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Length-to-weight and length-to-length relations of 15 freshwater fish species (Actinopterygii: Cypriniformes) from the Oujiang River, China

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Abstract

Length-to-weight and length-to-length relations were estimated for 15 freshwater fishes belonging to the order Cypriniformes from Yuxi power station to Kaitan reservoir dam trunk stream of the Oujiang River, Zhejiang Province, China. The following species were studied: *Distoechodon tumirostris* Peters, 1881, *Xenocypris davidi* Bleeker, 1871, *Plagiognathops microlepis* (Bleeker, 1871), *Hemibarbus labeo* (Pallas, 1776), *Hemibarbus maculatus* Bleeker, 1871, *Chanodichthys erythropterus* (Basilewsky, 1855), *Culter alburnus* Basilewsky, 1855, *Chanodichthys dabryi* (Bleeker, 1871), *Opsariichthys bidens* Günther, 1873, *Zacco platypus* (Temminck et Schlegel, 1846), *Sinibrama macrops* (Günther, 1868), *Hemiculter leucisculus* (Basilewsky, 1855), *Pseudohemiculter hainanensis* (Boulenger, 1900), *Rhodeus sinensis* Günther, 1868, and *Squalidus argentatus* (Sauvage et Dabry de Thiersant, 1874). The determination coefficients r^2 of LWRs were all over 0.96, and the 15 values of parameter *b* were consistent with the predicted range of 2.5–3.5. The total length-to-standard length relations were also calculated with $r^2 \geq 0.97$. Our study provides new information on LWR for 1 species and LLRs for 8 species, as well as new maximum total length recorded for 4 species (i.e., *Distoechodon tumirostris*, *Opsariichthys bidens*, *Pseudohemiculter hainanensis*, and *Rhodeus sinensis*) in FishBase. This study is expected to provide a useful baseline for further studies of population parameters to improve management decisions on the Oujiang River.

Keywords

growth coefficient, length-length relation, length-weight relation, Oujiang River

Introduction

The Oujiang River (118°45′–121°00′E, 27°28′–28°48′N) is the second major river in Zhejiang Province, China, with a basin area of about 18 028 km^2. Other than drinking, it also has power generation, flood control, irrigation, and tourism functions. The river had a history of rich fish resources with 111 species in the 1970s. However, fish stocks have continued to decline in recent decades due to overfishing, biological invasion, environmental damage, and hydroelectric dam construction (Guo et al. 2019; Kim et al. 2020; Lin et al. 2021), particularly the cascading development of power plants. It destroyed the integrity of the ecosystem, dividing it into units of discontinuous structure and increasing habitat fragmentation. Statistics show that more than 90 reservoirs with a storage capacity of more than 1 million m^3 were constructed in the river. Habitat fragmentation is becoming one of the most

Table 1. Descriptive statistics and estimated parameters of LWR ($W = aTL^b$) for 15 freshwater fish species sampled in the Oujiang River, southeast China.

Species	Total length [cm]			Total weight [g]		LWR parameters				
	N	Min	Max	Min	Max	*a*	95% CL of *a*	*b*	95% CL of *b*	r^2
Distoechodon tumirostris [A]	555	14.5	42.0	23.2	740.0	0.007	0.006–0.008	3.041	2.997–3.085	0.97
Xenocypris davidi	184	7.5	39.7	4.0	491.0	0.011	0.010–0.015	2.884	2.816–2.952	0.97
Plagiognathops microlepis	287	10.7	38.2	13.4	474.6	0.016	0.014–0.020	2.770	2.713–2.827	0.97
Hemibarbus labeo	287	10.2	42.5	8.2	695.6	0.009	0.008–0.010	2.976	2.934–3.017	0.99
Hemibarbus maculatus	19	6.3	29.5	2.0	241.3	0.015	0.008–0.029	2.877	2.635–3.119	0.97
Chanodichthys erythropterus	30	14.6	26.2	22.3	152.7	0.005	0.003–0.010	3.096	2.903–3.289	0.97
Culter alburnus	189	11.0	46.5	6.0	480.5	0.006	0.005–0.008	2.951	2.891–3.010	0.98
Chanodichthys dabryi	76	11.5	31.6	7.2	209.0	0.002	0.002–0.003	3.286	3.194–3.378	0.99
Opsariichthys bidens	30	9.2	21.2	6.4	105.5	0.003	0.002–0.006	3.402	3.194–3.609	0.98
Zacco platypus	206	6.4	16.3	2.6	45.7	0.006	0.006–0.008	3.157	3.083–3.232	0.97
Sinibrama macrops	399	7.1	22.5	3.8	119.1	0.003	0.003–0.004	3.354	3.292–3.417	0.97
Hemiculter leucisculus	49	10.4	23.0	6.8	107.4	0.003	0.002–0.006	3.231	3.061–3.401	0.97
Pseudohemiculter hainanensis	98	10.3	26.3	6.0	126.2	0.003	0.002–0.004	3.267	3.177–3.357	0.98
Rhodeus sinensis [A]	29	5.3	7.6	2.3	6.6	0.015	0.010–0.024	2.934	2.700–3.167	0.96
Squalidus argentatus	189	6.0	14.0	1.3	25.2	0.003	0.003–0.004	3.412	3.319–3.504	0.97

N = sample size, Max = maximum, Min, minimum, *a* and *b* = constant parameters in equation $W = aTL^b$, CI = confidence interval, r^2 = coefficient of determination. Species with new maximum size records are marked with **bold** font; [A] First record of LWR for the species.

important factors influencing biodiversity and is also a major reason for species extinction. However, little data was available on the growth characteristics of fish species in the river. In this study, length-to-weight (LWRs) and length-to-length relations (LLRs) were established for the 15 species captured from Yuxi power station to Kaitan reservoir dam trunk stream of the Oujiang River, in order to provide a useful reference for further studies of population parameters to improve management decisions.

Materials and methods

Fish samples were collected from Yuxi power station to Kaitan reservoir dam trunk stream of the Oujiang River, Zhejiang Province, China (28°17′–28°27′N, 119°44′–119°53′E), which is a relatively complete structural unit with original ecological preservation of the river's valley features. Sampling was conducted seasonally from the section between March and November 2019. Multipanel nylon gillnets ranging in size from 1 cm to 8 cm were deployed to collect the fish at 05:00–07:00 h. All fish caught were identified to species (Mao et al. 1991). Each specimen was measured to the nearest 0.1 cm (total length, TL; standard length, SL) and weighed to the nearest 0.1 g (weight, *W*) simultaneously.

The LWRs for 15 species were calculated using the formula

$$W = aTL^b$$

where *W* is the weight [g], TL is the total length [cm], *a* and *b* are the intercept and slope of the power equation, respectively. The formula was equipped with a simple linear regression model based on log-transformed data. The 95% confidence interval (CI) for parameters *a* and *b* and the coefficients of determination (r^2) were also determined (Keys 1928; Froese 2006). A similar linear regression was used to determine the LLR

$$TL = a + bSL$$

where SL is the standard length and other measurements are defined as above. For species with $r^2 < 0.95$, outliers were discarded and regression was recalculated. All statistical analyses were performed using SPSS 16.0 (SPSS, Inc., Chicago, IL, USA).

Results

A total of 2627 individuals were examined. The descriptive statistics and the estimated LWR parameters are summarized in Table 1, providing the regression parameters *a* and *b* along with the estimated 95% confidence intervals and the coefficient of determination (r^2). Additionally, similar parameters are given for the length-to-length relations (Total length versus Standard length) in Table 2.

Table 2. Length–length relations ($TL = a + bSL$) of 15 freshwater fish species sampled in the Oujiang River Basin, southeast China.

Species	LWR parameters		
	a	*b*	r^2
Distoechodon tumirostris	1.137	1.976	0.98
Xenocypris davidi	1.342	–0.944	0.98
Plagiognathops microlepis	1.219	0.208	0.99
Hemibarbus labeo	1.118	1.973	0.98
Hemibarbus maculatus	1.196	0.292	0.99
Chanodichthys erythropterus	1.155	0.750	0.99
Culter alburnus	1.163	1.529	0.98
Chanodichthys dabryi	1.192	0.607	0.99
Opsariichthys bidens	1.171	0.451	0.99
Zacco platypus	1.227	–0.009	0.99
Sinibrama macrops	1.222	0.395	0.97
Hemiculter leucisculus	1.223	–0.131	0.99
Pseudohemiculter hainanensis	1.211	–0.073	0.99
Rhodeus sinensis	1.186	0.373	0.97
Squalidus argentatus	1.152	0.507	0.98

a = intercept, *b* = slope; r^2 = coefficient of determination. **Bold** font denoted first record of LLR for the species.

Discussion

As a result, all LWR and LLR estimates were highly significant ($P < 0.01$), yielding $r^2 > 0.96$. One new LWR for *Distoechodon tumirostris* was found in comparison with the FishBase database (Froese and Pauly 2021) (Table 1). The values of parameter *b* for 15 species were consistent with the predicted range of 2.5–3.5 (Hile 1936; Froese 2006). The LLRs of the 15 species were updated, among which 8 new LLRs were discovered. Additionally, the LLR parameters of *b* for *D. tumirostris*, *Hemibarbus labeo*, *Culter alburnus*, *Zacco platypus*, *Sinibrama macrops*, and *Hemiculter leucisculus* here were not within the ranges from prior studies which are listed in FishBase (Froese and Pauly 2021), different growth stanzas and environmental factors can explain some of the reasons (Froese 2006; Lin et al. 2018; Yang et al. 2017). The new maximum values of total length for 4 species were also recorded, such as *D. tumirostris*, *Opsariichthys bidens*, *Pseudohemiculter hainanensis* and *Rhodeus sinensis*.

Froese et al. (2011) suggested that the individual number (sample size) for the LWR analysis of each species should be greater than 100 to meet the need for sampling statistics. Here, sample sizes for 7 species including *Hemibarbus maculatus*, *Chanodichthys erythropterus*, *Chanodichthys dabryi*, *O. bidens*, *H. leucisculus*, *P. hainanensis* and *R. sinensis*, were all less than 100, indicating an inadequate number of specimens to estimate an adequate LWRs equation. Therefore, we recommend using LWRs of these species from this study as baseline information for future studies.

Conclusion

This study provides basic information on LWRs and LLRs for 15 fish species. The new LWR for *D. tumirostris*, new LLRs for 8 species, and the new maximum size recorded for 4 species highlight the scarcity of information on the biological aspects of these fishes. These LWRs and LLRs should assist fisheries scientists and managers to complement their further studies of population parameters to improve management decisions on the Oujiang River.

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References

Froese R (2006) Cube law, condition factor and weight–length relationships: History, meta-analysis and recommendations. Journal of Applied Ichthyology 22(4): 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Froese R, Pauly D (2021) FishBase. [Version 08/2021] http://www.fishbase.org

Froese R, Tsikliras AC, Stergiou KI (2011) Editorial note on weight–length relations of fishes. Acta Ichthyologica et Piscatoria 41(4): 261–263. https://doi.org/10.3750/AIP2011.41.4.01

Guo AH, Yuan JL, Lian QP, Hao YB, Zhang AJ, Gu ZM (2019) Length–weight relationship of three fish species from the Qiantang River, China. Journal of Applied Ichthyology 35: 812–814. https://doi.org/10.1111/jai.13853

Hile R (1936) Age and growth of the cisco *Leucichthys artedi* (Le Sueur), in the lakes of the north-eastern highlands. Fishery Bulletin 48: 211–317.

Keys AB (1928) The weight–length relationship in fishes. Proceedings of the National Academy of Sciences of the United States of America 16(12): 922–925. https://doi.org/10.1073/pnas.14.12.922

Kim DK, Jo H, Lee WO, Park K, Kwak IS (2020) Evaluation of length–weight relations for 15 fish species (Actinopterygii) from the Seomjin River basin in South Korea. Acta Ichthyologica et Piscatoria 50(2): 209–213. https://doi.org/10.3750/AIEP/02787

Lin F, Zhou QH, Yang DH, Lu ZL, Zhang J (2018) Length–weight relationships of six fish species from the headstream region of the Dongjiang River, China. Journal of Applied Ichthyology 34(1): 203–205. https://doi.org/10.1111/jai.13534

Lin F, Wang Z, Luo Z, Sun G, Chen X (2021) Length–weight relationships of four fish species from the lower reaches of the Nujiang River and its tributaries in China. Journal of Applied Ichthyology 37(4): 635–637. https://doi.org/10.1111/jai.14152

Mao JR, Xu SS, Zheng GS, Zheng ML (1991) [Zhejiang fauna, freshwater fishes.] Zhejiang Science and Technology Press, Hangzhou, China. [In Chinese]

Yang Z, Wan L, Gong Y, Gong YT, Zhao N, Qiao Y, Tang HY (2017) Length–weight relationships of five fish species from the Daninghe River, China. Journal of Applied Ichthyology 34(1): 151–152. https://doi.org/10.1111/jai.13445

Supplementary material 1

Table S1

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Data type: Data of length and weight

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