9970)	1.002 (0.072)	-2.470 (0.0120)	3.390 (0.0086)
Perciformes/Gerreidae											
Diapterus auratus (Ranzani, 1842)	9	5.6	10.7	5.4	41.5	0.0249 (0.0154 - 0.0403)	3.1294 (2.8880 - 3.3709)	0.996 (0.982 - 0.999)	1.002 (0.073)	-1.600 (0.0106)	3.130 (0.0076)
Diapterus rhombeus (Cuvier, 1829)	21	5.9	11.1	6.9	36.8	0.0200 (0.0073 - 0.0547)	3.2269 (2.7569 - 3.6968)	0.957 (0.895 -0.983)	1.011 (0.152)	-1.700 (0.0295)	3.230 (0.0212)
Perciformes/Sciaenidae											
Bairdiella ronchus (Cuvier, 1830)	9	12	16.4	35.2	107.3	0.0063 (0.0010 - 0.0419)	3.5072 (2.8010 - 4.2133)	0.976 (0.885 - 0.995)	1.003 (0.080)	-2.200 (0.0032)	3.510 (0.00231)

N - sample size; SL - standard length; TW - total weight; LW - length weight; SL max in bold indicating the new maximum length recorded; CI - confidence interval; r^2 - Pearson r-squared for log–log regression, SD - standard deviation; K_{rel} - allometric condition factor; *a* - intercept; *b* - slope.

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