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Length–weight relations of ten freshwater fish species (Actinopterygii) from Abashiri River basin, eastern Hokkaido, Japan

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Abstract

Length–weight relations (LWRs) were estimated for ten freshwater fish species such as gin-buna, *Carassius langsdorfii* Temminck et Schlegel, 1846; lake minnow, *Rhynchocypris percnura* (Pallas, 1814); Siberian loach, *Barbatula toni* (Dybowski, 1869); Japanese smelt, *Hypomesus nipponensis* McAllister, 1963; masu salmon, *Oncorhynchus masou* (Brevoort, 1856); rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792); whitespotted char, *Salvelinus leucomaenis* (Pallas, 1814); ninespine stickleback, *Pungitius pungitius* (Linnaeus, 1758); hana-kajika, *Cottus nozawae* Synder, 1911; and a species of goby *Rhinogobius* sp. Specimens were collected once a month except in the snow season from the Abashiri River basin, eastern Hokkaido, between June 2007 and November 2011. Fishes were captured by an electrofishing device (Smith–Root Inc., Model 12-b). The estimated allometric coefficient *b* values ranged from 2.790 (ninespine stickleback) to 3.294 (hana-kajika), and r^2 values ranged from 0.772 (lake minnow) to 0.994 (goby). All the LWRs were highly significant, with $P < 0.001$. Besides, the study provides the first estimates of LWRs for the Siberian loach, Japanese smelt, masu salmon, whitespotted char, hana-kajika, and the goby.

Keywords

LWRs, gin-buna, goby, lake minnow, ninespine stickleback, hana-kajika, Siberian loach, rainbow trout

Introduction

Length–weight relations (LWRs) are important for morphological comparisons between different congeneric species and populations from different geographical areas (Herath et al. 2014; Panda et al. 2016; Roul et al. 2017a, 2017b, 2018; Tran et al. 2021). Several freshwater fishes inhabit the Abashiri River basin in Hokkaido. However, the species' primary biological parameters, such as LWRs, have been poorly studied or have not been studied at all. Hence, the presently reported study aimed to provide the first estimates of LWRs for gin-buna, *Carassius langsdorfii* Temminck et Schlegel, 1846 (Cyprinidae); Siberian loach, *Barbatula toni* (Dybowski, 1869) (Balitoridae) (Figs. 1 and 2); Japanese smelt, *Hypomesus nipponensis* McAllister, 1963 (Osmeridae); masu salmon, *Oncorhynchus masou* (Brevoort, 1856) (Salmonidae); whitespotted char, *Salvelinus leucomaenis*

Figure 1. Siberian loach, *Barbatula toni* collected from the Abashiri River, Japan.

Figure 2. Siberian loach, *Barbatula toni* collected from the Kemichappu River in the Abashiri River basin, Japan.

Figure 3. Hana-kajika, *Cottus nozawae* (16.3 cm TL, 72.7 g) collected from the Chimikeppu River in the Abashiri River basin, Japan.

(Pallas, 1814) (Salmonidae); hana-kajika, *Cottus nozawae* Synder, 1911 (Cottidae) (Figs. 3 and 4); and a goby *Rhinogobius* sp. (Gobiidae). In addition, this study was intended to provide a new estimate of LWRs for alien rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792) (Salmonidae), exploited in eastern Hokkaido, Japan, and new estimates of LWRs for lake minnow *Rhynchocypris percnura* (Pallas, 1814) (Cyprinidae) and ninespine stickleback *Pungitius pungitius* (Linnaeus, 1758) (Gasterosteidae) inhabiting Asia.

Figure 4. Hana-kajika, *Cottus nozawae* collected from the Abashiri River, Japan.

Materials and methods

The fishes were collected once a month except in the snow and snow-melt season from June 2007 to November 2011, from Abashiri River basin (i.e., Abashiri River, Horokama-hashiri stream, Kemichappu River, Chimikeppu River, and Tsubetsu River; 43°28′–44°01′N, 143°48′–144°16′E). All fishes were captured by an electrofishing device (Smith–Root Inc., Model 12-b). Fishes were measured in the field after being anesthetized by the clove oil (Anderson et al. 1997). In gin-buna, lake minnow, Japanese smelt, and salmonid fishes the fork length (FL) was measured while in other fishes the principal measurement was the total length (TL) and a fish measuring board with 0.1 cm accuracy was used. Total body weight (BW) was determined by an electronic balance with 0.1 g accuracy.

The length–weight relations (LWRs) for all species were calculated using the equation

$$\log(BW) = \log(a) + b \log(FLorTL)$$

where BW is the total body weight [g], FL is the fork length [cm], TL is the total length [cm], log(a) is the intercept related to body form and b is the coefficient indicating allometric growth. The parameters of a and b were estimated by a simple linear regression after logarithmic transformation of length and weight data. Extreme outliers were removed from the regression analysis by performing a log-log plot of the length–weight pairs (Froese 2006). The 95% confidence interval (CI) of parameters a and b and coefficient of determination (r^2) were estimated.

Results

The details on length–weight relations (LWRs) of all species are given in Table 1. All the LWRs showed highly significance levels ($r^2 > 0.772$, $P < 0.001$). The formula of LWRs were estimated to be $BW = 0.0213FL^{2.9353}$ for gin-buna, $BW = 0.0139FL^{2.9953}$ for lake minnow, $BW = 0.0076TL^{2.9797}$ for Siberian loach, $BW = 0.0089FL^{2.8731}$

Table 1. LWRs parameters for 10 freshwater fish species collected from Abashiri River basin, eastern Hokkaido, Japan.

Species	*n*	Fork length [cm]	Total length [cm]	Weight [g]	*a*	95%CI*a*	*b*	95%CI*b*	r^2
Carassius langsdorfii	764	2.1–29.7	—	22.4–410.0	0.0213	0.0176–0.0258	2.9353	2.8713–2.9991	0.915
Rhynchocypris percnura	58	5.3–9.7	—	1.6–13.5	0.0139	0.0058–0.0334	2.9953	2.5685–3.4221	0.772
Barbatula toni	4611	—	2.0–19.8	0.1–121.0	0.0076	0.0074–0.0079	2.9797	2.9635–2.9960	0.966
Hypomesus nipponensis	13	5.3–10.9	—	0.9–7.4	0.0089	0.0012–0.0636	2.8731	2.0411–3.7051	0.789
Oncorhynchus masou	8208	1.9–21.9	—	0.1–161.5	0.0106	0.0103–0.0109	3.0397	3.0245–3.0550	0.949
Oncorhynchus mykiss	3410	2.0–40.0	—	0.1–800.0	0.0117	0.0114–0.0120	2.9970	2.9854–3.0094	0.987
Salvelinus leucomaenis	3314	2.3–52.0	—	0.1–1700.0	0.0121	0.0117–0.0126	2.9424	2.9273–2.9558	0.978
Pungitius pungitius	9	—	3.0–6.8	0.2–3.0	0.0119	0.0028–0.0507	2.7901	2.0579–3.5222	0.873
Cottus nozawae	38	—	5.4–17.3	1.7–76.8	0.0071	0.0050–0.0099	3.2937	3.1593–3.4282	0.985
Rhinogobius sp.	3	—	6.0–9.0	2.2–8.4	0.0063	0.0001–0.7084	3.2860	2.9194–3.6526	0.994

n = number of individuals studied, *a* = intercept of relation, *b* = slope of relation, CI = confidence interval, r^2 = co-efficient of determination.

for Japanese smelt, BW = $0.0106FL^{3.0397}$ for masu salmon, BW = $0.0117FL^{2.9970}$ for rainbow trout, BW = $0.0121FL^{2.9424}$ for whitespotted char, BW = $0.0119TL^{2.7901}$ for ninespine stickleback, BW = $0.0071TL^{3.2937}$ for hana-kajika, and BW = $0.0063TL^{3.2860}$ for *Rhinogobius* sp.

Discussion

In addition to the fishes mentioned in the results, the following species were collected during the investigation: lampreys (especially ammocoetes larva), *Lethenteron reissneri* (Dybowski, 1869) and *Lethenteron camtschaticum* (Tilesius, 1811), and redfins, *Pseudaspius hakonensis* (Günther, 1877) and *Pseudaspius sachalinensis* (Nikolskii, 1889), these were difficult to identify in the field and were excluded from this study.

This study was the first report to determine LWRs of Siberian loach, Japanese smelt, masu salmon, whitespotted char, hana-kajika, and *Rhinogobius* sp. These LWRs were not found in the FishBase (Froese R, Pauly 2022) except for Russian sea-run form of masu salmon. However, Kato (1992) reported the LWR of whitespotted char in Japan; the formula was BW = $0.01389SL^{3.0181}$, where SL is the standard length. Besides, Kato (1991) reported the LWR of subspecies of masu salmon, *O.masou ishikawai* in Japan; the formula was BW = $0.00220SL^{3.66}$. Both reports using SL were not directly comparable to this study's results using FL. On the other hand, there are some reports of the LWRs of alien rainbow trout, *Oncorhynchus mykiss*, in Europe and western Asia (Esmaeili and Ebrahimi 2006; Erguden and Goksu 2008; Verreycken et al. 2011), but there has been no report from eastern Asia. In addition, the LWRs for lake minnow and ninespine stickleback were studied at Lake Baikal in Russia (IGFA 2001) and Lake Superior in the USA (Devine 2002), respectively. These LWRs of this study were the first records in Asia. Furthermore, since the LWRs of gin-buna were recorded from only one individual (IGFA 2001), the results of this study enriched the database. As for the goby, its species identity has not yet been determined, and according to Nakabo (2013), it is probably a species included in *Rhinogobius kurodai* (Tanaka, 1908), but *R. kurodai* is not listed in FishBase. These results that provide primary data for further biological research will be useful for fishery conservation in the Abashiri River basin.

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References

Anderson WG, McKinley RS, Colavecchia M (1997) The use of clove oil as an anesthetic for rainbow trout and its effects on swimming performance. North American Journal of Fisheries Management 17(2): 301–307. https://doi.org/10.1577/1548-8675(1997)017%3C0301:TUOCOA%3E2.3.CO;2

Devine JA (2002) A food web analysis of the fishery in Chequamegon Bay, Lake Superior. PhD Thesis, University of Wisconsin, Stevens Point, 141 pp. http://digital.library.wisc.edu/1793/80828

Erguden SA, Goksu MZL (2008) Length–weight relationships for 12 fish species caught in Seyhan Dam Lake in southern Anatolia, Adana, Turkey. Journal of Applied Ichthyology 25(4): 501–502. https://doi.org/10.1111/j.1439-0426.2009.01231.x

Esmaeili HR, Ebrahimi M (2006) Length–weight relationships of some freshwater fishes of Iran. Journal of Applied Ichthyology 22(4): 328–329. https://doi.org/10.1111/j.1439-0426.2006.00653.x

Froese R (2006) Cube law, condition factor and weight–length relationships: History, meta- analysis and recommendations. Journal of Applied Ichthyology 22(4): 241–253. https://doi.org/10.1111/j.1439-0426.2006.00805.x

Froese R, Pauly D (Eds) (2022) FishBase. [Version 01/2022] http://www.fishbase.org

Herath HMTNB, Radampola K, Herath SS (2014) Morphological variation and length weight relationship of *Oreochromis mossambicus* in three brackish water systems of southern Sri Lanka. International Journal of Research in Agriculture and Food Sciences 2(2): 11–22.

IGFA (2001) Database of IGFA angling records until 2001. IGFA, Fort Lauderdale, USA.

Kato F (1991) Morphological and ecological notes on large sized specimens of the amago, *Oncorhynchus ishikawai* and the yamame, *O. masou*. Suisanzoushoku 39(3): 279–288. [In Japanese with English abstract] https://doi.org/10.11233/aquaculturesci1953.39.279

Kato F (1992) Ecological and morphological notes on the charr, *Salvelinus leucomaenis* in the Nagara River and Ibi River systems. Suisanzoushoku 40(2): 145–152. [In Japanese with English abstract] https://doi.org/10.11233/aquaculturesci1953.40.145

Nakabo T (Ed.) (2013) Fishes of Japan with pictorial keys to the species Third edition, Tokai University Press, Hadano, Japan, 2428 pp. [In Japanese]

Panda D, Karna SK, Mukherjee M, Manna RK, Suresh VR, Sharma AP (2016) Length–weight relationships of six tropical fish species from Chilika Lagoon, India. Journal of Applied Ichthyology 32(6): 1286–1289. https://doi.org/10.1111/jai.13174

Roul SK, Kumar RR, Ganga U, Rohit P (2017a) Length–weight relationship of *Rastrelliger brachysoma* (Bleeker, 1851) and Rastrelliger faughni Matsui, 1967 from the Andaman Islands, India. Journal of Applied Ichthyology 33(6): 1–2. https://doi.org/10.1111/jai.13469

Roul SK, Retheesh TB, Prakasan D, Abdussamad EM, Rohit P (2017b) Length–weight relationship of *Thryssa malabarica* (Bloch, 1795) and *Thryssa dayi* Wongratana, 1983 from Kerala, southwest coast of India. Journal of Applied Ichthyology 33(6): 1–2. https://doi.org/10.1111/jai.13441

Roul SK, Retheesh TB, Ganga U, Abdussamad EM, Rohit P, Jaiswar AK (2018) Length–weight relationship of five needlefish species from Kerala waters, south-west coast of India. Journal of Applied Ichthyology 34(1): 190–192. https://doi.org/10.1111/jai.13527

Tran HD, Nguyen HH, Ha LM (2021) Length–weight relationship and condition factor of the mudskipper (*Periophthalmus modestus*) in the Red River delta. Regional Studies in Marine Science 46: e101903. https://doi.org/10.1016/j.rsma.2021.101903

Verreycken H, Van Thuyne G, Belpaire C (2011) Length–weight relationships of 40 freshwater fish species from two decades of monitoring in Flanders (Belgium). Journal of Applied Ichthyology 27(6): 1416–1421. https://doi.org/10.1111/j.1439-0426.2011.01815.x