ARPHA Preprints

PENSOFT

PREPRINT

Author-formatted, not peer-reviewed document posted on 28/01/2022

DOI: https://doi.org/10.3897/arphapreprints.e81371

Length-weight relationships of ten freshwater fish species from Abashiri River basin, eastern Hokkaido, Japan

Atsuya Yamamoto, Kota Tabata, Tomohiro Fukushige, Takuya Inoue, Hiroaki Furutsu, Michihisa Hiroya, Minoru Kanaiwa

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 28/01/2022* DOI: https://doi.org/10.3897/arphapreprints.e81371

Category: Short Communication

Title: Length-weight relationships of ten freshwater fish species from Abashiri River basin, eastern Hokkaido, Japan

Running title: LWRs of 10 freshwater fishes in Hokkaido, Japan

Authors: Atsuya YAMAMOTO[1*], Kota TABATA[1], Tomohiro FUKUSHIGE[1], Takuya INOUE[1], Hiroaki FURUTSU[1], Michihisa HIROYA, & Minoru KANAIWA[1,*,**]

Affiliation: [1]Faculty of Bioindustry, Tokyo University of Agriculture, Abashiri, Hokkaido, Japan

e-mail: (AY) a_yamamoto@bio.mie-u.ac.jp, (KT) lets_more_play_enjoy_baseball@i.softbank.jp, (TF) tomohiro.fukusige@gmail.com, (TI) sp7z88y9@waltz.ocn.ne.jp, (HF) exhaust.fumes.heaven@gmail.com, (MH) a-79.lv.153-u@docomo.ne.jp, (MK) kanaiwa@bio.mie-u.ac.jp

[*] **Present affiliation:** Faculty of Bioresources, Mie University, Tsu, Mie, Japan
[**] **Correspondence:** Dr Minoru KANAIWA, Faculty of Bioresources, Mie University, 1577 Kurimamachiya-cho, Tsu, Mie, 514-8507 Japan (kanaiwa@bio.mie-u.ac.jp)

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 28/01/2022* DOI: https://doi.org/10.3897/arphapreprints.e81371

Abstract

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

Key Words: Gin-buna, goby, lake minnow, LWRs, ninespine stickleback, sculpin, stone loach, trout

Introduction

Length-weight relationships (LWRs) are commonly used as a fundamental tool for estimating weight and biomass of the species understudies, where weighing fish in the field is often impossible to provide sufficient precision for LWR estimates (Froese 2006; Roul et al. 2018). LWRs are also important for morphological comparisons between different species in the same taxon and populations from a different geographical area (Herath et al. 2014; Panda et al. 2016; Pathak and Serajuddin 2015; Roul et al. 2017a, 2017b, 2018).

In the Abashiri River basin in Hokkaido, several freshwater fishes inhabit. However, the species' primary biological parameters, such as LWRs, have not been studied or poorly studied. Hence the present study aimed to provide the first estimates of LWRs for a species of stone loach *Barbatula toni* (Dybowski, 1869), Japanese smelt *Hypomesus nipponensis* McAllister, 1963, masu salmon *Oncorhynchus masou* (Brevoort, 1856), whitespotted char *Salvelinus leucomaenis* (Pallas, 1814), a species of sculpin, hana-kajika, *Cottus nozawae* Synder, 1911, and a species of goby *Rhinogobius* sp. OR. In addition, this study aimed to provide a new estimate of LWRs for alien rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) exploited in eastern Hokkaido, Japan, and new estimates of LWRs for lake minnow *Phynchocypris percnura* (Pallas, 1814) and ninespine stickleback *Pungitius pungitius* (Linnaeus, 1758) inhabiting in Asia.

Materials and methods

Fish were collected once a month except snowy season between June 2007 to November 2011, from Abashiri River basin (i.e., Abashiri River, Horokama-hashiri stream, Kemichappu River, Chimikeppu River, and Tsubetsu River, Lat. 43° 28'–44° 01' N; Lon. 143° 48'–144° 16' E). All fishes were captured by the electrofisher (Smith-Root, Model 12-b). Fish were measured after being anesthetized by the clove oil on the field (Anderson et al. 1997). Crucian carp, lake minnow, Japanese smelt, and Salmonid fishes were measured by fork length (FL),

other fish were measured by total length (TL) using a fish measuring board and scale with 0.1 cm accuracy. Total body weight (BW) was weighted by an electronic weighing balance with 0.1 g accuracy.

The length-weight relationships (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 co-efficient 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 co-efficient of determination (r^2) were estimated.

Results

The details on length-weight relationships (LWRs) of all species are given in Table 1. All the LWRs showed highly significance levels ($r^2 > 0.772$, $p < 0.001$). The allometric co-efficient b values ranged from 2.942 for whitespotted char to 3.294 for the sculpin, whereas the coefficient of determination (r^2) values ranged from 0.772 for lake minnow to 0.994 for the goby.

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 *L. camtschaticum* (Tilesius, 1811), and redfins, *Pseudaspius hakonensis* (Gunther, 1877) and *P. 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 the stone loach, Japanese smelt, masu

salmon, whitespotted char, the sculpin, and the goby. These LWRs were not found in the FishBase (https://www.fishbase.se/search.php/ "last access 13 Jan, 2022") except for Russian sea-run form of masu salmon. However, Kato (1992) reported the LWR of whitespotted char in Japanese; the formula is $BW=0.01389SL^{3.0181}$, where SL is a standard length. Besides, Kato (1991) reported the LWR of subspecies of masu salmon, *O. masou ishikawai* in Japanese; the formula is $BW=0.00220SL^{3.66}$. Both reports using SL are 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 in Europe and western Asia (Esmaeilli and Ebrahimi 2004; Erguden and Goksu 2008; Verreycken et al. 2011), but there is no report in 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 was recorded from only one individual (IGFA 2001), the results of this study enriched the database. As for the goby, its classification 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 recognized as a valid species by Fishbase. These results that provide primary data for further biological research will be useful for fishery conservation in the Abashiri River basin.

Acknowledgements

We would like to express our gratitude to Y Oyama, T Toyama, A Nakano, Y Takeuchi, R Hashimoto, Y Kayaba, Y Sera, T Saito, the late K Yano, and all the people who cooperated in this study.

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: 301-307. https://doi.org/10.1577/1548-8675(1997)017<0301:TUOCOA>2.3.CO;2

Devine JA (2002) A food web analysis of the fishery in Chequamegon Bay, Lake Superior. PhD Thesis, University of Wisconsin, Stevens Point, 141pp.

Erguden S A (2008) Length-weight relationships for 12 fish species caught in Seyhan Dam Lake in southern Anatolia, Adana, Turkey. Journal of Applied Ichthyology 25: 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**: 328-329. https://doi.org/10.1111/j.1439-0426.2006.00653.x

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

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: 279-288. https://doi.org/10.11233/aquaculturesci1953.39.279 (in Japanese with English abstract)

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

Nakabo T(ed) (2013) Fishes of Japan with pictorial keys to the species Third edition, Tokai

University Press, Hadano. 2428pp.

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: 1286–1289. https://doi.org/10.1111/jai.13174

Pathak BC, Serajuddin MA (2015) Comparative study of length- weight relationship and condition factor of lesser spiny eel, *Macrognathus aculeatus* (Bloach) from the different river basins of India. World Journal of Fish and Marine Sciences 7 (2): 82–86. https://doi.org/10.5829/idosi.wjfms.2015.7.2.92110

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: 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: 1–2. https://doi.org/10.1111/jai.13441

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

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: 1416-1421. https://doi.org/ 10.1111/j.1439-0426.2011.01815.x

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 28/01/2022 DOI: https://doi.org/10.3897/arphapreprints.e81371

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

Family	Species	*n*	Fork length range (cm)	Total length range (cm)	Weight range (g)	*a*	95%CI*a*	*b*	95%CI*b*	r^2
Cyprinidae	*Carassius langsdorfii* Temminck & Schlegel, 1846	764	2.1-29.7		22.4-410.0	0.0213	0.0176-0.0258	2.9353	2.8713-2.9991	0.915
	Phynchocypris percnura (Pallas, 1814)	58	5.3-9.7		1.6-13.5	0.0139	0.0058-0.0334	2.9953	2.5685-3.4221	0.772
Balitoridae	*Barbatula toni* (Dybowski, 1869)	4,611		2.0-19.8	0.1-121.0	0.0076	0.0074-0.0079	2.9797	2.9635-2.9960	0.966
Osmeridae	*Hypomesus nipponensis* McAllister, 1963	13	5.3-10.9		0.9-7.4	0.0089	0.0012-0.0636	2.8731	2.0411-3.7051	0.789
Salmonidae	*Oncorhynchus masou* (Brevoort, 1856)	8,208	1.9-21.9		0.1-161.5	0.0106	0.0103-0.0109	3.0397	3.0245-3.0550	0.949
	Oncorhynchus mykiss (Walbaum, 1792)	3,410	2.0-40.0		0.1-800.0	0.0117	0.0114-0.0120	2.9970	2.9854-3.0094	0.987
	Salvelinus leucomaenis (Pallas, 1814)	3,314	2.3-52.0		0.1-1700.0	0.0121	0.0117-0.0126	2.9424	2.9273-2.9558	0.978
Gasterosteidae	*Pungitius pungitius* (Linnaeus, 1758)	9		3.0-6.8	0.2-3.0	0.0119	0.0028-0.0507	2.7901	2.0579-3.5222	0.873
Cottidae	*Cottus nozawae* Synder, 1911	38		5.4-17.3	1.7-76.8	0.0071	0.0050-0.0099	3.2937	3.1593-3.4282	0.985
Gobiidae	*Rhinogobius* sp. OR	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 relationship, *b* = slope of relationship, CI = confidence interval, r^2 = co-efficient of determination.