Technical contribution

Length–weight relationships of nine fish species from the streams of Hunan Zhangjiajie Chinese Giant Salamander National Natural Reserve, China

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Summary

Length–weight relationships (LWR), $W = aL^b$, were estimated for nine fish species belonging to three orders, four families and nine genera from the Hunan Zhangjiajie Chinese Giant Salamander National Natural Reserve, in the northwestern part of Hunan Province of central China. Six of the species are endemic to China, of which three are also endemic to the Yangtze River. The r^2 value ranged from 0.9546 to 0.9924. Values of b varied from 2.9177 to 3.6752. This study represents the first reference on LWR for nine species, and are new maximum length records for six species.

Introduction

Hunan Zhangjiajie Chinese Giant Salamander National Natural Reserve (HZCGSNNR) is located in Zhangjiajie City, in the northwestern part of Hunan Province of central China. The nature reserve is famous for *Andrias davidianus,* which is a protected animal on a national level. Extending from 28°52′–29°48′N to 109°40′–110°20′E, the reserve has a total surface area of 142.85 km^2, including the main rivers and streams in Zhangjiajie; some of the streams flow through Karst caves. As *A. davidianus* preys mainly on small fishes, it is very important to monitor and assess the biomass of these small fishes in the reserve.

Length–weight relationships are used extensively in fishery research and management. In fisheries biology, the LWRs are used for determining weight and biomass when only length measurements are available (Petrakis and Stergiou, 1995; Binohlan and Pauly, 1998; Filiz and Bilge, 2004; Froese, 2006). To the best of our knowledge, the present study gives the first references worldwide on the LWRs for nine fish species.

Materials and methods

Fish assemblages were sampled between April 2011 and August 2014 at 21 sites in the HZCGSNNR where they were captured using gill nets and trammel nets with various mesh sizes. Easily identifiable specimens were measured and released in the field. Unidentifiable fish were immediately iced and transported to the laboratory for identification and measurement according to the references (FRIHP, 1980; Wu, 1982; Zhu, 1995). The nomenclature adopted was that of http://www.fishbase.org (also see Froese and Pauly, 2014). Total lengths (TL) were measured to the nearest 0.1 cm using a measuring board; total weight (TW) was measured to the nearest 0.1 g using a digital balance. The length-weight relationship was calculated using the expression: $W = aL^b$, where the W is the weight (g), L is the length (cm), a is the intercept, and b is the slope. The degree of association among the variables was computed by the determination coefficient, r^2. Parameters a and b were estimated by linear regression analyses based on the logarithm: log (W) = log (a) + b log (L). The 95% confidence interval of a and b was calculated by SPSS 19.0.

Results

The study was based on 674 fishes belonging to nine species representing three orders, four families and nine genera (Table 1). The a values for the species studied ranged from 0.0019 to 0.0097 for *Platysmacheilus exiguus* and *Siniperca scherzeri*, respectively. The b values ranged from 2.9177 for *Parabotia banarescui* to 3.6752 for *P. exiguus*. The r^2 value ranged from 0.9546 to 0.9924. Sample size ranged from 43 individuals for *Sarcocheilichthys sinensis* to 206 for *Pseudohemiculter dispar*. According to FishBase (Froese and Pauly, 2014) this study also provides new records of maximum lengths for six of the species.

Discussion

Six species in the present study are endemic to China, three of which are also endemic to the Yangtze River. All nine LWRs are presented to FishBase for the first time. Samples collected during this study had species of varied sizes and forms. There was a correlation between the body shape and

Table 1
Descriptive statistics and estimated parameters of LWRs for fishes from the streams of Zhangjiajie in China

	n	TL range (cm)	Weight range (g)	a	95% CL of a	b	95% CL of b	r^2
Parabotia banarescui (Nalbant, 1965)[1]	65	5.6–**21.4**	1.6–64.6	0.0081	0.0065–0.0103	2.9177	2.825–3.010	0.9843
Gnathopogon imberbis (Sauvage & Dabry de Thiersant, 1874)[1]	51	6.6–**22.1**	1.3–70.1	0.0045	0.0032–0.0062	3.1125	2.993–3.232	0.9899
Liobagrus marginatus (Günther, 1892)[1]	45	4.6–12.7	0.7–15.2	0.0070	0.0054–0.0091	3.0411	2.926–3.156	0.9884
Pseudohemiculter dispar (Peters, 1881)[2]	206	4.9–19.6	0.8–41.7	0.0064	0.0051–0.0079	2.9505	2.862–3.039	0.9546
Platysmacheilus exiguous (Lin, 1932)[2]	52	5.0–**15.9**	0.5–45.9	0.0019	0.0014–0.0026	3.6752	3.536–3.814	0.9898
Acrossocheilus kreyenbergii (Regan, 1908)[2]	90	6.2–**18.8**	1.9–103.8	0.0052	0.0036–0.0076	3.3537	3.206–3.501	0.9586
Sinibrama macrops (Günther, 1868)	61	6.2–**18.2**	1.6–54.2	0.0040	0.0034–0.0048	3.2701	3.196–3.344	0.9924
Siniperca scherzeri Steindachner, 1892	61	5.4–**26.3**	2.0–213.6	0.0097	0.0079–0.0119	3.0420	2.968–3.116	0.9913
Sarcocheilichthys sinensis Bleeker, 1871	43	5.9–15.5	1.8–50.8	0.0062	0.0046–0.0083	3.2819	3.158–3.406	0.9858

n, sample size; TL, total length; a, intercept; b, slope; CL, confidence limits; r^2, coefficient of determination.
Bold, new records of maximum lengths, max TL.
[1]Endemic species to China.
[2]Endemic species to the Yangtze River.

the a values, with weight in grams and length in centimeters, $a = 0.01$ represents a fusiform fish, bracketed by $a = 0.001$ in eel-like fish and $a = 0.1$ in spherical fish (Froese, 2006), the body shape varied from eel-like (*P. exiguus*) to fusiform bodied (*S. scherzeri*) (Froese et al., 2014).

It is recognized that a number of factors are known to influence the LWR in fishes, including growth phase, season, degree of stomach fullness, gonad maturity, sex, health and general fish condition, as well as preservation techniques (Tesch, 1971; Shepherd and Grimes, 1983), and the parameter b may vary seasonally, and even daily, and between habitats (Okan and Ertan, 2006). These factors were not accounted for during the sampling of fish assemblages in the present study, therefore the estimated parameters a and b should be treated as mean annual values. Some of LWR estimations in this study were identical to the Bayesian LWR predictions in FishBase, but parameter b of two species were not: the eel-like *P. exiguous* and fusiform *Acrossocheilus kreyenbergii* were higher than the Bayesian predictions in the same genus with this body shape (Froese et al., 2014), probably because of the high occurrence of gravid adult females in the sample.

The data collected in our study not only augments the information in FishBase, but can also serve as management and conservation guidance in the Hunan Zhangjiajie Chinese Giant Salamander National Natural Reserve.

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