

Research Article

Length-Weight Relationships of Twenty-Nine Native Fish Species from Hongshui River, Southern China

Jiayang He ¹, Zhiqiang Wu ¹, Liangliang Huang ^{1,2,3}, Yusen Li,⁴ Yangyan Sun,¹ Dongjie Wang,⁵ Jie Feng,¹ Yong Lin,⁴ and Anyou He⁴

¹College of Environmental Science and Engineering, Guilin University of Technology, Guilin 541004, China

²Guangxi Key Laboratory of Environmental Pollution Control Theory and Technology, Guilin University of Technology, Guilin 541004, China

³Innovation Center for Water Pollution Control and Water Safety Guarantee in Karst Areas, Guilin University of Technology, Guilin 541004, China

⁴Guangxi Academy of Fishery Sciences, Nanning 530021, China

⁵College of Marine Sciences, South China Agricultural University, Guangzhou, Guangdong 510642, China

Correspondence should be addressed to Zhiqiang Wu; wuzhiqiang@glut.edu.cn and Liangliang Huang; llhuang@glut.edu.cn

Received 18 October 2022; Revised 13 February 2023; Accepted 15 April 2023; Published 24 April 2023

Academic Editor: Umar Khan

Copyright © 2023 Jiayang He et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Twenty-nine native freshwater fish species belonging to the four orders and eight families were collected from the Hongshui River, which belongs to the upper reaches of the Pearl River, to analyze their length-weight relationships (LWRs). Twenty-nine freshwater native fish were sourced using cages (0.2 m in height, 0.25 m in width, and 8 m in length, with a mesh size of 5 mm) and triple gillnets (20–40 m long, 1–3 m high, and mesh size, 2–3 cm) between December 2021 and July 2022. For each freshwater fish, the total length (TL) and weight were measured to the nearest 1.0 mm and 0.1 g. All LWR parameters of the twenty-nine species were statistically significant ($P < 0.001$). The length-weight relationships for the nine species were new to the FishBase and new maximum lengths were recorded for the twenty species. The LWR values provided for the first time will help to validate the accuracy and predictability of the Bayesian models for estimating the species-specific growth parameters of the data-poor species.

1. Introduction

The length-weight relationships (LWRs) of fish are of great significance for studying the life history, growth, and reproduction of fish populations [1]. Although these relationships are widely used in the study of fish populations, the data on the length-weight relationships for many freshwater fishes are still not available [2]. Hongshui River is the mainstream of the Xijiang River system of the Pearl River basin. Its yearly runoff accounts for 39% of the Pearl River basin [3]. Hongshui River is an exceptional aquatic ecosystem which is a home to 180 fish species [4]. However, the length-weight relationships of the fish in this area have rarely been monitored, and this study provides estimates for twenty-nine native species captured in Hongshui River, Southern China.

In this paper, the estimates of LWR parameters of the 29 native fishes from the Hongshui River, include the first estimates for the 9 native fishes. The authors believe that the results of the study can contribute greatly toward a better understanding of the growth patterns of fishes from Hongshui River under cascade hydropower development and can improve the accuracy of the Bayesian LWR estimates for the data-poor species.

2. Materials and Methods

Twenty-nine freshwater native fish species (including nine species of native fish that were difficult to collect and were recorded for the first time: *Acrossocheilus iridescens*, *Discogobio multilineatus*, *Erromyzon sinensis*, *Beaufortia kweichowensis*, *Pterocryptis anomala*, *Sineleotris chalmersi*,

TABLE 1: Descriptive statistics and estimated relationships between the total length (cm) and weight (g) (LWRs) for the twenty-nine freshwater native fish species sampled between December 2021 and July 2022 from the Hongshui River, Southern China.

Family	Species	N	Length range (cm)		Weight range (g)		a	b	R ²	95% CL a	95% CL b	FishBase	
			Min	Max	Min	Max							
Cobitidae	<i>Tracacanthys pulcher</i>	35	3.9	11.4	0.8	10.7	0.0207	3.011	0.9078	0.0196–0.0387	2.824–3.337	*	
	<i>Simibotia robusta</i>	159	5.3	12.5	1.6	10.5	0.0073	3.128	0.9174	0.0040–0.0154	2.935–3.460	*	
	<i>Simibotia pulchra</i>	31	6.0	12.8	3.1	24.4	0.0036	3.338	0.9607	0.0035–0.0055	3.064–3.515	*	
	<i>Sinibrama macrops</i>	67	6.7	25.3	5.3	176.0	0.0052	3.136	0.9686	0.0022–0.1165	2.934–3.246	*	
	<i>Ctenopharyngodon idella</i>	29	16.7	82.6	52.4	5774.6	0.0082	3.090	0.9662	0.0042–0.0156	2.933–3.254	*	
	<i>Squaliobarbus curriculus</i>	474	7.1	49.7	3.0	1441.1	0.0019	3.166	0.9166	0.0014–0.0025	3.084–3.248	*	
	<i>Pseudohemiculter dispar</i>	186	8.2	30.7	4.7	171.6	0.0120	2.746	0.9614	0.0085–0.0168	2.638–2.856	*	
	<i>Hemibarbus medius</i>	42	7.5	28.8	5.4	182.5	0.0075	3.134	0.9393	0.0027–0.0096	3.009–3.378	*	
	<i>Squalidus atromaculatus</i>	31	7.6	18.0	3.3	38.0	0.0060	3.076	0.9698	0.0031–0.0113	2.834–3.335	*	
Cyprinidae	<i>Acheilognathus tonkinensis</i>	407	5.0	12.2	1.5	24.6	0.0218	3.142	0.9360	0.0138–0.0347	2.906–3.289	*	
	<i>Acrossocheilus iridescens</i>	58	8.7	27.0	8.9	207.1	0.0090	3.023	0.9711	0.0044–0.0174	2.811–3.253	▲	
	<i>Onychostoma gerlachi</i>	31	11.9	34.0	35.9	355.6	0.0115	3.231	0.9336	0.0157–0.0525	3.056–3.568	*	
	<i>Cirrhinus molitorella</i>	202	4.8	52.8	2.1	1487.6	0.0075	3.080	0.9653	0.0063–0.0094	3.02–3.22	*	
	<i>Osteochilus salsburyi</i>	110	6.6	20.1	4.1	114.4	0.0452	3.079	0.9257	0.0189–0.1036	2.970–3.299	*	
	<i>Rectoris posehensis</i>	69	7.8	23.0	7.7	126.2	0.0049	3.202	0.9568	0.0025–0.0098	2.964–3.439	*	
	<i>Pseudocrossocheilus bamaensis</i>	67	10.0	21.5	10.2	116.0	0.0107	3.048	0.9354	0.0053–0.0209	2.810–3.296	*	
	<i>Psychidio jordani</i>	207	5.0	37.0	2.2	608.8	0.0061	3.389	0.9384	0.0032–0.0191	3.005–3.686	*	
	<i>Discogobio multilineatus</i>	75	3.4	14.7	0.5	30.5	0.0342	2.528	0.9921	0.0301–0.0388	2.477–2.580	▲	
	<i>Discogobio tetrabarbatu</i>	232	3.2	16.5	0.6	46.4	0.0276	2.675	0.9253	0.0206–0.0367	2.525–2.748	*	
	Balitoridae	<i>Erromyzon sinensis</i>	19	2.6	3.6	0.2	0.9	0.0061	3.456	0.9203	0.0023–0.0152	2.964–4.561	▲
		<i>Sinogastromyzon wui</i>	161	2.4	9.3	0.2	11.0	0.0180	3.109	0.9189	0.0134–0.0240	2.937–3.284	*
<i>Beaufortia kweichowensis</i>		9	3.9	5.2	1.3	2.7	0.0332	2.673	0.9485	0.0147–0.0754	2.136–3.206	▲	
<i>Pterocryptis anomala</i>		66	6.9	25.0	1.6	103.1	0.0084	2.929	0.9901	0.0056–0.0124	2.803–3.062	▲	
Mastacembelidae	<i>Mastacembelus aculeatus</i>	7	12.1	24.8	5.0	48.3	0.0042	3.058	0.9163	0.0001–0.0073	2.955–3.320	*	
	<i>Mastacembelus armatus</i>	57	9.6	54.0	2.0	324.5	0.0036	2.979	0.9201	0.0011–0.0096	2.690–3.310	*	
Eleotridae	<i>Sineoetris chalmersi</i>	76	7.1	11.9	3.1	17.8	0.0102	3.032	0.9309	0.0048–0.0216	2.711–3.358	▲	
	<i>Neodontobutis hainanensis</i>	37	4.9	6.1	1.4	3.5	0.0076	3.275	0.9237	0.0033–0.0176	2.794–3.758	▲	
Channidae	<i>Channa asiatica</i>	34	9.5	23.5	6.4	113.5	0.0078	3.027	0.9965	0.0050–0.0116	2.901–3.162	▲	
Tetraodontidae	<i>Takifugu ocellatus</i>	10	10.1	15.2	15.9	59.7	0.0087	3.379	0.9636	0.0045–0.0204	2.946–3.530	▲	

N, sample size; Min and Max, the minimum and maximum of the standard length in cm and the total weight in g; a and b, parameters of LWRs; R², coefficient of determination; 95% CL, 95% confidence limits. ▲, new information for the FishBase [2]; *, new records of the maximum total length.

Neodontobutis hainanensis, *Channa asiatica* or *Takifugu ocellatus*) belonging to seven families were collected from the Hongshui River (23°04'–26°50'N; 102.5°100'–109°30'E), which belongs to the upper reaches of the Pearl River, to analyze their length-weight relationships (LWRs). The samples were collected using cages (0.2 m in height, 0.25 m in width, and 8 m in length, with a mesh size of 5 mm) and triple gillnets (20–40 m long, 1–3 m high, and mesh size, 2–3 cm) from June 2021 to July 2022. The collected fishes belonged to the four orders and eight families. The fish were identified at the species level according to the protocol described by Freshwater Fishes of Guangxi [5], and the scientific names and authors of each fish species were checked in accordance with the FishBase [2]. The total length (TL) and weight were measured to the nearest 1.0 mm and 0.1 g, respectively. The care and use of experimental animals complied with (The Animal Research and Ethics Committees of Guilin University of Technology (Approval Code: GUT-2022-006; Approval Date: March 28th, 2022)) the animal welfare laws, guidelines, and policies.

The length-weight relationship was expressed by using a regression equation, $W = aL^b$, which was fitted, where L was the total length (cm) and W was the total weight (g). The relationship was converted into its logarithmic form, $\log W = \log a + b \log L$, to compute a (the intercept) and b (the slope of the equation) [6]. The log-log plots of length and weight were fitted to remove the outliers before linear regression analysis. The correlation coefficient (R^2) and 95% confidence limits (95% CL) for parameters a and b also were calculated. The t -test was used to analyze the difference between this study and the reference of the value. All analyses were performed in SPSS 23.0.

3. Results

A total of 2988 specimens from the twenty-nine native species belonging to the four orders and eight families were included in the analyses. Descriptive statistics and LWR parameters for the twenty-nine freshwater fish species are shown in Table 1. Samples size ranges from 2.4 cm to 82.6 cm for *Sinogastromyzon wui* and *Ctenopharyngodon idella*, respectively. The values of LWRs for all species were statistically significant ($P < 0.001$). The b values of the regression model for LWRs ranged from 2.528 for *Discogobio multilineatus* to 3.456 for *Erromyzon sinensis*, and the coefficients of determination (R^2) ranged from 0.9078 for *Tracacichthys pulcher* to 0.9965 for *Channa asiatica*. Among these, no LWR estimates were available in the FishBase for the nine species, [2] (Table 1, ▲). The present study provides the maximum total length for twenty species for the first time (Table 1, *).

4. Discussion

For the twenty-nine native fish species, all the P values were extremely significant ($P < 0.001$) and the b values were within the expected range between 2.5 and 3.5 [6], which are in accordance with the previous estimates [1]. Although the LWRs presented in this study are first estimates for most species, some of them must be taken as tentative because of

the limited sample size ($N < 30$) and limited size range covered. According to the FishBase [2], no LWR information was available for *A. iridescens*, *D. multilineatus*, *E. sinensis*, *B. kweichowensis*, *P. anomala*, *S. chalmersi*, *N. hainanensis*, *C. asiatica*, or *T. ocellatus*. These results indicate that the models had a high degree of explanatory power for estimating the variation in LWRs, and would be a reliable resource for the Hongshui River fish in the FishBase [2].

The b values (this study value/reference value) reported for *Sinibotia pulchra* ($b = 3.338/3.300$), *Sinibotia robusta* ($b = 3.128/3.210$), *Sinibrama macrops* ($b = 3.136/3.250$), *Ctenopharyngodon idella* ($b = 3.090/3.050$), *Squaliobarbus curriculus* ($b = 3.166/3.140$), *Pseudohemiculter dispar* ($b = 2.746/2.520$), *Acheilognathus tonkinensis* ($b = 3.142/3.162$), *Onychostoma gerlachi* ($b = 3.231/3.060$), *Cirrhinus molitorella* ($b = 3.080/3.090$), *Osteochilus salsburyi* ($b = 3.079/3.010$), *Rectoris posehensis* ($b = 3.202/3.273$), *Pseudocrossocheilus bamaensis* ($b = 3.048/3.290$), *Ptychidio jordani* ($b = 3.389/3.150$), *Discogobio tetrabarbatulus* ($b = 2.675/2.678$), and *Mastacembelus armatus* ($b = 2.979/3.000$), and the t -test showed that there were no significant difference between the b value of this study and the reference value ($P < 0.05$, [3, 7]); but *Sinogastromyzon wui* showed a significant difference between the b value of this study ($b = 3.109$) and the reference value ($b = 2.880$, $P > 0.05$, [7]). However, such slight differences could be real or be the result of sampling biases because of the different fishing methods used. There is a need to standardize the sampling procedures in order to obtain comparable results. In addition, the direction and degree of deviation of the b value were affected by the fish growth environment and the biological productivity of plankton. High-productivity areas tend to result in b values greater than 3, while low-productivity areas tend to have b values less than 3 [8].

In conclusion, new records of the maximum total lengths of the twenty species were recorded. LWRs for the nine species are published herein for the first time for the FishBase. The results provide valuable information on the LWRs for twenty-nine native species, which itself is a useful resource for further fisheries research, conservation, and management of the Pearl River ecosystem.

Data Availability

The data used to support the findings of the study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This research was supported by the National Natural Science Foundation of China (Grant nos. 32060830 and U20A2087), Key Research and Development Program of Guangxi (Grant no. AB22035050), and the Survey of Fishery Resources in Guangxi (Grant no. GXZC2022-G3-001062-ZHZB).

References

- [1] R. Chandran, R. K. Singh, A. Singh et al., "Evaluating the influence of environmental variables on the length-weight relationship and prediction modelling in flathead grey mullet, *Mugil cephalus* Linnaeus, 1758," *Peer Journal*, vol. 11, Article ID 14884, 2023.
- [2] R. Froese and D. Pauly, "FishBase. World wide web electronic publication," 2022, <http://www.fishbase.org>.
- [3] C. Wang, S. Xie, J. G. Wang, X. L. Chang, and D. M. Huang, "Investigation of fish resources in longtan reservoir of Hongshui River," *Journal of Hydroecology*, vol. 2, pp. 39–48, 2014.
- [4] J. He, Z. Wu, L. Huang et al., "Diversity, distribution, and biogeography of freshwater fishes in Guangxi, China," *Animals*, vol. 12, no. 13, p. 1626, 2022.
- [5] Fisheries Research Institute of Guangxi Zhuang Autonomous Region, *Freshwater Fishes from Guangxi*, Guangxi People's Publishing House, Nanning, China, 2nd edition, 2006.
- [6] S. V. Sanaye, C. U. Rivonker, R. A. Sreepada, Z. A. Ansari, A. Murugan, and B. Ramkumar, "Weight-length relationship and fulton's condition factor of the Alligator pipefish, *Syngnathoides biaculeatus* (bloch, 1785) from the southeast coast of India," *Current Science*, vol. 113, no. 08, pp. 1605–1609, 2017.
- [7] Y. F. Que, L. Pan, F. Chen, S. Xie, L. Liao, and N. Zhao, "Length-weight relationships of thirty-seven fish species from the Hongshui River, Southwest China," *Journal of Applied Ichthyology*, vol. 31, no. 4, pp. 804–806, 2015.
- [8] P. Z. Wang, D. Song, Y. Z. Zhang et al., "Resource composition, length-weight relationship and condition factor of fishes in Bosten Lake," *Biotic Resources*, vol. 42, pp. 181–187, 2020.