Hindawi
Journal of Applied Ichthyology
Volume 2023, Article ID 8441358, 4 pages
https://doi.org/10.1155/2023/8441358

Research Article

Length-Weight Relationships of Four Fish Species from the Dongting Lake Basin, Central South China

Xiao Xie,[1] **Jiang Xie**,[2] **Congqiang Luo**,[1] **Jinlong Wang**,[1] **Bolan Song**,[1] **Ruisong Wang**,[1] **Hongxing Yin**,[1] **Liangguo Liu**,[1] **and Pinhong Yang**[1]

[1]*Aquatic Biological Resources Monitoring Station of Yuanjiang River and Lishui River, Key Laboratory of Health Aquaculture and Product Processing in Dongting Lake Area of Hunan Province, Collaborative Innovation Center for Efficient and Health Production of Fisheries in Hunan Province, Changde Key Innovation Team for Wetland Biology and Environmental Ecology, College of Life and Environmental Sciences, Hunan University of Arts and Science, Changde, China*
[2]*Key Laboratory of Sichuan Province for Fishes Conservation and Utilization in the Upper Reaches of the Yangtze River, Neijiang Normal University, Neijiang, China*

Correspondence should be addressed to Pinhong Yang; pinhongyang588@163.com

Received 18 September 2023; Revised 24 October 2023; Accepted 30 October 2023; Published 7 November 2023

Academic Editor: Georgii Ruban

Length-weight relationships (LWRs) were described for four fish species inhabiting the tributaries of the Dongting Lake, China. Fish were sampled using stationary gillnets (50 m long × 2.0 m high and mesh size: 2, 6, 10, and 14 cm) and lobster pots (18 m long × 0.33 m high × 0.45 m width and mesh size: 1 cm) twice a year from May 2021 to July 2023. All fishes were measured in the field immediately after collection for total length (L) to the nearest 0.1 cm and body weight (W) to the nearest 0.1 g. There was a strong correlation between total length and weight in all four species ($r^2 > 0.98$). The values of parameter b in LWR ranged from 2.9709 to 3.4373. The LWR of *Sinilabeo tungting*, *Acrossocheilus jishouensis*, *Onychostoma rara,* and *Onychostoma barbata* provide new data for https://Fishbase.org and can be useful for establishing conservation measures of fish resources after fishing closure in the Dongting Lake basin, China.

1. Introduction

Dongting Lake, situated on the southern bank of the Jingjiang section in the middle reaches of the Yangtze River, ranks as China's second-largest freshwater lake. The lake receives inflow from four major tributaries, Yuanjiang, Xiangjiang, Zishui, and Lishui Rivers, as well as three inlet channels, specifically Songzi, Hudu, and Ouchi Rivers. It drains into the Yangtze River via a single outlet, Chenglingji. The Dongting Lake basin is recognized as one of the world's 200 priority ecoregions for global conservation [1]. Covering an approximate area of 2.67×10^5 km^2, the basin constitutes around 12% of the Yangtze River's total floodplain area. The basin serves as a biodiversity hotspot, which is home to a diverse array of 217 fish species [2]. Moreover, the basin stands as one of the Yangtze River's most productive regions, offering a range of ecosystem services including biodiversity conservation, wetland maintenance, water and soil retention, as well as carbon sequestration [3, 4].

Length-weight relationships (LWRs) play a crucial role in both fish biology and fisheries research, serving various analytical purposes [5, 6]. Specifically, LWRs are instrumental in assessing fish biomass, evaluating the body condition of individual species, and comparing species-specific growth across different habitats and localities. However, the comparability of these studies hinges on the use of standardized sampling methods and protocols to mitigate the impact of gear selectivity [7]. To examine the correlation between total length and body weight, data were collected for four fish species in the Dongting Lake basin from May 2021 to July 2023. Subsequent analyses were

Table 1: Descriptive statistics and estimated parameters of length-weight relationship for four fish species sampled between May 2021 and July 2023 from the tributaries of the Dongting Lake, Central South China.

Species	*N*	Total length (cm)		Weight (g)		Regression parameters				
		Min.	Max.	Min.	Max.	*a*	95% CL of *a*	*b*	95% CL of *b*	r^2
Sinilabeo tungting (Nichols, 1925)*	27	35.1	56.5	653.8	2557.1	0.0141	0.0054~0.2283	2.9998	2.8373~3.1624	0.984
Acrossocheilus jishouensis Zhao, Chen and Li, 199*	210	6.9	23.3	6.4	163.2	0.0140	0.0115~0.0164	2.9709	2.9104~3.0315	0.985
Onychostoma rara (Lin, 1933)*	35	9.6	52.2	8.0	2086.0	0.0059	0.0046~0.0073	3.2319	3.1744~3.2893	0.999
Onychostoma barbata (Lin, 1931)*	21	14.5	19.3	25.7	67.3	0.0026	0.0022~0.0074	3.4373	2.8106~4.0639	0.984

N, sample size; min and max, minimum and maximum; *a* and *b*, intercept and slope; r^2, coefficient of determination; CL, confidence limit. *Species with no LWRs information in FishBase up to September 2023 (Froese and Pauly, 2023).

conducted to explore the relationships between body weight and total length.

2. Materials and Methods

Fish specimens were collected from three distinct sections: Sangzhi (29.447442°N; 110.029595°E) of the Lishui River, Laosicheng (28.997801°N; 109.967532°E), and Hongjiang (27.134105°N; 109.974432°E) of the Yuanjiang River. Sampling was conducted biannually from May 2021 to July 2023 using stationary gillnets (50 m × 2.0 m and mesh sizes: 2, 6, 10, and 14 cm) and shrimp cages (18 m × 0.33 m × 0.45 m and mesh size: 1 cm). Upon immediate collection, all fish were identified in the field, measured for total length (L) to the nearest 0.1 cm, and weighed (W) to the nearest 0.1 g. Species identification followed protocols outlined by Fauna Sinica (Osteichthyes and Cypriniformes III) [8] and The Fishes of Hunan Province [2], and scientific names and authors of each fish species were checked in accordance with the FishBase (https://www.fishbase.se/) [9]. All animal care and experimental procedures adhered to the guidelines of the Animal Research and Ethics Committees of Hunan University of Arts and Science (approval code: JSDX-2022-016; approval date: March 14, 2022).

The LWR was assessed by applying the following allometric equation [10,11]:

$$W_i = aL_i^b, \tag{1}$$

where W_i is the body weight (g), L_i is the total length (cm), and a (intercept) and b (slope) are the estimated parameters applying the linear regression model with the log-transformed data according to the following equation:

$$\log_{10}(W_i) = \log_{10}(a) + b\log_{10}(L_i) + \log_{10}(\xi_i). \tag{2}$$

The corrected back-transformed predicted value of the response variable was calculated by multiplying the back-transformed predicted value by the correction factor (cf), where RSE is the residual standard error and $\log_e(10)$ is used to adjust for the base of the logarithm used [12, 13].

$$\text{cf} = \frac{\exp\left(\log_e(10)\text{RSE}\right)^2}{2}. \tag{3}$$

The 95% confidence limits (95% CL) for parameters a and b were calculated [14]. All statistical analyses were performed by using R software (version: 4.2.3), with $a = 0.05$ as the significance level.

3. Results

Descriptive statistics for the four fish species, all belonging to the Cyprinidae, are summarized in Table 1. Table 1 includes sample size, length and weight ranges, and estimated parameters a and b of the length-weight relationships (LWRs), along with their 95% confidence limits and determination coefficients (r^2). All LWR values for the four species were statistically significant ($p < 0.001$). The b values in the regression models for LWR varied from 2.9709 in *Acrossocheilus jishouensis* to 3.4373 in *Onychostoma barbata*. The coefficients of determination (r^2) ranged from 0.984 in *Sinilabeo tungting* and *O. barbata* to 0.999 in *Onychostoma rara*.

4. Discussion

The length-weight relationships (LWRs) for all four fish species were statistically highly significant, with $p < 0.001$. The coefficient of determination (r^2) exceeded 0.98, indicating robust positive correlations between length and weight for each species. These findings align with previous research [15, 16] and suggest that the models possess strong explanatory power for estimating LWR variations. They serve as a reliable resource for FishBase in the context of the Dongting Lake basin [9]. Furthermore, the estimated b values in the regression models for all species ranged from 2.9709 to 3.4373, falling within the expected range of 2.5 to 3.5 [14]. Our study also provides the first empirical records for *S. tungting*, *A. jishouensis*, *O. rara*, and *O. barbata* in the Dongting Lake basin, expanding upon previous FishBase reports.

In this study, *A. jishouensis* and *S. tungting* are endemic to the Yangtze River Basin. The populations of *S. tungting*, *O. rara*, and *O. barbata* are in significant decline due to various anthropogenic stressors, such as hydropower dam construction. Consequently, sample collection poses a challenge. While the LWR reported here are initial estimates for these four species, caution is advised in their interpretation due to limited sample sizes ($N < 30$) and restricted size ranges.

The estimated LWR values may be influenced by various technical factors, including sampling methodology, equipment, and fish grid size [17]. In addition, the sample size, size range, gender, and seasonal variations at the time of sampling could also affect the LWR estimates [14, 18]. Therefore, future research should investigate the growth heterogeneity of these species.

In conclusion, this study offers length-weight relationships (LWRs) for four freshwater fish species in the Dongting Lake tributaries. These findings contribute valuable data to FishBase, serving as a critical resource for further fisheries research, conservation efforts, and effective management of the Dongting Lake 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 study is a contribution of the Aquatic Biological Resource Monitoring Group of Yuanjiang River and Lishui River at the Hunan University of Arts and Science. The authors would like to thank Mengdan Xi, Fang Dong, Cong Zeng, and Kerui Huang for helpful suggestions on this

paper. This research was funded by the Open Project for Key Laboratory of Sichuan Province for Fishes Conservation and Utilization in the Upper Reaches of the Yangtze River, Neijiang Normal University (NJTCSC22-3), the Open Project for Key Lab of Freshwater Biodiversity Conservation, Ministry of Agriculture and Rural Affairs of China (LFBC1008), the Open Project for Key Laboratory of Health Aquaculture and Product Processing in Dongting Lake Area of Hunan Province, Collaborative Innovation Center for Efficient and Health Production of Fisheries in Hunan Province (2019KJ008), and the Doctoral Start-up project of Hunan University of Arts and Science (20BSQD07).

References

[1] D. M. Olson and E. Dinerstein, "The global 200: a representation approach to conserving the earth's most biologically valuable ecoregions," *Conservation Biology*, vol. 12, no. 3, pp. 502–515, 1998.

[2] Y. A. Wu, H. Li, F. C. Liao, X. Yang, and Z. G. Xie, *The Fishes of Hunan Province*, Science Press Inc, Beijing, China, 2021.

[3] Z. D. Sun, T. Lotz, and N. B. Chang, "Assessing the long-term effects of land use changes on runoff patterns and food production in a large lake watershed with policy implications," *Journal of Environmental Management*, vol. 204, no. 1, pp. 92–101, 2017.

[4] H. Zhang, M. Kang, L. Shen et al., "Rapid change in Yangtze fisheries and its implications for global freshwater ecosystem management," *Fish and Fisheries*, vol. 21, no. 3, pp. 601–620, 2020.

[5] N. Jisr, G. Younes, C. Sukhn, and M. H. El-Dakdouki, "Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon," *The Egyptian Journal of Aquatic Research*, vol. 44, no. 4, pp. 299–305, 2018.

[6] S. K. Chang, Y. T. Chou, and S. D. Hoyle, "Length-weight relationships and otolith-based growth curves for brushtooth lizardfish off taiwan with observations of region and aging–material effects on global growth estimates," *Frontiers in Marine Science*, vol. 9, 2022.

[7] J. A. Gulland, *Fish Stock Assessment*, FAO/Wiley Series on Food and Agriculture, Rome, Italy, 1983.

[8] P. Q. Yue, *Fauna Sinica, Osteichthyes, Cypriniformes III*, Science Press Inc, Beijing, China, 2000.

[9] R. Froese and D. Pauly, *FishBase*, World wide web electronic publication, 2023, https://fishbase.net.br/search.php.

[10] A. B. Keys, "The weight-length relation in fishes," *Proceedings of the National Academy of Sciences*, vol. 14, no. 12, pp. 922–925, 1928.

[11] W. E. Ricker, "Computation and interpretation of biological statistics of fish population," *Bulletin of the Fisheries Research Board of Canada*, vol. 191, pp. 1–382, 1975.

[12] D. H. Ogle, *Introductory Fisheries Analyses with R*, Chapman and Hall/CRC, New York, NY, USA, 2016.

[13] D. G. Sprugel, "Correcting for bias in log-transformed allometric equations," *Ecology*, vol. 64, no. 1, pp. 209-210, 1983.

[14] R. Froese, "Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations," *Journal of Applied Ichthyology*, vol. 22, no. 4, pp. 241–253, 2006.

[15] F. Dong, H. L. Yang, X. J. Zhou et al., "Length–weight relationships of six freshwater fish species from the middle section of the Yangtze River basin, China," *Journal of Applied Ichthyology*, vol. 38, no. 3, pp. 325–327, 2022.

[16] S. L. Wang, Y. C. Wang, H. Y. Sun, and J. F. Tang, "Length-weight relationships of eight fish species in the world's largest water diversion project," *Journal of Applied Ichthyology*, vol. 2023, Article ID 5512824, 3 pages, 2023.

[17] J. Kubečka, O. R. Godø, P. Hickley et al., "Fish sampling with active methods," *Fisheries Research*, vol. 123-124, pp. 1–3, 2012.

[18] Q. Y. Ma, Y. Jiao, C. Zhou, and Y. P. Ren, "Sexual and spatio-temporal variation of Lake Erie walleye growth and maturity: a consequence of multiple impacting factors," *Aquaculture and Fisheries*, vol. 6, no. 4, pp. 400–413, 2021.