# Comparative characteristics of individual growth of *Spicara flexuosa* and *Spicara maena* (Pisces: Centracanthidae) inhabiting the south-western shelf of Crimea, Black Sea

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Received: August 2021 Accepted: December 2021

**Abstract**

The analyzes of the length and age characteristics and growth peculiarities of two species *Spicara maena* and *Spicara flexuosa* living on the South-Western shelf of Crimea are determined. The existing differences are shown, the issues of the influence of hydrological and climatic factors are discussed, as well as the features of the individual development of these species are noted. Calculations carried out using the Student's *t*-test showed that the weight and length of females and males differ, the probability of differences is in the range of 32–40%. Comparison of the obtained length-weight characteristics, index *GSI* and growth parameters with similar characteristics of *Spicara* species inhabiting different regions of the Mediterranean basin is carried out.

**Keywords:** *Spicara maena*, *Spicara flexuosa*, growth, Age distribution, Length distribution, Black Sea

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[ DOI: 10.18331/SFS2022.8.3.2 ]

## Introduction

According to the latest fish classification the genus *Spicara* is belongs to the family Sparidae (Santini *et al*., 2014; Nelson *et al*., 2016) and includes 9 species. Three of them are *Spicara maena* (Linnaeus, 1758), *Spicara flexuosa* Rafinesque, 1810 and *Spicara smaris* (Linnaeus, 1758), and it inhabit the Mediterranean, Aegean, Adriatic, Marmara and Black seas (Tortonese, 1986; Golani *et al*., 2006; Vasil′ieva, 2007; Froese and Pauly, 2017).

Of the three species indicated in the composition of the Black Sea ichthyofauna (Svetovidov, 1964), the species *S. smaris* is widespread and successfully reproduces in the Mediterranean-Black Sea area. Two other species, *S. maena* and *S. flexuosa*, also inhabit the Black Sea and in recent years are often found in coastal waters on the South-Western shelf of Crimea (Boltachev and Karpova, 2012). However, there are not so many published scientific papers on the identification and developmental characteristics of these two species in the studied region (Vasilieva, 2007; Kuzminova *et al*., 2020). The question of the similarities and differences between these two species remains controversial among scientists. Some experts believe that these two species are conspecific, that is, they belong to the same species (Arculeo *et al*., 1996; Queró *et al*., 2003; Froese and Pauly, 2017). Others in their papers indicate that these are two different, distinct from each other species (Vasil'eva and Salekhova, 1983; Tortonese, 1986; Miller and Loates, 1997; Golani *et al*., 2006; Imsiridou *et al*., 2011; Georgiadis *et al*., 2014; Bektas *et al*., 2018; Kuzminova *et a*l., 2020).

*S. maena* and *S. flexuosa* are very similar in morphological characteristics, and their area habitats mostly overlap, which causes problems in species identification. However, genetic and morphological studies have confirmed that *S. flexuosa* and *S. maena* are separate species (Imsiridou *et al*., 2011; Minos *et al*., 2013; Bektas *et al*., 2018). Species of the genus *Spicara* are schooling, benthopelagic, sublittoral fish living above sandy and silty grounds and in thickets of marine herbaceous plants at a depth of 15 to 130 m (Miller and Loates, 1997; Imsiridou *et al*., 2011).

All species of genus *Spicara* in Black Sea are Mediterranean immigrants, the growth and development of which are mainly influenced by regional hydrological and climatic factors, and biotope conditions (Salekhova, 1979). It is known that the Black Sea salinity is about 18‰ (Oguz *et al*., 1990; Altiok *et al*., 2012), which is much lower than in the Mediterranean Sea, where salinity reaches 40‰ (Topper and Meijer, 2015). For this reason, the geographical distribution of *S. maena* from south to north is limited by the Bosphorus. It is known that, unlike *S. maena*, the *S. flexuosa* species is able to inhabit marine areas with a wider salinity range of 18–39‰. This explains the fact that in the Black Sea species of the genus *S. flexuosa* are mainly found (Bektas *et al*., 2018). In last years, an increase of the Black Sea salinity has been observing, leading to a process known as the



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"mediterranization of the Black Sea fauna" (Gomoiu, 1981; Cvetkov and Marinov, 1986). A steady increase in heat and salt storage in the 100–2000 m layer indicates a continuing increase in the volume of the Marmara Sea waters (Belokopytov, 2013), and leads to the invasion of new Mediterranean species.

It is known from the literature that *S. maena* differs from *S. flexuosa* in a greater maximum body height, smaller eyes and coloration: its back is bluish-gray, sides are silvery, usually with dark spots, changing color from gray to brown. One of these spots is larger than the others, and is located above the tip of the pectoral fin. One of the characteristic features of the difference between these two species is also the fact that the head length of *S. maena* is shorter than its body height (Tortonese, 1986; Can and Bilecenolu, 2005; Bat *et al*., 2008).

The Mediterranean Sea is located in the subtropical climatic zone. The vivid specificity of the climate of the Mediterranean Sea and its coasts made it possible to distinguish a special Mediterranean type of climate. The Mediterranean climate is also typical for the Black Sea coast in those places where the regions are protected by mountains from the cold north winds (South Coast of Crimea, Balaklava). However, fish of the genus *Spicara* are also found in the coastal waters of Sevastopol, which is located in the temperate (continental) climatic zone.

The average monthly water temperature in the water area of the Mediterranean basin changes as it moves from south to north. The greatest warming of water is noticed in the Mediterranean, Aegean, and Adriatic Seas, and less warming in the Marmara and Black Seas (Oguz *et al*., 1990; Altiok and Yuce, 2012; Topper and Meijer, 2015).

The climatic changes observed in recent years increase the interest in monitoring studies of the individual and population growth of new Mediterranean species living in the Black Sea. Such investigations make it possible to identify the peculiarities of the marine organisms development, predict the tendencies of their changes, and are necessary for the development of measures for a rational fishing regime.

There is no regulation for picarel fishing in the Communiqué on the Fishing for Commercial Purposes, published by the Ministry of Food, Agriculture and Livestock Turkey in 2016. When TUIK's aquaculture statistics are examined, it is seen that the fishing amount of picarels caught in Turkish waters is quite low.

The picarel fish catch amount was determined as 877.5 year/tons for 2011 and as 349.9 year/tons for 2014 by the Turkish Statistical Institute (TUIK, 2015). The decrease in capture in Black Sea waters every year requires regulatory precautions. In order to apply appropriate management strategy, the stocks must be identified and their abundance must be determined and study the characteristics of individual and population growth.

The aim of this research is to determine the parameters of individual growth and to determine the reliability of differences in size and age



[ DOI: 10.18331/SFS2022.8.3.2 ]

characteristics of two species *S. flexuosa* and *S. maena*, of the genus Spicara, living in coastal waters on the South-Western shelf of the Crimea (Black Sea).

## Materials and methods

The study is based on the results of full biological analyzes of two species of the genus *Spicara*: *S. maena* and *S. flexuosa*.

Adult individuals were caught with bottom snares traps with a mesh of 12 mm on the South-Western shelf of the Crimea in the coastal waters of Sevastopol, Black Sea. (44.45-44.64°N; 33.37°-33.60°E) (Fig. 1).

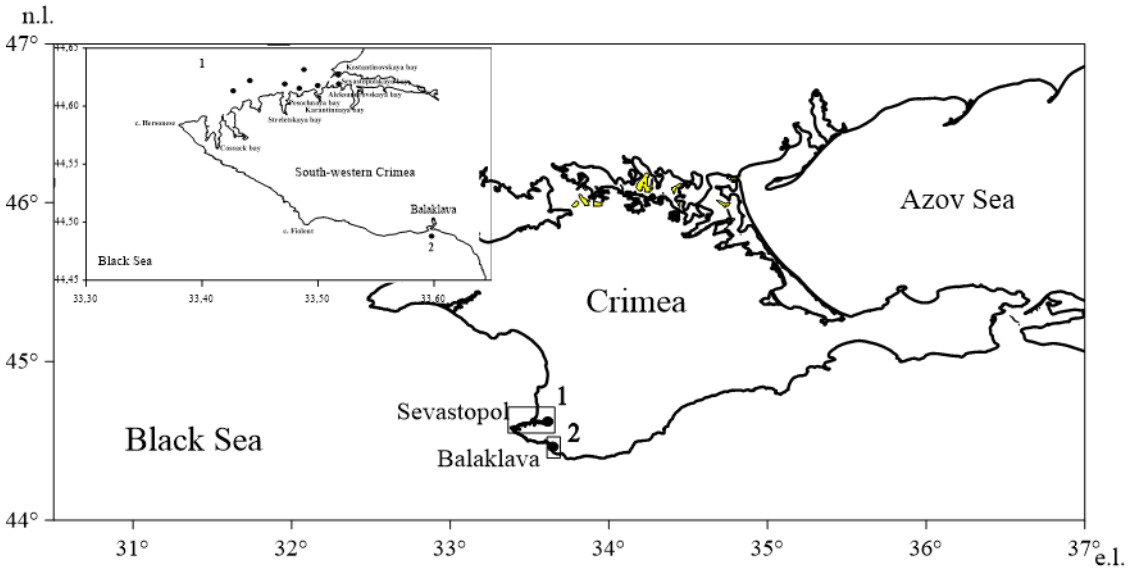


**Figure 1: Sampling sites of fish specimens in Sevastopol bays.**

In our studies, samples were taken between in 2017 to 2020; the sample consisted of 10-20 freshly caught individuals of different sizes and ages. The total number of studied individuals were as 1030, of which 702 individuals fish were *S. flexuosa* and 328 for *S. maena*.

Biological analysis during processing of samples was carried out separately for each species. Samples were processed same for each species. The total and standard lengths, weight, weight of fish without viscera were measured, age, sex, stage of maturity and gonads weights were determined. The age of fish was determined using scale reading (Pravdin, 1966). The total body weight of the fish was determined with an accuracy of 0.1 g, and the gonads weight, with an accuracy of 0.01 g.

The spawning period was established based on monthly variation in the gonadosomatic index (*GSI*) using the equation $GSI = [Wg/(W- Wg)] \times 100$, where *Wg* is the gonad weight (*g*) and *W* is the total weight (*g*) of the fish (Ricker, 1975).

To assess the significance of differences between size and weight of *S. flexuosa* and *S. maena*, caught in coastal waters on the South-Western



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shelf of Crimea, Student's *t*-test was used.

The dependence of the total length of *Spicara* individuals on age was found using the von Bertalanffy formula for length growth:

$$L_t = L_\infty\left[1 - e^{-K(t-t_0)}\right] \qquad (1)$$

Where $L_t$ is the length of the fish at the age *t* (cm); $L_\infty$ is the average maximum attainable (asymptotic) length of the fish in the population studied (cm); *K* is the growth coefficient (1/year); $t_0$ is a parameter with the dimension of time (year); *t* is the age of the fish (year).

The growth performance index was calculated by using formula (Pauly *et al*., 1984):

$$\varphi' = \lg K + 2\lg L_\infty$$

Length -weight ratios were found by the formula:

$$W = a \cdot TL^b \qquad (2)$$

Where *W* is the total body weight, g; *TL* is the total length of the fish, cm; *a* and *b* are constants parameters.

Statistical processing of the results was carried out on a personal computer using Microsoft Excel 2016, Statistica 6.0, SigmaPlot 12.5, Surfer 13.0.

## Results and discussion

The age distribution of *S. flexuosa* and *S. maena*, inhabiting coastal waters on the South-Western shelf of Crimea, is shown in Figure 2. The age of females of both species varies from 1 to 5 years old. Males of the *S. maena* were found mainly at the age from 2 to 6 years, and *S. flexuosa* from 1 to 6 years old, the relative number of males at the age of 1 years old was 8%. Single individuals of males of these two species were found at the age of 7–8 years old (Fig. 2).

Fishes of the Sparidae family are characterized by protogenic hermaphroditism (Reinboth, 1962; Jardas, 1996). In the pre-spawning period, the gonads are in an intermediate state, contain male and female cells. In individuals of the Sparidae family living on the South-Western shelf of the Crimea, representatives of the *Spicara* genus begin to mature at the age of one year with an average length of 8 cm. By the beginning of the spawning period, young individuals develop ovaries and fish participate in spawning as females, 1 year-old males are extremely rare.

Figure 2 shows that in representatives of the species *S. maena*, the largest relative number of females (more than 30%) was observed in the second year of life. In the third or fourth year, with the further growth of fish, a sex inversion occurs – the number of females decreases and the number of males increases. At the age of 3.4–4 years in representatives of the species *S. maena*, the relative number of females is equal to the relative number of males. Therefore, we can conditionally assume that at the age of 3.4–4 years, there is a sex reversal. All individuals over 5 years old were males.

In representatives of the species *S. flexuosa*, the largest relative number of females, more than 60% (Fig. 2), was observed in the second year of life. Sex inversion occurs at the age of 2.5–3 years. At the age of 4 years, the relative number of males in the catches exceeded the number of females by about 2 times. Females of *S. flexuosa* at the age of 5 y.o. accounted for 1%. All individuals of this



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species longer than 16.0–16.5 cm were males.

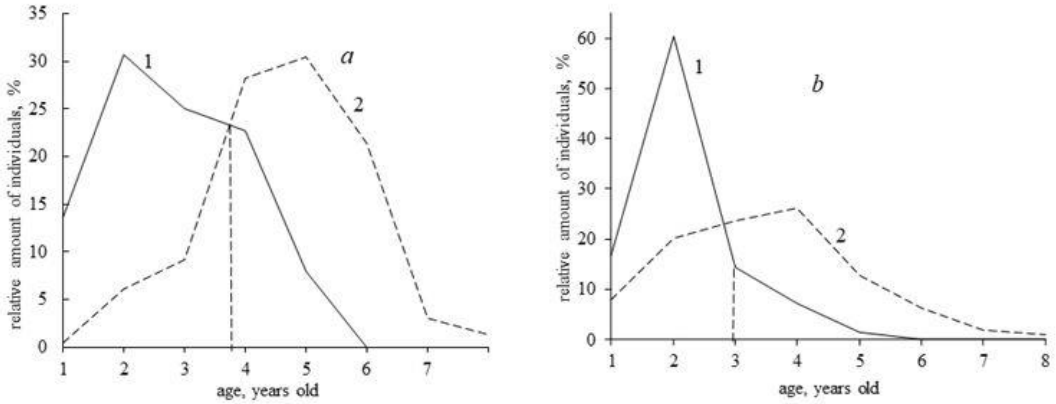


**Figure 2: Age distribution of individuals of the *Spicara maena* (*a*) and *Spicara flexuosa* (*b*) species, females (1) and males.**

On the South-Western shelf of the Crimea, fishes of the species *S. maena* spawn from late May to mid-July. The *GS*I index during this period varies from 2.8 to 6.0 for females and from 0.5 to 1.6 for males. The fishes of the species *S. maena* spawn from late April to mid-July. The *GSI* index during this period varies from 2.9 to 6.5 for females and from 0.9 to 1.8 for males.

To assess the reliability of differences of the mean age and mean length of the two species (Table 1) inhabiting the coastal waters on the South-Western shelf of the Crimea, we used Student's *t*-test.

**Table 1: The main averaged characteristics and growth parameters of the two species of *Spicara* caught in 2017–2020.**

| **Parameters** | ***S. flexuosa*** | | ***S. maena*** | |
|---|---|---|---|---|
| | **female** | **male** | **female** | **male** |
| Fish number, individuals | 449 | 206 | 88 | 230 |
| Mean age | 2.2 ±0.84 | 3.5 ±1.49 | 2.8±1.99 | 4.6±1.26 |
| Mean TL, cm / (min-max) | 11.4 ±1.46 | 14.5 ±2.35 | 12.4±1.88 | 16.1±1.67 |
| | 7.1–17.5 | 9.0–19.2 | 7.9–17.6 | 8.8–21.1 |
| Mean weight, g / (min-max) | 14.35 ±6.20 | 32.60 ±17.0 | 19.79±9.59 | 44.44±14.65 |
| | 4.33–51.33 | 6.98–84.60 | 4.32–58.74 | 7.54–116.6 |
| **Constants for «weight-length» relationships** | | | | |
| constant *a* | 0.012 | 0.0051 | 0.0079 | 0.0073 |
| constant *b* | 2.8873 | 3.2379 | 3.0762 | 3.1189 |
| **Constants for the Bertalanffy formula** | | | | |
| average maximum attainable length ($L_\infty$) | 15.943 | 17.894 | 18.288 | 18.397 |
| growth constant (*K*) | 0.2624 | 0.3664 | 0.204 | 0.4856 |
| constant ($t_0$) | 2.905 | 1.48 | 2.876 | 0.449 |



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Calculations showed that the probability of differences of mean age and mean length for females of the two species is $p_{age}$=0.318 and $p_{TL}$=0.325, respectively, and for males – $p_{age}$=0.424 and $p_{TL}$=0.418. That is, in general, the reliability of differences between the species *S. maena* and *S. flexuosa* is within 32–40%. Thus, the existing differences in size and age parameters are not so great, and they are not enough for reliable identification of the species analyzed without using additional parameters or without applying difficult genetic and / or morphological methods. This explains the disputes of experts about the significant differences between the species *S. maena* and *S. flexuosa*.

Using the multiple correlation coefficient, the identity of the character of change in size and age distributions was determined separately for females and males of *S. maena* and *S. flexuosa*. It was found that the correlation coefficient for age and size distribution for females of the two compared species is $r_{age}$=0.779 and $r_{TL}$=0.697 respectively. The relatively high correlation coefficients are explained by the fact that the maximum number of females of these two species is observed at the age of two years old. However, the number of *S. flexuosa* females at the age of 3–4 y.o. decreases sharply, and the sex reversal occurs at the age of 2.5–3 years. Females of *S. maena* are characterized by a gradual decrease in the number with age, and sex reversal occurs at the age of 3.5–4 years.

For the age and size distribution of males, the following correlation coefficients were found $r_{age}$=0.51 and $r_{TL}$=0.672. The obtained value of the correlation coefficient for the age distribution indicates the existing differences in the age composition of the two species. Analysis shows that the total relative number of 1 and 2 y.o. of *S. maena* is 6.4%, and in *S. flexuosa* it is 4.4 times higher (28.1%). The greatest number of individuals in *S. maena* was presented as 4–5 years old fish, and in *S. flexuosa* fish of age 3–4 years. The size distribution of *S. maena* and *S. flexuosa* males has a closer distribution pattern ($r_{TL}$=0.672). The largest number of males *S. maena* (97%) and *S. flexuosa* (71%) were more than 13.5 cm long.

As a rule, in the process of fish development, the nature of the increase in length, the maturity, sex ratio, and inversion is influenced by change in mass. As a result of applying regression analysis to the experimental data, the following length-weight relationships were obtained:

For *S. maena* $W=0.0066 \cdot TL^{3.1527}$ (3)

For *S. flexuosa* $W=0.0071 \cdot TL^{3.1062}$ (4)

The results obtained for the length and weight characteristics and growth parameters of *Spicara* living on the South-Western shelf of the Crimea are shown in Table. 1.

The analysis of the results showed that the total length (*TL*) of *S. maena* individuals varies from 7.9 cm to 21.1 cm with an average value of $TL_{mean}$=15.2±2.41 cm, and the weight changes from 4.32 g to 116.6 g with an



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average value of $W_{mean}$=37.62±17.39 g. In the catches of *S. flexuosa*, individuals with a total length from 7.1 cm to 19.2 cm with an average value of $TL_{mean}$=12.4±2.30 cm were presented. The weight of individuals of *S. flexuosa* varied from 4.33 g to 84.60 g with an average value of 20.09±13.72 g. Thus, the average weight of *S. maena* exceeds the average weight of *S. flexuosa* by 1.87.

Analysis of the length composition of the catches of *S. maena* and *S. flexuosa* during the year shows that individuals with minimum length (females and males) were caught in August, and with maximum length – in March-April.

If in equation (2) the parameter $b$=3, then the individuals are observed isometric growth. If $b$>3, then positive allometric growth is observed, if $b$<3, then negative allometric growth is observed. As can be seen from equations (3) and (4), the length-weight relationship for *S. maena* and *S. flexuosa* (parameters $b$ are equal to 3.1527 and 3.1062, respectively) as a whole shows a positive allometric population growth ($b$>3). However, an analysis of the growth pattern taking into account sex shows that males and females of *S. maena*, as well males of *S. flexuosa*, have positive allometric growth (parameters $b$ are equal to 3.1189; 3.0762 and 3.2379, respectively) ($b$>3). While females of *S. flexuosa*, have a slight negative allometric growth ($b$=2.8873) ($b$<3). The verification of the reliability of the obtained values of allometric growth was carried out using the Student's $t$-test. For this, the value of the isometric growth parameter $b$ = 3 was compared with the obtained values of the parameters $b$ for *S. maena* and *S. flexuosa* as a whole and separately for females and males. The reliability of all the obtained values of the parameter $b$ allometric growth is $p$<0.05.

Males of both species are 2.3–2.4 times heavier than females in weight. Females and males *of S. maena* are 1.38 and 1.36 times larger than those of *S. flexuosa*, respectively (Table 1).

Figure 3 shows the length-weight relationships averaged over the research period (from 2017 to 2020) for two species caught in coastal waters on the South-Western shelf of Crimea (Black Sea), as well as the relationships length-weight for a *Spicara* living in different regions of the Mediterranean Sea (data are calculated using basis of literature data).



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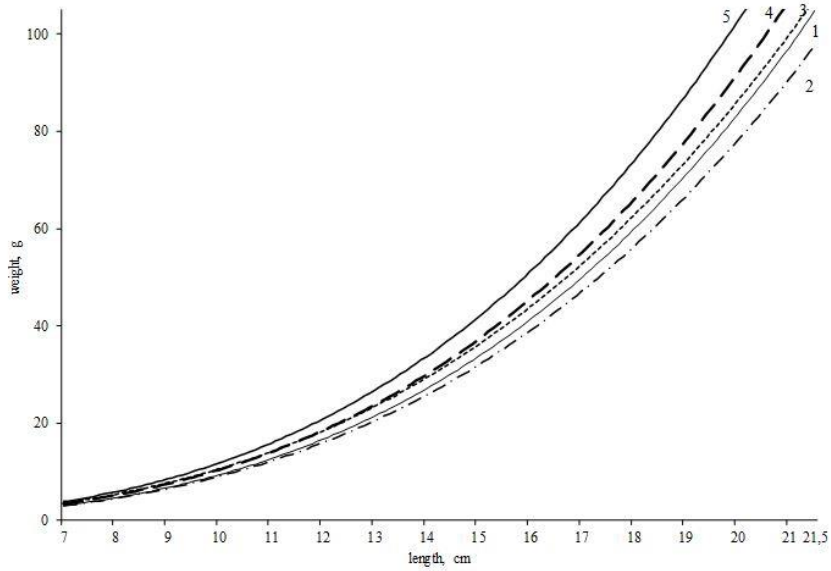


**Figure 3: Average weight-length relationships *Spicara maena* (1) and *Spicara flexuosa* (2) from South-Western shelf of Crimea (Black Sea), *Spicara maena* (3, 4, 5) inhabiting the Marmara (Demirel *et al*., 2012), the Mediterranean (Çiçek *et al*., 2007) and the Adriatic (DulcÏic *et al*., 2000) Seas, respectively.**

As a result of the application of regression analysis, coefficients were obtained and equations of the length growth of von Bertalanffy were compiled for two species of *Spicara* living on the South-Western shelf of the Crimea, which are applicable for calculating of parameters of fish of commercial sizes individuals:

for *S. maena:* $l(t) = 21.54[1 - e^{-0.201(t+2.12}]$ , at $t \geq 1.0$; (5)

for *S. flexuosa:* $l(t) = 19.33\ [1 - e^{-0.234(t+2.18)}]$ , at $\geq 1.0$, (6)

Where $t$=1.0 – minimal age, at which fish reaches of commercial size.

From formulas (5) and (6) it can be seen that the average limiting length of individuals of *S. maena* is 21.5 cm, and for the *S. flexuosa* species it is 19.3 cm (11% less).

The growth parameters of picarels from various regions are given in Table 2. It can be seen that the growth performance index for *S. maena* and *S. flexuosa*, inhabiting the South-Western shelf of the Crimea, is less than that of representatives of the genus *Spicara* inhabiting the Marmara, Aegean, Mediterranean and Adriatic Seas.

The growth curves calculated using equations (5) and (6) for two species *S. maena* and *S. flexuosa*, as well as for *S. maena* inhabiting various regions of the Mediterranean Sea (according the literature data), are shown in Figure 4.

Comparison of the age composition of individuals of the genus *Spicara* in our studies and from different regions of the Mediterranean Sea shows that, as in the Black Sea, fish of this genus live for a rather long time. So Salekhova (1979) in



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her works noted that representatives of the genus *Spicara* were observed in the area of the Italian island Lampedusa (Mediterranean Sea), the maximum age of which was 5+, and in the Lyon Bay area – 6–7 years old. In the Aegean Sea, the age varied within 1–7 years (Soykan *et al*., 2010), in the Adriatic Sea (Zei, 1951; Dulcic *et al*., 2000) it reached 8 years or more.

**Table 2: Parameters of von Bertalanffy growth equation and growth performance index of the genus *Spicara* from different areas.**

| References | Region | Sex | $L_\infty$ (cm) | $t_0$ | K | $\varphi'$ |
|---|---|---|---|---|---|---|
| Saygılı *et al*., 2016 | Marmara Sea | M+F | 17.20 | -1.040 | 0.520 | 2.18 |
| Soykan *et al*., 2010 | Aegean Sea | M+F | 21.99 | -1.165 | 0.255 | 2.09 |
| Çiçek *et al*., 2007 | E. Mediterranean | M+F | 25.40 | -0.350 | 0.270 | 2.24 |
| DulcÏic *et al*., 2000 | E. Adriatic | M+F | 24.82 | -0.090 | 0.532 | 2.16 |
| Present study | Black Sea (*S. maena*) | M+F | 21.537 | -25.116 | 0.201 | 1,969 |
| Present study | Black Sea (*S. flexuosa)* | M+F | 19.33 | -2.180 | 0.234 | 1,942 |

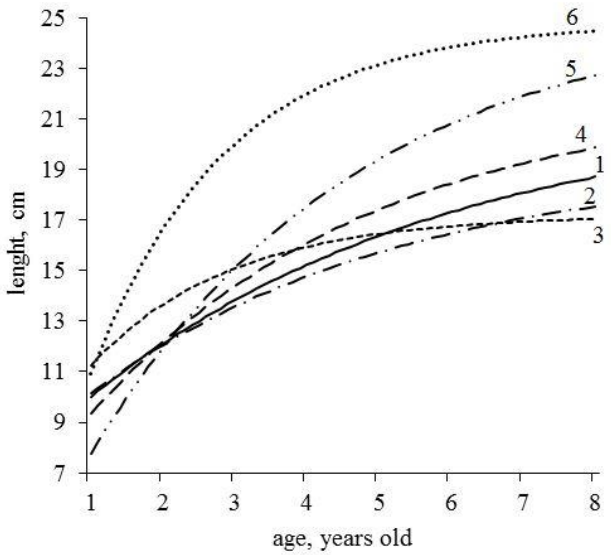


**Figure 4: Growth curves for: *Spicara maena* (1) and *Spicara flexuosa* (2) from the South-Western shelf of Crimea (Black Sea), *Spicara maena* (3, 4, 5, 6) inhabiting the Marmara (Saygılı *et al*., 2016), Aegean (Soykan *et al*., 2010), the Mediterranean (Çiçek *et al*., 2007) and the Adriatic (DulcÏic *et al*., 2000) Seas, respectively.**

Comparison of the results on sex inversion showed that for the genus *Spicara*, which lives in different regions of the Mediterranean basin, this process begins at a total length of individuals from 10 to 18 cm, but there are regional differences. Thus, in the Aegean Sea, sex reversal occurs at *TL*=14.5–15.0 cm (Soykan *et al*., 2010; Cengiz, 2019), in the Adriatic Sea at *TL*=16.0 cm (DulcÏic *et al*., 2000), in the North-Eastern part of the Mediterranean Sea at *TL*=10.9 cm (Çiçek *et al*., 2007), in the Mediterranean Sea near Lampedusa Island at *TL*=12.1–15.0 cm (Salekhova, 1979). As it was noted above, in our studies, the sex inversion occurs at a length *TL*=13.0–14.0 cm.



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Comparison of the results for the spawning period and the *GSI* index shows that on the South-Western shelf of the Crimea, spawning takes place at a later date than in the Mediterranean Sea area, and the *GSI* index differs insignificantly.

Thus, in the eastern Mediterranean Sea, *S. maena* spawning in between of March to May (Çiçek *et. al*., 2007). *GSI* values started to increase from November with the producing gonads and reach the highest value on March (*GSI*=3.4 for females + males). Because of the starting spawning, *GSI* values decreased sharply until May.

In Izmir Bay (Aegean Sea) the spawning occurred between March and June (Soykan *et. al*., 2010). The gonadosomatic index peaked in March (*GSI*=7.5 for females, *GSI*=1.9 for males) and then gradually declined until June.

In Saros Bay (Northern Aegean Sea) the variations in *GSI* values throughout the study period presented (Cengiz, 2019) a pronounced peak in April for both sexes. While *GSI* values ranged between 0.21 and 5.80 for females, these ones were between 0.12 and 2.09 for males. The *GSI* values suggested the spawning period was from April to end of May.

Analysis of the growth features of *Spicara* from different regions of the Mediterranean basin showed that in the early stages of growth, mainly at the age of 1–2 years, before reaching the length $TL_{mean}$=8.5–9.0 cm, the weights of females differ little from each other and to a lesser degree depend on the regional, climatic and hydrological conditions. And after the sex inversion, the mass of males with the same length differ from each other. The largest males were found in the Adriatic and Mediterranean Seas, and smaller ones in the Marmara and Black Seas (Fig. 4).

Fig. 4 it can be seen that the growth curve of *Spicara*, which lives in the Black Sea on the South-Western shelf of the Crimea, is located below the others. This indicates a low growth rate.

The low growth rate of picarels living in the Black Sea on the South-Western shelf of Crimea is also confirmed by the lowest growth performance index $\varphi'$ (Table 2), compared with representatives of the genus *Spicara* living in other regions of the Mediterranean Sea.

At the same age, individuals living on the South-Western shelf of the Crimea are characterized by a shorter length than fish from other regions, except for old individuals (more than 5 years old) living in the Marmara Sea.

The Black and Marmara Seas are characterized by a continental climate– cool winters ($t_{mean}$=9°C) with unstable weather and hot summers ($t_{mean}$=25°C). A large number of rivers flow into the Black and Marmara Seas, which affects the sea salinity. The middle salinity for the Black and Marmara Seas averages 18‰ and 23‰ respectively, which is significantly lower than the Mediterranean Sea, which is characterized by a milder Mediterranean climate and by average salinity of 40‰. It is possible that the influence of these climatic and hydrological conditions in



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the Black Sea led to reduction of growth rate of the species examined, which are Mediterranean immigrants.

It can be assumed that the development of sex differences in the northern direction from the Mediterranean Sea to the Black Sea is due to temperature conditions and may have an adaptive value. Since *S. maena* and *S. flexuosa* are thermophilic species belonging to the Mediterranean faunal complex, the temperature conditions of the northern part of the Black Sea impose restrictions on both the rate of metabolic processes that directly affect growth and the length of the feeding period. The development of sex differences in such conditions helps to reduce intraspecific competition and provides females with a large amount of food resources necessary for generative growth and maintaining the reproductive capacity of the population at an optimal level.

## Conclusions

*S. maena* and *S. flexuosa* living on the South-Western shelf of the Crimea have interspecific differences in average age, average length, sex inversion, growth rate, weight-length relationship. The significance of differences between two species is within 32–40% in terms of the size and age parameters of males and females. Comparison of the obtained growth parameters showed that individuals of the genus *Spicara* living on the South-Western shelf of the Crimea are characterized by lower growth rates than those living in other regions of the Mediterranean.

## Acknowledgements

The work was carried out on the state theme of Institute of Natural and Technical Systems (№0012-2019-0002) «Fundamental investigations of processes in climatic system, determining the spatio-temporal variability of the natural environment in global and regional scales». The work was funded by a state grant for the Institute of Biology of the Southern Seas 'Molismological and biogeochemical basis of the homeoeostasis of marine ecosystems' (№ 075- -007-44-21-00, registration number 121031500515-8).

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