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Length–weight relationships for 15 fish species from the Cujubim Lake, Amazon Basin, Brazil

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ABSTRACT

Length–weight relationships (LWRs) informations are very important in fishery science and management. The aim of this study was to estimate LWRs for 15 fish species from the Cujubim Lake, localized on the Madeira River, using conventional methods and Baysian analysis. In total, 639 individuals were captured distributed in four orders and nine families, the most diverse being Characiformes and Pimelodidae, respectively. Of the species collected, only *Megaleporinus trifasciatus* was not studied in the Madeira River, and for *Pimelodus tetramerus* we present a new weight and length data. In addition, a new maximum length has been recorded for *Reoboides affinis*. All condition factor values were above or equal to 1,000, except *P. tetramerus*, therefore, it may be a indicative of better nutritional status for fish in Lake Cujubim.

Keywords: allometry; bayesian analysis; freshwater fish; somatic growth; Western Amazon.

Relações peso-comprimento de 15 espécies de peixes do Lago Cujubim, Bacia Amazônica, Brasil

RESUMO

As informações sobre relações peso-comprimento (RPC) são muito importantes na ciência e gestão pesqueira. O objetivo deste estudo foi estimar RPC para 15 espécies de peixes no Lago Cujubim, localizado no rio Madeira, com o uso de métodos convencionais e análises baysianas. No total foram capturados 639 indivíduos pertencentes a quatro ordens e nove famílias, sendo mais diversos Characiformes e Pimelodidae, respectivamente. Das espécies coletadas, apenas *Megaleporinus trifasciatus* não foi estudada no rio Madeira, e para a espécie *Pimelodus tetramerus*, apresentamos novos dados de peso e comprimento. Além disso, um novo comprimento máximo foi registrado para *Reoboides affinis*. Todos os valores dos fatores de condição foram superiores ou iguais a 1.000, exceto para *P. tetramerus*, portanto, os valores podem ser indicativos de um melhor estado nutricional para os peixes no Lago Cujubim.

Palavras-chave: alometria, análise bayesiana, peixe de água doce, crescimento somático, Amazônia Ocidental

Introduction

The Madeira River is the largest tributary in the Amazon River leak and is approximately 1,450 km long with morphostructural differences (GUYOT et al., 2007) and water (HORBE et al., 2013). This river harbours the greatest known wealth diversity of freshwater fish, with more of 1,000 species identified so far (OHARA et al., 2015). In this tributary occur floodplain lakes, that are dynamic environments with periodic connections between the lake and the main river channel that facilitate homogenize fish communities (MIRANDA; LUCAS 2004). Additionally, aid the high productivity by generating a fish biomass that is intensively exploited by fisheries (PETRERE JR, 1978).

The informations accurate length–weight relationships (LWRs) are tools that assist in fishery science and management, as they allow conversions of length or weight for stock assessment models, to understanding the pattern of somatic growth, general health, condition indices, life history, fish fatness and condition, morphological characteristics of the fish and also are used to convert length to weight and wight to lenght (PETRAKIS; STERGIOU, 1995; MERELLA et al., 1997; FROESE, 2006). The condition factor (K_{rel}) that was derived from the LWRs is a parameter which is used widely in order to understand survival, reproduction, maturity and health of fish, as they reflect the physiological state, which is influenced by intrinsic factors (e.g. gonadal development, presence or absence of food in the gut) and extrinsic factors (e.g. food availability, environmental variability) (LE CREN, 1951; NIKOLSKY, 1969).

The aim of this study was to estimate LWRs and condition factor for 15 fish species present in ichthyofauna from the Cujubim Lake, localized on the Madeira River.

Material and methods

The specimens were collected from the Cujubim Lake in Madeira River, Brazil (Figure 1). In this lake, at certain times of the year, there are exchanges of water and fish fauna with Madeira River. Fish samples were obtained using gillnets (10 × 5 m, mesh size 40, 60, 80 and 100 mm) and casting nets (1.25 × 2.7 m, mesh size 40 mm) in months of March and November, 2019 and February 2020, in one day each months the fisheries were performed every 6 h during 24 h, and the fish species were taken for identification, measured for standard length (SL, to the nearest 0.1 cm), and total weight (TW, to the nearest 0,01 g). Fish species identification was done by following Queiroz et al. (2013) and Ohara et al. (2017).

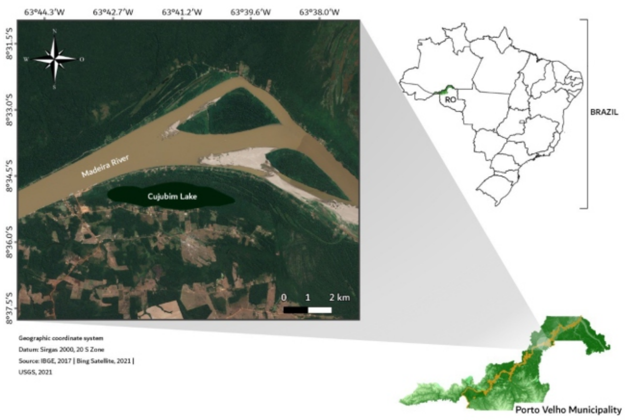

Figure 1. Study site located from the Cujubim Lake in Madeira River (Rondônia, Brazil). / **Figura 1.** Área de estudo localizada no Lago Cujubim no Rio Madeira (Rondônia, Brasil).

The LWRs were determined by conventional analyses (regular linear regression) and Bayesian analysis (FROESE, 2006; FROESE et al., 2014). Bayesian methods combine existing knowledge with new data and thus provide results in updated earning chains in science (KUIKKA et al., 2014). The first method, was estimated by growth model, $W = aL^b$, using log-transformed data, a is a constant and b is the allometric coefficient, the correlation coefficient of Pearson r-squared (r^2) was estimated and the allometric condition factor K_{rel} was calculated according to the equation $K_{rel} = W / aL^b$ (Le Cren, 1951), while for Bayesian analysis, the necessary information with the existing knowledge (prior probabilities) and a code-to-use were taken from Froese and Pauli (2019). The prior probabilities were taken from data provided for the Madeira River or other locations in Brazil in cases of non-occurrence and combining with the new data from this study (likelihood function). 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

A total of 639 specimens belonging to 15 species from nine families, and four orders were analyzed (Table 1). The most diverse orders were Characiformes (nine species) and the Siluriformes (three species), while families was the Pimelodidae (three species). There are significant correlations between LWRs for all species ($p < 0.001$), although the samples were small for some estimates, as well as presenting small size range, thus species with N <10, we have established a tentative at LWRs. The allometric coefficient (b) for the LWRs ranged from 2.107 and 3.526, while for Baysian analysis, it was between 2.140 and 3.520 for the species *Pimelodus tetramerus* (Siluriformes/Pimelodidae) and *Megaleporinus trifasciatus* (Characiformes/Anostomidae), respectively. All condition factor values were above or equal to 1,000, except *P. tetramerus*.

Table 1. Analysis for 15 fish species collected from the Cujubim Lake in Madeira River (Rondônia, Brazil). Number of specimens (N), standard length (min and max), total weight (min and max), length weight parameters determined by linear regression and Bayesian analysis (CI = confidence interval; r^2 = Pearson r-squared for log–log regression; SD = standard deviation; K_{rel} = allometric condition factor; a = intercept; b = slope), SL max in bold indicating the new maximum length recorded. / **Tabela 1.** Análise para 15 espécies de peixes coletadas no Lago Cujubim no Rio Madeira (Rondônia, Brasil). Número de indivíduos (N), comprimento padrão (mínimo e máximo), peso total (mínimo e máximo), parâmetro das relações peso e comprimento determinando por regressão linear e análise Baysiana (CI = intervalo de confiança; r^2 = Correlação de Pearson para regressão log - log; SD = desvio padrão; K_{rel} = fator de condição alométrico; a = intercepto; b = inclinação), SL máx em negrito indica um novo comprimento máximo registrado.

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)
Characiformes/Anostomidae											
Megaleporinus trifasciatus (Steindachner, 1876)	6	14.1	22.0	43.6	214.3	0.004 (0.001-0.021)	3.526 (2.951-4.100)	0.993 (0.936-0.999)	1.002 (0.074)	-2.400 (0.006)	3.520 (0.004)
Schizodon fasciatus Spix & Agassiz, 1829	44	14.2	25.5	41.3	249.8	0.028 (0.004-0.046)	3.031 (2.572-3.489)	0.899 (0.822-0.944)	1.022 (0.204)	-1.880 (0.004)	3.030 (0.003)
Characiformes/Characidae											
Roeboides affinis (Günther, 1868)	34	10.1	14.3	14.0	35.0	0.054 (0.012-0.248)	2.387 (1.779-2.996)	0.816 (0.661-0.905)	1.007 (0.126)	-1.280 (0.014)	2.390 (0.010)
Roeboides myersii Gill, 1870	7	12.8	16.5	27.4	63.4	0.009 (0.001-0.124)	3.147 (2.175-4.119)	0.966 (0.780-0.995)	0.961 (0.069)	-2.04 (0.004)	3.150 (0.003)
Characiformes/Curimatidae											
Potamorhina altamazonica (Cope, 1878)	62	11.0	24.1	23.0	456.5	0.023 (0.013-0.046)	2.938 (2.738-3.137)	0.967 (0.948-0.980)	1.011 (0.167)	-1.64 (0.002)	2.940 (0.002)
Psectrogaster amazonica Eigenmann & Eigenmann, 1889	14	13.0	17.0	56.1	120.4	0.056 (0.005-0.633)	2.690 (1.789-3.591)	0.883 (0.662-0.962)	1.005 (0.106)	-1.260 (0.003)	2.690 (0.002)
Characiformes/Prochilodontidae											
Prochilodus nigricans Spix & Agassiz, 1829	36	12.0	32.0	34.2	672.0	0.018 (0.011-0.029)	3.003 (2.838-3.168)	0.988 (0.976-0.934)	1.008 (0.120)	-1.740 (0.000)	3.000 (0.000)
Semaprochilodus insignis (Jardine, 1841)	269	9.7	21.1	15.7	194.4	0.022 (0.015-0.031)	2.958 (2.813-3.102)	0.927 (0.908-0.942)	1.007 (0.110)	-1.67 (0.010)	2.960 (0.007)
Characiformes/Triportheidae											
Triportheus albus Cope, 1872	26	11.0	24.4	18.8	167.0	0.011 (0.004-0.036)	2.988 (2.586-3.391)	0.953 (0.896-0.979)	1.017 (0.178)	-1.950 (0.003)	2.990 (0.002)
Clupeiformes/Engraulidae											
Lycengraulis batesii (Günther, 1868)	8	12.5	18.2	13.9	57.0	0.001 (0.000-0.005)	3.857 (3.223-4.491)	0.9867 (0.926-0.998)	1.003 (0.079)	-3.050 (0.005)	3.860 (0.004)
Clupeiformes/Pristigasteridae											
Pellona flavipinnis (Valenciennes, 1837)	48	13.1	30.5	28.0	360.2	0.107 (0.007-0.017)	3.037 (2.874-3.199)	0.984 (0.972-0.991)	1.007 (0.118)	-1.970 (0.003)	3.040 (0.002)
Perciformes/Sciaenidae											
Plagioscion squamosissimus (Heckel, 1840)	12	14.0	28.5	35.0	220.6	0.060 (0.017-0.206)	2.401 (1.996-2.805)	0.973 (0.902-0.992)	1.006 (0.109)	-1.230 (0.006)	2.400 (0.004)
Siluriformes/Pimelodidae											
Hypophthalmus edentatus Spix & Agassiz, 1829	10	32.3	39.7	318.0	617.0	0.012 (0.004-0.035)	3.039 (2.712-3.366)	0.991 (0.963-0.998)	1.000 (0.029)	-2.090 (0.001)	3.040 (0.000)
Pimelodus blochii Valenciennes, 1840	57	13.2	22.0	32.3	123.3	0.042 (0.014-0.126)	2.623 (2.229-3.017)	0.874 (0.794-0.924)	1.011 (0.154)	-1.390 (0.006)	2.630 (0.004)
Pimelodus tetramerus Ribeiro & Lucena, 2006	6	13.3	15.5	41.0	54.0	0.176 (0.020-1.537)	2.107 (1.297-2.917)	0.964 (0.698-0.996)	0.990 (0.052)	-0.800 (0.006)	2.140 (0.004)

Discussion

Of the 15 species in the present study, only *M. trifasciatus* was not studied in the Madeira River, that was studied in the Lago Puraquequara, Amazonas with LWRs (a=0.0127, b=3.0000) calculated for two individuals mentioned in FishBase, and for *P. tetramerus* we present new weight and length data. In addition, a new maximum length has been recorded for *R. affinis* previously reported in 11.0 cm SL (FROESE; PAULY, 2019). Outliers were not observed in slopes calculated and the value of b for all species were within the expected range of 2.0 to 4.0, as suggested by Le Cren (1951), as out of range values are often derived from samples with narrow size ranges (CARLANDER, 1977). Condition factor values above 1,000 for most species may be a indicative of better nutritional status for fish in Lake Cujubim , as Le Cren's (1951) condition factor is suitable for comparing condition within a given sample (FROESE, 2006). Therefore this study brings important information about the population biology of several species and represents an additional contribution to the knowledge of ichthyofauna in floodplain lakes of the Madeira River in the Amazon basin, contributing to fisheries management and environmental conservation in the region.

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