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Length-weight relationship and condition of *Arnoglossus kessleri* Schmidt, 1915 in Iskenderun Bay (Eastern Mediterranean, Turkey)

Sibel Alagöz Ergüden^{*1}, Ayhan Altun², Deniz Ergüden³

ABSTRACT

Length weight relationship (LWR) studies have an important role in estimating population biomass, determining growth rate and stock status of fishes. In this study a total of 133 scaldback, *Arnoglossus kessleri* Schmidt, 1915 were caught in Iskenderun Bay between September 2014 and May 2015 using a commercial bottom trawler. As a result, the estimates for b parameter of the LWR ranged between and 2.97, 2.68 and 2.74 for males, females and both sexes, respectively. Fulton's condition (KF) factor values also revealed significant variations ($p < 0.01$) for female (1.089) and male (1.100) specimens of *A. kessleri*. The 11.9 cm long male individual found in this study was the longest individual recorded for the Mediterranean Sea. No information currently exists on the length weight relationship of *A. kessleri* in the Mediterranean coast of Turkey. Therefore, this paper is an important contribution to the science and fisheries management applications for this species.

Keywords: *Arnoglossus kessleri*, Length-weight parameters, condition factor, Iskenderun Bay.

1. INTRODUCTION

The scaldback, *Arnoglossus kessleri* schmidt, 1915, is endemic to the mediterranean and black sea and distributed throughout the east mediterranean sea including aegean sea, the sea of Marmara and the Black Sea [1, 2], including the crimean peninsula and the sea of azov [3, 4].

Arnoglossus kessleri is a benthic species that can be found at depths ranging from 10 to 200 m on the upper part of the continental shelf. The species mainly feeds on small fishes and invertebrates [3]. Although *A. kessleri* is not commercially targeted

species, it is a bycatch product in fisheries and is usually discarded. Due to the lack of studies relating the species the conservation status of it has been declared as Data Deficient (DD) globally [5] and in the Mediterranean [6], and there have been no specific conservation measure in action up to date.

Length-weight relationship is an important aspect in fish and fisheries biology and very useful tool for the assessment of fish population dynamics and the management of fisheries [7]. Therefore; the relationship is often used to convert growth in length equations for prediction of weight-at-age and use in stock assessment models [8], to estimate

* Corresponding Author

¹ Çukurova University, Vocational School of İmamoğlu, İmamoğlu/Adana, Turkey - alagozs@cu.edu.tr

² İskenderun Technical University, Faculty of Marine Sciences and Technology, İskenderun/Hatay, Turkey - ayhan.altun@iste.edu.tr

³ İskenderun Technical University, Faculty of Marine Sciences and Technology, İskenderun/Hatay, Turkey - deniz.erguden@iste.edu.tr

biomass from the length-frequency distribution [9, 10] and to calculate the condition of the fish [11].

A number of studies on the length weight relationships of various populations of *A. kessleri* in Turkish Seas were reported previously [12-17]. Nevertheless, the sex ratio and the condition of the fish have not been included in previous studies.

No information currently exists on the length weight relationship of *A. kessleri* in the region covering eastern Mediterranean coast of Turkey. This study focused on the length and weight parameters of *A. kessleri* population from Iskenderun Bay in order to compare the population characteristics of this species with previous reports. Additionally, the condition and the sex ratio of the population have also been determined in order to contribute as much as possible for the growing data file of the species. Therefore, this paper is an important contribution to the science and fisheries management applications relating to *A. kessleri*.

2. MATERIALS AND METHODS

A total of 133 specimens of *A. kessleri* were collected via a commercial trawler at depths ranging from 30 m to 65 m in Iskenderun Bay (Figure 1) between September 2014 and May 2015. Length, weight and sex-ratio distributions were constructed separately. Total length (TL, cm) of specimens were measured to the nearest 0.1 cm. Total weight (W, g) was measured with a digital balance to an accuracy of 0.01 g. Sex was determined by macroscopic analysis of the gonads.

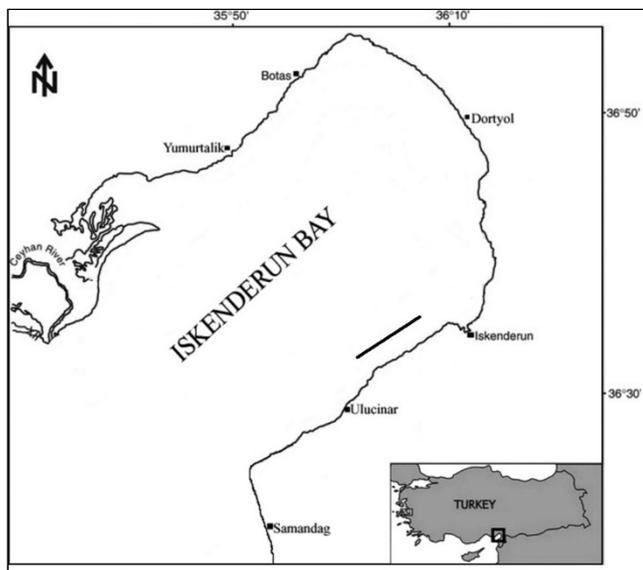


Figure 1. Sampling area of *Arnoglossus kessleri*

The growth relationship, isometric or allometric, between total length and total weight was calculated as $W = a \times TL^b$ using a plotted power function, where a is the power function coefficient (the regression intercept) and b is the exponent (the regression slope) [18]. The relationships were estimated by linear regression analyses based on natural logarithms: $\ln(W) = \ln(a) + b \ln(TL)$. The parameters a and b were calculated using least-squares regression as the coefficient of determination (r^2). An estimate of b equal to 3 is an indication of an isometric growth whereas a greater or lesser value is an indication of either positive or negative allometric growth, respectively.

Prior to the analyses, ln-ln plots of length and weight values were performed for visual inspection of outliers in accordance with Froese [19]. To verify if the results were significantly different from 3 the b values for each of male, female and total of the specimens were tested using a t-test at the 0.001 significance level.

Fulton's condition factor (KF) [20] was calculated using the equation: $KF = (W/L^3) \times 100$. Where: W = Total body weight (g), L = Total length (cm). The scaling factor of 100 was used to bring the KF close to unit.

3. RESULTS

Investigation of 133 specimens revealed that *A. kessleri* population inhabiting the waters of Iskenderun Bay was composed of 51.12% ($n=68$) female and 48.8% ($n=65$) male. Female to male sex ratio of the population was found as 1:0.95. Total length values of overall, female and male specimens ranged from 7.0-11.9 cm, 7.7-11.8 cm and 7.7-11.9 cm, respectively. Weight values for overall, female and male specimens were in the order of 5.32-19.4 g, 3.65-19.7 g and 3.65-19.7 g.

The growth was negative allometric for Iskenderun Bay population of *A. kessleri* and the b values ranged from 2.687 to 2.791 for all three groups: female, male and both sexes (Table 1). All regression values were found to be highly significant ($P < 0.001$) and the values of coefficient of determination (r^2) were greater than 0.95 for all groups. There was no significant difference between length of males and females. Males were slightly larger than females. Length-weight relationships for females, males and both sexes

were calculated as $W=0.00224TL^{2.687}$, ($R^2= 0.953$) (Figure 2), $W= 0.00177TL^{2.791}$ ($R^2= 0.960$) (Figure 3) and $W=0.00196TL^{2.745}$ ($R^2= 0.957$) (Figure 4).

Fulton’s condition (K) factor values also showed significant variations ($P<0.01$). Females were the best performers with a K factor of 1.089 and the values for males and both sexes were observed as 1.100 and 1.095, respectively. A geographic comparison concerning the length-weight relationship for the species was also made using the results reviewed from previous studies (Table 2).

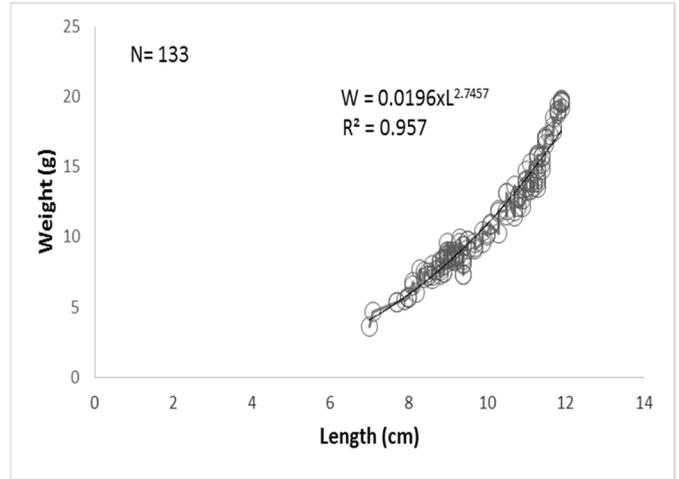


Figure 4. Length–weight relationships of *Arnoglossus kessleri* all specimens from Iskenderun Bay, Eastern Mediterranean coast of Turkey

Table 1. Descriptive statistics and estimated parameters of length-weight relationships for *Arnoglossus kessleri* from Iskenderun Bay (Eastern Mediterranean, Turkey).

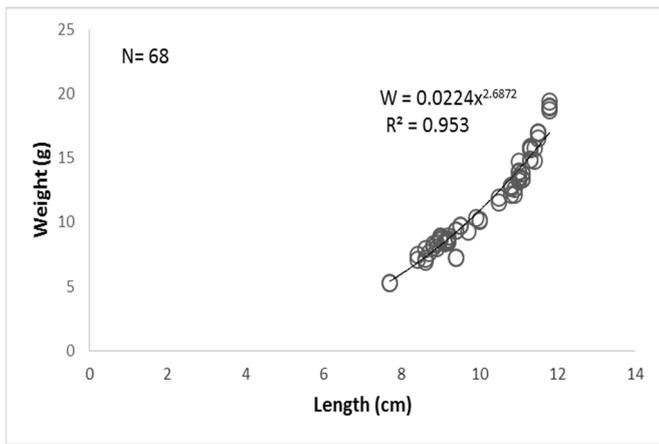


Figure 2. Length–weight relationships of *Arnoglossus kessleri* females from Iskenderun Bay, Eastern Mediterranean coast of Turkey

Table 2. Comparison of length-weight parameters for *A.*

Sex	n	TL (cm)		Parameters of the relationship				r^2
		L_{min}	W_{min}	a	95% C.I. of a	b	95% C.I. of b	
Female	68	7.7-	5.32-	0.022	0.0159-	2.68	2.540-	0.953
		11.8	19.4					
Male	65	7.0-	3.65-	0.017	0.0097-	2.79	2.648-	0.960
		11.9	19.7					
Both	133	7.0-	3.65-	0.019	0.0155-	2.74	2.645-	0.957
		11.9	19.7					

kessleri inhabiting the seas of Turkey.

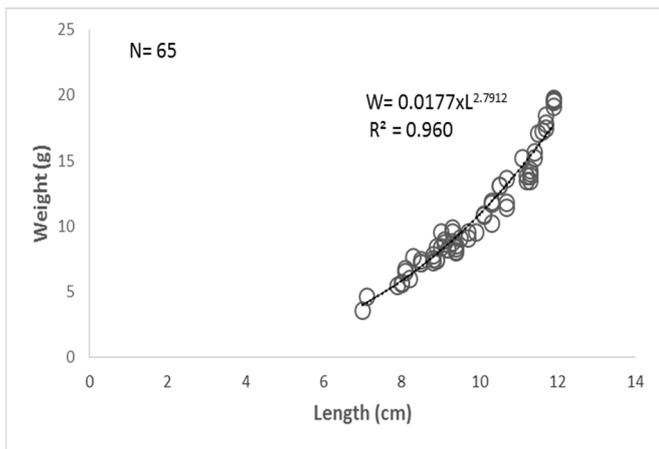


Figure 3. Length–weight relationships of *Arnoglossus kessleri* males from Iskenderun Bay, Eastern Mediterranean coast of Turkey

Reference	Locality	Country	Sex	n	Length Type	L _{min} -L _{max}	a	b	r ²
Türker Çakır et al. [23]	Northern Edremit Bay, north, Aegean Sea	Turkey	-	32	TL	5.2-8.9	0.00174	2.682	0.869
Bayhan et al. [12]	Izmir Bay, Aegean Sea	Turkey	-	76	TL	6.0-8.9	0.01790	2.601	0.878
İlkyaz et al. [14]	Izmir Bay, Turkey	-	-	7	TL	6.9-9.6	0.00185	2.740	0.960
Türker-Çakır et al. [13]	Edremit Bay, north, Aegean Sea	Turkey	-	32	TL	0.8-5.9	0.00004	3.124	0.944
Ak et al. (2009) [15]	Eastern Black Sea	Turkey	-	60	TL	4.3-9.8	0.02100	2.984	0.725
Ozen et al. [23]	Çanakkaile, Marmara Sea	Turkey	-	44	TL	2.9-9.8	0.00673	3.150	0.974
Keskin & Gaygusuz [16]	Erdek Bay, Marmara Sea	Turkey	-	24	TL	4.2-8.7	0.00410	3.474	0.968
Altın et al. [17]	Gökçeada Island, northern Aegean Sea	Turkey	-	393	TL	1.3-11.2	0.0050	3.292	0.933
This study	Iskenderun Bay (NE Mediterranean Sea)	Turkey	M	65	TL	7.0-11.9	0.0224	2.687	0.953
This study	Iskenderun Bay (NE Mediterranean Sea)	Turkey	F	68	TL	7.7-11.8	0.0177	2.791	0.960

4. DISCUSSION

The present data is the first set of data on maximum length and weight for *A. kessleri* in Mediterranean coast, Turkey. This study reveals that the length of males and females of *A. kessleri* did not differ significantly. However, the maximum length of males was slightly larger (11.9 cm) than that of the females (11.8 cm).

This study also reports the longest maximum total length of *A. kessleri* for entire Mediterranean Sea. Bauchot [21] reported that maximum total length of *A. kessleri* for males/unsexed as 10.0 cm in Mediterranean. However, Altın et al [17] found that maximum total length of *A. kessleri* from Gökçeada Island (northern Aegean Sea, Turkey) was 11.2 cm. The present study showed that the maximum total length of the species can extend to 11.9 cm for males and 11.8 for females. This study claims that the maximum total length of the species exceeds the values recorded in the FishBase so far.

The parameter b of length-weight relationships of *A. kessleri* from Iskenderun Bay was significantly different from 3 ($P < 0.05$). The values of b for all groups were within the expected ranges of 2.5-3.5 [19].

Different growth patterns were reported for *A. kessleri* populations. Bayhan et al [12], İlkyaz et al [14] and Türker Çakır et al [22] reported negative allometry for *A. kessleri* from the Aegean coast (Izmir Bay and Edremit Bay), Turkey. Almost isometric growth has also been reported from eastern Black Sea [15]. On the contrary, Keskin and Gaygusuz [16], Altın et al [17] and Ozen et al [23] have reported that populations from the Sea of Marmara and Aegean Sea revealed positive allometric growths. Similar to results of Türker Çakır et al [13], Bayhan et al. [12] and İlkyaz et al. [14] a negative allometric growth was also observed in Iskenderun Bay. The value for all individuals was found as $b=2.745$.

The differences in the b-values may be attributed to seasonal changes in the water temperature and the maturity stage [24]. Besides different sampling area, age, sex and other factors, for example habitat, degree of stomach fullness, preservation techniques, etc., were not considered in this study.

In conclusion, the present study reports a new maximum total length for the native species, *A. kessleri* inhabiting Mediterranean Sea and provides some essential information on *A. kessleri* from Iskenderun Bay. The data on length and weight parameters are expected to be helpful in fisheries management in eastern Mediterranean, Turkey since the species has been declared as a data deficient species in the IUCN red list.

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