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LENGTH–WEIGHT RELATIONS FOR 20 FISH SPECIES FROM THE PEARL RIVER, CHINA

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Abstract. The length–weight relations (LWR) were estimated for 20 fish species from the Pearl River, South China. A total of 3610 specimens representing 10 families were used to estimate the relation parameters. The *b* values in the LWR ($W = aL^b$) ranged from 2.068 for *Odontamblyopus lacepedii* (Temminck et Schlegel, 1845) to 3.423 for *Pseudogobius javanicus* (Bleeker, 1856). The LWR with high coefficient of determination (r^2) is significant for all the species. The r^2 value ranged from 0.919 to 0.993. This study presents the first reference on length–weight relations for 7 species and new records of maximum total length for 6 species. The results may be helpful in future fisheries studies in this areas.

Keywords: fish, length–weight relation, Pearl River, China

The length–weight relation (LWR) is an important tool in fish biology, physiology, ecology, and fisheries assessment (Oscoz et al. 2005). It can be used for converting lengths into biomass, determining fish condition, comparing fish growth among areas, and as a complement to species-specific reproduction and feeding studies (Petrakis and Stergiou 1995, Koutrakis and Tsikliras 2003, Froese 2006, Froese et al. 2011). Thus, if it was properly calculated, it can be very useful to fisheries management.

The resources of freshwater fish are very rich in the Pearl River, China (Lu 1990). The length–weight relations of some important commercial species have been relatively well studied in the Pearl River (Pan 1987, Lu 1990), but the length–weight relations of alien and small indigenous fishes are still poorly known. The aim of the presently reported study was to estimate the length–weight relation of 20 fish species (alien and small indigenous fishes) collected from the Pearl River: Chinese icefish, *Neosalanx tangkahkeii* (Wu, 1931); rohu, *Labeo rohita* (Hamilton, 1822); mrigal, *Cirrhinus cirrhosus* (Bloch, 1795); north African catfish, *Clarias gariepinus* (Burchell, 1822); vermiculated sailfin catfish, *Pterygoplichthys disjunctivus* (Weber, 1991); Nile tilapia, *Oreochromis niloticus* (Linnaeus, 1758); striped snakehead, *Channa striata* (Bloch, 1793); mosquitofish, *Gambusia affinis* (Baird et Girard, 1853); *Eleotris oxycephala* Temminck et Schlegel, 1845; broadhead sleeper, *E. melanosoma* Bleeker, 1853; *Mugilogobius myxodermus* (Herre, 1935); *M. abei* (Jordan et Snyder, 1901); *Pseudogobius javanicus* (Bleeker, 1856); tank goby, *Glossogobius giuris* (Hamilton, 1822); *G. olivaceus* (Temminck et Schlegel, 1845); *Rhinogobius giurinus* (Rutter, 1897); *Stenogobius ophthalmoporus* (Bleeker, 1853); Shimofuri goby, *Tridentiger bifasciatus* Steindachner, 1881; *Odontamblyopus lacepedii* (Temminck et Schlegel, 1845); pugnose ponyfish, *Secutor insidiator* (Bloch, 1787).

This study was carried out in the lower reaches of the Pearl River, Guangdong Province, south China (23°02′–23°04′N, 113°18′–113°24′E) (Fig. 1). The Pearl River, with a total length of 2214 km and a drainage area of 442 100 km^2, is the third largest river in China and the largest in south China, flowing through Yunnan, Guizhou, Guangxi, Guangdong, Hunan, and Jiangxi provinces before finally emptying into the South China Sea (Radhakrishnan et al. 2011). The Pearl River basin has a network of rivers, fertile soil, abundant natural resources, and a dense population (Weng 2007). Fish samples were collected monthly from January to December 2010 by traditional fishing gears (hook and line, fish pots, gill nets, seine nets, traps, and electrofishing devices). Identification of the fish specimens captured was aided by Pan (1991), Wu (2008), and Zhou (2006) and the scientific names are consistent with Froese and Pauly (2012). Collected specimens were held in ice, but not frozen, to preserve them in fresh conditions before being identified in the laboratory. Total length (L) [cm] and Body weight (W) [g] of each fish were measured.

The length–weight relation (LWR) between total length and body weight was estimated using the equation:

$$W = aL^b$$

which is estimated through logarithmic transformation:

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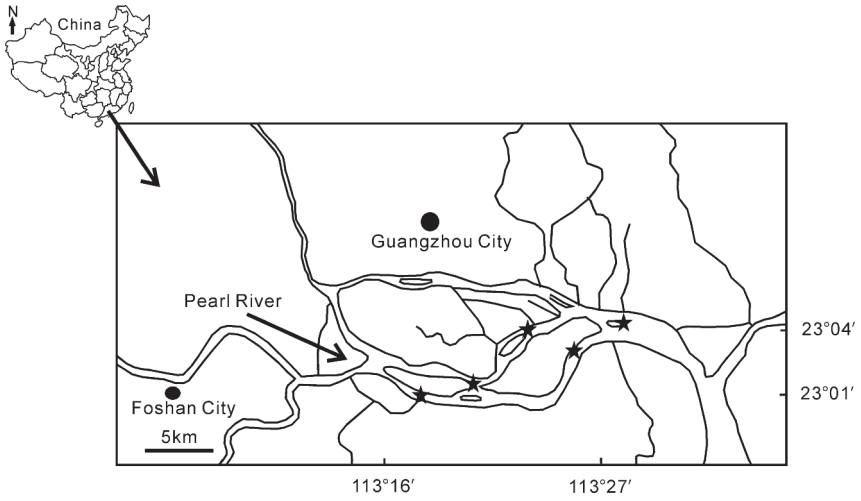

Fig. 1. Map of the study location: the Pearl River Delta, Guangdong Province, south China; asterisks indicate sampling sites

$$\log W = \log a + b \log L,$$

where: a is the intercept and b is the slope of the linear regressions (Koutrakis and Tsikliras 2003, Froese 2006). The degree of relation between the variables was computed by the coefficient of determination (r^2).

Values of the exponent b provide information on fish growth. When $b = 3$, the increase in weight is isometric. When the value of b is other than 3, the weight increase is allometric (positive allometric if $b > 3$, negative allometric if $b < 3$) (Santos et al. 2002, Morey et al. 2003). The null t-test, using the statistic:

$$t_s = (b - 3) \cdot S_b^{-1}$$

where S_b is the standard error of the slope (Zar 1999). All statistical analyses were considered significant at 5% ($P < 0.05$). All analyses were performed using Statistica software (Version 10, 2011, StatSoft Inc.).

A total of 3610 specimens, representing 20 species and 10 families, were collected and studied. The species, sample size, size range, weight range, length–weight parameters a and b, the standard error of the slope, and the coefficient of determination (r^2) are given in Table 1.

The sample size ranged from 13 for *Channa striata* to 580 for *Odontamblyopus lacepedii*. The b values in the LWR ($W = aL^b$) ranged from 2.068 for *O. lacepedii* to 3.423 for *Pseudogobius javanicus*. Overall, the values of parameter b, which varies between 2 and 4 (Yin 1995), mostly remained within the expected range of 2.5–3.5 (Froese 2006), with extreme values of 2.068 for *O. lacepedii* and 2.211 for *Stenogobius ophthalmoporus*. These extreme values are possibly caused by an evolutionary reason to change adult body shape.

In terms of growth type, the results showed that 8 species had isometric growth, 6 species negative allometric, and 6 species positive allometric growth. This study also presents the first reference on length–weight relations for 7 species (marked with N in Table 1) and new records of maximum total length for 6 species (marked with L in Table 1).

The parameters estimated here should be considered only as mean values since the data were collected over an extensive period of time and are not representative of any particular season. However, as a result of the size-selective characteristics of the fishing gear, the samples may not have included all available lengths. For more precise weight estimation, the application of these length–weight relations should be restricted to the observed length ranges (Heydarnejad 2009), otherwise it may be erroneous (Petrakis and Stergiou 1995, Heydarnejad 2009). What is more, The LWR parameters a and b of the fish are readily affected by a series of factors such as season, habitat, gonad maturity, sex, diet and stomach fullness, health, preservation methods, and annual differences in environmental conditions (Froese 2006). The length–weight relation of some species have been studied in China and other localities (Yie 1988, 1993, Chen et al. 1989, Wang et al. 1996, Xu et al. 1996, Xiao et al. 2002, Yalçın et al. 2002, Kimmerer et al. 2005, Ye et al. 2007, Garcia 2010, Ujjania et al. 2012, Zhang et al. 2013), and a and b values as well as r^2 values reported in these studies are presented in Table 2 for a comparison. Dissimilarities seen between present study and results given by various researchers may be attributed the fishing methodology and physical conditions of the habitat (water depth and temperature, sandy and vegetated bottom structures and oxygen).

In conclusion, this paper provides the knowledge of fish populations in this area and also assists fisheries scientists and managers for future studies.

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Table 1

Descriptive statistics and estimated parameters of the length–weight relations for the 20 fish species collected in the Pearl River

Family/species	Total length [cm]		Body weight [g]		Parameters of LWR					*t* value	*P*	Growth	Data	Status
	Range	Mean ± SD	Range	Mean ± SD	*n*	*a*	*b*	r^2	SE_b					
Neosalanx tangkahkeii	3.4–7.8	5.88 ± 1.10	0.08–1.58	0.63 ± 0.34	220	0.001	3.221	0.972	0.0366	6.0383	<0.01	+A	+	Nt
Labeo rohita	8.5–39.4	15.05 ± 5.64	6.90–921.90	69.47 ± 178.49	25	0.005	3.237	0.985	0.0816	2.9044	<0.01	+A	+	Itr
Cirrhinus cirrhosus	9.0–41.8	19.53 ± 5.74	6.50–855.20	97.15 ± 104.45	458	0.006	3.151	0.992	0.0130	11.6154	<0.01	+A	+	Itr
Clarias gariepinus	9.5–111.5	29.24 ± 16.29	6.10–8880.00	388.51 ± 801.70	242	0.006	3.014	0.993	0.0155	0.9032	>0.05	I	+	Itr
Pterygoplichthys disjunctivus	6.6–39.2	19.87 ± 4.84	2.20–520.40	75.02 ± 67.61	170	0.012	2.840	0.957	0.0460	–3.4783	<0.01	–A	+	Itr
Oreochromis niloticus	3.4–29.6	11.94 ± 5.75	0.70–661.20	59.79 ± 96.90	83	0.018	3.023	0.990	0.0333	0.6907	>0.05	I	+	Itr
Channa striata	10.6–39.3	26.15 ± 7.84	10.80–413.00	211.52 ± 120.70	13	0.010	2.993	0.982	0.1207	–0.0580	>0.05	I	+	Itr
Gambusia affinis	1.0–4.0	2.23 ± 0.42	0.01–0.78	0.16 ± 0.12	180	0.009	3.367	0.957	0.0531	6.9115	<0.01	+A	+	Itr
Eleotris oxycephala	6.4–19.0	10.38 ± 3.17	2.49–82.87	16.67 ± 18.67	36	0.008	3.102	0.979	0.0770	1.3247	>0.05	I	L	Nt
Eleotris melanosoma	4.5–12.7	6.77 ± 1.32	1.01–22.53	4.87 ± 3.27	56	0.019	2.833	0.953	0.0849	–1.9670	>0.05	I	+	Nt
Mugilogobius myxodermus	1.6–4.9	2.68 ± 0.53	0.05–1.46	0.29 ± 0.19	372	0.013	2.983	0.930	0.0424	–0.4009	>0.05	I	NL	Nt
Mugilogobius abei	1.2–5.0	2.74 ± 0.74	0.04–1.50	0.37 ± 0.29	241	0.016	2.876	0.944	0.0450	–2.7556	<0.01	–A	NL	Nt
Pseudogobius javanicus	1.6–4.9	3.16 ± 0.57	0.04–1.17	0.39 ± 0.22	122	0.006	3.423	0.954	0.0683	6.1933	<0.01	+A	N	Nt
Glossogobius giuris	6.5–18.3	9.63 ± 2.25	3.40–62.60	9.05 ± 9.07	66	0.013	2.815	0.976	0.0543	–3.4070	<0.01	–A	L	Nt
Glossogobius olivaceus	3.8–16.4	7.33 ± 1.81	0.76–35.75	4.56 ± 3.60	200	0.030	2.455	0.942	0.0432	–12.6157	<0.01	–A	N	Nt
Rhinogobius giurinus	2.3–9.8	5.19 ± 1.68	0.12–12.30	2.58 ± 2.80	166	0.007	3.348	0.968	0.0474	7.3418	<0.01	+A	L	Nt
Stenogobius ophthalmoporus	5–14.8	10.53 ± 1.77	1.76–24.66	11.06 ± 3.95	206	0.058	2.211	0.933	0.0415	–19.0120	<0.01	–A	NL	Nt
Tridentiger bifasciatus	3.5–6.9	5.07 ± 0.62	0.68–5.21	1.95 ± 0.77	158	0.014	3.003	0.940	0.0604	0.0497	>0.05	I	N	Nt
Odontamblyopus lacepedii	7.1–23.2	13.81 ± 3.07	1.27–14.72	6.10 ± 2.66	580	0.025	2.068	0.919	0.0256	–36.4063	<0.01	–A	N	Nt
Secutor insidiator	6.9–8.3	7.63 ± 0.34	5.08–8.81	7.06 ± 1.03	16	0.009	3.270	0.945	0.2097	1.2876	>0.05	I	+	Nt

SD = standard deviation, *n* = sample size; *a* and *b*, the parameters of the length–weight relation, SE_b = standard error, r^2 = the coefficient of determination, *t* value (difference of *b* from 3), *P* = *P*-value; Data = availability of data: (+) = *L–W* relation data available in FishBase (Froese and Pauly 2012), N = new *L–W* data (presently acquired), L = new records of maximum total length; Nt = native, Itr = introduced, +A = allometric (+), –A = allometric(–), I = isometric.

Table 2

Length–weight relations of the fishes targeted in the presently reported study published by other authors

Species	Locality	Sex	Length	*a*	*b*	r^2	Source
Neosalanx tangkahkeii	Xingyun Lake, Yunnan, southwest China	Both	TL	0.0026	3.198	0.998	Chen et al. 1989
	Xin'anjiang Reservoir, Zhejiang, southeast China	Both	SL	0.0039	3.060	0.996	Xu et al. 1996
	Xujiahe Reservoir, Hubei, central China	Both	SL	0.0030	3.170	0.998	Wang et al. 1996
	Xinfengjiang Reservoir, Guangdong, south China	Both	SL	0.0020	3.280	0.990	Xiao et al. 2002
	Dongshan, China	Both	TL	0.0031	3.070	0.940	Zhang et al. 2013
	Taihu Lake, Jiangsu, southeast China	Both	TL	0.0024	3.340	0.950	Zhang et al. 2013
Labeo rohita	Mahi Bajaj Sagar, India	Both	SL	0.0039	3.376	0.953	Ujjania et al. 2012
	Luzong Island, Philippines	Both	SL	0.0280	2.920	0.950	Garcia 2010
Cirrhinus cirrhosus	Mahi Bajaj Sagar, India	Both	SL	0.0042	3.362	0.941	Ujjania et al. 2012
Clarias gariepinus	Asi River, Turkey	Female	TL	0.0100	2.900	0.960	Yalçın et al. 2002
	Asi River, Turkey	Male	TL	0.0160	2.270	0.970	Yalçın et al. 2002
Pterygoplichthys disjunctivus	Luzong Island, Philippines	Both	SL	0.0800	2.560	0.910	Garcia 2010
Oreochromis niloticus	Luzong Island, Philippines	Both	SL	0.0360	3.040	0.970	Garcia 2010
Channa striata	Luzong Island, Philippines	Both	SL	0.0180	2.960	0.960	Garcia 2010
Eleotris oxycephala	Dongjiang River, China	Both	SL	0.0189	3.045		Yie 1988
	Dongjiang River, China	Both	SL	0.0154	3.102	0.991	Yie and Zhang 1993
Glossogobius giuris	Luzong Island, Philippines	Both	SL	0.0150	3.060	0.990	Garcia 2010
Rhinogobius giurinus	Niushan Lake, Hubei,China	Both	TL	0.0075	2.983	0.849	Ye et al. 2007
Tridentiger bifasciatus	San Francisco Estuary, USA	Both	SL	0.0017	3.470		Kimmerer et al. 2005

a and *b*, the parameters of the length–weight relation, r^2 = the coefficient of determination; TL = total length, SL = standard length.

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