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Age, growth, sexual maturity and food composition of *Sciaena umbra* in the south-eastern Black Sea, Turkey

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Summary

Studied were the age, growth, maturity and food composition of the brown meager, *Sciaena umbra,* caught off Trabzon, south-eastern Black Sea (Turkey) in 2002–2003. A total of 329 individuals was collected by spear fishing and hand nets. The thin sectioning method was used for aging the fish otoliths. Fitted von Bertalanffy growth parameters for all fish were: $L_\infty = 51.14\ (\pm 1.19)$ cm, $k = 0.27\ (\pm 0.02)$ year^{-1} and $t_0 = -0.93\ (\pm 0.07)$ year. This study revealed that *S. umbra* is a relatively slow-growing and long-lived species with a life span in excess of 18 years. Sexual maturity begins when they reach a length of about 15 cm. Lengths at which 50% of brown meagre become mature are 19.50 for males and about 22 cm for females. Spawning begins in June, when the temperature is approximately 18°C, and ends in August. Gut content analysis indicated that this species feeds mainly on crustaceans, then switches to fish as they grow. *Sciaena umbra* appears to be an apex predator in the upper littoral zone.

Introduction

The brown meager, *Sciaena umbra* (Linnaeus, 1758), is a subtropical marine fish belonging to the family Sciaenidae, distributed mainly along the Eastern Atlantic coasts, the Mediterranean and the Black Sea. It is a demersal species inhabiting various types of sea bottoms, especially rocky substrates.

In Turkey along the Mediterranean and Black Sea coasts, this is no longer a target species of the demersal fishery, but used to be captured throughout the year, mainly in game fishery. The small-scale artisanal fishery also favored this species due to its generally high market price. However, in the past decades, *S. umbra* catches have declined in the area and banning regulations have been implemented since 2002 to protect local stocks.

Despite its economical and ecological importance, the ecology and biology of *S. umbra* remain unknown for the Black Sea area. In the Mediterranean Sea, some studies have been published on the growth, sexual cycle and diet of brown meager (Chakroun and Ktari, 1981; Fabi et al., 1998; Froglia and Gramitto, 1998; Chakroun and Ktari, 2003; Fabi et al., 2006; Derbal and Kara, 2007).

The present paper deals with food composition and growth of *S. umbra* in the Black Sea, providing some basic biological information also relevant for stock assessment.

Materials and methods

A total of 329 individuals of *S. umbra* was collected in the south-eastern Black Sea off Trabzon either by spear fishing or with hand nets, from September 2002 to August 2003. Except for February when was no catch, more than 20 specimens were collected per month at depths between 3 and 12 m. Soon after capture, the fish were transported to the laboratory and frozen at −18°C. Individual total length was measured to the nearest millimeter and total weight to 0.1 g.

All specimens were classified by macroscopic examination of the gonads as male, female, or immature. Mean size at first sexual maturity (L_{50}) was estimated for males and females by fitting the logistic Gompertz function to the proportion of mature fish per cm size-class and reading the length from this curve at which 50% were mature. The annual sexual cycle was determined by analyzing the monthly evolution of the gonado somatic index (GSI).

Age was determined by interpreting otolith growth rings. The otoliths were first removed from the fish, numbered, and placed in a pre-heated oven at 200°C for 40 min. All otoliths were polished with a grinder using an emery no. 180 sander. They were subsequently fixed to microscope slides with transparent glue and a second polishing was made on the reverse side of the otolith to achieve a thickness of about 200–250 μm.

Finally, otoliths were fully immersed in a solution of glycerin and read under a binocular microscope using reflected light. Digital photos of all aged otoliths were taken and stored on a computer. Counts of increment rings were made for each specimen on the posterior part of the otoliths. Each otolith was read twice, and only coincidental interpretation was accepted.

The von Bertalanffy growth equation (VBGE) was used to describe the growth of *S. umbra* and was fitted to the observed individual lengths-at-age instead of the mean length-at-age frequently used. The software FiSAT (Gayanilo et al., 1996) including Mardquart's algorithm as the non-linear estimation method was used to estimate the growth parameters.

The growth performance index $\varnothing'$ (Gayanilo and Pauly, 1997) was calculated to provide a basis for the comparison of growth characteristics in terms of length:

$$\varnothing' = \log_{10} k + 2 \log_{10} L_{\text{inf}}$$

where k and L_{inf} are the VBGE parameters.

To study the food composition, 329 *S. umbra* stomachs in total were examined. Stomach contents were removed, placed in a plastic bag, marked, and stored at −18°C for subsequent analysis. Prey organisms were identified and counted to the

lowest taxonomic level possible. The proportions of individual prey taxa were analyzed (Hyslop, 1980; Seyhan, 1994).

Results

Age and growth

Age estimates were obtained from all 329 fish sampled. In the cases of poorly-defined growth zones, visibility was enhanced by painting the digital photographs of the otoliths on the computer whereby all sagittal otoliths showed a distinct opaque nucleus and allowed straightforward age readings. The observed ages ranged from 0 to 18 years. For example, Fig. 1 depicts an otolith of an 18-year-old fish. The number of specimens analyzed per age group and the average values for length (cm) and weight (g) are listed in Table 1.

The calculated length–weight relationship ($W_{(g)} = 0.0045 \times L_{(cm)}^{3.3}$) provides a good fit to the observed data (Fig. 2) and indicates a positive allometric growth characteristic. Growth in length over time is presented in Fig. 3. Parameter values of VBGE for both sexes pooled are $L_\infty = 51.14$ cm, $k = 0.27$, $t_o = -0.93$, which leads to a growth performance index ∅' of 2.85.

Sexual maturity

Maturation by size is presented in Fig. 4. The proportion of individuals per length group that had reached maturity, plotted against size, formed a well-defined logistic curve. L_{50} values were found to be 19.5 and 22 cm for males and females, respectively.

Monthly development of GSI values (Fig. 5), in combination with the sea surface temperature, indicates gonad maturation from March to June, and spawning activity in July and August when the temperature reaches levels above 20°C. Sexual resting extends from September to March.

Food composition

From the stomach content data, the proportions of individual prey taxa are presented in Fig. 6a–d. The main food of brown

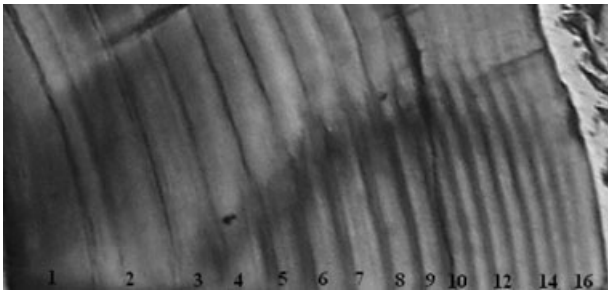

Fig. 1. Ring structure of otolith, with age counts included

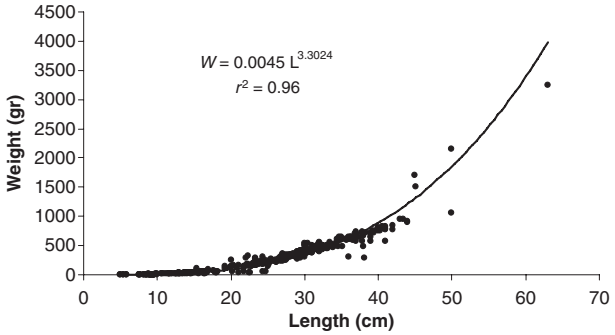

Fig. 2. Length–weight relationship of brown meager, *Sciaena umbra*, sampled in eastern Black Sea, Turkey

Table 1
Observed mean length (cm) ± SD and weight (g) ± SD per age group

Age	Length (cm) ± SD	Weight (g) ± SD	n
0	10.70 ± 2.7	14.54 ± 13.2	86
1	21.13 ± 3.5	170.34 ± 81.3	72
2	26.87 ± 3.1	304.66 ± 110.8	57
3	32.14 ± 2.9	455.49 ± 107.2	61
4	37.61 ± 2.0	677.20 ± 62.5	33
5	40.92 ± 3.5	816.06 ± 111.9	16
12	45.10	1500	1
13	50	2150	1
15	45	1200	1
18	63	3250	1

n, number of observations.

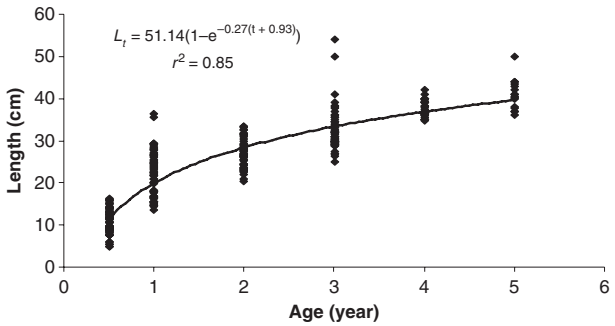

Fig. 3. Growth in length of Black Sea brown meager, *Sciaena umbra*

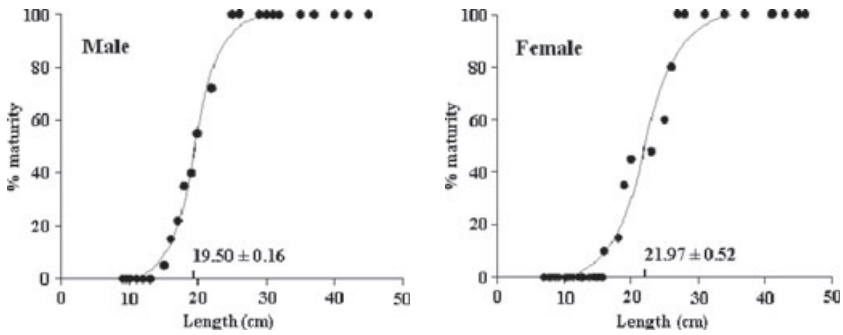

Fig. 4. Maturity ogives and length at which 50% of brown meagers, *Sciaena umbra*, are mature (L_{50}) in the eastern Black Sea marine ecosystem, sexes separately

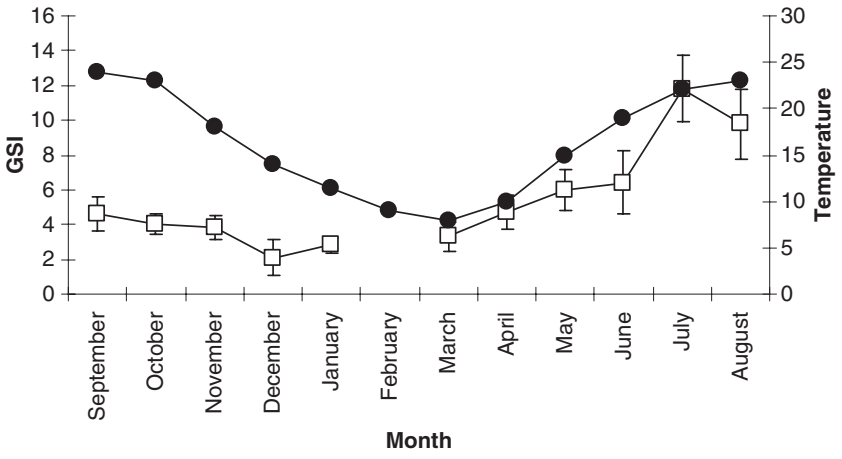

Fig. 5. Seasonal development of sea surface temperature and gonado somatic index (GSI) of brown meager (*Sciaena umbra*) in eastern Black Sea, Turkey. Monthly means and standard error given for the period Sept. 2002–Aug. 2003

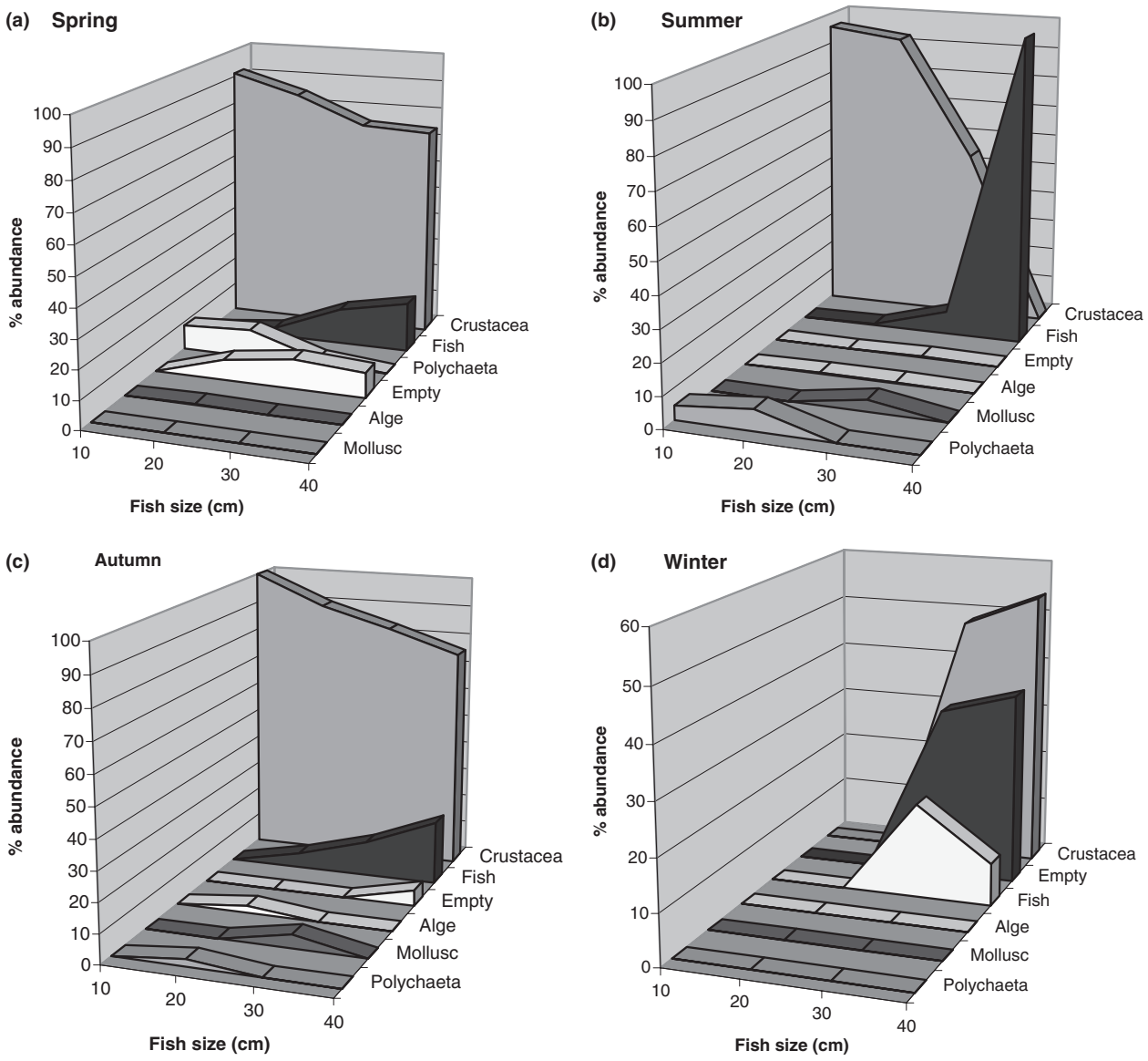

Fig. 6a–d. Food composition of *Sciaena umbra* by size group and season in eastern Black Sea, Turkey

meagre throughout the year was found to be crustaceans, namely, *Palaeman elegans,* and fish. Mollusks and polychaetes made small but noticeable contributions to the diet throughout the year. There is a shift from crustaceans to fish as the *S. umbra* grows. This is obvious in the spring through autumn but not in the winter.

Discussion

The largest brown meagre in the sample was 72 cm in length, weighing 4700 g. This was rated as an exceptional specimen and was excluded from the estimation of the growth parameters. Bauchot (1987) also recorded a size of 70 cm in the Mediterranean; however, the lifespan and reproduction of Black Sea *S. umbra* remained unknown in this earlier study.

The results obtained in the present study on size at first maturity and on the seasonality in reproductive activity are very close to corresponding data for the Tunisian coast as obtained by Chakroun-Marzouk and Ktari (2003), who determined first maturity lengths of 20 and 21 cm for males and females, respectively, differing by less than 1 cm from those in the present study. Spawning was also reported for the period July and August, and sexual resting extended from September to March.

Various growth parameter prediction models were used to estimate L_{inf}. Kohn (1986) suggested that if parameter values were estimated by formal optimization methods, it was essential to show that these estimates were reasonable and reliable for the biological data that the model was depicting. Therefore, in the VBGE the estimate of L_{inf} should be reasonably close to the maximum length observed in the samples (Taylor, 1958; Pauly, 1979; Moreau, 1987), t_0 should be smaller than 0, so that the fish at age 0 could have a positive length (Moreau, 1987), and k might vary between 0 and 1 per year for fish species with long lifespans (Pauly, 1978). The presented estimates for *Scianea umbra* in the eastern Black Sea conform with all of these criteria and are similar to the parameter values reported for the brown meagre from the Tunisian coast in the Mediterranean (Chakroun-Marzouk and Ktari, 2003) as the only currently available information. The k-values estimated for the Tunisian coast (0.186 year^{-1} for females and 0.225 year^{-1} for males), as well as the ∅' values (2.57 for females and 2.65 for males) are slightly lower than the present estimates of $k = 0.27$ year^{-1} and ∅' = 2.86 for males and females combined.

Previous studies found that *S. umbra* feeds preferentially on crustaceans that dominate its diet (Chakroun and Ktari, 1981; Fabi et al., 1998, 2006; Froglia and Gramitto, 1998; Derbal and Kara, 2007). This corresponds to the present results; however, feeding preferences change with length, and fish prey become dominant in the predator size range 30–40 cm, especially in summer.

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