

Length-weight relationship in ten fish species from the Nhamundá River, the Amazon Basin, Brazil

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ABSTRACT

Studies on the length-weight relationship (LWR) of fishes are an important tool to describe several biological aspects of the species. Consequently, these studies are relevant due the necessity of comprehension about fish life cycle. Thus, this study aimed to establish the length-weight relationship of the ten most common fish in the Lower Nhamundá River, left tributary of the Amazon River. The capture of fish was conducted in January 2008 using gill nets. A total of 807 individuals, ten species and three Orders (Characiformes, Siluriformes and Clupeiformes) were analyzed. The parameter b varied from 2.680 to 3.698. The LWR were shown for the first time for two species: *Anostomoides laticeps* and *Ageneiosus polystictus*. Finally, this research emphasizes the importance of LWR studies in the Amazon and the use of primary data for fisheries management plans.

KEYWORDS: growth pattern, allometry, fish, Amazonia.

Relação peso-comprimento de dez espécies de peixes do Rio Nhamundá, Bacia Amazônica, Brasil

RESUMO

Estudos acerca da relação peso-comprimento em peixes são importantes ferramentas para descrever diversos aspectos biológicos das espécies. Consequentemente, estes estudos são importantes em decorrência da necessidade de compreensão do ciclo de vida dos peixes. Sendo assim, este estudo visou estabelecer a relação peso-comprimento de dez espécies mais comuns de peixes na região do baixo Rio Nhamundá, afluente da margem esquerda do Rio Amazonas. A captura dos peixes foi realizada em janeiro de 2008, utilizando redes de emalhar. Foram analisados 807 indivíduos, pertencentes a dez espécies e três Ordens (Characiformes, Siluriformes e Clupeiformes). O coeficiente alométrico "b" variou de 2,680 à 3,698. A relação peso-comprimento é apresentada pela primeira vez para duas espécies: *Anostomoides laticeps* e *Ageneiosus polystictus*. Por fim, esse estudo enfatiza a importância de estudos de relação peso-comprimento de peixes na Amazônia e o uso de dados primários para fins conservacionistas.

PALAVRAS-CHAVE: padrão de crescimento, alometria, peixe, Amazônia.

Studies of the length-weight relationship (LWR) of fishes were performed since the late 19th century, and are an important tool to describe several biological aspects (Le Cren 1951; Froese 2006). The LWR allows to 1) estimate fish weight based on length and *vice versa*, 2) analyze the growth pattern by the allometric coefficient of the analyzed species, and 3) obtain the body conditions of the sampled fish specimens (i.e. fat storage or gonadal development etc.) (Froese 2006). Additionally, the knowledge from LWR is essential to assess fish stocks, fisheries, and environmental monitoring programs (Froese *et al.* 2011; Giarrizzo *et al.* 2015). According to Freitas *et al.* (2014), the LWR studies become relevant due the need to comprehend the fish lifecycle, principally regions where fisheries represent one of the most important economic activities and fish stocks are the main food source for many traditional communities.

The Amazon Basin has the largest fish diversity on Earth (Albert and Reis 2011), but there are few studies concerning the fish LWR in this region (Freitas *et al.* 2014; Giarrizzo *et al.* 2015; Schmid *et al.* 2015). Due the high environmental heterogeneity of the Amazon Basin (Junk and Furch 1993), the wide-ranged species have to improve different life strategies, which may reflect variances in the biological parameters, such as those obtained from LWR studies. Consequently, these knowledges will be important to local management and conservation policies of these species. Thus, this study presents information about the LWR of common fish species from the Lower Nhamundá River, in a protected area in the Central Amazon, Brazil.

The samplings were carried out in the Lower Nhamundá River (Figure 1), left tributary of the Amazon River (Central Amazon, Brazil), dividing Pará and Amazonas States (1°42'25"S, 52°17'35" W). This stretch is characterized as a clear water river and a lowland amazon rainforest, nearly 40 meters above the sea level, and is located at the Floresta Estadual de Faro (State Forest of Faro), one of the five conservation units forming the northern mosaic of the Amazon River in the State of Pará (Ávila-Pires *et al.* 2010).

Fishes were collected in January 2008, using gillnets (mesh size: 2, 4, 6, 8, 10, 12 and 18 cm, opposite knots), and processed in the field, measured to the nearest centimeter (standard length, L_s) and weighted to the nearest gram (total weight, W). Voucher specimens were deposited at the ichthyology collection of the Museu Paraense Emilio Goeldi - MPEG (Pará, Brazil) under the codes: MPEG 14764-14769, MPEG 14776-14780, MPEG 14785-14795, MPEG 14800, MPEG 14859, MPEG 14863, and MPEG 14866-14871. All scientific names, authorship, and years of description were checked in FishBase (Froese and Pauly 2016).

The LWR was estimated following the model first proposed by Järvi (1920; see Froese 2006): $W = a * L_s^b$, which

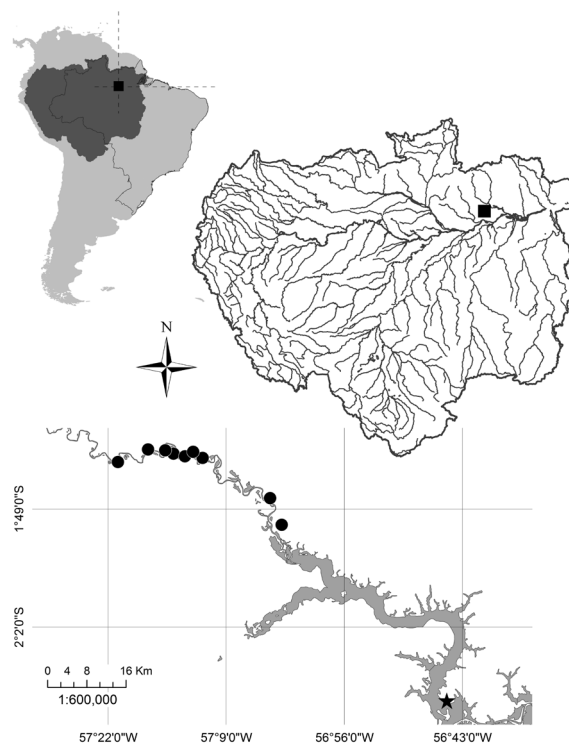


Figure 1 - Sampling area in the Nhamundá River, Amazon Basin, Brazil. Black spots can represent more than one collection site. Black star represents the city of Faro (State of Pará).

considers that the relative body proportions of the fishes increase according to the coefficient of proportionality (a) and by the coefficient of allometry (b). The LWRs were determined using a non-linear regression routine, after the exclusion of outliers identified graphically by plotting L_s vs W measurements (Froese and Binohlan 2000). The LWR was applied in fish species with at least 15 individuals.

A total of 807 specimens representing ten different species belonging to seven Families and three Orders were analyzed. The best-represented Order was Characiformes (six species), followed by Siluriformes (three species) and Clupeiformes (one species). Table 1 summarizes the data concerning sample size, minimum and maximum length, and weight for each species, the parameters of the LWR with confidence intervals (95%), and, for comparison purpose, available information from the literature.

The allometric coefficient b varied from 2.680 for *Anostomoides laticeps*, to 3.698 for *Boulengerella maculata*. According to the parameter b , the species *A. polystictus* had an isometric growth pattern ($b \sim 3$). Negative allometry ($b < 3$) was recognized for *A. laticeps*, *A. halecinus*, *T. albus*, *A. nuchalis* and *I. amazonica*; whereas *A. microlepis*, *B. maculata*,

Table 1. Length-weight relationships of dominant fish species, Lower Nhamundá River, State of Pará, Brazil. Sample size (N), length and weight range are by species; estimated *a* and *b* values with confidence limits (95%), determination coefficient (R^2), and published *a* and *b* values.

ORDER/Family/ Species	N	Length range (cm)	Weight range (g)	Estimated parameters		R^2	Published values		Source
				<i>a</i> (95% CL)	<i>b</i> (95% CL)		<i>a</i>	<i>b</i>	
CHARACIFORMES									
<i>Acestrorhynchidae</i>									
<i>Acestrorhynchus microlepis</i> (Jardine 1841)	43	11.5–21.5	22–117	0.008 (0.0012–0.0141)	3.121 (2.837–3.405)	0.941	0.0071–0.0255	2.66–3.37	Freitas <i>et al.</i> (2014) Freese and Pauly (2016) Giarizzo <i>et al.</i> (2011; 2015)
<i>Anostomidae</i>									
<i>Anostomoides laticeps</i> (Eigenmann 1912)	29	19–25	118–275	0.061 (0.0213–0.1369)	2.680 (2.185–3.175)	0.912	0.0060–0.0288	2.84–3.22	Freese and Pauly (2016)
<i>Ctenolucidae</i>									
<i>Boulengerella maculata</i> (Valenciennes 1850)	39	24.5–38.5	83–410	0.001 (0.0008–0.0012)	3.698 (3.341–4.043)	0.950	0.0005–0.0012	3.36–3.61	Giarizzo <i>et al.</i> (2011)
<i>Hemiodontidae</i>									
<i>Hemiodus im- maculatus</i> Kner 1858	278	13–23	32–183	0.012 (0.0081–0.0159)	3.140 (2.047–3.223)	0.938	0.0016–0.0033	3.32–3.56	Giarizzo <i>et al.</i> (2011)
<i>Triporthidae</i>									
<i>Agoniates halecinus</i> Müller and Troschel 1845	147	13.5–20.5	22–90	0.018 (0.0101–0.0259)	2.730 (2.570–2.890)	0.907	0.0024–0.0411	2.81–3.27	Freese and Pauly (2016) Giarizzo <i>et al.</i> (2015)
<i>Triporthus albus</i> Cope 1872	81	13–18	32–74	0.031 (0.0171–0.0489)	2.690 (2.502–2.878)	0.900	0.0049–0.0532	2.46–3.22	Freitas <i>et al.</i> (2014) Freese and Pauly (2016) Giarizzo <i>et al.</i> (2015)
SILURIFORMES									
<i>Auchenipteridae</i>									
<i>Ageneiosus polystictus</i> Steindachner 1915	20	19–44	107– 1235	0.011 (0.0046–0.0184)	3.072 (2.895–3.249)	0.987	0.0020–0.0118	2.92–3.36	Freese and Pauly (2016)
<i>Auchenipterichthys longimanus</i> (Günther 1864)	104	8.5–16.5	14–97	0.013 (0.0070–0.0200)	3.210 (3.019–3.404)	0.924	0.0024–0.0420	2.47–3.22	Giarizzo <i>et al.</i> (2011) Freitas <i>et al.</i> (2014)
<i>Auchenipterus nuchalis</i> (Spix and Agassiz 1829)	51	10.5–18.5	19–75	0.034 (0.0199–0.0491)	2.661 (2.500–2.823)	0.949	0.0032–0.0149	2.72–3.32	Freese and Pauly (2016) Giarizzo <i>et al.</i> (2015)
CLUPEIFORMES									
<i>Pristigasteridae</i>									
<i>Ilisha amazonica</i> (Miranda Ribeiro 1920)	15	14.5–18	41–76	0.037 (0.0083–0.0927)	2.622 (2.086–3.159)	0.888	0.0253–0.0481	2.39–3.24	Freese and Pauly (2016) Giarizzo <i>et al.</i> (2011)

H. immaculatus and *A. longimanus* had a positive allometric growth ($b > 3$).

Considering the confidence intervals of the growth patterns, all analyzed species corroborate with the expected values of the allometric coefficient b (2.5 - 3.5) as defined by Froese (2006), except for *B. maculata* ($b = 3.698$). The allometric growth factor (b) obtained for *A. microlepis*, *B. maculata*, *A. halecinus*, *T. albus*, *A. longimanus*, *A. nuchalis* and *I. amazonica* ranged the same value range that already described by literature (Giarrizzo *et al.* 2011, Freitas *et al.* 2014, Giarrizzo *et al.* 2015). For *H. immaculatus* we recorded an isometric growth, while Giarrizzo *et al.* (2011) verified a positive allometry for the specie. Although the b values for *A. laticeps* and *A. polystictus* can be found at Fishbase website, the values were not obtained with primarily length-weight data of these species. The values were estimated using an innovative methodology proposed by Froese *et al.* (2014), based on LWR data of closest taxon and a Bayesian approach.

As already observed by Fulton (1904) in one of the early studies with LWR, and by other current studies (Karakulak *et al.* 2006; Fontoura *et al.* 2010), the growth pattern (b) within the same species can be changeable, depending on the season, food availability, population, sex, environmental conditions or physiology. Since each place has its environmental peculiarity and the corresponding fauna, this study emphasizes the importance of amplifying the biological knowledge of the species distribution, improving conservation actions and management plans.

Finally, this research emphasizes the importance of LWR studies in the Amazon and the use of primary data for fisheries management plans, since different environment conditions result different lifecycle parameters in the same species. This may allow more sustainable fishery exploitation and increase the probability of non-exhaustion of natural populations of fish in the region.

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