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Age and Growth of Scorpion Fish (*Scorpaena porcus*, Linneaus 1758) from The Southeastern Black Sea (Turkey)

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Abstract: The growth and age of the scorpion fish (*Scorpanea porcus*, Linneaus 1758) were studied using 316 fishes collected from Southeastern Black Sea during the period of March 2012 to April 2013. Age of *S. porcus* was found between 0 and 7 years and the age group 2 was detected dominant (55.06%). The mean total length and weight of the specimens were found 12.90±0.19 cm and 50.51±2.84 g, respectively. The length-weight relationship for female, male and both sexes were calculated as $W=0.0154*L^{3.1017}$, $W=0.0193*L^{2.9897}$, $W=0.0189*L^{3.0122}$. Von Bertalanffy growth equation parameters considering all individuals were L_∞=40.52 cm, K=0.098 year^{-1}, t_0=-1.764 year. The growth performance index (Ø) was determined as 2.21.

Keywords: Growth, Age, Scorpion fish, *Scorpaena porcus*, Black Sea

Güneydoğu Karadeniz'deki (Türkiye) İskorpit Balığının (*Scorpaena porcus*, Linneaus 1758) Yaş ve Büyümesi

Öz: Araştırmada, güneydoğu Karadeniz'de Mart 2012-Nisan 2013 tarihleri arasında örneklenmiş 316 adet iskorpit (*Scorpaena porcus*, Linneaus 1758) balığının büyüme ve yaş kompozisyonu çalışılmıştır. *S. porcus* bireylerinin yaşı 0 ile 7 arasında değişmekte olup en fazla birey 2 yaş grubunda bulundu (% 55.06). Ortalama total boy ve ağırlıklar sırasıyla 12.90±0.19 cm ve 50.51±2.84 g olarak tespit edildi. Boy-ağırlık ilişkisi dişi, erkek ve genel olarak, $W=0.0154*L^{3.1017}$, $W=0.0193*L^{2.9897}$, $W=0.0189*L^{3.0122}$ şeklinde belirlendi. Tüm bireyler için Von Bertalanffy'nin boyca büyüme parametreleri L_∞=40.52 cm, K=0.098 yıl^{-1}, t_0=-1.764 yıl şeklinde hesaplandı. Büyüme performansı indeksi (Ø) 2.21 olarak belirlendi.

Anahtar Kelimeler: Büyüme, yaş, İskorpit balığı, *Scorpaena porcus*, Karadeniz

1. Introduction

Scorpaena porcus (black scorpion fish) are distributed in wide areas such as in the eastern Atlantic, from the British Isles to Morocco and along the Mediterranean to the Black Sea (Fischer et al. 1986). Generally, the Scorpaenidae family are represented by six species in the seas of Turkey. However, two species of them, such as *Scorpaena porcus* and *Scorpaena notata* are found in the Black Sea (Bilecenoğlu et al. 2014). These species usually are caught during the all year in the Black Sea, (Akşıray 1987). *Scorpaena porcus* is chiefly caught by a kind of trammel and gill nets (Demirhan and Can 2009).

The age, growth, length-weight relationship, reproductive and feeding biology of this species has been investigated by different researchers (Bradai and Bouain 1988; Ünsal and Oral 1994; Koca 2002; Çelik and Bircan 2004; Alpaslan et al. 2007; Kalaycı et al. 2007; Bilgin and Çelik 2009; Demirhan and Can 2009; La Mesa et al. 2010; Scarcella et al. 2011; Erbay 2013). The growth parameters contain important information about the environmental pressure imposed on a fish population (Weatherley and Gill 1987).

There are a transformations in fish population such as the changes of growth rate, term of maturing, amplitude of sizes and age composition for first

matured fish, life duration of matured fish, sex ratio, changes of environmental conditions (Goncharenko 2001; Moiseenko 2002). We recommend regularly monitoring of these parameters. The present study aim was to determine the age, growth, length frequency distribution, length-weight relationship and population parameters of *S. porcus* in Southeastern Black Sea, Turkey.

2. Materials and Methods

A total of 316 *S. porcus* were randomly collected from bottom trawl nets (40 mm codend mesh size) and trammel nets (32-36-38 mm mesh size) between March 2012-April 2013 within the areas among Samsun (41^0 41,040' N – 35^0 25,193' E) - Ordu (41^0 08,725' N – 37^0 17,531' E) (Figure 1).

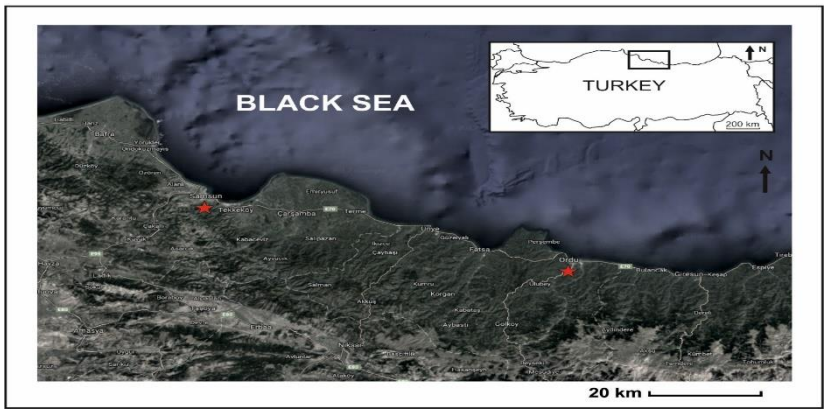

Figure 1. The sampling area
Şekil 1. *Örnekleme alanı*

Total length (TL, nearest 0.1 cm), weight (W, nearest 0.01 g) were measured in all sampled fish. The sagittal otoliths were used for age determination (Türkmen et al. 2005).

The length-weight relationship was calculated according to the equation given by Ricker (1975); $W=a*TL^b$ where W is the fish weight (g) and TL is the total length (cm). The parameters a and b were derived by least-squares regression, as was the coefficient of determination (r^2). The isometric growth (b=3) was tested by t test. When b=3, weight growth is called isometric (Pauly, 1984). Fulton's condition factor (K) was calculated as: $K=W/TL^3*100$ (Ricker 1973, 1975).

The Von Bertalanffy growth equation (VBGE) parameters (L_∞, K, t_0) were estimated from the length-at-age data using nonlinear least-squares function (Everhart et al. 1975), where L_∞ is the asymptotic length, k is the growth coefficient, t_0 is the age at length of zero. The growth performance index (Ø') calculated by $Ø'=\log K+2*\log L_\infty$, where K and L_∞ Von Bertalanffy growth equations parameters (Munro and Pauly, 1983).

Length and weight growth rate were calculated by following equations (Ricker 1975). Absolute growth in length, L_2-L_1; absolute growth in weight W_2-W_1; relative growth in length $(L_2–L_1/L_1)*100$, relative growth in weight $(W_2-W_1/W_1)*100$, where L_1; the average length of the first age group (cm), L_2; the average length of the next age group (cm), W_1; the average weight of the first age group (g), W_2; the average weight of the next age group (g).

Statistical analyses were done to test the significance difference between calculated and observed values and, male and female specimens to show whether the proportions deviated significantly from expected 1:1 ratio using Chi-square and Student's t-test. All descriptive statistics were calculated using Microsoft Excel® program.

3. Results and Discussion

Of the 316 *S. porcus* individual ranged in length and weight from 3.8-23.8 cm and 1.01-335.12 g respectively. Dominant length class in the total specimens is 11-13 cm (Table 1 and Figure 2). Alpaslan et al. (2007) recorded the length range of *S. porcus* in Dardanelles (Marmara Sea, Turkey) 10.5

to 32.0 cm. In the İzmir Bay (Egean Sea, Turkey), the length distribution was recorded from 7.5 cm to 27.2 cm (Akalın et al. 2011).

Table 1. Number individuals (N) according to size classes
Çizelge 1. *Boy sınıflarına göre birey sayıları (N)*

Size Classes (cm)	N	%
3-5	1	0.32
5-7	3	0.95
7-9	23	7.28
9-11	61	19.30
11-13	116	36.71
13-15	53	16.77
15-17	34	10.76
17-19	5	1.28
19-21	6	1.90
21-23	10	3.16
23-25	4	1.27
Total	**316**	**100**

In the Black Sea (Sinop province), the average length was determined as 17.26 cm (Koca 2002). In the present study, length range was from 3.8 to from 23.8 cm with mean length of 12.90 cm. Alpaslan et al. (2007) carried out that the differences of the average length and weight values in the other studies can be related to the sampling period and location and stomach contents. 292 of *S. porcus* specimens were sexed of which 137 (47%) females and 155 (53%) males. 24 of specimens were unsexed. The sex ratio (M:F) was determined as 1:1.12 and this is not statistically significant (P>0,05).

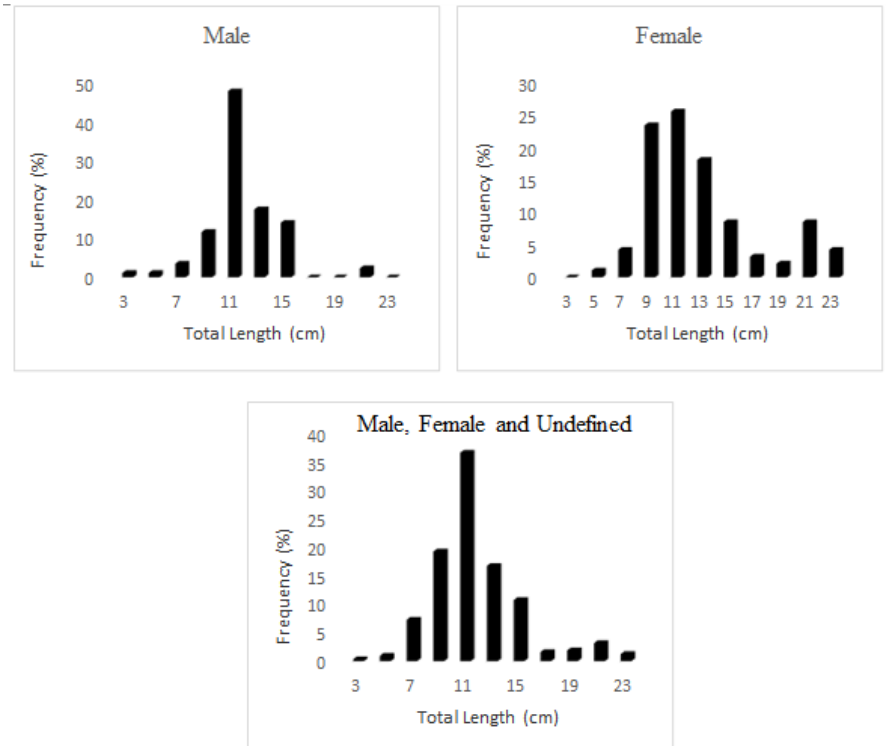

Figure 2. Length-frequency distribution for male, female and overall
Şekil 2. *Erkek, dişi ve tüm bireyler için boy-frekans dağılımı*

Table 2. Length-weight relationship parameters for *S. porcus*
Çizelge 2. *S. porcus için boy-ağırlık ilişkisi parametreleri*

	a	b	95% Cl of b	Growth	r^2
Female	0.0154	3.1017	2.9828–3.2206	Isometric	0.97
Male	0.0193	2.9897	2.8126–3.1668	Isometric	0.93
Female and male	0.0189	3.0122	2.9502–3.0743	Isometric	0.97

The b values were calculated for females, males and overall as 3.1017, 2.9897 and 3.0122 (Table 2, Figure 3). Because b values for female, male and all indivuduals were close to 3, growth type was determined as isometric.

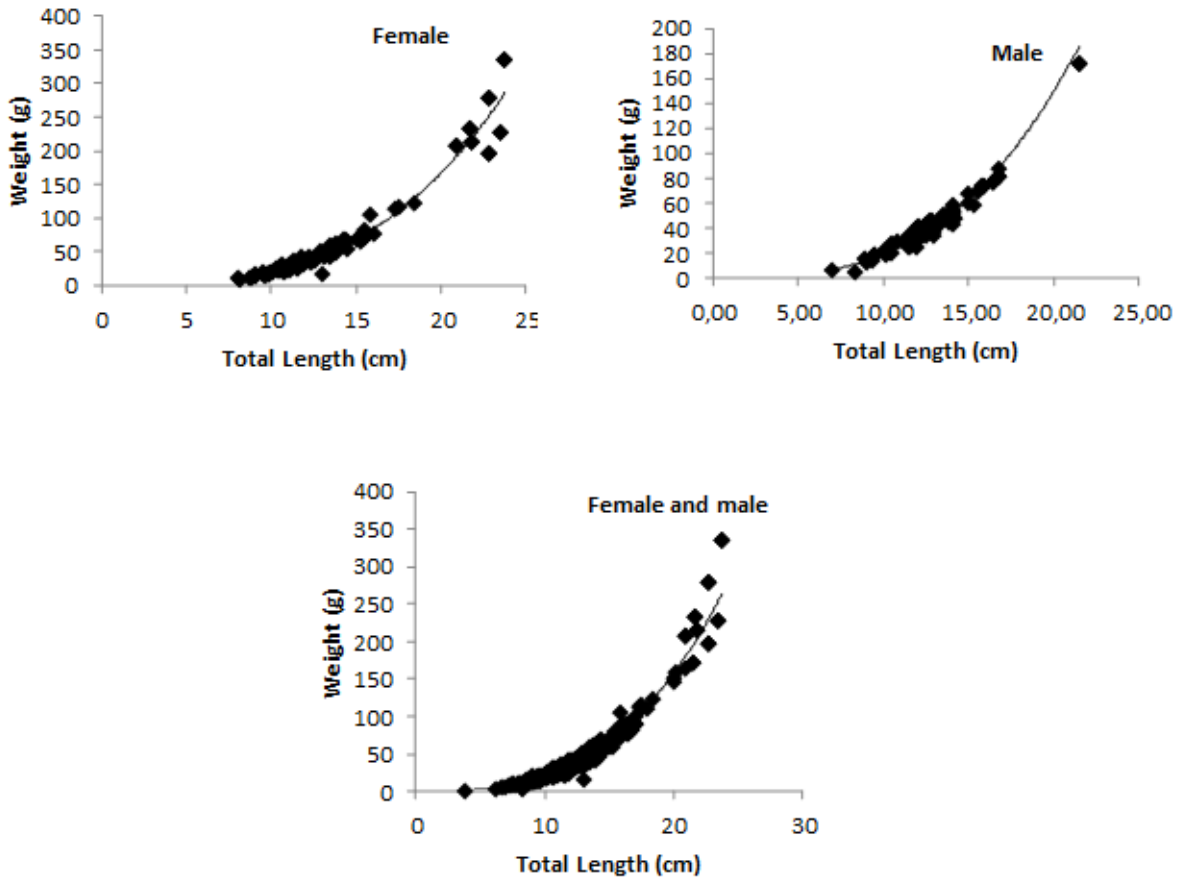

Figure 3. The length-weight relationship for female, male and overall
Şekil 3. *Dişi, erkek ve tüm bireyler için boy-ağırlık ilişkisi*

We found that our results are similar to that obtained by Morey et al. (2003), Demirhan and Can (2009), Bilgin and Çelik (2009), but lower than that calculated by Bök et al. (2011) and Erbay (2013) (Table 3). Observed differences could be due to sampling procedure, namely size and length range or related to seasonal reproduction or feeding activities (Wotton 1990).

The age composition of the samples were ranged between 0 to VII years (Table 4). According to the percentages of all age groups, 2 is the most abundant (55.06%) and it was followed by age group 1 (18.99%), 3 (14.24%), 5 (4.11%), 0 (3.16%), 4 (2.22%), 7 (1.27%) and 6 (0.95%).

Table 3. LWR parameters of *S. porcus* calculated in this study and different studies
Çizelge 3. *Farklı çalışmalar ve bu çalışmada S. porcus için hesaplanan boy-ağırlık ilişkisi parametreleri*

Area	Length (cm)	a	b	r^2	References
Southeastern Black Sea	3.8-23.8	0.0189	3.0122	0.97	Recent study
Western Mediterranean	6.1-35.5	0.0183	3.0202	0.97	Morey et al. 2003
Dardanelles, Marmara Sea	10.5-32.0	0.023	2.96	-	Alpaslan et al. 2007
Middle Black Sea	8.5-29.2	0.0173	3.0337	0.98	Kalaycı et al. 2007
North Aegean Sea	8.2-26.4	0.0122	3.1820	0.98	Karachle and Stergiou 2008
Southeastern Black Sea	4.6-22.9	0.015	3.10	0.98	Demirhan and Can 2009
İzmir Bay, Aegean Sea	7.5-27.2	0.0209	2.987	0.99	Akalın et al. 2011
Marmara Sea	17.3-21.4	0.0067	3.343	0.94	Bök et al. 2011
Central Aegean Sea	10.6-21.0	0.0001	3.13	0.97	Kapiris and Klaoudatos 2011
Eastern Black Sea	6.7-25.5	0.0101	3.2546	0.96	Erbay, 2013

Table 4. Age composition and condition factor of *S. porcus*
Çizelge 4. *S. porcus'un kondisyon faktörü ve yaş kompozisyonu*

Age	**0**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
N	10	60	174	45	7	13	3	4
Age%	3.16	18.99	55.06	14.24	2.22	4.11	0.95	1.27
Con. Fac.	1.75	2.02	1.96	1.97	2.02	1.95	2.26	2.12

Most of *S. porcus* were composed of I - III year old fish and represented 88.29% of overall. The oldest age for this short-lived species was estimated as 11 years in the Adriatic Sea (Bradai and Bouain, 1988). In the previous studies, age classes for *S. porcus* determined as I-VI; I-IX; 0-VIII and 0-VII by Koca (2002), Alpaslan et al. (2007), Mesa et al. (2010) and, Demirhan & Can (2009), respectively. The different exploitation patterns and/or ecological conditions related to habitat quality, such as salinity and temperature, could explain age classes variations (Boudinar et al. 2016).

Fulton's conditions factor (K) was estimated for each age group. The lowest K value was found 1.75 in age group 0 and the highest in age group 6 (2.26) (Table 4). Take into consideration the condition factor (K) of studies, the health of a fish rely on its environment and recent feeding conditions (Le Cren 1951).

The mean K values were determined as 2.00. Alpaslan et al. (2007) the average K was determined as 1.73, and the highest value was determined for the age 9. Koca (2002) declared the average condition factor as 1.74, the highest value were detected as 2.34 (for the age group 1) for *S. porcus* individuals, it means good condition in this study. VBGE parameters were calculated as L_{∞}=40.52 cm, K=0.098 $year^{-1}$ and t_0=-1.764 year for all individuals. The difference between the lengths derived from VBG equation and observed lengths of *S. porcus* were found to be statistically insignificant ($p>0.05$) (Table 5, Figure 4). According to the length values, growth was rapid in the first year of life-span. The growth performance index (Ø') was calculated as 2.21. Von Bertalanffy growth model is widely used method for theoretical growth studies in fisheries biology (El-Haweet et al. 2013).

Table 5. Observed lengths and lengths derived from Von Bertalanffy growth equation for *S. porcus*
Çizelge 5. *S. porcus için ölçülen ve VBBD'den hesaplanan boy değerleri*

Age	Observed Length (cm)	Back-calculated Length (cm)
0	6.99	6.45
1	9.56	9.64
2	12.29	12.53
3	15.54	15.15
4	17.53	17.53
5	21.29	19.68
6	22.47	21.63
7	23.65	23.40

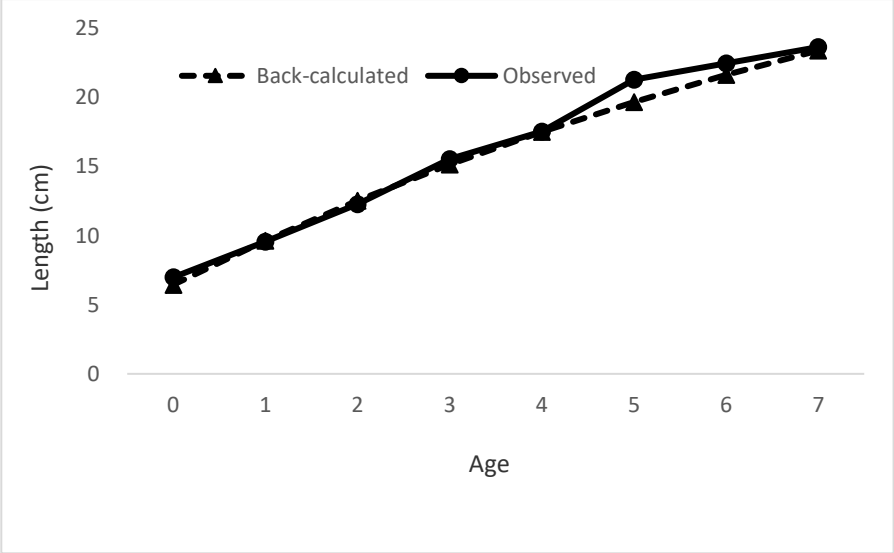

Figure 4. Length-at-age growth curve of *Scorpaena porcus* according to observed lengths and lengths derived from Von Bertalanffy growth equation
Şekil 4. *S. porcus'un ölçülen* ***ve*** *VBBD'den hesaplanan boy değerlerine göre yaş-boy eğrisi*

Within different studies of *S. porcus*, the K was ranging from 0.011 to 0.29 year^{-1}, L_∞ ranged from 40.52 to 268.47 cm and the t_0 ranged from -1.557 to -5.955 year, Ø' ranged from 2.07 to 2.71 (Table 6).

Table 6. K, L_∞, t_0 and Ø' of *S. porcus* estimated in the present study and previous studies
Çizelge 6. *Mevcut çalışma ve daha önce yapılan çalışmalarda S. porcus için K, L_∞, t_0 ve Ø' değerleri*

	Growth Parameter				
Area	L_∞	K	t_0	Ø	References
Southern Black Sea, Turkey	40.52	0.098	-1.764	2.21	Recent study
Sinop Peninsula, Black Sea, Turkey	40.81	0.107	-2.227	2.25	Koca 2002
Dardanelles, Marmara Sea, Turkey	51.77	0.049	-5.955	-	Alpaslan et al. 2007
Southeastern Black Sea, Turkey	268.47	0.011	-1.92	-	Demirhan and Can 2009
Black Sea, Turkey	140.745	0.026	-1.557	2.71	Bilgin and Çelik 2009
Adriatic Sea, Italy	22.30	0.23	-3.43	2.07	La Mesa et al. 2010
Northern Adriatic Sea, Italy	21.80	0.29	-2.51	2.14	Scarcella et al. 2011
Black Sea, Turkey	22.15	0.287	-1.577		Erbay 2013

The differences between the growth parameters change due to the habitat, presence of food, climatic effects, physical and chemical properties of water from one region to another (Ozeren 2009). In other results differences may be related to differences in the length ranges sampled in the various areas**.**

Absolute growth and relative growth increases of *S. porcus* for different age groups was summarized in Table 7.

Table 7. Absolute growth and relative growth values of *S. porcus*
Çizelge 7. *S. porcus'un mutlak büyüme ve oransal büyüme değerleri*

	Absolute Growth		Relative Growth	
Age	In Length	In Weight	In Length	In Weight
0-I	2.57	11.74	36.77	188.14
I-II	2.73	18.68	28.56	103.89
II-III	3.25	37.34	26.44	101.85
III-IV	1.99	34.95	12.81	47.23
IV-V	3.76	79.79	21.45	73.24
V-VI	1.18	68.74	5.54	36.42
VI-VII	1.18	23.51	5.25	9.13

According to results it can be said that growth rate decraeases as the fish grow to older ages. The length growth rate is very high during the early years of their lives. However, it continues dwindling. Contrast to length growth rate, the weight growth rate is low during the early years of their lives (Koca 2002). In present study, it is declared that the length growth rate is high at the beginning and then reduces gradually, conversely the weight growth rate increases rapidly after 2 age.

4. Conclusions

Consequently, we show that *S. porcus* has a good condition in the Black Sea. The population the percentage of young individuals occurs as a big values. This situation indicates that fishing pressure is intensive. *Scorpaena porcus* is of commercial interest and is an important coastal fishing gear, particularly trammels, in the Black Sea. But, there are no length regulations for catching this species. In this work, two years old- individuals are dominant and this remarks that the pressure of fishing is very intensive.

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