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Length–weight and length–length relations of 16 freshwater fish species (Actinopterygii) caught in Jiaxing section of the Beijing–Hangzhou Grand Canal, China

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Abstract

The length–weight (LWRs) and length–length (LLRs) relations were estimated for 16 fish species obtained from Jiaxing section of the Beijing–Hangzhou Grand Canal, China. One species represented Engraulidae: *Coilia nasus* Temminck et Schlegel, 1846; 11 species Cyprinidae: *Hypophthalmichthys molitrix* (Valenciennes, 1844); *Hypophthalmichthys nobilis* (Richardson, 1845); *Chanodichthys erythropterus* (Basilewsky, 1855); *Chanodichthys mongolicus* (Basilewsky, 1855); *Culter alburnus* Basilewsky, 1855; *Chanodichthys dabryi* (Bleeker, 1871); *Pseudobrama simoni* (Bleeker, 1864); *Hemiculter leucisculus* (Basilewsky, 1855); *Megalobrama terminalis* (Richardson, 1846); *Carassius auratus* (Linnaeus, 1758); *Cyprinus carpio* Linnaeus, 1758; one species Bagridae: *Tachysurus fulvidraco* (Richardson, 1846); two species Odontobutidae: *Odontobutis potamophilus* (Günther, 1861); *Micropercops swinhonis* (Günther, 1873); and one species Osphronemidae: *Macropodus ocellatus* Cantor, 1842. Fishes were collected using multipanel nylon gillnets with mesh sizes of 1–8 cm from November 2020 through August 2021. All fishes were measured for length (total length, TL; standard length, SL) to the nearest 0.1 cm and weight (W) to the nearest 0.1 g. The coefficients of determination R^2 of LWRs and LLRs were all over 0.950, and the 16 values of LWR parameter b were estimated from 2.505 to 3.364. Our study provides new information on LWRs for 2 species and LLRs for 7 species, as well as a new maximum total length recorded for 3 species for FishBase. This study would allow for the convenience of the conversion of TL–W and SL–TL in fish stock assessment and is expected to provide a useful baseline for further studies of population parameters to improve management decisions.

Keywords

growth coefficient, LLR, LWR, Beijing–Hangzhou Grand Canal

Introduction

The Beijing–Hangzhou Grand Canal, located in eastern China, is listed as a World Heritage Site and is one of the longest and oldest canals in the world, with a total length of about 1797 km. It has played an important role in economic and cultural exchanges between the north and south regions of China. Fish stocks became seriously depleted and the reduction of the ichthyofauna biodiversity tended to be obvious in the 1980s due to overfishing,

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water pollution caused by shipping, and other anthropogenic factors (Qin et al. 1988). Qin et al. (1988) collected 27 fish species in the Changzhou section of the canal from 1984 to 1985, accounting for only 26.73% of fish species inhabiting the Taihu Lake basin, and only 354 specimens were captured over the two-year period. Di et al. (2021) caught 14 fish species in the North Canal in 2019, showing characteristics of rare species/genus, high resistance to pollution, and a widely distributed type of fish population. However, limited data were available on the growth characteristics of fish species in the canal. In this study, length–weight (LWRs) and length–length (LLRs) relations were estimated for 16 species caught from the Jiaxing section of the canal. Estimates would provide a useful reference for further studies of population parameters to improve management decisions.

Materials and methods

A total of 16 freshwater fish species was studied for their length–weight (LWRs) and length–length (LLRs) relations. One species represented Engraulidae: *Coilia nasus* Temminck et Schlegel, 1846; 11 species Cyprinidae: *Hypophthalmichthys molitrix* (Valenciennes, 1844); *Hypophthalmichthys nobilis* (Richardson, 1845); *Chanodichthys erythropterus* (Basilewsky, 1855); *Chanodichthys mongolicus* (Basilewsky, 1855); *Culter alburnus* Basilewsky, 1855; *Chanodichthys dabryi* (Bleeker, 1871); *Pseudobrama simoni* (Bleeker, 1864); *Hemiculter leucisculus* (Basilewsky, 1855); *Megalobrama terminalis* (Richardson, 1846); *Carassius auratus* (Linnaeus, 1758); *Cyprinus carpio* Linnaeus, 1758; one species Bagridae: *Tachysurus fulvidraco* (Richardson, 1846); two species Odontobutidae: *Odontobutis potamophilus* (Günther, 1861); *Micropercops swinhonis* (Günther, 1873); and one species Osphronemidae: *Macropodus ocellatus* Cantor, 1842. Fish samples were collected from Jiaxing section (120°34′–120°69′E, 30°50′–30°96′N) of the Beijing–Hangzhou Grand Canal, China. Species were seasonally captured between November 2020 and August 2021, using multipanel nylon gillnets with a mesh size of 1–8 cm at about around 03:00–07:00 hours. Fish species identification was performed in accordance with the procedures of Mao et al. (1991). Species validation was confirmed with FishBase (Froese and Pauly 2022). 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 were determined using the formula

$$W = a\mathrm{TL}^b,$$

where *W* was the weight [g], TL was the total length [cm], *a* was the intercept and *b* was the allometric coefficient/slope. 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 linear regression was used to determine the LLR,

$$\mathrm{TL} = a + b\mathrm{SL}$$

where SL was the standard length [cm] cm and other measurements are defined as above. For species with $R^2 < 0.95$, outliers were discarded and regression was recalculated. All statistical analysis was done in SPSS 16.0 (SPSS, Inc., Chicago, IL, USA).

The raw data are available as Suppl. material 1.

Results

LWRs and LLRs of 16 fish species were estimated. The descriptive statistics and the estimated LWR parameters are summarized in Table 1. In addition, similar parameters

Table 1. Length–weight relations of 16 fish species (Actinopterygii) sampled between November 2020 and August 2021 from Jiaxing section of the Beijing–Hangzhou Grand Canal, China.

Species	*N*	TL range[cm]	*W* range [g]	*a*	*a* CL	*b*	*b*CL	R^2
Coilia nasus Temminck et Schlegel, 1846	51	14.5–25.7	7.6–34.9	0.004	0.003–0.007	2.791	2.626–2.956	0.959
Hypophthalmichthys molitrix (Valenciennes, 1844)	298	10.2–85.2	10.0–7150.0	0.010	0.009–0.011	3.019	2.981–3.057	0.988
Hypophthalmichthys nobilis (Richardson, 1845)	125	18.8–76.1	50.0–5513.2	0.010	0.008–0.013	3.058	2.992–3.124	0.986
Chanodichthys erythropterus (Basilewsky, 1855)	214	9.3–29.4	3.1–196.0	0.002	0.002–0.003	3.364	3.266–3.461	0.956
Chanodichthys mongolicus (Basilewsky, 1855)	107	13.5–49.2	10.0–905.0	0.003	0.002–0.004	3.234	3.124–3.343	0.970
Culter alburnus Basilewsky, 1855	311	7.3–78.5	3.0–2125.6	0.008	0.007–0.010	2.843	2.778–2.907	0.961
Chanodichthys dabryi (Bleeker, 1871)	400	6.7–40.1	1.2–442.7	0.003	0.002–0.003	3.284	3.215–3.352	0.957
***Pseudobrama simoni* (Bleeker, 1864)**	50	11.5–21.5	12.6–90.2	0.004	0.002–0.007	3.310	3.098–3.522	0.954
Hemiculter leucisculus (Basilewsky, 1855)	274	8.2–22.5	3.3–68.5	0.009	0.007–0.011	2.846	2.768–2.924	0.950
Megalobrama terminalis (Richardson, 1846)	29	9.0–54.0	6.7–1915.1	0.008	0.005–0.011	3.123	3.015–3.231	0.992
Carassius auratus (Linnaeus, 1758)	263	6.7–29.8	3.6–455.6	0.014	0.012–0.018	3.025	2.954–3.095	0.965
Cyprinus carpio Linnaeus, 1758	159	14.4–70.0	51.2–4542.0	0.011	0.008–0.014	3.063	2.989–3.137	0.977
Tachysurus fulvidraco (Richardson, 1846)	79	12.0–27.0	23.7–172.0	0.045	0.035–0.059	2.505	2.414–2.596	0.975
***Odontobutis potamophilus* (Günther, 1861)**	58	5.8–15.5	2.1–45.0	0.015	0.010–0.022	2.979	2.824–3.135	0.964
***Micropercops swinhonis* (Günther, 1873)** [a]	25	4.0–7.6	0.7–4.2	0.018	0.015–0.027	2.692	2.456–2.927	0.960
Macropodus ocellatus Cantor, 1842 [a]	24	4.5–7.9	0.8–6.0	0.008	0.005–0.014	3.215	2.925–3.505	0.960

N = sample size, TL = total length, *W* = weight, *a* and *b* = relation parameters in equation $W = a\mathrm{TL}^b$, CI = 95% confidence interval, R^2 = determination coefficient. Species with new maximum size records are marked with **bold** font; [a] First record of LWR for the species.

are provided for the LLRs (TL vs. SL) in Table 2. All LWR and LLR estimates were statistically significant ($P < 0.05$), yielding $R^2 > 0.950$. Two new LWRs for *Micropercops swinhonis* and *Macropodus ocellatus*, and 7 new LLRs for *Chanodichthys mongolicus*, *Chanodichthys dabryi*, *Pseudobrama simoni*, *Megalobrama terminalis*, *Tachysurus fulvidraco*, *Odontobutis potamophilus*, and *Micropercops swinhonis*, were determined, as well as 3 new total lengths for *Pseudobrama simoni*, *Odontobutis potamophilus*, and *M. swinhonis* were recorded when compared with FishBase data (Froese and Pauly 2022).

Table 2. Length–length relations (TL = *a* + *b*SL) of 16 fish species sampled in the Jiaxing section of the Beijing–Hangzhou Grand Canal, China.

Species	LWR parameters		
	a	*b*	R^2
Coilia nasus	0.586	1.061	0.954
Hypophthalmichthys molitrix	0.084	1.186	0.987
Hypophthalmichthys nobilis	1.028	1.139	0.987
Chanodichthys erythropterus	0.814	1.146	0.978
Chanodichthys mongolicus	0.952	1.149	0.993
Culter alburnus	–0.171	1.223	0.981
Chanodichthys dabryi	0.734	1.166	0.981
Pseudobrama simoni	0.856	1.125	0.969
Hemiculter leucisculus	0.219	1.203	0.961
Megalobrama terminalis	0.296	1.202	0.993
Carassius auratus	0.656	1.202	0.991
Cyprinus carpio	1.076	1.178	0.971
Tachysurus fulvidraco	1.712	1.042	0.957
Odontobutis potamophilus	0.785	1.136	0.972
Micropercops swinhonis	0.530	1.129	0.961
Macropodus ocellatus	0.441	1.285	0.951

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

Discussion

The values of LWR parameter *b* were estimated from 2.505 to 3.364, which are consistent with the predicted range of 2.5–3.5 (Hile 1936; Froese 2006). Deviations of parameter *b* for some species in this study were identified when compared with values reported in FishBase (Froese and Pauly 2022). The LWRs are influenced by different growth stanzas, gender, fishing, and environmental factors, such as season, temperature, and food (Quasim 1973; Froese 2006; Rekha et al. 2021; Ni et al. 2022; Zhang et al. 2022). Since the specimens here were collected using multipanel nylon gillnets of mesh size from 1 to 8 cm, the inherent size biasedness might be expected. In this study, we estimated the LWRs and LLRs of 16 fish species inhabiting the Jiaxing section of the canal based on the long-term surveyed data, and the estimated parameters could be considered as the mean annual values (Guo et al. 2019; Ni et al. 2022). Our results provided the new data for FishBase (Froese and Pauly 2022), allow for the convenience of fish stock assessment, and are expected to provide a useful baseline for further studies of population parameters to improve management decisions in the Beijing–Hangzhou Grand Canal.

Conclusion

This study provides basic parameters on LWRs and LLRs for 16 fish species. The new information on LWRs for 2 species and LLRs for 7 species, as well as the new maximum total length recorded for 3 species, highlight the scarcity of information on the biological aspects of these fishes. These LWRs and LLRs allow for the conversion of TL (total length)–*W* (weight) and SL (standard length)–TL (total length) in fish stock assessment, and are useful for further studies of population parameters to improve management decisions in the Beijing–Hangzhou Grand Canal.

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Supplementary material 1

Original data

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Data type: excel file

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