

2 **Technical Contribution**

3

4 **Length–weight relationships of four fish species from the upper Paraná River**
5 **basin, Southeastern Brazil**

6

7 Valter M. Azevedo-Santos¹, Paula N. Coelho², Eduardo M. Brambilla², Felipe P. de
8 Lima³, André B. Nobile³, J. Robert Britton⁴

9

10 ¹Laboratório de Ictiologia, Departamento de Zoologia, Universidade Estadual Paulista
11 “Júlio de Mesquita Filho”, Botucatu, São Paulo, Brazil

12 ²Departamento de Zoologia, Universidade Estadual Paulista “Júlio de Mesquita Filho”,
13 Botucatu, São Paulo, Brazil

14 ³Departamento de Morfologia, Instituto de Biociências, Universidade Estadual Paulista
15 “Júlio de Mesquita Filho”, Botucatu, São Paulo, Brazil

16 ⁴Department of Life and Environmental Sciences, Faculty of Science and Technology,
17 Bournemouth University, Poole, BH12 5BB, United Kingdom.

18

19 **Correspondence**

20 Valter M. Azevedo-Santos, Laboratório de Ictiologia, Departamento de Zoologia,
21 Universidade Estadual Paulista “Júlio de Mesquita Filho”, Botucatu, Brazil

22 E-mail: valter.ecologia@gmail.com

23

24 **Summary**

25

26 Here the length–weight relationships (LWR, hereafter) of *Pareiorhina pelicicei*,
27 *Trichomycterus candidus*, *T. pirabitira*, and *T. piratymbara* are provided. Samples of
28 each species were collected between April and July 2017 with a hand net (1.5 mm
29 mesh) in three sites from the upper Paraná River basin, Southeastern Brazil. These
30 results increase knowledge about the LWR of Neotropical freshwater fish.

31

32 INTRODUCTION

33 In recent years, a number of length–weight relationship (LWR, hereafter) studies
34 have been published for Neotropical freshwater fishes, providing biological information
35 on numerous fish species (e.g., Oliva-Paterna et al., 2009; Orsi & Britton, 2011; Batista-
36 Silva et al., 2014; Vegh et al., 2014; Giarrizzo et al. 2015; Nobile et al., 2015; Freitas-
37 Souza et al., 2016; Marques et al., 2016; Lima et al. 2017). Nevertheless, there remains
38 a lack of available biological data, especially for those species in smaller tributaries or
39 that have only been described recently. Correspondingly, to contribute to LWR studies
40 of fishes from the Neotropics, we present here data on four species from streams of the
41 Grande River basin, upper Paraná River basin, Minas Gerais, Brazil.

42

43 MATERIAL AND METHODS

44 Individuals of each species were collected between April and July 2017 using a
45 hand net (1.5 mm mesh size) in three sites from the Grande River basin, Upper Paraná
46 River basin (Tab. 1). As accurate species identification and weighing in the field was
47 not feasible, captured specimens were euthanized with anesthetic and fixed in formalin
48 (10%) before being taken back to the laboratory. There, species identification was based
49 on Barbosa & Costa (2003), Katz et al. (2013), Azevedo-Santos & Roxo (2015) and
50 Barbosa & Azevedo-Santos (2012). Following identification, specimens were weighed
51 on a digital balance (to 0.00001 g) and measured standard length (SL, to 0.01 cm) under
52 stereomicroscope using a digital caliper. Data for the fishes represent their LWR
53 following fixation in formalin. After these procedures, specimens were transferred to
54 alcohol 70 % for preservation.

55 The relationship between standard length and weight for each species was
56 determined based on Keys (1928). As recommended by Froese (2006), the data were
57 examined in log-log plots to identify and remove outlying data points.

58

59 **RESULTS**

60 A total of 68 specimens were captured, representing four species (Tab. 2).
61 Their data were appropriate for length-weight analyses and their values of a and b , plus
62 the associated statistical information, are provided in Table 2.

63

64 **DISCUSSION**

65 Whilst the sample size of each species was relatively low, all values of r^2 were
66 considered acceptable, with values of b in the LWR being between 2.70 and 3.13 (Tab.
67 2). Froese (2006) suggests that values of b between 2.5 and 3.5 are adequate, with
68 others suggest values of 2.5 to 2.7 might be erroneous (e.g., Britton and Harper, 2006).
69 Consequently, the derived b values for each species here are within the range that is
70 expected for the LWR of fish generally (see Froese 2006).

71 The size range covered for *Trichomycterus candidus* was small (i.e., 2.39 to 4.97
72 cm). Therefore, the LWR for this species should be considered as preliminary and needs
73 to be verified in future studies using a larger sample size collected over a larger spatial
74 range.

75 In summary, here the LWR of four fish species (i.e., *Pareiorhina pelicicei*,
76 *Trichomycterus candidus*, *T. pirabitira*, and *T. piratymbara*) are provided. These data
77 consist of important biological information for Neotropical freshwater fishes.

78

79

80 **ACKNOWLEDGEMENTS**

81 We are grateful to Rainer Froese, for the comments to improve this manuscript.
82 VMAS and EMB were supported by Coordenação de Aperfeiçoamento de Pessoal de
83 Nível Superior (CAPES); FPL was supported by Conselho Nacional de
84 Desenvolvimento Científico e Tecnológico (CNPq); and ABN was supported by
85 Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, process 15/19025-
86 9).

87

88 **REFERENCES**

89

- 90 Anzueto-Calvo, M. J., Velázquez-Velazquez, E., Matamoros, W. A., Maza, B. G. A. C.,
91 Nettel-Hernanz, A. (2017). Effect of conservation of fish in formalin and ethanol
92 on length-weight relationships and condition factor in *Tlaloc labialis* (Günther,
93 1866). <https://doi.org/10.1111/jai.13461>
- 94 Azevedo-Santos, V. M., & Roxo, F. F. (2015). A new species of the genus *Pareiorhina*
95 (Teleostei: Siluriformes: Loricariidae) from the upper rio Paraná basin,
96 southeastern Brazil. *Zootaxa*, 3937, 377-385.
- 97 Barbosa, M. A., & Costa, W. J. E. M. (2003). Validade, relações filogenéticas e
98 redescrição de *Eremophilus candidus* Ribeiro, 1949 (Teleostei, Siluriformes,
99 Trichomycteridae). *Arquivos do Museu Nacional*, 61, 179-188.
- 100 Barbosa, M. A., & Azevedo-Santos, V. M. (2012). A new species of the catfish genus
101 *Trichomycterus* (Teleostei: Siluriformes: Trichomycteridae) from the rio Paraná
102 basin, southeastern Brazil. *Vertebrate Zoology*, 62, 357-362.
- 103 Barletta, M., Jaureguizar, A. J., Baigun, C., Fontoura, N. F., Agostinho, A. A., Almeida-
104 Val, V. M. F., Val, A. L., Torres, R. A., Jimenez-Segura, L. F., Giarrizzo, T.,
105 Fabré, N. N., Batista, V. S., Lasso, C., Taphorn, D. C., Costa, M. F., Chaves, P.
106 T., Vieira, J. P. & Correa, M. F. M. (2010). Fish and aquatic habitat conservation
107 in South America: a continental overview with emphasis on Neotropical
108 systems. *Journal of Fish Biology*, 76, 2118–2176.
- 109 Batista-Silva, V. F., Bailly, D., Kashiwaqui, E. A. L., Abelha, M. C. F., & Graça, W. J.
110 (2015). Length-weight relationships for 55 freshwater fish species from the

111 Iguatemi River, Upper Paraná River basin, Brazil. *Journal of Applied*
112 *Ichthyology*, 31, 257-260.

113 Britton, J. R., Harper, D. M., 2006: Length weight relationships of some fish species in
114 the Rift Valley Lakes of Kenya. *Journal of Applied Ichthyology*, 22, 334-336.

115 Freitas-Souza, D., Nobile, A. B., Lima, F. P., Britto, S. G. C., Nogueira, M. G. (2016).
116 Length–weight relationships for 11 species at three small hydropower plants on
117 the Sapucaí-Mirim River (Grande River basin, Brazil). *Journal of Applied*
118 *Ichthyology*, 32, 1360-1362.

119 Froese, R. (2006). Cube law, condition factor and weight–length relationships: History,
120 meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22, 241-
121 253.

122 Giarrizzo, T., Oliveira, R.R.S., Andrade, M.C., Gonçalves, A.P., Barbosa, T. A. P.,
123 Martins, A. R., Marques, D. K., Santos, J.L.B., Frois, R.P.S., Albuquerque,
124 T.P.O., Montag, L.F.A., Camargo, M., Sousa, L.M. (2015). Length–weight and
125 length–length relationships for 135 fish species from the Xingu River (Amazon
126 Basin, Brazil). *Journal of Applied Ichthyology*, 31, 415–424

127 Katz, A.M., Barbosa, M.A., & Costa, W.J.E.M. (2013). Two new species of the catfish
128 genus *Trichomycterus* from the Paraná river basin, southeastern Brazil
129 (Teleostei: Trichomycteridae). *Ichthyological Exploration of Freshwaters*, 23,
130 359-366.

131 Keys, A. B. (1928) The weight-length relationship in fishes. *Proceedings of the*
132 *National Academy of Science*, 14, 922–925.

133 Lima, F. P., Nobile, A. B., Freitas-Souza, D., Siqueira, C. A., Lemos, C. A., Abreu-
134 Santos, B., Santos, J. A. P. (2017) Length–weight relationships for 35 fish
135 species of the Atlantic Forest, SP/RJ—Brazil. *Journal of Applied Ichthyology*,
136 33, 600–603

137 Marques, H., Nobile, A. B., Dias, J. H. P., & Ramos, I. P. (2016). Length–weight and
138 length–length relationships for 23 fish species of Porto Primavera reservoir,
139 Upper Paraná River, Brazil. *Journal of Applied Ichthyology*, 32, 1342-1346.

140 Nahum, V. J. I., Castello, J. P., Rosenthal, H., (2009). Editorial Special issue: modern
141 fisheries research approaches in Brazil. *Journal of Applied Ichthyology*, 25, 243.

142 Nobile, A. B., Brambilla, E. M., de Lima, F. P., Freitas-Souza, D., Bayona-Perez, I. L.,
143 & Carvalho, E. D. (2015). Length–weight relationship of 37 fish species from
144 the Taquari River (Paranapanema Basin, Brazil). *Journal of Applied*
145 *Ichthyology*, 31, 580-582.

146 Oliva-Paterna, F. J., Torralva, M., and Carvalho, E. D. (2009). Length–weight
147 relationships for 20 species collected in the Jurumirim reservoir (Paranapanema
148 Basin, Brazil). *Journal of Applied Ichthyology*, 25, 360-361.

149 Orsi, M. L., and Britton, J. R. (2011). Length–weight relationships of 15 fishes of the
150 Capivara Reservoir (Paranapanema basin, Brazil). *Journal of Applied*
151 *Ichthyology*, 28, 146-147.

152 Vegh, S. L., Lozano, I. E., & Dománico, A.A. (2014).Length–weight, length–length
153 relationships and length at first maturity of fish species from the Paraná and
154 Uruguay rivers, Argentina. *Journal of Applied Ichthyology*, 30, 555-557.

155
156
157
158
159

Table 1. Sampled localities in the Grande River basin, Upper Paraná River basin, Minas Gerais, Brazil

| Site | Remarks | Coordinates |
|------|--|------------------------------|
| S1 | Stream known as “Tamborete”. | 20°38'37.07"S, 46°10'15.98"W |
| S2 | Small river known as “Santa Quitéria”. | 21° 0'17.85"S, 46°14'48.27"W |
| S3 | A small stream of unknown name. | 21°7'36.65"S, 46°16'59.10"W |

Table 2. Standard length (cm) weight (g) relationship for the **four** sampled fishes of the Grande River basin, Brazil, where $W=aL^b$. The length-weight relationships for all species were significant at $P < 0.001$.

| Site | Family | Taxa | n | WT range (g) | SL range (cm) | a (95% CI) | b (95% CI) | r ² |
|------|------------------|---|----|--------------|---------------|------------------------|------------------|----------------|
| S1 | Loricariidae | <i>Pareiorhina pelicicei</i> Azevedo-Santos & Roxo, 2015 | 24 | 0.13-1.83 | 1.87-4.28 | 0.0201 (0.0178-0.0224) | 3.13 (3.01-3.25) | 0.992 |
| S2 | Trichomycteridae | <i>Trichomycterus candidus</i> (Miranda Ribeiro, 1949) | 14 | 0.16-1.09 | 2.39-4.97 | 0.0149 (0.0093-0.0204) | 2.70 (2.30-3.11) | 0.946 |
| S3 | Trichomycteridae | <i>Trichomycterus pirabitira</i> Barbosa & Azevedo-Santos, 2012 | 11 | 0.29-5.62 | 2.76-7.72 | 0.0125 (0.0088-0.0162) | 2.99 (2.77-3.22) | 0.990 |
| S1 | Trichomycteridae | <i>Trichomycterus piratymbara</i> Katz, Barbosa & Costa, 2013 | 18 | 0.31-2.07 | 3.01-5.46 | 0.0119 (0.0071-0.0167) | 2.92 (2.56-3.28) | 0.949 |