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MORPHOMETRIC RELATIONS OF FRESHWATER FISHES OF THE SUAZA RIVER (HUILA DEPARTMENT, COLOMBIA)

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Abstract. The knowledge of freshwater fishes in remote Andean mountains is scarce and restricted to changes of occurrence distribution along a specific gradient. The high number of endemic fish species requires further studies regarding their biology and their conservation status. The present study aims to estimate the length–weight, length–length, and length–girth relations for nine native freshwater fish species representing five families (Loricariidae, Characidae, Heptapteridae, Crenuchidae, and Parodontidae): *Chaetostoma thomsoni* Regan, 1904; *Lasiancistrus caucanus* Eigenmann, 1912; *Rineloricaria jubata* (Boulenger, 1902); *Bryconamericus huilae* Román-Valencia, 2003; *Gephyrocharax melanocheir* Eigenmann, 1912; *Pimelodella chagresi* (Steindachner, 1876); *Rhamdia guatemalensis* (Quoy et Gaimard, 1824); *Characidium fasciatum* Reinhardt, 1867; *Parodon suborbitalis* Valenciennes, 1850. The fishes were collected in the Suaza River (Huila, Colombia). These are the first length–weight relations reported for all these species, mostly endemic to the Colombian Andes. The report also provides the new maximum size for four species.

Keywords: length, weight, girth, neotropical fishes, mountain river, Andes

In fisheries biology, the knowledge of length–weight relations (LWRs) of fishes is useful:

- In determining weight and biomass when only length measurements are available;
- For providing information on energy budget, reproductive patterns, and feeding conditions of individuals (Park and Huh 2015); and
- For management and conservation of natural populations (Hossain et al. 2012).

Regarding other biometric relations, maximum girth of fish body is related to the efficiency of gill and trammel nets, determining the size of the fish caught by different mesh sizes (Kurkilahti et al. 2002). High selection effectiveness would lower the pressure on undersized fish, and thereby increase the future size of an exploitable stock (Sistiaga et al. 2009). Relations between total and standard lengths of fishes are also important in management for comparative growth studies (Sandoval-Huerta et al. 2015). These relations have been studied for the most common and exploited species, nevertheless few LWRs are known for fish without a prominent commercial interest that use to be restricted to remote areas (Gaspar et al. 2012).

Colombia is considered one of the world's top biodiversity hotspots, harboring probably more than 10% of global biodiversity (Arbeláez-Cortés 2013). The freshwater fish diversity in the Colombia Andes is very high with 188 reported species, the majority of which inhabit only the Colombian Andean basins (Maldonado-Ocampo et al. 2005).

However, our knowledge of the biology of these fishes is very poor. In this context, we estimated biometric relations for nine captured species from an ecological survey in the Suaza River, located on the Colombian Andes, as a first approach to study the biology of fish species in this remote area.

This work represents the first biological survey of the Suaza River, in Colombia. The river was studied

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from the source, in the Cueva de los Guacharos National Park, almost to the confluence with the Magdalena River (1°38'–1°59′N, 76°06′–75°46′W). The river flows, from south to North, for 136 km through the cloud forest and Andean páramo ecosystems of the Huila Department. The altitude varies from more than 1880 to 720 m above sea level in the Magdalena River junction.

Fish sampling was conducted using a backpack electrofishing unit (Hans Grassl model IG200/2D, 300–600 V, 0.2–2 A) at eleven sampling sites located along the river in January 2011. The collected fishes were anesthetized and subsequently measured to the nearest 0.01 cm total length (TL), weighed with a digital scale to an accuracy of 0.05 g, and released after the survey, with the exception of some voucher specimens kept for posterior identification.

In the laboratory, fish were preserved in alcohol (75%) and identified to species using taxonomic keys and scientific literature (Maldonado-Ocampo et al. 2005, Mojica et al. 2005, Galvis et al. 2006). Once identified, specimens were deposited in the fish collection of the Universidad de la Amazonia, Florencia, Colombia.

The parameters of LWRs were estimated using the allometric model

$$W = a\mathrm{TL}^b$$

where W is the total body weight (expressed in grams), TL is the total length (expressed in centimeters), a is the intercept and b the slope of the regression line. Length–length relations (LLRs) were also estimated by linear regression analysis:

$$\mathrm{TL} = a + b\mathrm{SL}$$

where SL is the standard length. Only extreme outliers attributed to data error were omitted from analyses (Froese 2006). The 95% confidence limits (CL) of b were calculated (Zar 1999) to estimate differences between calculated slopes and those estimated in the future.

Maximum girth (G) of a fish was obtained from the maximum height and width, using the approximate formula proposed by Ramanujan in 1914 (cited after Arfken and Weber 2000). Maximum height and width were measured to the nearest 0.01 cm with a caliper. The perimeter of ellipse (where minor and major radii are the maximum height and width) is more accurate than the maximum circumference to estimate the true perimeter of the fish body. The length–girth relations (LGRs) between fish TL and maximum girth were estimated by linear regression analysis:

$$G = a + b\mathrm{TL}$$

Statistical analyses were performed using PAST software package (Hammer et al. 2001).

Descriptive statistics of the parameters studied and results of the regression analyses are shown in Table 1. A total of 303 specimens belonging to five families and nine species were analyzed. The following species were studied: *Chaetostoma thomsoni* Regan, 1904; *Lasiancistrus caucanus* Eigenmann, 1912; *Rineloricaria jubata* (Boulenger, 1902); *Bryconamericus huilae* Román-Valencia, 2003; *Gephyrocharax melanocheir* Eigenmann, 1912; *Pimelodella chagresi* (Steindachner, 1876); *Rhamdia guatemalensis* (Quoy et Gaimard, 1824); *Characidium fasciatum* Reinhardt, 1867; *Parodon suborbitalis* Valenciennes, 1850. The number of specimens ranged from 8 to 93 and TL ranged from 2.8 to 26.5, depending on species. All regressions were highly significant ($P < 0.001$), with r^2 values being higher than 0.851 and the allometric coefficient b ranged from 2.91 for *Rhamdia guatemalensis*, to 3.44 for *Characidium fasciatum*. The estimated parameters of the LGRs and LLRs of the same species are presented in Table 2. Length–length relations were highly significant ($P < 0.001$), with r^2 values ranged from 0.803 for *Pimelodella chagresi*, to 0.993 for *Bryconamericus huilae*.

The knowledge on the biology of the presently studied fish species is scarce. Only one species (*Bryconamericus huilae*) has been evaluated and included in the IUCN Red List of Threatened Species as least concern (Jimenez-Segura 2016). From the nine studied species, four of them are endemic species of Colombian Andes, and future efforts should be focused on the study of freshwater fishes of this singular region, seriously threatened for current and future exploitation projects (Finer et al. 2008, Finer and Jenkins 2012). All LWRs for the studied species were not previously estimated according to FishBase database (Froese and Pauly 2016) and new maximum sizes for four out of the nine studied species were also provided (Table 1). Although at least 100 specimens are adequate to estimate LWRs, for rare species collected in remote areas, such as those of the present study, fewer measurements are acceptable (Froese et al. 2011).

The allometric coefficient b felt within the expected range of 2.5–3.5 as suggested by Carlander (1969) for fish's growth and Froese and Pauly (2016). High value of this coefficient for *Characidium fasciatum* was similar that estimated for the species *Characidium zebra* Eigenmann, 1909 in other Andean river (Gaspar et al. 2012) associated to the tendency to present heavier, compact bodies as they grow (Carlander 1969).

The parameters of the LWRs can vary significantly according to sex and season, or due to other factors such as feeding rate, gonad maturity, growth phase, habitat, health and preservation techniques (Hossain et al. 2008), all of which were not accounted for in the present study. Nevertheless, these results will contribute to a better understanding of the poorly known Andean freshwater fishes; and serve as baseline data for species without previous information on length–weight relations and for comparison with future studies of these fishes.

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Table 1

Descriptive statistics and estimated length–weight relation parameters for nine fish species captured in Suaza River, Colombian Andes

Family	Species	*n*	Min TL	Max TL	*a*	*b*	95% CL of *b*	r^2
Loricariidae	*Chaetostoma thomsoni*	46	2.8	**13.4**	0.0098	3.238	2.978–3.425	0.984
	Lasiancistrus caucanus	30	4.0	17.5	0.0059	3.340	3.116–3.633	0.964
	Rineloricaria jubata	8	9.7	12.2	0.0041	2.986	1.571–4.043	0.851
Characidae	*Bryconamericus huilae*	93	4.2	**13.2**	0.0060	3.285	3.142–3.405	0.904
	Gephyrocharax melanocheir	17	2.8	**5.5**	0.0060	3.354	1.732–3.830	0.887
Heptapteridae	*Pimelodella chagresi*	20	6.1	13.3	0.0071	3.024	2.777–3.282	0.967
	Rhamdia guatemalensis	37	10.3	26.5	0.0100	2.912	2.790–3.053	0.981
Crenuchidae	*Characidium fasciatum*	41	3.3	6.0	0.0049	3.441	3.288–3.610	0.966
Parodontidae	*Parodon suborbitalis*	11	10.7	**14.9**	0.0161	2.923	2.555–3.257	0.960

LWR units: *W* in g and TL in cm; *n* = sample size, Min TL = minimum total length, Max TL = maximum total length, *a* and *b* = equation parameters, CL = confidence limits, r^2 = coefficient of determination; Bold type = Maximum total length reported data (according to FishBase).

Table 2

Total length–maximum girth (TL–*G*) and total length–standard length (TL–SL) relations for nine fish species captured in Suaza River, Colombian Andes

Species	*n*	$TL = a + G_x$				$TL = a + SL_x$			
		a	*b*	95% CL of *b*	r^2	a	*b*	95% CL of *b*	r^2
Lasiancistrus caucanus	30	–0.065	0.817	0.795–0.891	0.989	–0.641	0.685	0.657–0.784	0.967
Bryconamericus huilae	52	0.128	0.820	0.804–0.839	0.993	–0.609	0.636	0.601–0.672	0.938
Chaetostoma thomsoni	42	–0.169	0.822	0.798–0.844	0.984	–0.571	0.750	0.704–0.784	0.967
Characidium fasciatum	41	–0.382	0.924	0.878–0.969	0.983	–0.564	0.562	0.496–0.627	0.899
Gephyrocharax melanocheir	17	–0.359	0.907	0.875-1.069	0.980	–0.247	0.623	0.541–1.168	0.838
Parodon suborbitalis	11	–0.032	0.850	0.823–0.930	0.992	0.124	0.526	0.380–0.692	0.869
Pimelodella chagresi	20	0.267	0.781	0.749–0.825	0.991	–0.203	0.462	0.359–0.572	0.803
Rhamdia guatemalensis	37	–0.714	0.887	0.846–0.905	0.995	0.762	0.383	0.333–0.437	0.874
Rineloricaria jubata	8	–0.234	0.829	0.489–0.992	0.876	1.513	0.256	0.204–0.316	0.913

n = sample size, *a* and *b* = parameters of the equation, CL = confidence limits, r^2 = coefficient of determination.

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REFERENCES

Arbeláez-Cortés E. 2013. Knowledge of Colombian biodiversity: Published and indexed. Biodiversity and Conservation **22**: 2875–2906.
DOI: 10.1007/s10531-013-0560-y

Arfken G.B., Weber H. 2000. Mathematical methods for physicists, 5th edn. Academic Press, London, UK.

Carlander K. 1969. Handbook of freshwater fishery biology. Vol. 1. Iowa State University Press, Ames, IA, USA.

Finer M., Jenkins C.N. 2012. Proliferation of hydroelectric dams in the Andean Amazon and implications for Andes–Amazon connectivity. PloS one **7**: e35126.
DOI: 10.1371/journal.pone.0035126

Finer M., Jenkins C.N., Pimm S.L., Keane B., Ross C. 2008. Oil and gas projects in the western Amazon: Threats to wilderness, biodiversity, and indigenous peoples. PloS one **3**: e2932.
DOI: 10.1371/journal.pone.0002932

Froese R. 2006. Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology **22**: 241–253.
DOI: 10.1111/j.1439-0426.2006.00805.x

Froese R., Pauly D. (eds.) 2016. FishBase. [Version 01/2016] *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. DOI: 10.3750/AIP2011.41.4.01

Galvis G., Mojica J.I., Dique S.R., Castellanos C., Sánchez Duarte P., Arce M., Gutiérrez A., Jiménez L.F., Santos M., Vejarano S., Arbeláez F., Prieto E., Leiva M. 2006. Peces del Medio Amazonas: Región Leticia. Conservación Internacional, Bogotá, Colombia. [In Spanish.]

Gaspar S., Tobes I., Miranda R., Leunda P.M., Peláez M. 2012. Length–weight relationships of sixteen freshwater fishes from the Hacha River and its tributaries (Amazon Basin, Caquetá, Colombia). Journal of Applied Ichthyology **28**: 667–670. DOI: 10.1111/j.1439-0426.2011.01928.x

Hammer Ø., Harper D.A.T., Ryan P.D. 2001. PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica **4**: 9 p.

Hossain, Y., Leunda P.M., Ohtomi J., Ahmed Z.F., Oscoz J., Miranda M. 2008. Biological aspects of the Ganges River sprat *Corica soborna* (Clupeidae) in the Mathabhanga River (SW Bangladesh). Cybium **32** (3): 241–246.

Hossain M.Y., Rahman M.M., Fulanda B., Jewel M.A.S., Ahamed F., Ohtomi J. 2012. Length–weight and length–length relationships of five threatened fish species from the Jamuna (Brahmaputra River tributary) River, northern Bangladesh. Journal of Applied Ichthyology **28**: 275–277. DOI: 10.1111/j.1439-0426.2011.01900.x

Kurkilahti M., Appelberg M., Hesthagen T., Rask M. 2002. Effects of fish shape on gillnet selectivity: a study with Fulton's condition factor. Fisheries Research **54**: 153–170. DOI: 10.1016/S0165-7836(00)00301-5

Jimenez-Segura L., Mojica J., Alonso J. C., Reis R., Lima F. 2016. *Bryconamericus huilae*. The IUCN Red List of Threatened Species 2016: e.T167793A53824819. Downloaded on 17 June 2016. DOI: 10.2305/IUCN.UK.2009-2.RLTS.T167793A6383481.en

Maldonado-Ocampo J.A., Ortega-Lara A., Usma J.S., Galvis V.G., Villa-Navarro F.A., Vásquez G.L., Prada-Pedreros S., Ardila R.C. 2005. Peces de los Andes de Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, ARFO Editores, Bogota, Colombia.

Mojica J.I., Galvis G., Arbeláez F., Santos M., Vejarano S., Prieto-Piraquive E., Arce M., Sánchez-Duarte P., Castellanos C., Gutiérrez A., Duque S.R., Lobón-Cerviá J., Granado-Lorencio C. 2005. Peces de la Cuenca del Río Amazonas en Colombia: Región de Leticia. Biota Colombiana **6**: 191–210.

Park J.M., Huh S.H. 2015. Length–weight relations for 29 demersal fishes caught by small otter trawl on the south-eastern coast of Korea. Acta Ichthyologica et Piscatoria **45** (4): 427–431. DOI: 10.3750/AIP2015.45.4.13

Sandoval-Huerta E.R., Madrigal-Guridi X., Domínguez-Domínguez O., Ruiz-Campos G., González-Acosta A.F. 2015. Length–weight and length–length relations for 14 fish species from the central Mexican Pacific coast. Acta Ichthyologica et Piscatoria **45** (2): 199–201. DOI: 10.3750/AIP2015.45.2.10

Sistiaga M., Herrmann B., Larsen R.B. 2009. Investigation of the paired-gear method in selectivity studies. Fisheries Research **97**: 196–205. DOI: 10.1016/j.fishres.2009.02.002

Zar J.H. 1999. Biostatistical analysis. 4th edn. Prentice-Hall, Upper Saddle River, NJ, USA.

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