

Length-weight relationships of ornamental fish species from Amanã Lake, Amanã Reserve, Amazonas, Brazil

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Abstract

Length-weight relationships (LWRs) were estimated for 16 ornamental fish species from Amanã Lake and nine tributary streams, in Central Brazilian Amazonia. Sampling was carried out bimonthly for a year (2007–2008), using two sets of four gillnets (20 m × 2 m, 2,5; 3,5; 04; 4,5 cm stretch mesh size); trawls were performed with seine nets (35 m × 6 m, 3 mm stretch mesh size); native fish-traps (fyke-net like fish-traps woven from local lianas), and dip nets (0.5 m × 0.5 m stretch mesh size). Measurements were done for standard length (SL - 0.1 cm precision) and total weight (Wt - 0.01 g precision). This study provides information on the length-weight relationships for all sampled species and, in addition, provides new maximum standard lengths for six species.

KEYWORDS

allometry, Amazon fishes, Middle Solimões Basin, neotropical fish fauna

1 | INTRODUCTION

Morphometric parameters, such as the length-weight relation (LWR), is usually the first step in obtaining estimates

of population growth for fish communities, and form a key element in fish biology and ecology research, potentiating is species biomass estimations from length observations (Froese et al., 2011). The relationship between these two variables generates information contributing to the development of fish population and

TABLE 1 Length – weight relation of 16 fishes species sampled in Amanã Lake, Brazil, between February 2007 and February 2008. Black is new maximum standard lengths. * length-weight relationships build with samples dominated by small individuals length-weight relation. Bold values are indicate maximum standard length.

Family	Species	N	SL (cm)		Wt (g)		a	b	r ²
			Mín.	Máx.	Mín.	Máx.			
Gasteropelecidae	<i>Carnegiella marthae</i> Myers, 1927	190	1.5	3.0	0.10	0.81	0.0210 (0.0164–0.0260)	3.3092 (2.8973–3.7628)	0.9807
			1.9	3.5	0.12	1.03	0.0130 (0.0112–0.0149)	3.4615 (3.2581–3.6407)	0.9834
Characidae	<i>Hemigrammus ocellifer</i> (Steindachner, 1882)	506	1.3	3.7	0.04	1.48	0.0153 (0.0115–0.0211)	3.4822 (3.0560–4.0699)	0.9805
			2.1	3.5	0.17	0.83	0.0184 (0.0164–0.0210)	3.0205 (2.8799–3.1655)	0.9802
Lebiasinidae	<i>Hyphessobrycon bentosii</i> Durbin, 1908*	88	1.6	3.5	0.06	0.78	0.0154 (0.0131–0.0172)	3.1316 (2.9466–3.2835)	0.9825
			1.5	4.7	0.04	0.89	0.0110 (0.0077–0.0139)	3.0828 (2.6722–3.3387)	0.9754
Cichlidae	<i>Nannostomus eques</i> Steindachner, 1876	1,249	1.8	4.1	0.05	0.74	0.0070 (0.0052–0.0081)	3.3410 (2.9486–3.4874)	0.9822
			1.2	5.7	0.03	3.08	0.0169 (0.0102–0.0234)	2.9967 (2.0442–3.5585)	0.9852
Cichlidae	<i>Pyrrhulina semifasciata</i> Steindachner, 1876	451	1.1	8.8	0.04	19.60	0.0300 (0.0181–0.0496)	2.9534 (3.3219–3.7384)	0.9846
			0.7	4.5	0.02	2.40	0.0338 (0.0249–0.0463)	2.7914 (2.0839–3.5888)	0.9758
Cichlidae	<i>Acarichthys heckelii</i> (Müller & Troschel, 1849)*	1,307	1.0	3.6	0.04	1.26	0.0327 (0.0273–0.0400)	2.7859 (2.1675–3.5847)	0.9867
			1.4	3.7	0.09	1.75	0.0322 (0.0257–0.0375)	2.9537 (2.4671–3.2004)	0.9705
Cichlidae	<i>Apistogramma hippolytae</i> Kullander, 1982	488	1.3	3.9	0.07	1.51	0.0340 (0.0283–0.0403)	2.8081 (2.4373–3.4944)	0.9842
			1.6	17.4	0.17	268.20	0.0374 (0.0275–0.0525)	3.1179 (2.8859–3.3960)	0.9958
Cichlidae	<i>Apistogramma pertensis</i> (Haseman, 1911)	396	1.23	12.4	0.07	72.15	0.0435 (0.0233–0.0705)	2.9586 (2.2676–3.6790)	0.9843
			1.3	16.3	0.07	369.23	0.0187 (0.0160–0.0226)	3.5045 (3.4381–3.5837)	0.9805

dynamics models (Froese, 2006), can reveal biogeographical relationships, as well as provide baseline information for fish stock management strategies and conservation (Barros et al., 2018; Camargo et al., 2018; Froese et al., 2011; Silva et al., 2019).

This paper describes the length-weight relationships (LWR) for 16 ornamental fish species from the Amanã Sustainable Development Reserve (ASDR), sampled at Amanã lake, in Central Brazilian Amazonia, and of its nine tributary streams. The study were carried out as part of a larger research project, conducted by the Mamirauá Institute, to support the sustainable management of ornamental fish in the area by the local traditional fishing communities.

2 | MATERIALS AND METHODS

Sampling was carried out bimonthly between February 2007 and February 2008, at Amanã Lake and nine tributary streams (02° 37' 07" / 64° 38' 47"), all lying within Amanã Sustainable Development Reserve (ASDR), Amazonas State, Brazil. Sampling was conducted using two sets of four gillnets (20 m × 2 m, 2,5; 3,5; 04; 4,5 cm stretch mesh size) immersed in water for 24-hr with 3-hr interval between catches; five trawls were performed with seine nets (35 m × 6 m, 3 mm stretch mesh size); five woven native fish-traps (fyke-net like fish-traps woven from local lianas) immersed in water for 24-hr, and two hundred trawls were performed with dip nets (0.5 m × 0.5 m stretch mesh size). Collected fish were anesthetized, fixed in 10% formalin and preserved in 70% ethanol after a 10-day-period. Fish specimens were later identified to the species level by consulting the literature (e.g. Barata & Lazzarotto, 2008; Gery, 1977) and specialists. All scientific names, authority and year of description followed Eschmeyer et al. (2020), and all species relationships were checked using Fishbase (Froese & Pauly, 2020).

For the body measurements, the fish were removed from the alcohol solution and immediately dried on paper towels to remove the excess, then measured and weighed (SL, nearest 0.1 cm and Wt, 0.01 gram precision). The weight-length relation species were estimated using the equation $W = aSL^b$ (Le Cren, 1951), where W is the total weight in grams; SL is the standard length in millimeters; a is the linear coefficient to the equation; and b is the growth coefficient of each species. The equation ($W = aSL^b$) was converted into the natural logarithmic form ($\ln W = \ln a + b \ln SL$) and parameters a (regression intercept) and b (slope) were calculated using regression analysis (King, 2007). Presence of outliers for each species was identified graphically using log TL versus log WT plots (Froese & Binohlan, 2000), and obvious outliers were removed.

3 | RESULTS

A total of 16 species in 4 families were analyzed. Prior to the study none of the analyzed species had a known LWR, and maximum standard length values of six species were updated. All regressions were significant in all species ($p < .001$), with the coefficient of determination (r^2) ranging

from 0.96 to 0.99. The LWR allometry coefficient (b) ranged from 2.7859 for *Apistogramma bitaeniata* Pellegrin, 1936, to 3.5045 for *Symphysodon tarzoo* Lyons, 1959. The median value for b was 3.13, with 50% of the values found lying between 2.95 and 3.34 (Table 1).

4 | DISCUSSION

This study provides the first biological information for these 16 species of ornamental fish from the Central Amazon basin, including *Symphysodon tarzoo*, the most important species for the local ornamental trade, and a major source of income for local fishermen (Mendonça & Camargo, 2006). As expected, all b values fell within the expected range (2.5–3.5), as suggested by Froese (2006).

The estimate for four species *Hyphessobrycon bentosi*, *Nannostomus unifasciatus*, *Acarichthys heckelii* and *Apistogramma bitaeniata*, may be very tentative, because the smaller size classes dominate the sample, and the very small fish usually do have a different growth stanza (before they reach final body shape).

The data presented here are part of a previous and larger project, aimed at surveying stocks or ornamental fish in Amana Reserve streams, to support the sustainable management of resources by local populations. This explains the high number of animals collected (Queiroz & Hercos, 2009).

This length-weight relationships, and maximum length provided for the ichthyofauna from one of the most important parts of the central region Amazon, not only comprise important information on population and community ecology, but can also serve as baseline data for future studies focused on the management and conservation of aquatic resources in the region.

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CONFLICT OF INTEREST


The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data sets generated during and/or analysed during the current study are not publicly available due to the data also forms part of an ongoing study but are available from the corresponding author on reasonable request.

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REFERENCES

- Barata, J. P. B., & Lazzarotto, H. (2008). Identificação das espécies de *Apistogramma* Regan (Cichlidae: Perciformes) da drenagem dos lagos Amanã e Urini (AM, Brasil) e chave para as espécies de ocorrência local. *Uakari*, 4(1), 7–22. <https://doi.org/10.31420/uakari.v4i1.32>
- Barros, T. F., Althoff, B. B., Pereira, D. C., Lazzarotto, H., & Caramaschi, E. P. (2018). Length–weight relationships in seven ornamental freshwater species of Characiformes from the Unini River basin (Brazilian Amazon). *Journal of Applied Ichthyology*, 34(5), 1188–1191. <https://doi.org/10.1111/jai.13699>
- Camargo, M. P., Aranha, J. M. R., & Menezes, M. S. (2018). Length-weight relationship (LWR) of fish species in the Morato River, Paraná, Brazil. *Journal of Applied Ichthyology*, 00, 1–2. <https://doi.org/10.1111/jai.13658>
- Eschmeyer, W. N., Fricke, R., & Van der Laan, R. (2020). Catalog of fishes. Genera, Species, References. Retrieved from <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>
- Froese, R. (2006). Cube law, condition factor and weight-length relationships: History, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22, 241–253. <https://doi.org/10.1111/j.1439-0426.2006.00805.x>
- Froese, R., & Binohlan, C. (2000). Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. *Journal of Fish Biology*, 56, 758–773. <https://doi.org/10.1111/j.1095-8649.2000.tb00870.x>
- Froese, R., & Pauly, D. (2020). FishBase. Retrieved from <http://www.fishbase.org/>
- Froese, R., Tsikliras, A. C., & Stergiou, K. I. (2011). Editorial note on weight–length relations of fishes. *Acta Ichthyologica et Piscatoria*, 41(4), 261–263. <https://doi.org/10.3750/AIP2011.41.4.01>
- Gery, J. (1977). *Characoids of the world* (pp. 1–672). T.F.H. Publications, 672 pp.
- King, M. (2007). *Fisheries biology, assessment and management*, 2nd ed. (pp. 1–381). Blackwell Scientific Publications.
- Le Cren, E. D. (1951). The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *Journal of Animal Ecology*, 20, 201–219. <https://doi.org/10.2307/1540>
- Mendonça, M., & Camargo, M. (2006). Etnoecologia da produção de peixes ornamentais num setor do médio Solimões, Flona Tefé e Reservas Mamirauá e Amanã. *Estado do Amazonas. Uakari*, 2(1), 53–61. <https://doi.org/10.31420/uakari.v2i1.15>
- Queiroz, H. L., & Hercos, A. L. (2009). *Plano de manejo das áreas de coleta de peixes ornamentais da Reserva Amanã (PORA) – sétima versão* (pp. 1–64). IDSM /ZSL.
- Silva, R. S., Corrêa, F., de Oliveira, L. P., & Vieira, L. J. (2019). Length-weight relation of the 14 fish species occurring on sandy beaches along a tropical river in the Amazon. *Journal of Applied Ichthyology*, 35(2), 622–624. <https://doi.org/10.1111/jai.13852>

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