Biota Neotropica 23(3): e20231523, 2023
www.scielo.br/bn
CC BY
biotaneotropica
ISSN 1676-0611 (online edition)

Short Communication

Length-weight relationships of 24 stream-dwelling fish species from the Atlantic Forest in Rio de Janeiro, Brazil

Luisa R. Manna[1], Eugenia Zandonà[1], Priscila Oliveira-Cunha[2] & Rosana Mazzoni[1]

[1]*Universidade do Estado do Rio de Janeiro, Departamento de Ecologia, Rio de Janeiro, RJ, Brasil.*
[2]*Universidade do Estado do Rio de Janeiro, Programa de Pós-Graduação em Ecologia e Evolução, Rio de Janeiro, RJ, Brasil.*
**Corresponding author: priscilacunhaoli@gmail.com*

MANNA, L.R., ZANDONÀ, E., OLIVEIRA-CUNHA, P., MAZZONI, R. **Length-weight relationships of 24 stream-dwelling fish species from the Atlantic Forest in Rio de Janeiro, Brazil.** *Biota Neotropica* 23(3): e20231523. https://doi.org/10.1590/1676-0611-BN-2023-1523

Abstract: The length-weight relationship parameter is important for obtaining fish weight and biomass data with relevant implications about species role on ecosystem functioning. Here we report the length-weight relationship (LWR) for 24 fish species from three streams located in the Atlantic Forest in the Rio de Janeiro State, Brazil. Fish were collected with electrofishing and standard length (cm) and wet weight (g) were measured to obtain the a and b parameters of the Log (W) = Log (a) + b Log (SL) equation. Length-weight relationships for seven out of 24 species (*Hypostomus punctatus, Deuterodon taeniatus, Deuterodon hastatus, Deutorodon janeiroensis, Characidium vidali, Characidium interruptum* and *Rineloricaria zawadiskii*) are reported for the first time. The length-weight relationships reported here contribute to the database that can support fish diversity conservation, fisheries management plans and studies on fish biology.
Keywords: *biodiversity; conservation; freshwater fish.*

Relação peso-comprimento de 24 espécies de peixes de riachos da Mata Atlântica do Rio de Janeiro, Brasil

Resumo: A relação peso-comprimento é um parâmetro importante para se obter o peso do peixe e sua biomassa, fornecendo dados importantes a serem incorporados em estudos sobre o papel das espécies em processos ecossistêmicos. Aqui, reportamos as relações peso-comprimento de 24 espécies de peixes de três rios localizados na Mata Atlântica do estado do Rio de Janeiro, Brasil. Os peixes foram coletados com a pesca elétrica e seu comprimento padrão (cm) e peso (g) foram medidos para obter os parâmetros a e b da equação Log(P) = Log (a) + b Log (CP). As relações peso-comprimento de sete entre as 24 espécies (*Hypostomus punctatus, Deuterodon taeniatus, Deuterodon hastatus, Deutorodon janeiroensis, Characidium vidali, Characidium interruptum* e *Rineloricaria zawadiskii*) são reportados pela primeira vez. As relações peso-comprimento informadas contribuem para a base de dados que auxilia na conservação da diversidade de peixes, na preparação de planos de manejo de pesca e estudos da biologia de peixes.
Palavras-chave: *biodiversidade; conservação; peixes de água doce.*

Introduction

Length-weight relationships (LWR) are very important for ecological, ichthyological and fisheries studies as it allows one to calculate weight by measuring length and to estimate the condition factor, providing important information on fish physiology (Le Cren 1951, Froese 2006). Data about LWR can also elucidate different aspects about fish health, individual growth and, once the fish weight is known, it is possible to estimate the biomass of an entire population or community and thus investigate ecosystem processes and how fish species can affect them (Froese 2006, Giarrizzo et al. 2006, Joyeux et al. 2009, Camara et al. 2011, Zandonà et al. 2021, Lima et al. 2022).

Here, we report the length-weight relationships for 24 stream-dwelling fish species from three Atlantic Forest streams located in the state of Rio de Janeiro, Brazil. These fish species are relatively common in the Atlantic Forest streams, but information on length-weight relationships are missing for seven species (*Hypostomus punctatus, Deuterodon taeniatus, Deuterodon hastatus, Deuterodon janeiroensis, Characidium vidali, Characidium interruptum* and *Rineloricaria zawadiskii*) in FishBase (Froese & Pauly 2023) or other published literature. As a matter of fact, *Rineloricaria zawadiskii* was described for the first time in 2022, therefore this is the first data on LWR for this species (Silva et al. 2022). In this sense, our results can be of great importance for all researchers working in this biome.

Material and Methods

Fish were collected in three Atlantic Forest streams in Rio de Janeiro, Brazil: Rio Guapiaçu (22°26′08.2′′S and 42°45′31.8′′W), Rio Ubatiba (22°52′15.9′′S and 42°44′14.1) and Rio Mato Grosso (22°52’24.7”S and 42°39’06.4”W) (Figure 1). Rio Guapiaçu is within the Guapiaçu-Macacu basin, which provides water to 2.5 million people among five cities in the surrounding area. Rio Guapiaçu is a fourth-order stream with a maximum width of 13m and a maximum depth of 1.5m (Manna et al. 2019). The riparian area is densely forested and the substrate composed of a mixture of bedrock, sand and leaf litter distributed across runs and pools (Manna et al. 2017). Rio Ubatiba is a low-elevation second-order stream in the Serra do Mar mountain

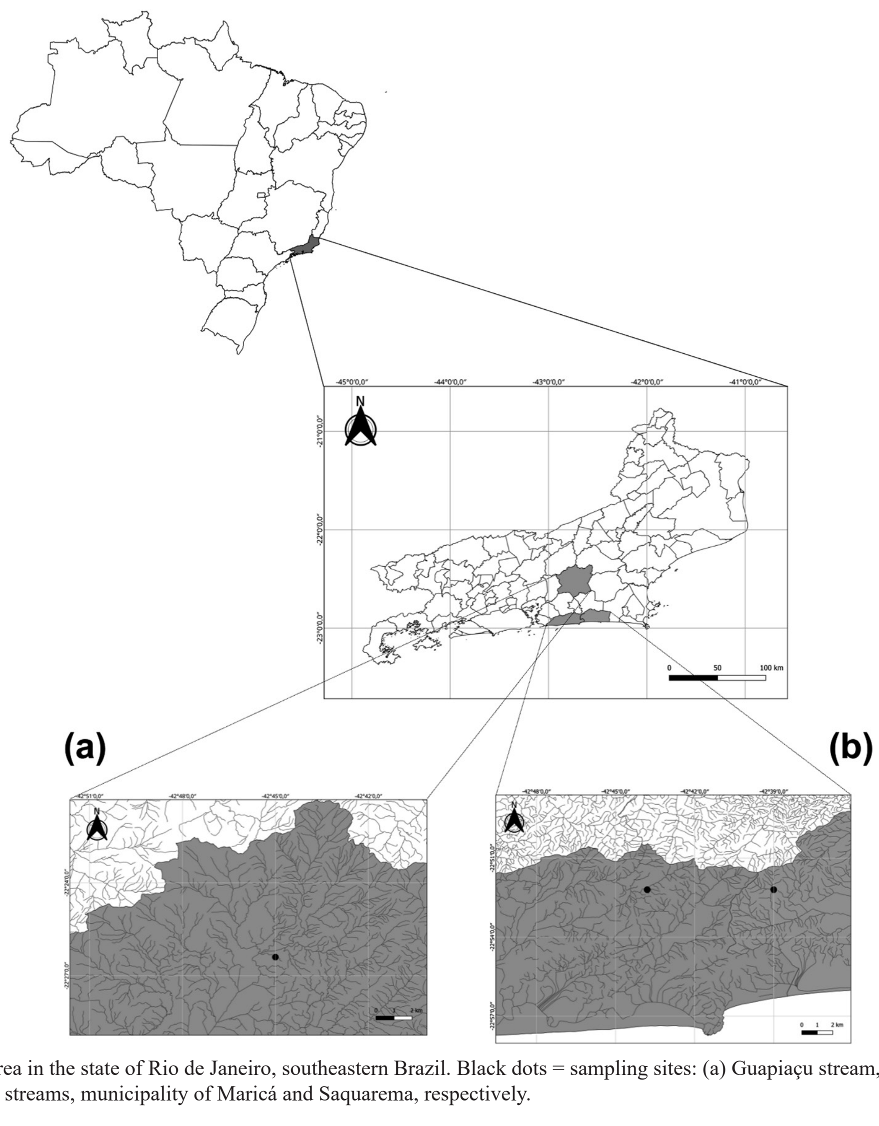

Figure 1. Map of the study area in the state of Rio de Janeiro, southeastern Brazil. Black dots = sampling sites: (a) Guapiaçu stream, municipality of Guapimirim, (b) Ubatiba and Mato Grosso streams, municipality of Maricá and Saquarema, respectively.

range. It flows through meadows deforested for agricultural practices and cattle ranching, but patches of secondary Atlantic Forest are still common on the top of the surrounding hills. The average width and depth of our sampling sites was 1.2 m and 0.4 m, respectively. Rio Mato Grosso is a third-order stream that flows for about 11 km before discharging into the Saquarema lagoon, a large brackishwater lagoon formed by the accumulation of sand dunes offshore. Average width and depth of our sampling sites was 3.6 m and 27.4 cm, respectively (this sampling site is described in more detail in Mazzoni & Lobón-Cervià 2000, Rezende et al. 2013, Manna et al. 2020).

Fish sampling was conducted in Rio Guapiaçu during the dry season in June, July, and October 2012; in Rio Ubatiba during three periods: (i) from July 1994 to July 1995, (ii) July 2015 to January 2016, and (iii) February 2019; and in Rio Mato Grosso from March 2016 to January 2017. In all sites, fish were collected in a 200-m long reach, delimited by two seine nets (mesh size 5 mm). We used a backpack portable electrofishing device (Mazzoni et al. 2000) to catch fish using successive removals (Zippin 1958). The fish were euthanized with a solution of 0.4 ml of eugenol, 3.6 ml of methanol and 1L of distilled water, and subsequently fixed in formalin 10%. After seven days, all fish specimens were preserved in 70% ethanol.

Fish species identification was confirmed by specialists at the National Museum of the Federal University of Rio de Janeiro (MN-UFRJ). After fixation, fish were measured with a caliper for standard length (to the nearest 0.01 cm) and weighted (wet weight, nearest 0.01g). The length-weight relationships were obtained using the equation Log (W) = Log (a) + b Log (SL) where W is the fish wet weight (g), and SL is the standard length (cm). The coefficient of determination (R^2) and the 95% confidence interval of the a and b parameters of the equation were calculated. Outliers were excluded by visual detection when plotting the Log W – Log SL relationship.

Results

In this study, we sampled a total of 1081 specimens belonging to 24 fish species and 11 families to obtain their length (cm) and weight (g) measurements. Length-weight relationships (LWR) from each species and study site, sample sizes (N), ranges for standard length and weight, the means and 95% Confidence Interval (95% CI) for the equation parameters a and b, and the coefficient of determination (R^2) are presented in Table 1. The coefficient of determination (R^2) ranged from 0.720 to 0.994, a values ranged from 0.0008 to 0.039 and b values from 2.55 to 3.60.

Table 1. Length-weight relationships (LWR) for 24 fish species from Atlantic Forest streams in Brazil.

Species/Family	**N**	**Standard Length (Min-Max) (cm)**	**Weight (Min-Max) (g)**	***a* (95% CI)**	***b* (95%CI)**	**R^2**
Rio Guapiaçu						
Characidae						
Deuterodon taeniatus	17	6.71–10.69	8.74–35.85	*0.031 (0.015–0.067)*	*2.95 (2.60–3.30*	0.956
Bryconamericus ornaticeps	23	3.44–5.07	0.82–3.00	*0.018 (0.011–0.030)*	*3.09 (2.76–3.42)*	0.948
Mimagoniates microlepis	44	1.36–4.80	0.04-2.10	*0.016 (0.014–0.017)*	*3.07 (2.98–3.16)*	0.991
Heptapteridae						
Acentronichtys leptos	19	2.86–7.74	0.156–3.761	*0.009 (0.006–0.013)*	*2.85 (2.63–3.07)*	0.977
Pimelodella lateristriga	29	2.7–10.7	0.3–14.1	*0.013 (0.010–0.017)*	*2.93 (2.80–3.07)*	0.987
Crenuchidae						
Characidium vidali	43	2.42–6.22	0.32–3.75	*0.029 (0.022–0.0038)*	*2.66 (2.48–2.84)*	0.956
Poeciliidae						
Phalloceros harpagos	18	1.53–2.77	0.10–0.47	*0.031 (0.024–0.040)*	*2.55 (2.17–2.94)*	0.924
Loricariidae						
Rineloricaria zawadiskii	24	6.14–14.70	1.55–35.0	*0.002 (0.001–0.003)*	*3.60 (3.41–3.79)*	0.986
Ancistrus multispinis	9	2.76–7.85	0.56–18.68	*0.02 (0.012–0.032)*	*3.28 (2.98–3.57)*	0.990
Callichthyidae						
Scleromystax barbatus	20	2.44–6.54	0.47–7.79	*0.039 (0.032–0.046)*	*2.82 (2.71–2.93)*	0.994
Synbranchidae						
Synbranchus marmoratus	5	21.05–34.06	9.01–41.82	*0.001 (0.000–0.025)*	*3.05 (2.03–4.07)*	0.968
Trichomycteridae						
Trichomycterus gr. *zonatus*	8	2.75–5.48	0.28–2.03	*0.016 (0.011–0.021)*	*2.83 (2.61–3.05)*	0.994

Continue...

...Continuation

Species/Family	N	Standard Length (Min-Max) (cm)	Weight (Min-Max) (g)	*a* (95% CI)	*b* (95%CI)	R^2
Rio Ubatiba						
Anablepidae						
Jenynsia multidentata	17	2.0–2.9	0.17–0.54	*0.019 (0.013–0.028)*	*3.19 (2.74–3.64)*	0.938
Characidae						
Deuterodon hastatus	399	2.5–6.2	0.22–8.32	*0.019 (0.016–0.022)*	*3.21 (3.11–3.31)*	0.911
Deuterodon janeiroensis	328	0.29–42.2	2.3–11.4	*0.026 (0.024–0.029)*	*3.00 (2.94–3.05*	0.973
Mimagoniates microlepis	374	1.2–4.6	0.06–1.60	*0.028 (0.025–0.032)*	*2.57 (2.44–2.69)*	0.806
Cichlidae						
Geophagus brasiliensis	115	1.0–7	0.01–16.09	*0.019 (0.017–0.021)*	*3.38 (3.31–3.46)*	0.985
Crenuchidae						
Characidium sp	154	2.6–7.2	0.2–6.48	*0.014 (0.010–0.019)*	*3.06 (2.87–3.25)*	0.864
Characidium interruptum	15	2.1–4.0	0.14–1.5	*0.015 (0.005–0.045)*	*3.09 (2.14–4.04)*	0.791
Erythrinidae						
Hoplias malabaricus	18	1.8–17.8	0.08–79.48	*0.017 (0.010–0.029)*	*2.92 (2.69–3.14)*	0.979
Heptapteridae						
Pimelodella lateristriga	94	3.7–7.4	0.61–4.99	*0.013 (0.010–0.016)*	*2.91 (2.77–3.05)*	0.949
Rhamdia quelen	12	6.4–8.3	1.99–6.03	*0.002 (0.0005–0.0074)*	*3.74 (3.09–4.39)*	0.943
Poeciliidae						
Phalloceros harpagos	90	1.0–3.2	0.02–0.69	*0.016 (0.014–0.018)*	*3.06 (2.91–3.22)*	0.946
Poecilia reticulata	13	1.4–3.3	0.04–0.68	*0.018 (0.014–0.023)*	*3.10 (2.72–3.48)*	0.966
Poecilia vivipara	98	1.0–4.0	0.01–2.13	*0.019 (0.017–0.020)*	*3.36 (3.29–3.44)*	0.987
Synbranchidae						
Synbranchus marmoratus	7	15.5–22.5	3.64–11.4	*0.0008 (0.0001–0.0005)*	*3.05 (2.44–3.65)*	0.971
Rio Mato Grosso						
Heptapteridae						
Pimelodella lateristriga	206	3.0–11.7	0.5–19.5	*0.015 (0.014–0.017)*	*2.89 (2.82–2.96)*	0.972
Rhamdia quelen	14	9.54–16.5	12.48–69.54	*0.013 (0.005–0.036)*	*3.04 (2.66–3.42)*	0.961
Loricariidae						
Hypostomus punctatus	34	2.2–11.1	0.23–25.83	*0.025 (0.017–0.037)*	*2.89 (2.58–3.20)*	0.919
Parotocinclus maculicauda	121	2.4–3.9	0.29–1.30	*0.032 (0.022–0.047)*	*2.62 (2.29–2.94)*	0.720

Discussion

In this study, we present length-weight relationships (LWR) of 24 fish species, of which seven have no previous LWR documented in FishBase (Froese & Pauly 2023). The coefficient of allometry (b) ranged from 2.55 (*Phalloceros harpagos*) to 3.74 (*Rhamdia quelen*), with the majority of the species presenting values within the expected range of 2.5–3.5 (Froese 2006).

Among the species for which LWR are reported, for *B. ornaticeps, A. leptos, P. lateristriga, S. marmoratus, T. zonatus, H. malabaricus, P. reticulata* and *R. quelen* the b value is similar to the records in FishBase (Froese & Pauly 2023). On the other hand, for *P. harpagos, S. barbatus, H. malabaricus, M. microlepis, Jenynsia multidentata* and *P. maculicauda,* b values are lower than Fishbase data, while for *A. multispinis, Poecilia vivipara* and *G. brasiliensis,* b values are higher. This variability in b values is also present in previous studies and can

https://doi.org/10.1590/1676-0611-BN-2023-1523

be due to a combination of biological factors, such as the length range of individuals sampled, their maturity stage, stomach fullness, diet, the presence of disease or parasite, and environmental conditions, such as temperature, pollution or fishing pressure (Franklin et al. 2009, Froese 2006, Ogunola et al. 2018).

In contrast to our results, previous studies described higher values of standard length, R^2 and b coefficients for *P. harpagos*, revealing that differences in local conditions, such as habitat, seasonal variation and stream area, can explain differences in length-weight relationships (Campos et al. 2020). Other factors, such as predation and intra and interspecific competition can affect reproduction, condition factor, and growth rate, thus influencing maximum length, intraspecific weight variation, and a and b coefficients, as observed here. For instance, *P. harpagos* fecundity and size is affected by predation (Gorini-Pacheco et al. 2018). Also, being a matrotrophic species (the mother provides nutrients to the developing embryos throughout pregnancy), pregnancy stage could affect the female weight (Zandonà et al. 2021) and thus be a source of variation in the LWR.

Moreover, our study observed a low R^2 for *P. maculicauda* in a stream impacted by pasture ($R^2 = 0.720$). In contrast, Campos et al (2020) found a $R^2 = 0.956$ for the same species in well preserved streams. This difference in R^2 values could indicate the influence of environmental conditions in LWR. Therefore, it is possible that the lower R^2 in impacted streams could be a consequence of differences in resource availability which is resulting in higher individual variability in fish weight. Other sources of intraspecific variation in fish weight that could be causing lower R^2 values are differences in reproductive status, condition factor, or seasonality (Campos et al. 2020, Lima et al. 2022). As for *S. marmoratus*, it is worth mentioning that its low sample size (Rio Guapiaçu: n = 5; Rio Ubatiba: n = 7) is because this is a rare species. Thus, this estimate must be treated with caution.

Anthropogenic threats to fish biodiversity from Atlantic Forest coastal streams are already known, caused especially by biological invasions and environmental alterations (Bezerra et al. 2019). Therefore, it is very important to gather information and increase our understanding of fish biology to trace effective conservation strategies and preserve the biodiversity of this biome.

Acknowledgments

We are grateful to the members from the “Laboratório de Ecologia de Peixes” (LEP/UERJ) for their assistance during the field work. We also thank Tauany Rodrigues for helping in the elaboration of the map of study area. This study was supported by CAPES (#BEX 352 0152/14-5) and FAPERJ (E-26/203.911/2022) to LRM, by CNPQ (PQ - 301621/2013-6) and FAPERJ (CNE E-26/203.193/2015) to RM, and by FAPERJ (E-26/205.768/2022) to POC.

Associate Editor

Juan Schmitter-Soto

Author Contributions

Luisa R. Manna: Conceptualization; Methodology; Writing.

Eugenia Zandonà: Conceptualization; Statistical analysis; Writing.

Priscila Oliveira-Cunha: Conceptualization; Statistical analysis; Writing.

Rosana Mazzoni: Conceptualization; Methodology; Writing; Funding acquisition.

Conflict of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

Ethics

All sampled fish were collected in accordance with the applicable Brazilian environmental legislation (collecting permit IBAMA/MMA 02022.002475/2006-10, authorization number 118/2006 – DIFAP/IBAMA). Voucher specimens, obtained in previous studies developed in the three studied streams, were placed in the collection of the Museu Nacional do Rio de Janeiro and Universidade Federal do Tocantins (MNRJ and UFT).

Data Availability

https://doi.org/10.48331/scielodata.ZLTY5L

References

Bezerra, L. A. V., Freitas, M. O., Daga, V. S., Occhi, T. V. T., Faria, L., Costa, A. P. L., ... & Vitule, J. R. S. (2019). A network meta-analysis of threats to South American fish biodiversity. Fish and Fisheries, 20(4), 620–639.

Camara, E. M., Caramaschi, E. P., & Petry, A. C. (2011). Fator de condição: Bases conceituais, aplicações e perspectivas de uso em pesquisas ecológicas com peixes. Oecologia Australis, 15, 249–274. https://doi.org/10.4257/oeco.2011.1502.05

Campos, L. L., Gomes, L. C., Gentilin-Avanci, C., & Benedito, E. (2020). Length-Weight Relationships for freshwater fishes from streams of the Atlantic Rainforest, State of Paraná, Brazil. Journal of Applied Ichthyology, 36(6), 866–869. https://doi.org/10.1111/jai.14095

Froese, R. & D. Pauly. Editors. (2023). FishBase. www.fishbase.org, version (02/2023).

Franklin, E. C., Brong, C. V., Dow, A. R., & Craig, M. T. (2009). Length–weight and length–length relationships of three endemic butterfly- fish species (Chaetodontidae) from coral reefs of the Northwestern Hawaiian Islands, USA. Journal of Applied Ichthyology, 25, 616–617. https://doi.org/10.1111/j.1439-0426.2009.01281.x

Froese, R. (2006). Cube law, condition factor and weight–length relationships: History, meta-analysis and recommendations. Journal of Applied Ichthyology, 22(4), 241–253. https://doi. org/10.1111/j.1439-0426.2006.00805.x

Giarrizzo, T., Silva de Jesus, A. J., Lameira, E. C., Araújo de Almeida, J. B., Isaac, V., & Saint-Paul, U. (2006). Weight–length relationships for intertidal fish fauna in a mangrove estuary in Northern Brazil. Journal of Applied Ichthyology, 22(4), 325–327. https://doi. org/10.1111/j.1439-0426.2006.00671.x

Gorini-Pacheco, B., Zandonà, E., & Mazzoni, R. (2018) Predation effects on matrotrophy, superfetation and other life history traits in *Phalloceros harpagos*. Ecol Freshw Fish, 27: 442– 452. https://doi.org/10.1111/eff.12359

Joyeux, J.-C., Giarrizzo, T., Macieira, R. M., Spach, H. L., & Vaske, T. J. R. (2009). Length-weight relationships for Brazilian estuarine fishes along a latitudinal gradient. Journal of Applied Ichthyology, 25(3), 350– 355. https://doi.org/10.1111/j.1439-0426.2008.01062.x

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(2), 201–219. https://doi.org/10.2307/1540

Lima, RGS, Soares, B.E., Barros, T.F., Mazzoni, R & Caramaschi, E.P. (2022). Length-weight relationships in 45 Neotropical fish species from the upper Tocantins River basin (Brazil). Journal of Applied Ichthyology. DOI: 10.1111/jai.14314

Manna, L. R., Rezende, C. F., & Mazzoni, R. (2017). Effect of body size on microhabitat preferences in stream-dwelling fishes. Journal of Applied Ichthyology, 33(2), 193–202.

Manna, L. R., Villéger, S., Rezende, C. F., & Mazzoni, R. (2019). High intraspecific variability in morphology and diet in tropical stream fish communities. Ecology of Freshwater Fish, 28(1), 41–52.

Manna, L. R., Miranda, J. C., Rezende, C. F., & Mazzoni, R. (2020). Feeding strategy and morphology as indicators of habitat use and coexistence of two loricariid fishes from a Brazilian coastal stream. Biota Neotropica, 20 (Biota Neotrop., 2020 20(1)). https://doi.org/10.1590/1676-0611-BN-2019-0764

Mazzoni, R. & Lobón-Cerviá, J. (2000), Longitudinal structure, density and production rates of a Neotropical stream fish assemblage: the river Ubatiba in the Serra do Mar, southeast Brazil. Ecography, **23**, 588–602

Ogunola, O. S., Onada, O. A., & Falaye, A. E. (2018). Preliminary evalua- tion of some aspects of the ecology (growth pattern, condition fac- tor and reproductive biology) of African pike, Hepsetus odoe (Bloch 1794), in Lake Eleiyele, Ibadan, Nigeria. Fisheries and Aquatic Sciences, 21, 12. https://doi.org/10.1186/s41240-018-0087-y

Rezende C.F.; Lobón-Cerviá J.; Caramaschi E.P. & Mazzoni R. (2013). Trophic ecology of two benthivorous fishes in relation to drift and benthos composition in a pristine Serra do Mar stream (Rio de Janeiro, Brazil). Fundam. Appl. Limnol. Vol. 183/2

Silva, G., Silva, G. & Oliveira, Claudio. (2022). A new species of spiny Rineloricaria (Siluriformes: Loricariidae) from the Rio Paraba do Sul basin and coastal rivers from Rio de Janeiro State. Zootaxa. 5175. 285–292. 10.11646/zootaxa.5175.2.6.

Zandonà, E., Kajin, M., Buckup, P. A., Amaral, J. R., Souto-Santos, I. C. A., & Reznick, D. N. (2021). Mode of maternal provisioning in the fish genus *Phalloceros*: a variation on the theme of matrotrophy. Biological Journal of the Linnean Society, 134(4), https://doi.org/10.1093/biolinnean/blab121

Received: 21/06/2023

Accepted: 03/09/2023

Published online: 20/10/2023