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RESEARCH ARTICLE

Determination of the Length-Weight Relationship and Otolith Biometry Characteristics of *Scorpaena scrofa* (Linnaeus, 1758) in the Çanakkale Region

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Abstract: This study, conducted from October 2019 to September 2021 in the regions of the Çanakkale Strait and the Northern Aegean incleuding, Kepez, Kumkale, Yeniköy, Dardanos, Güzelyalı, Morto Bay, and Saros Bay. 162 individuals of the species *Scorpaena scrofa* examined. The total weights and lengths of the individuals were recorded. The average otolith weights of female and male individuals were found to be 0.023 g and 0.023 g, respectively (P<0.05); otolith lengths were 5.13 mm and 4.67 mm (P<0.05); and otolith widths were 2.01 mm and 1.87 mm (P<0.05), respectively. It was determined that males had smaller values than females across all three otolith biometric measurements, and these differences were statiscially significant. Additionally, there were no differences in size between the left and right otoliths (P>0.05). The lenght-weight relationship analysis indicated that the species exhibited isometric growth, with b values approaching 3.

Anahtar kelimeler:

Çanakkale
İskorpit
Otolit biyometrisi
Scorpaena scrofa

Çanakkale Bölgesinde Bulunan *Scorpaena scrofa* (Linnaeus, 1758)'nın Boy-Ağırlık İlişkisi ve Otolit Biyometri Özelliklerinin Belirlenmesi

Öz: Bu çalışma Ekim 2019 – Eylül 2021 tarihleri arasında Çanakkale Boğazı ve Kuzey Ege Denizi olmak üzere; (Kepez, Kumkale, Yeniköy, Dardanos, Güzelyalı, Morto Koyu ve Saroz Körfezi) mevkilerinde gerçekleştirilmiştir. *Scorpaena scrofa* türünden toplam 162 birey temin edilmiştir. Bireylerin toplam ve standart ağırlıkları ile boyları belirlenmiştir. Dişi ve erkek bireylerin ortalama otolit ağırlıkları sırasıyla 0,023 g- 0,023 g (P<0,05); otolit boyları 5,13 mm- 4,67 mm (P<0,05); otolit genişlikleri ise 2,01 mm- 1,87 mm (P<0,05) olarak belirlenmiştir. Tüm üç otolit biyometrisinde, erkek bireylerin dişi bireylere karşılık olarak daha küçük değerlere sahip olduğu ve aralarındaki farkın istatistiksel olarak anlamlı olduğu bulunmuştur. Ayrıca otolit çiftleri sol ve sağ oluşuna göre de karşılaştırılmış, ancak aralarındaki büyüklük farkının önemsiz olduğu (P>0,05) saptanmıştır. Boy – ağırlık ilişkisi hesaplamalarında ise türün genel olarak b değerleri 3'e yakın olduğu için izometrik büyüme gösterdiği tespit edilmiştir.

Introduction

Fish age determination plays a crucial role in fisheries biology research. To ensure sustainable fisheries management, it's essential to accurately assess fish stocks, a task that hinges on understanding population age structures and growth rates (Keskin, 2013). Determining the growth and mortality rates, sexual maturity, and age information of fish across different age groups forms an integral part of population studies (Polat, 2000). In order to achieve maximum yield from a population, understanding the age compositions of the species is one of the crucial factors (Das, 1994). This is particularly important for economically important fish species.

Studies utilizing otolith analyses aim to determine the characteristics of sagittal otoliths and investigate variations in otolith morphology among species using shape indices. Additionally, comparisons of otolith variability with other morphometric features such as fish depth distribution, length, head length, and migration range were conducted (Tuset et al., 2003; Aydın et al., 2004; Ceyhan and Akyol, 2006; Tuset et al., 2008; Bostancı and Polat 2009; Zorica et al., 2010; Bostancı et al., 2011; Atılgan et al., 2012; Bostancı et al., 2012; Cengiz et al., 2012; Başusta et al., 2013; Öztekin et al., 2016; Öztekin et al., 2018; İnnal and Engin, 2020; İnnal, 2020).

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Scorpaena scrofa (scorpion fish), belonging to the Scorpaenidae family, is a species of high economic value. Particularly, *S. scrofa* is widely consumed both in soups and fresh due to its culinary popularity. While studies on otolith biometry exist for *S. porcus* in Türkiye (Bostancı et al., 2012), there is a lack of research specifically on the otolith biometry for *S. scrofa*. This study aims to fill this gap in the literature by determining the otolith characteristics, biometry, and exploring the relationships between otolith size, width, weight, and fish length of *S. scrofa* inhabiting the Çanakkale Strait, Gallipoli Peninsula, and the Saros Gulf, with a focus on gender differences between males and females.

Material and Methods

This study was conducted between October 2019 and September 2021 in Çanakkale Strait, including areas such as Kepez, Kumkale, Yeniköy, Dardanos, Güzelyalı, Morto Bay, and Saros Bay (Figure 1).

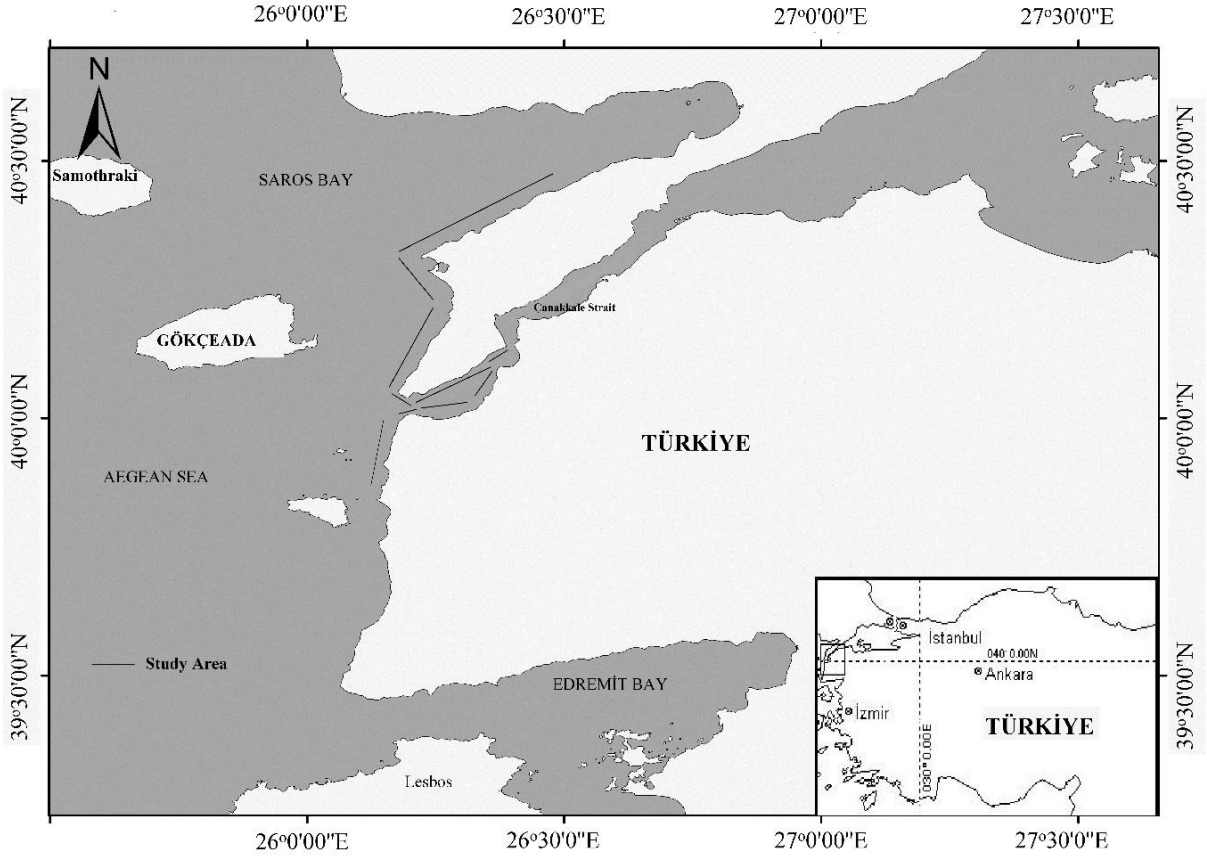

Figure 1. Sampling locations of *Scorpaena scrofa*

Fishing operations targeting *Scorpaena scrofa* utilized gill nets with mesh sizes of 18, 20, and 22 mm, resulting in the capture of 162 individuals. Upon retrieval, each fish was sorted by species, and their total lengths were measured using a precision measurement board (± 1 mm), while weights were recorded with a scale (± 1 g). Subsequently, otoliths were extracted from each specimen, with both left and right otolith pairs individually weighed using a Precisa XB220A series precision balance (± 0.0001 g). Otolith dimensions were measured along the dorsoventral axis for width (OWi) and from anterior to posterior for length (OL) using 'Kameram' image analysis on an Olympus SZX16 microscope, ensuring measurements were taken on undamaged surfaces (Figure 2).

In the final analysis, the difference between otolith pairs was determined using a Paired t-test. The difference in otolith biometry between female and male individuals was identified using a t-test. In addition female and male otolith lengths, widths and weights did not show statistically significant differences according to the Kolmogorov-Smirnov test results ($p > 0.05$).

In this study, the formula W = aL^b (Bagenal and Tesch, 1978) was used to calculate the length-weight relationships of fish. In this formula, W represents the weight of the fish (g), L represents the length of the fish (cm), and a and b represent the constants of the relationship.

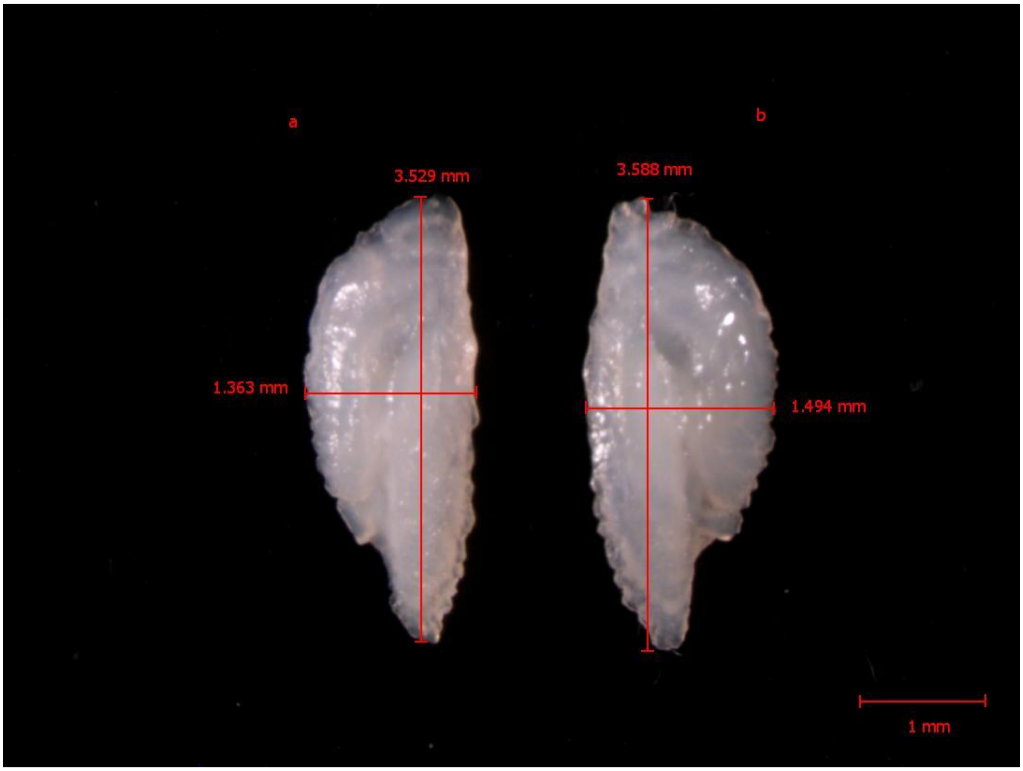

Figure 2. Measurements of length and width of the left (a) and right (b) otoliths of *S. scrofa* species

Results

Table 1 presents the distribution of total length and weight among individuals included in this study. Female *Scorpaena scrofa* ranged in total length from 11.7 to 27.2 cm and in weight from 25.63 to 355.86 g, while males ranged from 11.6 to 35.5 cm in length and 27.46 to 847.28 g in weight. Statistical analysis revealed significant differences in both total length ($P<0.05$) and weight ($P<0.05$) between females and males. The mean total length and weight for males were 17.6 cm and 122.15 g, respectively, and for females, 19.9 cm and 163.64 g, respectively. The length-weight relationships were characterized by the equation $W=0.0153L^{3.0705}$ ($r^2=0.9517$) for all samples, $W=0.0149L^{3.0823}$ ($r^2=0.9045$) for females, and $W=0.0183L^{3.001}$ ($r^2=0.9891$) for males, with "b" values of 3.0705, 3.0823, and 3.001, respectively. These "b" values align with isometric growth (b=3.0), as indicated by Froese (2006), with no statistically significant difference from 3.0 ($P>0.05$) observed across sexes in this study.

Table 1. Distribution of TL (cm) and W (g) of male and female individuals of *S. scrofa*

Measurement	Gender	Mean	Min.	Max.	S. e.	S. d.
Weight (g)	♀	163.64	25.63	355.86	7.93	84.38
	♂	122.15	27.46	847.28	23.75	166.78
Total Length (cm)	♀	19.9	11.7	27.2	0.38	4.07
	♂	17.6	11.6	35.5	0.55	3.89

The weights of both right and left otoliths in all individuals of the population were determined to be 0.0235-0.0236 g ($P>0.05$); the widths of both left and right otoliths were 1.97-1.83 mm ($P>0.05$); and the lengths of both left and right otoliths were 4.992-4.995 mm ($P>0.05$) (Figure 3). The weights of the right otoliths were found to be larger than those of the left otoliths, but the difference between them was determined to be statistically insignificant. Similarly, the differences in both the lengths and widths of the right and left otoliths were also found to be statistically insignificant.

The means of otolith weight, width, and length differed significantly between female and male *Scorpaena scrofa* individuals, with values of 0.023 g vs. 0.023 g ($p<0.05$), 2.017 mm vs. 1.87 mm ($p<0.05$), and 5.130 mm vs. 4.671 mm ($p<0.05$), respectively (Table 2). This indicates that females have larger otoliths than males in terms of weight, width, and length.

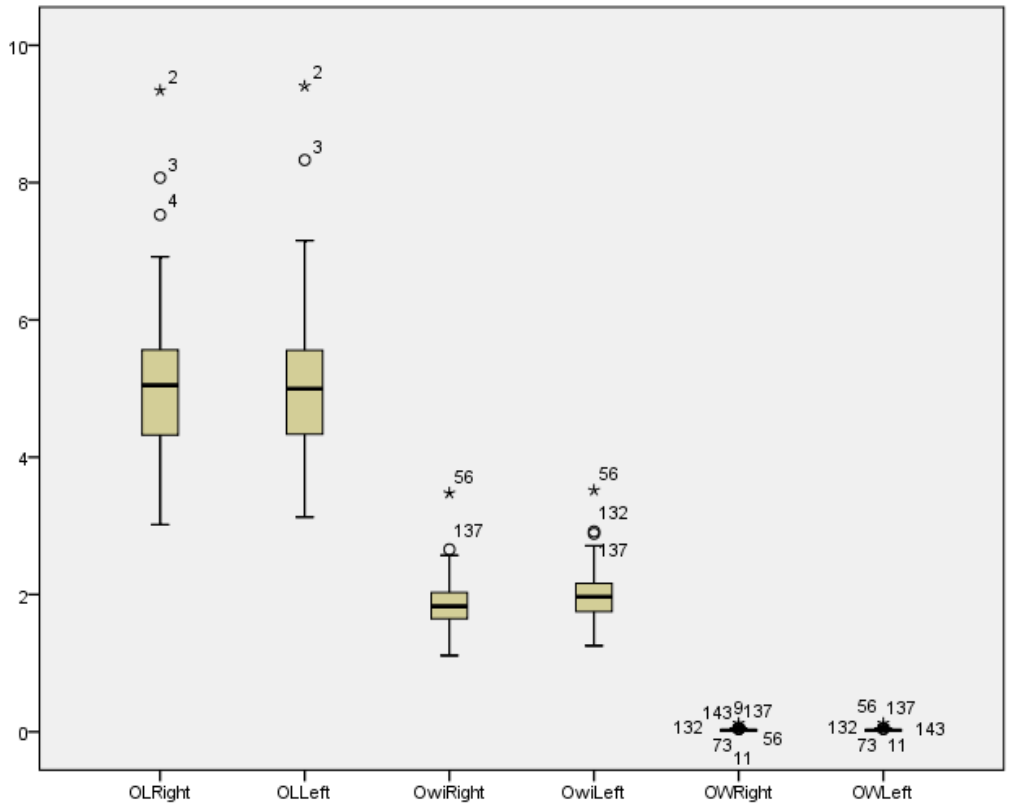

Figure 2. Right and left otolith weight (g), length, and width (mm) of *S. scrofa*

Table 2. Left otolith weight (g), length, and width (mm) in female and male individuals of *S. scrofa*

Measurement	Gender	Mean	Min.	Max.	S. e.	S. d.
Otolith Weight (g)	♀	0.023	0.0097	0.0673	0.00086	0.0091
	♂	0.023	0.0071	0.1246	0.0027	0.0188
Otolith Width (mm)	♀	2.017	1.448	2.919	0.022	0.23
	♂	1.87	1.407	2.136	0.041	0.29
Otolith Length (mm)	♀	5.130	3.461	7.155	0.079	0.855
	♂	4.671	3.127	9.405	0.136	0.956

The relationship between the growth of left otoliths in *Scorpaena scrofa* in terms of weight, length, and width and fish growth was analyzed separately for each gender, with results depicted in Figures 4-12. High correlation coefficients were observed between otolith biometry and total length in both females and males. Notably, the R^2 values for male individuals were consistently higher than those for females across all three otolith properties. Analysis of length-weight relationships indicated that the species generally exhibits isometric growth, as evidenced by "b" values close to 3.0. This finding underscores the uniformity in growth patterns across sexes within the studied population of *S. scrofa*.

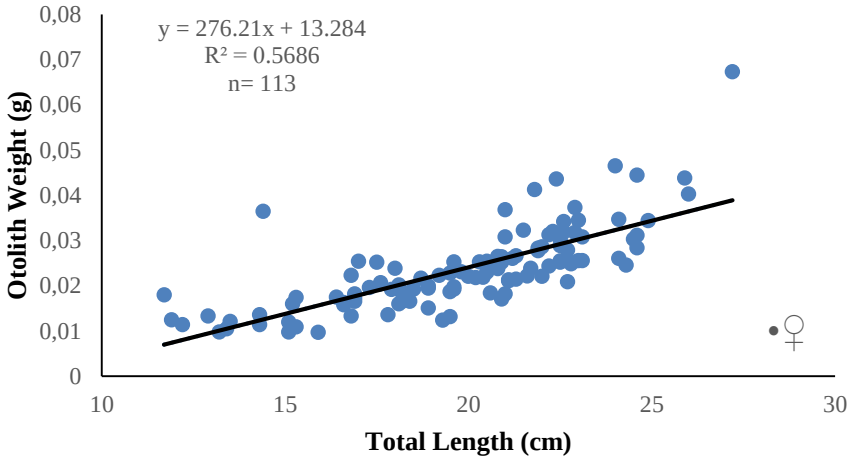

Figure 4. Relationship between OW and TL of *S. scrofa* (female)

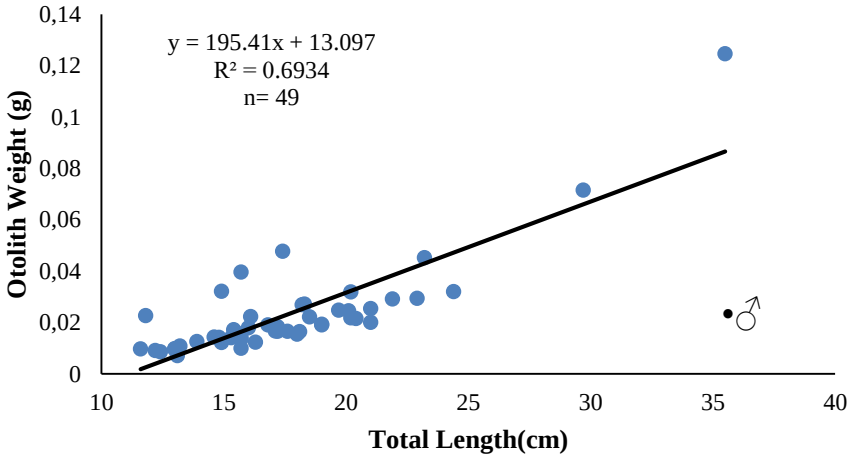

Figure 5. Relationship between OW and TL of *S. scrofa* (male)

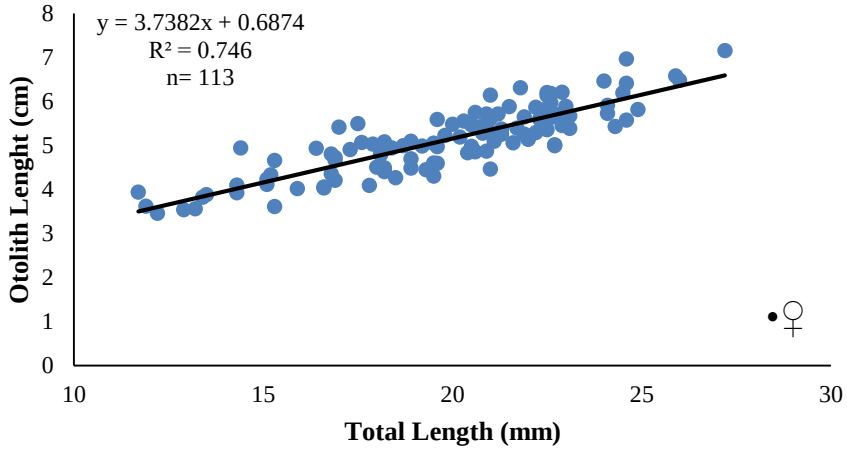

Figure 6. Relationship between OL and TL of *S. scrofa* (female)

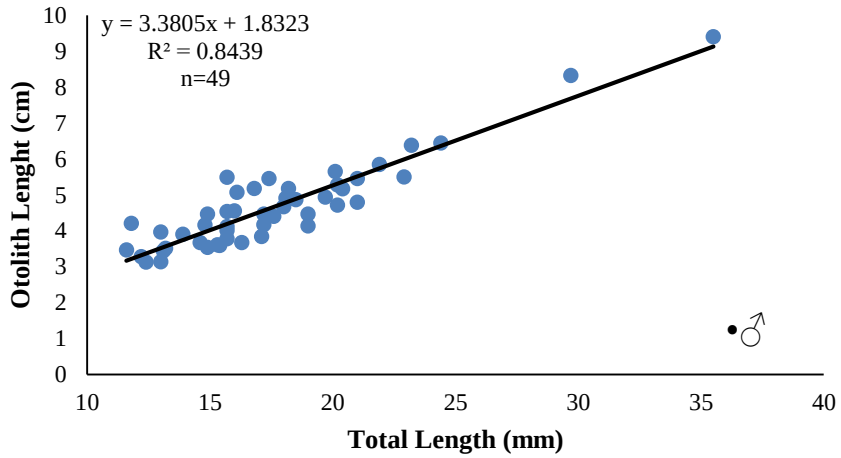

Figure 7. Relationship between OL and TL of *S. scrofa* (male)

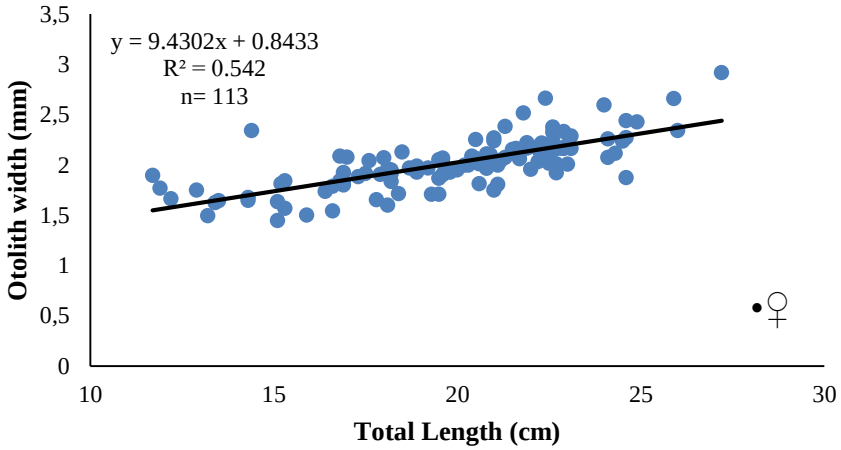

Figure 8. Relationship between OWi and TL of *S. scrofa* (female)

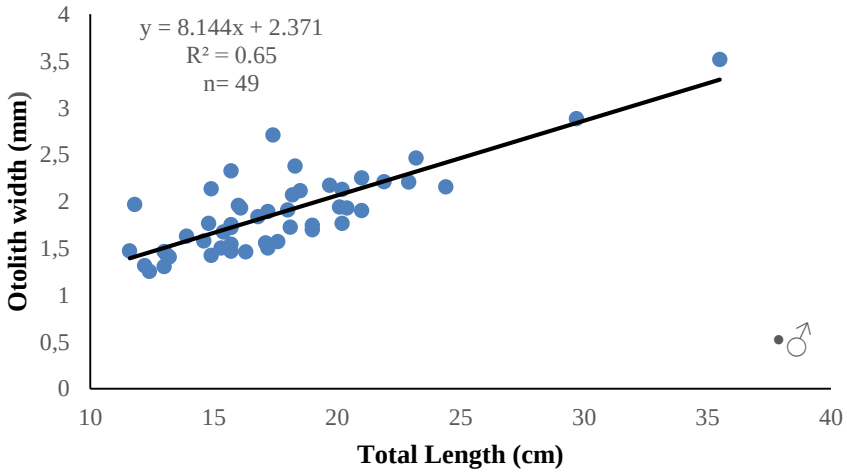

Figure 9. Relationship between OWi and TL of *S. scrofa* (male)

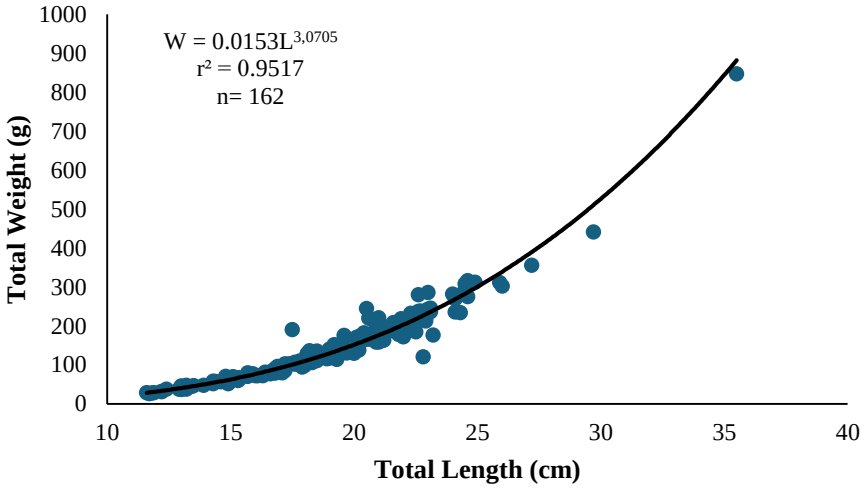

Figure 10. Length-weight relationship of *S. scrofa*

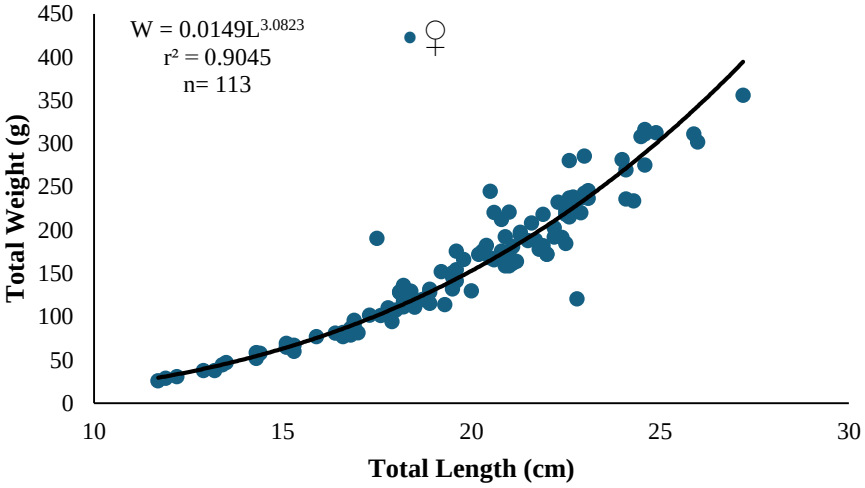

Figure 11. Length-weight relationship of *S. scrofa* (female)

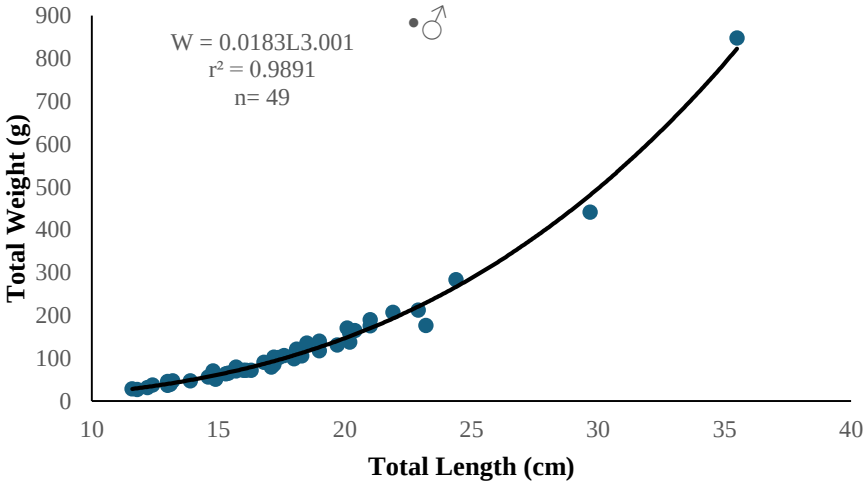

Figure 12. Length-weight relationship of *S. scrofa* (male)

Discussion

In this study there were no statistically significant differences in the right and left pairs of *S. scrofa* otoliths in terms of weight, width, and length, (P>0.05). Therefore, either left of right pair of *S. scrofa* can be used in studies on otolith biometry. In terms of differences between male and females, the otoliths of males were significantly smaller than those of females (P<0.05). Therefore, gender differences should be taken into consideration in future studies. When comparing the b values of *S. scrofa* from various seas (Table 4), it was observed that the b value ranged from 2.686 to 3.298. Özaydın et al. (2007) documented the b value as 2.686 in Izmir Bay. However, in another study conducted in the same region, the b value for *S. scrofa* was calculated as 2.993 (Arslan and Bostancı, 2019). This difference may possibly be due to differences in the sample sizes and length ranges. In this study, 162 individuals with a total size distribution of 11.6 - 35.5 cm were examined, while Cengiz (2013) studied 134 samples with a total size distribution of 8.6 - 29.1 cm and Öztekin et al. (2016) studied 12 samples with a total size distribution of 13.8 – 32.00 cm. Since b value is also a factor of weight, wheather stomach contents were digested or not could impact body weight and alter the parameters of the length-weight relationship. In addition, "b" coefficients may vary significantly due to regional differences.

Our findings on biological characteristics for both sexes of *S. scrofa* from the North Aegean Sea will contribute to future population and stock assessment studies of this species as valuble reference. In addition, our data will be a potential guideline for future sustainable management measures.

Table 4. Comparison of length-weight relationships of *S. scrofa* from different areas

Study Area	n	a	b	r^2	References
Eastern Adriatic (Croatia)	125	0.0000078	3.298	0.960	Dulčić and Kraljević, 1996
Naxos Island, Greece	37	0.01692	2.999	0.980	Moutopoulos and Stergiou, 2002
Iberian Peninsula	359	0.022	2.942	0.981	Morey et al., 2003
Eastern Spain	23	0.03134	2.803	0.986	Valle et al., 2003
Western Portuguese	22	0.0121	3.124	0.966	Mendes et al., 2004
Gökçeada Island, Turkey	15	0.0180	3.005	0.985	Karakulak et al., 2006
İzmir Bay, Turkey	12	0.0448	2.686	0.983	Özaydın et al., 2007
Madeira Archipelago (Eastern Atlantic)	12	0.01526	3.039	0.974	Ferreira et al., 2008
French Catalan coast	32	0.330	2.89	0.990	Crec'hriou et al., 2012
Gallipoli Peninsula (Çanakkale), Turkey	134	0.0221	2.96	0.980	Cengiz, 2013
Korinthiakos Gulf, Greece	53	0.0169	3.002	0.981	Moutopoulos et al., 2013
Gökçeada Island, Turkey	16	0.012	3.135	0.983	Altın et al., 2015
The mid-coastal region of the Adriatic	1700	0.0013	3.068	0.978	Matić-Skoko et al., 2015
Gallipoli Peninsula (Çanakkale), Turkey	12	0.0337	2.794	0.990	Öztekin et al., 2016
Gulf of İzmir (Güzelbahçe), Turkey	199	0.0016	2.993	0.914	Arslan and Bostancı, 2019
Çanakkale Region, Turkey	162	0.0153	3.071	0.952	This study

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Conflict of Interest

The authors affirm that they do not have any conflicts of interest.

Author Contributions

Alkan Öztekin: Designed the field work and study. Data collection, writing and final editing. Gençtan Erman Uğur: Field work, data collection, laboratory work, data analysis and writing.

Ethics Approval

This research was conducted with the approval of the Çanakkale Onsekiz Mart University Local Ethics Committee for Animal Experiments dated 19.10.2018 and numbered 2018/10, and with the permission of the Republic of Turkey Ministry of Agriculture and Forestry, Directorate General of Fisheries and Aquaculture, dated 15.10.2018 and numbered 74397875-1800148726.

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