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Length–Weight and Length–Length Relationship of 11 Fish Species From the Oujiang River, China

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ABSTRACT

The Oujiang River, the second-largest river in Zhejiang Province, southern China, supports rich fishery resources. However, these resources have experienced significant decline due to multiple anthropogenic and environmental pressures. To assess the current status of fishery resources, this study investigated the length–weight relationships (LWRs) and length–length relationships (LLRs) of 11 economically and ecologically important fish species. The results showed that the b values ranged from 2.534 to 3.469, with the coefficient of determination (r^2) ranging from 0.893 to 0.987. Notably, we provide the first LWR and LLR records for *Acrossocheilus fasciatus* and *Microphysogobio oujiangensis* in FishBase, along with a new maximum length record for *Onychostoma barbatulum*. These findings offer valuable baseline data to inform science-based conservation and sustainable management of fisheries in the Oujiang River.

1 | Introduction

The Oujiang River (118°45′–121°00′E, 27°28′–28°48′N), situated in southern Zhejiang Province, China, ranks as the second-largest river in the region [1, 2]. With a total length of 388 km and a drainage area of 18,000 km² [3], it serves multiple critical functions, including drinking water supply, hydroelectric power generation, flood control, agricultural irrigation, and tourism. Historically, the river supported rich fish biodiversity, with 111 species recorded in the 1970s [1]. However, in recent decades, fish populations have experienced significant declines due to anthropogenic pressures such as dam construction, over-exploitation, habitat degradation, and water pollution [4–6].

Length–weight relationships (LWRs) and length–length relationships (LLRs) serve as fundamental tools in fish ecology and fisheries management [7]. While previous studies have documented 15 fish species in the Oujiang River [1], the present study utilizes recent sampling data to establish LWRs and LLRs for 11

of these species inhabiting this ecosystem. These results provide essential references for ecological research and sustainable management of this river ecosystem.

2 | Materials and Methods

All fish samples were seasonally collected from the Oujiang River between March 2022 and December 2024 using gill nets (100 m length × 1.5 m height; mesh sizes: 2, 3, 6, and 8 cm) and cage nets (15 m length × 20 cm height × 25 cm width; mesh size: 0.5 cm). All specimens were transported to the laboratory for taxonomic identification following Mao et al. [8] and subsequent morphometric analysis. For each specimen, total length (TL) was measured to the nearest 0.1 cm, and body weight (W) was recorded to the nearest 0.1 g.

The LWRs was determined for 11 fish species using the following formula: $W = aTL^b$, where W is the weight (g), TL is the total length (cm), a is the intercept, and b is the allometric coefficient/

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TABLE 1 | Descriptive statistics and estimated parameters of total length–weight relationship (LWR: $W = aTL^b$) for 11 fish species collected in the Oujiang River, China.

Family	Species	N	Total length (cm)		Total weight (g)		Regression parameters				
			Min	Max	Min	Max	a	b	r ²	aCL95%	bCL95%
Plecoglossidae	<i>Plecoglossus altivelis</i> (Temminck & Schlegel, 1846)	51	14.5	24.5	23.9	133.2	0.0090	2.965	0.893	0.0038–0.0213	2.671–3.259
	<i>Squaliobarbus curriculus</i> (Richardson, 1846)	13	16.5	37.5	41.1	578.9	0.0044	3.240	0.982	0.0017–0.0109	2.947–3.532
	<i>Culter alburnus</i> (Basilewsky, 1855)	91	12.0	46.0	10.4	558.1	0.0086	2.887	0.973	0.0086–0.0121	2.785–2.988
	<i>Sinibrama macrops</i> (Günther, 1868)	584	7.2	22.0	2.7	108.4	0.0094	3.002	0.937	0.0079–0.0112	2.938–3.065
	<i>Xenocypris microlepis</i> (Bleeker, 1871)	186	12.3	37.0	17.0	387.2	0.0121	2.885	0.987	0.0104–0.0140	2.836–2.934
Cyprinidae	<i>Onychostoma barbatulum</i> (Pellegrin, 1908) [#]	34	10.0	28.0	9.5	200.4	0.0176	2.802	0.951	0.0092–0.0333	2.573–3.032
	<i>Acrossocheilus fasciatus</i> (Steindachner, 1892) [*]	245	5.1	19	1.7	109.1	0.0122	2.961	0.961	0.0100–0.0150	2.886–3.037
	<i>Hemibarbus labeo</i> (Pallas, 1776)	149	7.5	44	3.9	805.1	0.0077	3.027	0.940	0.0055–0.0108	2.902–3.151
	<i>Microphysogobio oujiangensis</i> (Sun, Huang & Zhao, 2022) [*]	38	5.8	9.7	1.8	10.9	0.0041	3.469	0.910	0.0019–0.0087	3.099–3.838
Bagridae	<i>Pseudobagrus albomarginatus</i> (Rendahl(de), 1928)	69	6.7	29.8	2.9	116.0	0.0244	2.534	0.934	0.0157–0.0378	2.369–2.698
	<i>Siniperca scherzeri</i> (Steindachner, 1892)	28	11.4	32.7	10.6	452.6	0.0101	3.064	0.980	0.0059–0.0172	2.885–3.242

Note: N, sample size; a, intercept; b, slope; CI, confidence interval; r², coefficient of correlation.

^{*}First record of LWR for the species.

[#]New maximum length records.

TABLE 2 | Length-length relationship (LLR: $SL = a + bTL$) for 11 fish species collected in the Oujiang River, China.

Family	Species	LLR parameters				
		<i>a</i>	<i>b</i>	<i>r</i> ²	aCL95%	bCL95%
Plecoglossidae	<i>Plecoglossus altivelis</i> (Temminck & Schlegel, 1846)	-0.3092	0.8812	0.9800	0.7161-0.9333	0.974-1.064
	<i>Squaliobarbus curriculus</i> (Richardson, 1846)	-0.9656	0.877	0.9935	0.5495-0.8318	1.000-1.133
	<i>Culter alburnus</i> (Basilewsky, 1855)	-0.4199	0.8462	0.9892	0.7380-0.8570	0.992-1.035
	<i>Sinibrama macrops</i> (Günther, 1868)	-0.5844	0.8457	0.9458	0.5943-0.7638	1.019-1.111
Cyprinidae	<i>Xenocypris microlepis</i> (Bleeker, 1871)	0.0517	0.8142	0.9916	0.7852-0.8433	0.990-1.013
	<i>Onychostoma barbatulum</i> (Pellegrin, 1908)	0.0107	0.8168	0.9934	0.7311-0.8770	0.975-1.040
	<i>Acrossocheilus fasciatus</i> (Steindachner, 1892)	-0.2621	0.8389	0.9813	0.7180-0.07830	1.016-1.052
	<i>Hemibarbus labeo</i> (Pallas, 1776)	-0.2897	0.8436	0.9946	0.7674-0.8241	1.000-1.026
	<i>Microphysogobio oujiangensis</i> (Sun, Huang & Zhao, 2022)	-0.3573	0.8687	0.9543	0.6368-0.8770	0.969-1.124
Bagridae	<i>Pseudobagrus albomarginatus</i> (Rendahl(de), 1928)	-0.2293	0.8965	0.9852	0.7780-0.9016	0.991-1.046
Serranidae	<i>Siniperca scherzeri</i> (Steindachner, 1892)	-0.6150	0.8896	0.9962	0.7047-0.8318	1.010-1.065

Note: N, sample size; a, intercept; b, slope; *r*², coefficient of correlation.

slope. The 95% confidence interval (CI) for parameters *a* and *b* and the coefficients of determination (*r*²) were also determined [7]. A linear regression was used to determine the LLRs, $SL = a + bTL$, where SL is the standard length (cm), and other measurements are defined as above. For species with *r*² < 0.95, outliers were identified by log-log plot and discarded [6, 7]. Regression was recalculated [6]. All statistical analyses were performed using SPSS 24.0 (SPSS, Inc., Chicago, IL, USA).

3 | Results

A total of 1488 individuals were examined. The LWRs and LLRs of 11 individuals were analyzed. Descriptive statistic on sample number, TL and weight range, regression parameters *a* and *b*, and coefficient of determination (*r*²) of 11 species are shown in Table 1, while Table 2 presents corresponding data for LLRs. All regressions of LWRs and LLRs were statistically significant (*p* < 0.01). This study contributed new insights by establishing two previously undocumented LWRs for *Acrossocheilus fasciatus* and *Microphysogobio oujiangensis*, as well as two novel LLRs for *A. fasciatus* and *M. oujiangensis*. Additionally, the novel TLs for *Onychostoma barbatulum* was recorded, surpassing the data available in FishBase [9].

4 | Discussion

This study successfully established the LWRs for 11 freshwater fish species in the Oujiang River. While previous research has documented LWRs and LLRs for 9 species in this river [9], the first reported LWRs and LLRs for *A. fasciatus* and *M. oujiangensis* were provided in this river. The parameter *b* values of the 11 species ranged from 2.534 to 3.469, remained within the expected range of between 2.5 and 3.5 [7]. This suggests that the growth patterns of most fish conformed to the general rule. The *b* value is known to be influenced by multiple factors, including sampling size, season variation, diet composition, sex ratio, and fishing pressure [7, 10, 11]. The findings indicate species-specific differences in the growth patterns. When *b* = 3, growth is isometric, i.e., specimens maintain their shape as they grow. *Plecoglossus altivelis*, *Sinibrama macrops*, *A. fasciatus*, *Hemibarbus labeo*, and *Siniperca scherzeri* showed this pattern. When *b* < 3, growth is negative allometric. It indicates faster growth in length relative to

weight among the samples. The body shape becomes longer or thinner as it grows. *Culter alburnus*, *Xenocypris microlepis*, *O. barbatulum*, and *Pseudobagrus albomarginatus* adhere to this pattern. When *b* > 3, allometric growth is positive. *Squaliobarbus curriculus* and *M. oujiangensis* were categorized under this pattern. Such variations can result from environmental factors (e.g., habitat of the Oujiang River) [7]. The LWR parameters of *b* was 2.951 for *C. alburnus* and 2.976 for *H. labeo* in 2019 [1]. For *C. alburnus* and *H. labeo*, the LWR parameters of *b* was 2.887 and 3.027. The LWR parameters of *b* for *C. alburnus* and *H. labeo* were inconsistent with *b* values from prior studies, which may be partially explained by following environmental factors (e.g., dam construction and pollution) [2-4].

In this study, the *b* values can be considered representative of annual mixed values of the fish populations because our sampling was carried out over three years along the Oujiang River. Nonetheless, the sample size was limited, especially *P. altivelis*, *S. curriculus*, *O. barbatulum*, *M. oujiangensis*, *P. albomarginatus*, and *S. scherzeri*. According to Froese et al. [12], a minimum of 100 individuals per species is recommended to ensure robust statistical analysis. Thus, future studies should prioritize larger sample sizes to enhance data reliability and overcome current limitations.

All the fish LWRs showed significant differences (*p* < 0.01), and the *r*² values ranged from 0.893 to 0.987. This suggested that the LWRs of those species had relatively high reliability and validity in this study. In the process of fishery resource monitoring, if it was difficult to directly obtain the fish weight data, the body length data could be used to estimate the weight through the established LWRs model to understand the change in fish resource quantity. This approach facilitates the assessment of fish resource dynamics and has been widely employed in various studies, including those conducted in the Qiangtang River [6] and Southern Sicily [13], among others.

5 | Conclusion

This study successfully established LWRs for 11 freshwater fish species in the Oujiang River. Notably, we provide the first reports of both LWRs and LLRs for *A. fasciatus* and *M. oujiangensis*, along with the first record of maximum TL for *O. barbatulum* in

FishBase. These findings contribute valuable baseline data to support future fish conservation and management efforts in the Oujiang River ecosystem.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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