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), Sinosilurus macrops ( Günther, 1868), Hemiculter leuciscus (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 km². 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 m³ were constructed in the river. Habitat fragmentation is becoming one of the most
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 of 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

\[ W = a \cdot TL^b \]

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.
Discussion

As a result, all LWR and LLR estimates were highly significant (P < 0.01), yielding $r^2 > 0.96$. One new LWR for Dristochoodon 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 LWR parameters of $b$ for D. tumirostris, Hemibarbus labeo, Culter alburnus, Zacco platypus, Sinibrama macrops, and Hemiculter leucisculus here were not within the ranges of 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, Opsarichthys 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, Zacco platypus, and Oryzias latipes were all less than 100, in contrast to the 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.

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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Supplementary material 1

Table S1

| Authors        | Title                                                                 | Data type       | Data: length and weight                                                                 |
|----------------|----------------------------------------------------------------------|-----------------|------------------------------------------------------------------------------------------|
| Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited. | Link: https://doi.org/10.3897/aiep.52.80322.suppl1 |