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Length–weight and length–length relationships of four endemic fish species from the middle reaches of the Yangtze River basin, China

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Summary

Length-weight (LWR) and length-length relationships (LLR) were evaluated for four endemic fish species, including *Hemibagrus macropterus* Bleeker, 1870; *Rhinogobio cylindricus* Günther, 1888; *Rhinogobio typus* Bleeker, 1871; and *Siniperca scherzeri* Steindachner, 1892, in the middle reaches of the Yangtze River basin. A total of 252 specimens were collected using gillnets and cast nets between November 2014 and January 2016. No information regarding length-weight and length-length relationships were reported previously in FishBase for these four endemic species.

1 | INTRODUCTION

The length-weight relationship (LWR) is useful for estimating the biomass of fish stocks when only the length is known, and the lengthlength relationship (LLR) is useful for converting different body length types (Forese, 2006; Moutopoulos & Stergiou, 2002; Oscoz, Campos, & Escala, 2005). This information also allows biometric and morphological comparisons between and among different fish species (Baeck, Jeong, Yeo, Huh, & Park, 2012; Lavergne, Zajonz, & Sellin, 2013).

A total of 178 endemic fish species inhabit the Yangtze River basin (Ye, Li, Liu, Zhang, & Xie, 2011). However, despite such rich fish diversity, basic biological information for most of the species is still scarce (Li, 2001). To expand this knowledge, the present study estimates the LWRs and LLRs of four endemic fish species from the middle reaches of the Yangtze River basin.

2 | MATERIALS AND METHODS

A total 252 specimens were captured using gill nets (mesh size: 2-3 cm) and cast nets (mesh size: 2 cm) between November 2014 and January 2016 downstream from the Gezhouba Dam (30°44′-30°34′N; 111°15′-111°23′E). After identification according to Anonymous (1976) and Wei and Wu (2015), each freshly captured individual was immediately measured for total length (TL, nearest

0.1 mm), standard length (SL, nearest 0.1 mm) and body weight (BW, nearest 0.1 g).

The length-weight relationship is described by the model $W = a L^b$, where W is the body weight (BW, g) and L the standard length (SL, cm), a the intercept, and b the slope. Parameters a and b of the length-weight relationship were estimated by linear regression analyses based on natural logarithms: Log $W = \log a + b \log L$ (Ricker, 1975). Log-log plots of length and weight were performed to detect outliers. TL and SL relationships were established using linear regression analysis of TL = p + q SL (Hossain et al., 2006). The coefficients of determination (r^2) and the 95% confidence limits (CL) were also estimated. Analyses were carried out with the Lab Origin pro 8.5 (OriginLab, Northampton, MA, USA), with $\alpha = .05$ set for all statistical analyses.

3 | RESULTS

A total of 252 specimens belonging to four species were collected and analyzed. Sample size (*n*), total length and body weight range, parameters of length-weight and length-length relationships and the correlation coefficient (r^2) are shown in Table 1. All LWRs and LLRs were statistically significant (p < .001). The b value of LWRs ranged from 2.884 for *Rhinogobio cylindricus* to 3.770 for *Siniperca scherzeri*. Coefficients of determination (r^2) of LWRs ranged from .900 for *Rhinogobio cylindricus* to .980 for *Hemibagrus macropterus*. **TABLE 1** Descriptive statistics and parameters of length-weight relationships (LWRs) and length-length relationships (LLRs) for four endemic fish species, Yangtze River, China

		TL range (cm)		LWR parameters					LLR parameters		
Species	n		BW range (g)	а	95% CL of a	b	95% CL of b	r ²	р	q	r ²
Hemibagrus macropterus	33	19.2- 54.2	39.7-388.3	0.0101	0.00503 to 0.0152	2.933	2.792-3.073	.980	0.352	1.141	.987
Rhinogobio cylindricus	121	16.3- 26.6	29.4-123.2	0.0159	0.00713 to 0.02466	2.884	2.698-3.070	.900	1.109	1.134	.978
Rhinogobio typus	50	13.9- 45.2	16.8-800.6	5.29E-7	1.15E-7 to 9.44E-7	3.543	3.406-3.680	.974	6.641	1.147	.990
Siniperca scherzeri	48	15.3- 33.4	34.9-607.3	0.00197	6.42E-4 to 0.00329	3.770	3.556-3.984	.969	0.165	1.161	.987

n, sample size; TL, total length; BW, body weight; CL, confidence limits; r^2 , coefficient of determination; a and b: intercept and slope in equation log W = log a + b log L; p and q: intercept and slope in equation TL = p + q SL.

Bold = new maximum length record in FishBase.

4 | DISCUSSION

These are the first LLRs and LWRs reported for these four endemic fish species in the middle reaches of the Yangtze River. Length-weight relationships of fishes are influenced by such factors as the growth phase, season, degree of stomach fullness, gonad maturity, sex, health, and general condition (Tesch, 1971). Meanwhile, the parameter b may vary seasonally-even daily-and between habitats (Okan & Ertan, 2006). These factors were not taken into account for the four species. In this study, parameter b of Rhinogobio typus and Siniperca scherzeri were higher than the Bayesian predictions in the same genus for this body shape, probably because the sample size, gear selection, and narrow length range might have influenced the LWR parameter values (Froese, Thorson, & Reyes, 2014; Froese, Tsikliras, & Stergiou, 2011). Our survey did not cover a broad-enough seasonal and geographical range to be representative for these species, thus the growth patterns estimated in this study might not be appropriate for all populations of these four species. However, these fishes play important roles in maintaining an ecological balance in the middle reaches of the Yangtze River basin (Ye et al., 2011). This study provides basic information on the LWRs and LLRs of these endemic species, which could serve as baseline data for further biological research.

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