Length–weight relationships of three endemic fish species from the upper Yellow River, China

By Y. Han[1,2,3,*], E.-Y. Fan[2,*], B.-B. Lv[4], C.-G. Zhang[3], Z.-X. Shen[5], Y.-H. Zhao[3] and Y.-C. Xing[2]

[1]*College of Fisheries and Life Science, Shanghai Ocean University, Shanghai, China;* [2]*Natural Resource and Environment Research Center, Chinese Academy of Fishery Sciences, Beijing, China;* [3]*Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing, China;* [4]*Yellow River Fisheries Research Institute, Chinese Academy of Fishery Sciences, Xi'an, China;* [5]*Qinghai Provincial Fishery Environmental Monitoring Center, Xining, China*

Summary

Length–weight relationships (LWRs) of three Chinese endemic fish species (*Gymnocypris eckloni eckloni* Herzenstein, 1891, *Platypharodon extremus* Herzenstein, 1891 and *Triplophysa pseudoscleroptera* (Zhu & Wu, 1981)) were analyzed, collecting from the upper Yellow River (Xunhua and Guide Counties, Qinghai Province). Totally 347 specimens monthly collected by gill nets with 40 mm mesh size and traps with 5 m length from August to October 2014, were used to estimate the relationship parameters. The allometric factor *b* values ranged from 2.96 in *T. pseudoscleroptera* to 3.33 in *G. eckloni eckloni*. The condition factor *a* values varies between 0.0063 and 0.0175 in three species. Three WLRs of fishes distributed in the upper Yellow River were firstly reported and will fill in some of the empty spaces on endemic species in the Fishbase.

Introduction

The upper Yellow River, located in the Qinghai–Tibetan Plateau with the highest elevation in the world, is harboring special ecological environment and unique fish fauna. This region is suffering obvious negative influences by the global climate changes and human activities (Lan et al., 2005; Cuo et al., 2013). As high nutrient level biological components in the aquatic ecosystem, fish is more vulnerable to habitat changes (Sala et al., 2000; Tilman et al., 2001).

The weight–length relationship (WLR) is the index to describe basic biological characters and reflect growth status of fishes (Tesch, 1968). It plays a significant role in assessment of fish resources, as well as conservation and management of the fish populations (Anene, 2005; Fafioye and Oluajo, 2005; Froese, 2006; Pervin and Mortuza, 2008). The parameters of maximum length are able to indirectly reflect fishing pressures and habitat suitability in the certain river (Shin et al., 2005).

The major sympatric species living in the upper Yellow River, *Gymnocypris eckloni eckloni* Herzenstein, 1891,

Platypharodon extremus Herzenstein, 1891 and *Triplophysa pseudoscleroptera* (Zhu & Wu, 1981), have no estimates in Fishbase. All three species are endemic to China and the Yellow River drainage (Wu and Wu, 1991). The first two are from Cypriniformes, Cyprinidae, and the last from Nemacheilidae. *G. eckloni eckloni* and *P. extremus* are threatened (Yue and Chen, 1998), and data deficiency may be adverse to effectively protect on endangered species like them. This study aims to fit LWRs of these three endemic fish species, in order to accumulate the normal biological data and protect the fish population, and fill the empty of Fishbase.

Materials and methods

Total three hundred forty-seven specimens were collected from the upper Yellow River (Xunhua and Guide Counties, Qinghai Province) (Fig. 1). Study samples were collected by gill nets (40 mm mesh size) and traps (5 m) during August to October, 2014. The fresh specimens were fixed by 10% formalin solution in the field. The fixed samples were measured of standard length to the nearest 0.01 cm and weighed of body weight to the nearest 0.1 g and then preserved in over 75% solution of alcohol, and deposited at the fish collection of the National Zoological Museum, Institute of Zoology, and Chinese Academy of Science (ASIZB).

This study adopted the most wildly used regression equation $W = aL^b$ to fit the length–weight relationships (LWRs) where *W* is the total weight (g), *L* is the standard length (cm), and *a* and *b* are regression parameters (Ricker, 1973). The coefficient of determination R^2 was used to evaluate correlation between *W* and *L*. It is difficult to identify the sex of specimens accurately because their gonads were not completely developed. All individuals were used to fit the length–weight relationships (LWRs). The LWRs were analyzed by software Origin version 7.5.

Results

The information of number of samples, degree of threat, range of standard length and total weight, WLRs parameters,
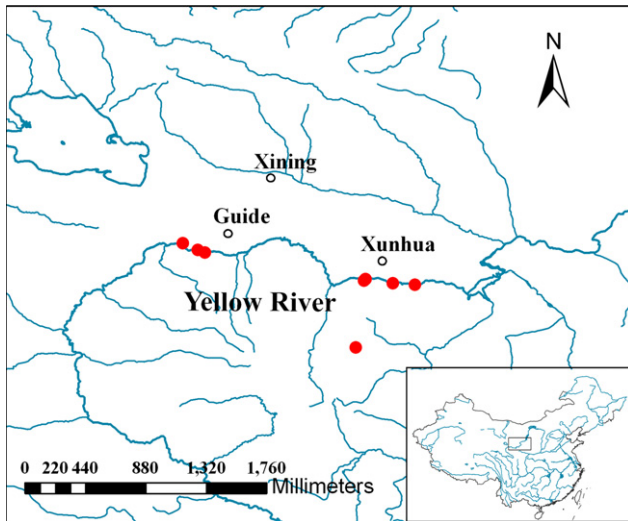
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[*]Co-first authors.

Fig. 1. Locations of *Gymnocypris eckloni eckloni* Herzenstein, 1891; *Platypharodon extremus* Herzenstein, 1891; and *Triplophysa pseudoscleroptera* (Zhu & Wu, 1981)

the 95% confidence interval (CL) of *a* and *b*, as well as the determination coefficient (R^2) were listed in Table 1.

The sampling size of *G. eckloni eckloni* was most and 3–4 times than others. And the natural stock of *P. extremus* was actually lower than others. However, each species had not less than 44 samples and enough for analysis. The condition factor *a* value ranged from 0.0063 in *G. eckloni eckloni* and 0.0175 in *T. pseudoscleroptera*. The allometric factor *b* values ranged from 2.96 in *T. pseudoscleroptera* to 3.33 in *G. eckloni eckloni*. The R^2 values were higher than 0.95, which closed to 0.96 about three species.

Discussion

According to the previous studies, if *b* value is close to 3, it indicates that the large fish individuals have changed their body shape to be more elongated or small individuals in the better nutritional condition, and the growth of fish expressed as isauxesis for length and body weight (Tesch, 1968; Huang and Chang, 1999; Froese, 2006); *b* values above three indicates that fish becomes more grossness otherwise more

slender (Kimmerer et al., 2005). As our results, the *b* values of three species all were within a normal range (between 2.5 and 3.5) (Froese, 2006), which indicated present growth status of them were well, and the body shape of *G. eckloni eckloni* (*b* = 3.33 > 3) and *P. extremus* (*b* = 3.12 > 3) were more grossness.

The LWR parameters with previous studies in Fishbase of two species, *Schizothorax biddulphi* and *Hedinichthys yarkandensis*, also had been compared to our results to indicate relationships of body shape between related species (Table 2). The LWR parameters of species in genera *Gymnocypris*, *Platypharodon* and *Triplophysa* in China were empty in Fishbase, so *S. biddulphi* belonging to same subfamily Schizothoracinae with *G. eckloni eckloni* and *P. extremus*, and *H. yarkandensis* belong to same subfamily Nemacheilidae with *T. pseudoscleroptera* were compared. The results of comparison indicated *b* value of *S. biddulphi* was also more than 3 and its gross was similar to two species studied in our paper, as well as *b* value of *H. yarkandensis* was more than 3 and its body shape might be more grossness than that of *T. pseudoscleroptera* (Table 2).

Mentioned above *G. eckloni eckloni* and *P. extremus* are threatened species. *P. extremus* had been listed as 'Vulnerable' (Wang and Xie, 2009) and *G. eckloni eckloni* as 'Endangerd' by the Key Protected Wild Animals Database of Qinghai Province (promulgated in 1995). On the basis of our field surveys, hydraulic facilities and overfishing might be key factors for fish resources decreasing.

Table 1
WLR parameters of three endemic fish species, upper Yellow River

Species	N	Degree of threat	Length (cm)		Weight (g)		*a*	*b*	R^2	*a*CL95%	*b*CL95%
			Min	Max	Min	Max					
Gymnocypris eckloni eckloni Herzenstein, 1891	219	EN	8.52	27.67	10.01	471.00	0.0063	3.33	0.961	0.0037–0.0091	3.26–3.42
Platypharodon extremus Herzenstein, 1891	44	VU	8.54	14.50	10.28	58.84	0.013	3.12	0.958	0.0012–0.028	2.89–3.34
Triplophysa pseudoscleroptera (Zhu & Wu, 1981)	84		4.87	13.92	1.88	44.65	0.0175	2.96	0.963	0.0068–0.028	2.83–3.08

EN, endangered; VU, Vulnerable.

Table 2
WLR parameters of two related species recorded in FishBase

Species	Length (cm)	a	b	Locality
Schizothorax biddulphi Günther, 1876	7.8–50.6	0.0041	3.27	Tarim River, China
Hedinichthys yarkandensis (Day, 1877)	3.1–18.4	0.0073	3.06	Tarim River, China

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Author's address: Yingchun Xing, Chinese Academy of Fishery Sciences, Qingta Road, Fengtai District, Beijing 100141, China.
E-mail: xingych@cafs.ac.cn
Dr. Yahui Zhao, Institute of Zoology, Chinese Academy of Sciences, Datun Road, Chaoyang District, Beijing 100101, China.
E-mail: zhaoyh@ioz.ac.cn