



TECHNICAL CONTRIBUTION

Length–weight relationships of four cavefish species from China

Chengyi Niu^{1,2} | Jiahui Luo¹ | Junxing Yang² | Yahui Zhao¹

¹Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing, China

²State Key Laboratory of Genetic Resources and Evolution, Kunming Institute of Zoology, Chinese Academy of Sciences, Kunming, Yunnan, China

Correspondence

Yahui Zhao, Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
Email: zhaoyh@ioz.ac.cn

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Summary

Length–weight relationships (LWRs) were estimated for four cavefish species belonging to the genus *Sinocyclocheilus* (Cypriniformes: Cyprinidae) occurring in the Nanpanjiang River and Hongshuihe River, which constitute the upstream of the species, *S. angularis*, *S. furcodorsalis*, *S. rhinoceros*, and *S. tileihornes*, were collected from 2011 to 2017. The *b* values of LWRs of these four species ranged from 2.830 to 3.719 and the correlation coefficient values (R^2) were high for all species. This is the first record of LWRs for cavefish species with the horn in FishBase database.

1 | INTRODUCTION

Cavefish or hypogean fish is an ecological definition referring to those species restricted to the subterranean waterbodies for at least part of their life history (Zhao, Gozlan, & Zhang, 2011). Around two hundred valid cavefish species are found on all continents but Antarctica (Borowsky, 2018). China is the richest country in terms of the species diversity of cavefish in the world (Zhao et al., 2011). Many cavefishes are highly endangered and threatened by human activities due to their extremely limited distribution and small population sizes. Some of them are under high risk of extinction. Twenty-two cavefish species have been included in Redlists or Redbooks with limited assessment of their status (Wang & Xie, 2009; Yue & Chen, 1998). The lack of data on their biology, life history, and ecology is a huge problem for the protection of Chinese cavefishes. Therefore, we intend to gather biological information of cavefish for the purpose of conservation based on the samples we collected in our cave surveys of past years. In this study, we choose four species from the genus *Sinocyclocheilus* (Cypriniformes: Cyprinidae), which is the largest cavefish genus in the world and the largest cyprinid genus in China as well (Xing, Zhang, Fan, & Zhao, 2016).

The length–weight relationships (LWRs) is the index to describe basic biological characters and reflect growth status of fishes (Tesch, 1968). It has been widely used in the environmental

monitoring programs such as calculation of fish weight at a certain length, conversion of an equation of growth in weight (Oliveira, Loverde-Oliveira, Mateus, & Teixeira-de Mello, 2014; Yoon et al., 2013). The establishment of LWRs allow for life history and morphological comparisons between different fish species or between fish populations from different habitats and or regions (Gonçalves et al., 1997; Özaydın, Uçkun, Akalın, Leblebici, & Tosunoğlu, 2007).

2 | MATERIALS AND METHODS

From 2011 to 2017, this research was conducted in two tributaries streams of the Xijiang River Basin. Four species of the genus *Sinocyclocheilus* were collected by using traps (mesh size is 0.5 cm) and hand net (0.3 cm), including *S. angularis* Zheng & Wang, 1990 (23 specimens), *S. furcodorsalis* Chen, Yang, & Lan, 1997 (67), *S. rhinoceros* Li & Tao, 1994 (59) and *S. tileihornes* Mao, Lu, & Li, 2003 (11). Standard length (SL) and total weight (TW) of these four species were measured to the nearest 0.1 cm and 0.1 g, respectively. Samples are preserved in the National Zoological Museum of the Institute of Zoology, Chinese Academy of Sciences (ASIZB).

This study used the regression equation $W = aL^b$ to fit the length–weight relationship, where *W* is the total weight (TW, g), *L* is

TABLE 1 Descriptive statistics and estimated parameters of length–weight relationships ($W = aL^b$) for four cavefish, *S. angularis*, *S. furcodorsalis*, *S. rhinoceros*, and *S. tileihornes*, from the Upper Xijiang River Basin, China

Species	N	Standard length (cm)		Total weight (g)		Length–weight parameters				
		Min	Max	Min	Max	a	CIa (95%)	b	CIb (95%)	R ²
<i>S. angularis</i>	23	2.9	10.0	0.4	13.6	0.0217	0.00515 to 0.0486	2.830	2.057–3.604	0.935
<i>S. furcodorsalis</i>	67	1.9	11.7	0.3	25.6	0.0124	0.00414–0.0206	3.243	2.885–3.600	0.988
<i>S. rhinoceros</i>	59	3.0	7.3	0.4	9.0	0.0121	0.0346 to 0.0587	3.331	1.308–5.354	0.919
<i>S. tileihornes</i>	11	3.1	6.0	0.4	3.2	0.00569	0.00364–0.00773	3.719	3.484–3.954	0.997

N: sample size; Min–Max: Minimum–maximum values; a: regression parameter; b: slope of the regression; CI: confidence interval; R²: coefficient of correlation.

the standard length (SL, cm), and *a* and *b* are regression parameters (Froese, 2006), with confidence interval equal to 95%. This equation can be transformed as: $\log w = \log a + b \log L$, where *b* is the slope and $\log a$ is the intercept. The length–weight relationships (LWRs) were calculated by software Origin version 8.0.

3 | RESULTS

In this research, the data of the length–weight relationships (LWRs) were represented in Table 1. The standard length and total weight range of species were recorded as: *Sinocyclocheilus angularis* (2.9–10.0 cm, 0.4–13.6 g), *S. furcodorsalis* (1.9–11.7 cm, 0.3–25.6 g), *S. rhinoceros* (3.0–7.3 cm, 0.4–9.0 g) and *S. tileihornes* (3.1–6.0 cm, 0.4–3.2 g). All regressions were highly significant while the R² values range from 0.919 (*S. rhinoceros*) to 0.997 (*S. tileihornes*). The *b* values of LWRs ranged from 2.830 (*S. angularis*, 95% CI = 0.774) to 3.719 (*S. tileihornes*, 95% CI = 0.235).

4 | DISCUSSION

Based on the previous study, the acceptable range of *b* value is between 2.5 and 3.5 (Froese, 2006). It is nearly agreement with our results and indicating that except for the growth of *Sinocyclocheilus angularis* is negative allometric in nature, the growth of *S. furcodorsalis*, *S. rhinoceros* and *S. tileihornes* are all positive allometric in nature. The correlation coefficient value (R²) in the length–weight relationships (LWRs) were high for all species, showing that length and weight increase proportionally (Parsa, Rahnama, & Khoshdarehgi, 2017).

This research provides new and basic data on LWRs for four endemic cavefish from upper Xijiang River Basin, China. There are conflicts between human activities and subterranean habitat in South China. A long-term accumulation of biological data will have great significance to the conservation of cavefishes. Meantime, it will help

us understand the adaptive strategy of living creatures in an extreme environment such as the cave.

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ORCID

Jiahui Luo  <http://orcid.org/0000-0002-5688-2124>

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