

Short Communication

Length-weight relationships of three endemic fish species of the Arabian Peninsula

Amir Hassan Masoumi¹, Saud M. Al Jufaili², Fereshteh Pourhosseini¹, Hamid Reza Esmaeili^{1*}

¹Ichthyology and Molecular Systematics Research Laboratory, Department of Biology, School of Science, Shiraz University, Shiraz, Iran.

²Department of Marine Science and Fisheries, Sultan Qaboos University, Muscat, Oman.

Abstract: Length-weight relationships (LWRs) were evaluated for three endemic fish species collected from the north and south of inland waters of Oman in 2022 including *Garra sindhae*, *G. smartae*, and *Oxyurichthys omanensis* by using foldable shrimp and crab fishing traps (mesh size of 3*3mm) and hand nets (mesh size of 3*3mm). The parameter of *b* for all three species was between the estimated ranges of 2.5-3.5 as proposed for different other fish species, and there was high and significant coefficient of determination for all three species (0.87-0.984).

Article history:

Received 30 October 2022

Accepted 29 December 2022

Available online 25 February 2023

Keywords: Growth coefficient, Cube law, Population dynamics, Oman.

Introduction

Parameters of length-weight relationships (LWRs) for marine and freshwater fishes have a historical background in ichthyology and fisheries science; hence, these relationships have been estimated for many commercial and noncommercial species (Esmaeili et al., 2014, 2015; Keivany et al., 2015; Sadeghi and Esmaeili, 2018). At the beginning of the 20th century, length-weight relationships were implemented to evaluate fish population conditions in fish farms (Froese, 2006; Jellyman et al., 2013; Purrafee Dizaj et al., 2020). LWRs play a significant role in fisheries science (Esmaeili and Ebrahimi, 2006; Esmaeili et al., 2014, 2015; Hossain and Sultana, 2014; Sadeghi and Esmaeili, 2018; Mouludi-Saleh and Eagderi, 2019; Al-Jufaili et al., 2021). LWRs can be used to estimate unmeasured length or weight. As the LWRs data are the most available information in fisheries sciences, therefore, these parameters make a backbone in population dynamic investigations such as sex ratio, age at first maturity, longevity, and fecundity (Esmaeili et al., 2014, 2015; Sadeghi and Esmaeili, 2018; Mouludi-Saleh and Eagderi, 2019).

To date, LWRs for many endemic fishes of the

Middle East, including the Arabian Peninsula, have been reported; these parameters have not been estimated for several other endemics, especially those restricted to the Arabian Peninsula. However, biological information, especially LWRs for three endemic fishes: *Garra sindhae* Lyon, Geiger and Freyhof, 2016, *Garra smartae* Krupp and Budd, 2009 (Cyprinidae: Labeoninae); and eyebrow goby *Oxyurichthys omanensis* Zarei, Al Jufaili and Esmaeili, 2022 (Gobiidae: Gobionellinae). *Garra sindhae* is found in the south of Oman near Salalah in the Wadi Andhur. *Garra smartae* have been recorded from two localities, including the Wadis Hadhabram and Laggashalyon. *Oxyurichthys omanensis* is restricted to the Yeti estuary, Oman (Esmaeili et al., 2022; Zarei et al., 2022). This study aims to provide LWRs for these three species of the Arabian Peninsula.

Materials and Methods

Specimens of *G. sindhae*, *G. smartae*, and *O. omanensis* were collected from the Wadis Andhur; Hadhabram and Laggashalyon, and Yeti, respectively, using foldable shrimp and crab fishing traps (mesh size of 3*3 mm, 3 nets for overnight)

*Correspondence: Hamid Reza Esmaeili
E-mail: hresmaeili@shirazu.ac.ir

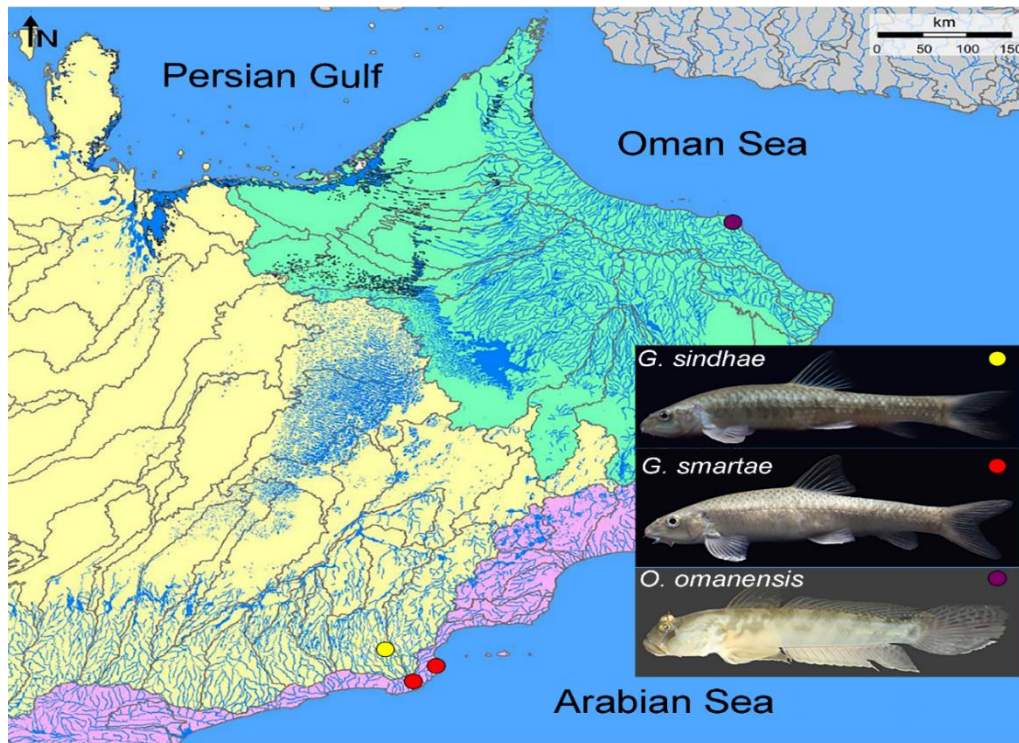


Figure 1. Collection sites of three endemic fish species in the Arabian Peninsula (Oman).

(Fig. 1). The sampling was conducted twice in winter and summer 2022. The total length (TL), Standard length (SL), and fork length (FL) of the individuals were measured to the nearest 0.1 mm using digital calipers, and total weight (TW) to the nearest 0.01 g using a digital electronic balance.

The parameters of length and weight relationships were computed with the formula $W=aL^b$ and expressed by linear regression of the log-transformed length and weight which gives the linear equation (Koutrakis and Tsikliras, 2003): $\text{Log } W = \text{Log } a + b \text{ Log } L$, where W = total weight in grams, L = length (total, standard and fork) in cm, a = a constant being the initial growth index, and b = growth coefficient. Prior to regression analysis, log-log plots of length and weight values were performed for visual inspection of outliers (Froese, 2006).

The significance of the regression between length-weight relationships of fishes was tested by ANOVA. Bailey's t-test was used to determine whether b value significantly deviated from the expected cube value of 3. Data were analyzed statistically by using IBM SPSS (Version 22) statistical software package.

Results

The parameters of length-weight relationships are

given in Table 1. LWRs were significant for all three species ($P<0.001$) with a high coefficient of determination ($r^2\geq 0.870$). The b values of 2.627-3.285, 2.772-2.965, and 2.999-3.362 were estimated for *Garra sindhae*, *G. smartae*, and *O. omanensis* respectively, based on standard length. Bailey's t-test reveals that the b values significantly deviated from 3.

Discussion

Length and weight measurements are generally recorded in fisheries surveys as these parameters make a foundation for other research and management investigations in fisheries sciences. The b -value of LWR is an exponent commonly different among fish species being 2.5 to 4. The slope parameter, b , is used to describe the growth pattern of a fish: allometric growth ($b \neq 3$) represents a fish that has less girth as length increases ($b < 3$) or has an increase in plumpness as length increases ($b > 3$) and occurs more commonly among fish species compared to isometric growth. Isometric growth ($b = 3$) describes a fish that grows with an unchanging body form. Therefore, the b value represents the well-being and general morphology of fishes (Esmaeili et al., 2014, 2015; Sadeghi and Esmaeili, 2018; Mouludi-Saleh and Eagderi, 2019). LWRs of some *Garra* species in Oman are available e.g. b -

Table 1. Descriptive statistics and parameters of LWRs for three fish species from Oman.

Species	N	Characters	TL/SL range (cm)	TW range (g)	<i>a</i>	95% CI of <i>a</i>	<i>b</i>	95% CI of <i>b</i>	<i>r</i> ²
<i>Garra sindhae</i>	30	TL	5.37-9.66	1.1-10.7	0.01288	0.00567-0.0293	2.886	2.454-3.318	0.87
	30	SL	4.1-7.73	1.1-10.7	0.02182	0.01259-0.03793	2.956	2.627-3.285	0.924
	30	FL	4.74-8.69	1.1-10.7	0.175	0.00837-0.03656	2.886	2.475-3.296	0.881
<i>Garra smartae</i>	142	TL	2.79-8.05	0.29-5.445	0.01534	0.01285-0.01832	2.914	2.792-3.035	0.941
	142	SL	2.27-6.65	0.29-5.445	0.03	0.02667-0.03396	2.868	2.772-2.965	0.961
	142	FL	2.5-7.3	0.29-5.445	0.02037	0.01774-0.0234	2.911	2.81-3.012	0.958
<i>Oxyurichthys omanensis</i>	23	TL	4.7-9.03	0.483-4.083	0.00387	0.00195-0.00769	3.128	2.767-3.49	0.939
	23	SL	3.28-6.26	0.483-4.083	0.01096	0.0083-0.01449	3.18	2.999-3.362	0.984

N: number of specimens; TL: total length; FL: fork length; SL: standard length; TW: total weight; *a*: intercept; *b*: regression slope; CI: confidence Interval; *r*²: coefficient of determination.

value of *G. barreimiae* Fowler and Steinitz, 1956, and *G. longipinnis* Banister and Clarke, 1977, estimated for TL, FL, and SL are 3.441, 3.470, 3.269, and 3.104, 3.098, and 3.253, respectively (Al Jufaili et al., 2021). Compared with the studied *G. sindhae*, *G. smartae* in this paper, they have a higher *b* value. This can be due to the habitat characteristics of these two studied fishes being restricted to small ponds or streams with no co-existing species and low vegetation. For the genus *Oxyurichthys*, the *b* values have been reported to be 2.677 and 3.057 for *O. microlepis* (Bleeker, 1849) from the Pulicat lagoon in India and *O. petersi* (Klunzinger, 1871) from the eastern Mediterranean coast of Turkey respectively (Taskavak and Bilecenoglu, 2001; Nallathambi et al., 2020). The *b* value of 2.999-3.362 reported here for *O. omanensis* is close to *O. petersi*.

Previous studies suggested that variation in *b*-value in fishes might be because of several factors like season, species, habitat, sex, gonad maturity, diet, stomach fullness, health, preservation techniques, and locality (Le Cren, 1951; Esmaeili, 2001; Sadeghi and Esmaeili, 2018). One or more of the above factors could be the reason for variation in the LWRs in studied species. In conclusion, this study provides basic information about the LWRs of three endemic fishes, including two *Garra* species and a goby from the Arabian Peninsula (Oman), which will be useful in their fisheries and future conservation management.

Acknowledgments

This research results from the scientific

collaboration between Sultan Qaboos and Shiraz Universities.

References

- Al Jufaili S.M., Sayyadzadeh G., Jawad L., Esmaeili H.R. (2021). Length-weight relationships of five fish species from the inland waters of Oman. *Iranian Journal of Ichthyology*, 8(1): 63-67.
- Esmaeili H.R., Al Jufaili S.M., Masoumi A.H., Zarei F. (2022). Ichthyodiversity in southeastern Arabian Peninsula: Annotated checklist, taxonomy, short description and distribution of Inland fishes of Oman. *Zootaxa*, 5134(4): 451-503.
- Esmaeili H.R., Ebrahimi M. (2006). Length-weight relationships of some freshwater fishes of Iran. *Journal of Applied Ichthyology*, 22(4): 328-329.
- Esmaeili H.R., Gholamifard A., Vatandoust S., Sayyadzadeh G., Zare R., Babaei S. (2014). Length-weight relationships for 37 freshwater fish species of Iran. *Journal of Applied Ichthyology*, 30(5): 1073-1076.
- Esmaeili H.R., Masoudi M., Sayyadzadeh G., Mehraban H.R., Gholami Z., Teimori A. (2015). Length-weight relationships for four *Aphanius* species of Iran (Teleostei: Cyprinodontidae). *Journal of Applied Ichthyology*, 31(3): 578-579.
- Esmaeili, H.R. (2001). Biology of an exotic fish silver carp *Hypophthalmichthys molitrix* valenciennes from Gobindsagar reservoir Himachal Pradesh India.
- Froese R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22(4): 241-253.
- Hossain M., Sultana N. (2014). Morphometric characters and length-weight relationship of Bele, (*Glossogobius giuris*) from Mithamoin haor, Kissorgonj,

- Bangladesh. Journal of the Bangladesh Agricultural University, 12(2): 389-395.
- Jellyman P.G., Booker D.J., Crow S.K., Bonnett M.L., Jellyman D.J. (2013). Does one size fit all? An evaluation of length–weight relationships for New Zealand's freshwater fish species. New Zealand Journal of Marine and Freshwater Research, 47(4): 450-468.
- Keivany Y., Nezamoleslami A., Dorafshan S., Eagderi S. (2015). Length-weight and length-length relationships in populations of *Garra rufa* from different rivers and basins of Iran. International Journal of Aquatic Biology, 3(6): 409-413.
- Koutrakis E., Tsikliras A. (2003). Length-weight relationships of fishes from three northern Aegean estuarine systems (Greece). Journal of Applied Ichthyology, 19(4): 258-260.
- Le Cren E. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). The Journal of Animal Ecology, 20(2): 201-219.
- Mouludi-Saleh A., Eagderi S. (2019). Length-weight relationship and condition factor of ten fish species (Cyprinidae, Sisoridae, Mugilidae, Cichlidae, Gobiidae and Channidae) from Iranian inland waters. Journal of Wildlife and Biodiversity 3(4): 12-15.
- Nallathambi M., Arumugam U., Jayasimhan P., Chandran S., Paramasivam K. (2020). Length-weight relationships of six tropical estuarine fish species from Pulicat lagoon, India. Journal of Applied Ichthyology, 36(1): 125-127.
- Purrafee Dizaj L.P., Esmaili H.R., Abbasi K., Valinassab T., Salarpouri A. (2020). Does length-weight equation fit clupeid fishes? An evaluation of LWRs for six clupeids from Iran (Teleostei: Clupeiformes). International Journal of Aquatic Biology, 8(2): 126-131.
- Sadeghi R., Esmaili H.R. (2018). Length-weight relationships of three gobiid species (Perciformes: Gobiidae) along the Iranian intertidal coast of the Persian Gulf and Makran Sea. Journal of Applied Ichthyology, 34(5): 1233-1234.
- Taskavak E., Bilecenoglu, M. (2001). Length-weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the eastern Mediterranean coast of Turkey. Journal of the Marine Biological Association of the United Kingdom, 81(5): 895-896.
- Zarei F., Al Jufaili S.M., Esmaili H.R. (2022). *Oxyurichthys omanensis* sp. nov., a new Eyebrow Goby (Teleostei: Gobiidae) from Oman. Zootaxa, 5182(4): 361-376.