



-RESEARCH ARTICLE-

Length-Weight Relationships of Four Lessepsian Puffer Fish Species From Muğla Coasts of Turkey

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Abstract

In this study, length-weight relationships were given belonging to Tetraodontidae family: *Lagocephalus sceleratus* (Gmelin, 1789), *Lagocephalus spadiceus* (Richardson, 1845), *Lagocephalus suezensis* Clark & Gohar, 1953 and *Torquigener flavimaculosus* Hardy & Randall, 1983. Specimens were collected via different fishing activities (e.g. longline, trammel net, bottomtrawl) from Muğla coasts (South Aegean Sea, Turkey) during 2014. Specimens were thrown back sea after length and weight measurements because of restrictive legal requirements. Minimum, maximum and mean total lengths and weights were established as 5.3, 10.6, 7.25 cm, 3.96, 31.57, 11.28 g for *T. flavimaculosus*, as 16.7, 63.8, 29.34 cm, 64.36, 2968.42, 342.39 g for *L. sceleratus*, as 11.8, 27.9, 16.48 cm, 27.98, 287.48, 74.24 g for *L. spadiceus* and as 8.6, 15.9, 10.62 cm, 7.94, 43.56, 15.47 g for *L. suezensis*, respectively. LWR equations were calculated as follow: $W = 0.03761 * L^{2.8363}$ ($R^2 = 0.896$) for *T. flavimaculosus*, $W = 0.01646 * L^{2.9272}$ ($R^2 = 0.974$) for *L. sceleratus*, $W = 0.03327 * L^{2.7315}$ ($R^2 = 0.913$) for *L. spadiceus* and $W = 0.02138 * L^{2.7586}$ ($R^2 = 0.871$) for *L. suezensis*. Four pufferfish species were show negative allometric growth (A-) model.

Keywords:

Pufferfish, Tetraodontidae, South Aegean Sea, Turkey

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Introduction

The family Tetraodontidae, known as pufferfishes, consists of 200 species (Froese & Pauly, 2017). However, the family Tetraodontidae is represented in the Mediterranean Sea by ten species (Mastsuura et al., 2011; Farrag et al., 2016).

In the fisheries science, length-weight relations have a several uses: Estimate weight from length for individual fish and for length classes of fish; estimate standing-crop biomass when the length frequency distribution is known (Anderson & Gutreuter, 1983; Petrakis & Stergiou, 1995); convert growth-in-length equations to growth-in weight for prediction of weight-at-age and use in stock assessment models (Pauly, 1993); calculate condition indices (Anderson & Gutreuter, 1983; Petrakis & Stergiou, 1995); and compare populations from different regions in terms of their life histories and morphology (Petrakis & Stergiou, 1995).

The purpose of the relationships presented here is to enable researchers merely to derive length estimates for the species, found in the Muğla coasts, that are weighed but not measured, or vice versa.

Material and Methods

In this study, length-weight (LWR) relationships were calculated for: *L. sceleratus* (Gmelin, 1789) (n= 125), *L. spadiceus* (Richardson, 1845) (n= 117), *L. suezensis* Clark & Gohar, 1953 (n= 84) and *T. flavimaculosus* Hardy & Randall, 1983 (n= 28) specimens collected seasonally via different fishing methods (e.g. longline, trammel net, bottom trawl) from Muğla coasts (South Aegean Sea, Turkey) and Each fish was measured for total length (TL) to the nearest 0.1 cm and weighed (wet weight, *W*) to the nearest 0.01 g on board during the year of 2014, all specimens were thown back sea after length and weight measurements because of restrictive legal requirements.

The length-weight relationships were estimated using the equation $W = aL^b$, where *W* is total weight (g), *L* the total length (cm), *a* the intercept and *b* the slope. The degree of association between the variables was computed by the determination coefficient, r^2 . The significance of the regression was assessed by ANOVA, and the *b*-value for each species was tested by t-test to verify that it was significantly different from the predictions for isometric growth ($b = 3$) (Pauly, 1993).

Results and Discussion

We were collected 354 fish specimens belonging Tetraodontidae family, two genus (*Torquigener* and *Lagocephalus*) and four species: 7.90% of *T. flavimaculosus*, 35.31% of *L. sceleratus*, 33.05% of *L. spadiceus* and 23.73% of *L. suezensis*.

Table 2. Length-weight relationships of *Torquigener* and *Lagocephalus* species from Muğla coasts (South Aegean Sea, Turkey).

Species	N	L _{min}	L _{max}	L _{mean}	W _{min}	W _{max}	W _{mean}
<i>T. flavimaculosus</i>	28	5.3	10.6	7.256	3.96	31.57	11.28
<i>L. sceleratus</i>	125	16.7	63.8	29.341	64.36	2968.42	342.39
<i>L. spadiceus</i>	117	11.8	27.9	16.482	27.98	287.48	74.24
<i>L. suezensis</i>	84	8.6	15.9	10.627	7.94	43.56	15.47

N = sample size, L = Total length [cm], W= weight [g], min = minimum, max = maximum

Descriptive statistics and sample size (N) of four pufferfish species were given in Table 1, collected from Muğla coasts and length-weight relationships, the coefficient of determination (R^2), the Standard error (SE) and confidence interval (CI) of b . Of *Torquigener* and *Lagocephalus* species from Muğla coasts (South Aegean Sea, Turkey) shown in Table 2.

Table 2. Length-weight relationships of *Torquigener* and *Lagocephalus* species from Muğla coasts (South Aegean Sea, Turkey).

$W = aL^b$									
Species	N	L_{min}	L_{max}	a	b	S.E. (b)	R^2	95% CI of b	Growth type
<i>T.flavimaculosus</i>	28	5.3	10.6	0.03761	2.8363	0.0166	0.896	0.0257	(A-)
<i>L. sceleratus</i>	25	16.7	63.8	0.01646	2.9272	0.0128	0.974	0.0265	(A-)
<i>L. spadiceus</i>	17	11.8	27.9	0.03327	2.7315	0.0135	0.913	0.0227	(A-)
<i>L. suezensis</i>	4	8.6	15.9	0.02138	2.7586	0.0157	0.871	0.0234	(A-)

N = sample size, L = Total length [cm], min = minimum, max = maximum, r^2 = coefficient of determination, a = intercept, b = slope, SE of b = standart error of b, CI = confidence interval, A (-) = negative allometry.

Values of the allometric coefficient (b) ranged from 2.7315 for *L. spadiceus* to 2.9272 for *L. sceleratus* and all species were shows negative allometric growth (A-) model.

Discussion

Comparisons of length-weight relationships of *Torquigener* and *Lagocephalus* species in the Mediterranean were given in Table 3. Concerning all species, the b -values of the relationship ranged from 2.645 to 3.150. Negative allometric growth was observed in all studies while only one study showed positive allometric growth (Wang et al., 2011).

Table 3. Comparisons of length-weight relationships of *Torquigener* and *Lagocephalus* species from Muğla coasts (South Aegean Sea, Turkey) (*in SL, ** in FL, Sp.: Species, 1: *T. flavimaculosus*, 2: *L. sceleratus*, 3: *L. spadiceus*, 4: *L. suezensis*).

Sp.	Study	a	b	Length (cm)	r^2	n	Country
1	Ergüden et al.(2015)	0.04030	2.902	4.8-11.6	0.970	11	Turkey
	Present study	0.03761	2.8363	5.3-10.6	0.896	28	Turkey
2	Başusta et al.(2013)	0.03810	2.645	8.9-78.4	0.939	49	Turkey
	Letourneur et al. (1998)	0.01940	2.904	9.0-71.5**	0.992	67	New Caledonia
	Başusta et al.(2013)	0.01380	2.915	15.4-52.3	0.973	28	Turkey
	Kulbicki et al.(2005)	0.01823	2.924	9.0-72.0**	0.994	94	New Caledonia
	Farrag et al. (2015)	0.01300	2.933	5.0-83.0	0.996	-	Egypt
	Present study	0.01646	2.9272	16.7-63.8	0.974	125	Turkey

3	Başusta et al.(2013)	0.03880	2.674	6.8-37.4	0.856	574	Turkey
	Başusta et al.(2013)	0.03430	2.718	10.6-43.1	0.873	515	Turkey
	Ergüden et al. (2009)	0.02040	2.901	6.9-26.9	0.943	89	Turkey
	Taşkavak and Bilecenoğlu (2001)	0.01860	2.951	15.9-19.9	0.970	19	Turkey
	Wang et al.(2011)	0.02060	3.150	8.7-20.6*	0.990	18	China
	Present study	0.03327	2.7315	11.8-27.9	0.913	117	Turkey
	4	Başusta et al. (2013)	0.2700	2.677	6.5-16.7	0.832	494
Ergüden et al.(2009)		0.02360	2.749	10.2-16.7	0.957	86	Turkey
Başusta et al. (2013)		0.01980	2.795	6.5-17.1	0.858	979	Turkey
Başusta et al. (2013)		0.01450	2.914	7.1-17.1	0.883	485	Turkey
Present study		0.02138	2.7586	8.6-15.9	0.871	84	Turkey

Although the findings are compatible, fish samples in the present study were intermittently collected throughout the year. Estimated LWR parameters should be considered only as mean annual values for most of these species since the data were collected over an extensive period of time and are not representative of any particular season (Dulčić & Glamuzina, 2006). Additionally, the estimation of LWR parameters depends on a series of factors, such as seasonality, habitat, sex and maturity of a species (Karachle & Stergiou, 2008). The length-weight relationships provided in this study could serve as a useful tool in the future studies in the wider study area and as a future reference for comparisons of similar parameters estimated in other Mediterranean regions for four pufferfish species. It is also essential to monitoring their ecological and socio-economic impacts.

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