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Feeding Habit and Length-Weight Relationship, *Sciaena umbra* Linnaeus, 1758 from Southeastern Black Sea

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Research Article

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Abstract

There are many studies on the growth, reproduction, and diet of *Sciaena umbra* Linnaeus, 1758 in the Mediterranean Sea, while general information on the species is scarce with only a few limited regions from along the Turkish coasts of the Mediterranean Sea, the Aegean Sea, Sea of Marmara and the Black Sea. A total of 217 individuals, 98 males, and 119 females were obtained between March 2018 and February 2019 from the Southeastern Black Sea (Ordu province). Length of the individuals ranged from 11.70-48.20 cm, and weight ranged from 16.43-1934.48 g. According to IRI % analysis, the primary prey group is crustaceans for all individuals and each sex. The secondary prey group was teleost and the third was mollusks. This study extends the current knowledge of length and weight relationships and dietary habits of near threatened brown meagre for its long-needed sustainable management, especially in the Black Sea.

Keywords: Brown meagre, Black Sea, LWR, feeding habits

Güneydoğu Karadeniz'den *Sciaena umbra* Linnaeus, 1758 türünün Beslenme Alışkanlığı ve Boy-Ağırlık İlişkisi

Özet

Akdeniz'de *Sciaena umbra* Linnaeus, 1758 türünün büyüme, üreme ve diyeti üzerine bir çok çalışma yayınlanmış olmasına karşın Akdeniz'in Türkiye kıyıları, Ege Denizi, Marmara Denizi ve Karadeniz'den tür üzerine genel bilgi sınırlıdır. Toplamda 217 birey, 98 erkek ve 119 dişi, Mart 2018 ve Şubat 2019 arasında güneydoğu Karadeniz'den (Ordu) elde edilmiştir. Bireylerin boyları 11,70-48,20 cm ve ağırlıkları 16,43-1934,48 gr arasında değişmektedir. Tüm ve her eşey için %IRI analizine göre ana besin grubu krustaselerdir. İkincil besin grubu teleost ve üçüncül molluskadır. Bu çalışma, özellikle Karadeniz'de uzun süredir avlanan eşkina türünün sürdürülebilir yönetimi için ihtiyaç duyulan boy ve ağırlık ilişkileri ve beslenme alışkanlıkları hakkındaki güncel bilgi birikimini genişletmektedir.

Anahtar Kelimeler: Eşkina, Karadeniz, boy-ağırlık ilişkisi, beslenme alışkanlığı

INTRODUCTION

Economically and ecologically important brown meagre, *Sciaena umbra* Linnaeus, 1758, can be found throughout the Mediterranean Sea, the Black Sea, and the Azov Sea, inhabiting inshore waters down to about 180 m depth (Fischer et al., 1987). In the coastal zones with their favorable habitats, the presence of brown meagre is considered an indication of high environmental quality and fish community richness (Mouillot et al., 2002; Garcia-Rubies et al., 2013; Harmelin-Vivien et al., 2015). Additionally, the species was suggested as a useful bioindicator of professional and recreational fishing pressures (Harmelin and Ruitton, 2007).

There are studies published on brown meagre growth (Chakroun and Ktari, 2003; Ragonese et al., 2004; Chater et al., 2018), reproduction (Chakroun and Ktari, 2003; Grau et al., 2009), and diet (Fabi et al., 1998) in the Mediterranean Sea. However, information on the species is scarce with only a few limited regions from along the Turkish coasts of the Mediterranean Sea, Aegean Sea (Karakulak et al., 2006; Bilge et al., 2014), Sea of Marmara (Artüz, 2006; Keskin and Gaygusuz, 2010) and the Black Sea (Engin and Seyhan, 2009).

According to the Turkish Statistic Institute (TUIK) (2019) reports, the annual production of brown meagre in Turkish waters has declined within the last decade (Table 1). Similarly, there is a report of a declining trend globally by Chao (2015) and brown meagre, is categorized as a “Near Threatened” species, by IUCN categories.

Table 1. Annual catch of all species and brown meagre (TUIK, 2019)

Year	Total (tons)	Brown meagre (tons)
2008	395,660.0	41
2009	380,636.0	32
2010	399,656.0	20
2011	432,246.0	6.6
2012	315,636.5	5.6
2013	295,167.9	2.5
2014	231,058.3	7.6
2015	345765.0	5
2016	263,724.5	4.5
2017	269,676.4	3

Conservational status and trend of this species are not available in the Black Sea due to limited knowledge on the species. Consideration of threats and habitat preference of the species (Chao 2015) is required to fill data gaps for the population of the species in the area. This study aims to extend the current bio-ecological knowledge of the near-threatened brown meagre for its sustainable management. The length-weight relationship and dietary habits of this were investigated in the southeastern Black Sea.

MATERIALS and METHODS

Samples were collected monthly between March 2018 and February 2019 from the Southeastern Black Sea (Ordu province) (Figure1). The samples were brought to the laboratory fresh and morphological measurements of each individual were conducted. Total length was measured using a measuring board with a sensitivity of 1 mm, and body weight was taken with an electronic scale with a sensitivity of 0.01 g. Then, each individual was dissected by cutting from the anus towards the head and the body cavity was exposed. The sex of each specimen was determined by microscopic observation of the gonad. Stomach contents were identified, separated, counted, and weighed. The stomach contents was determined by using Fischer et al., (1987) and Aydın et al., (2013).

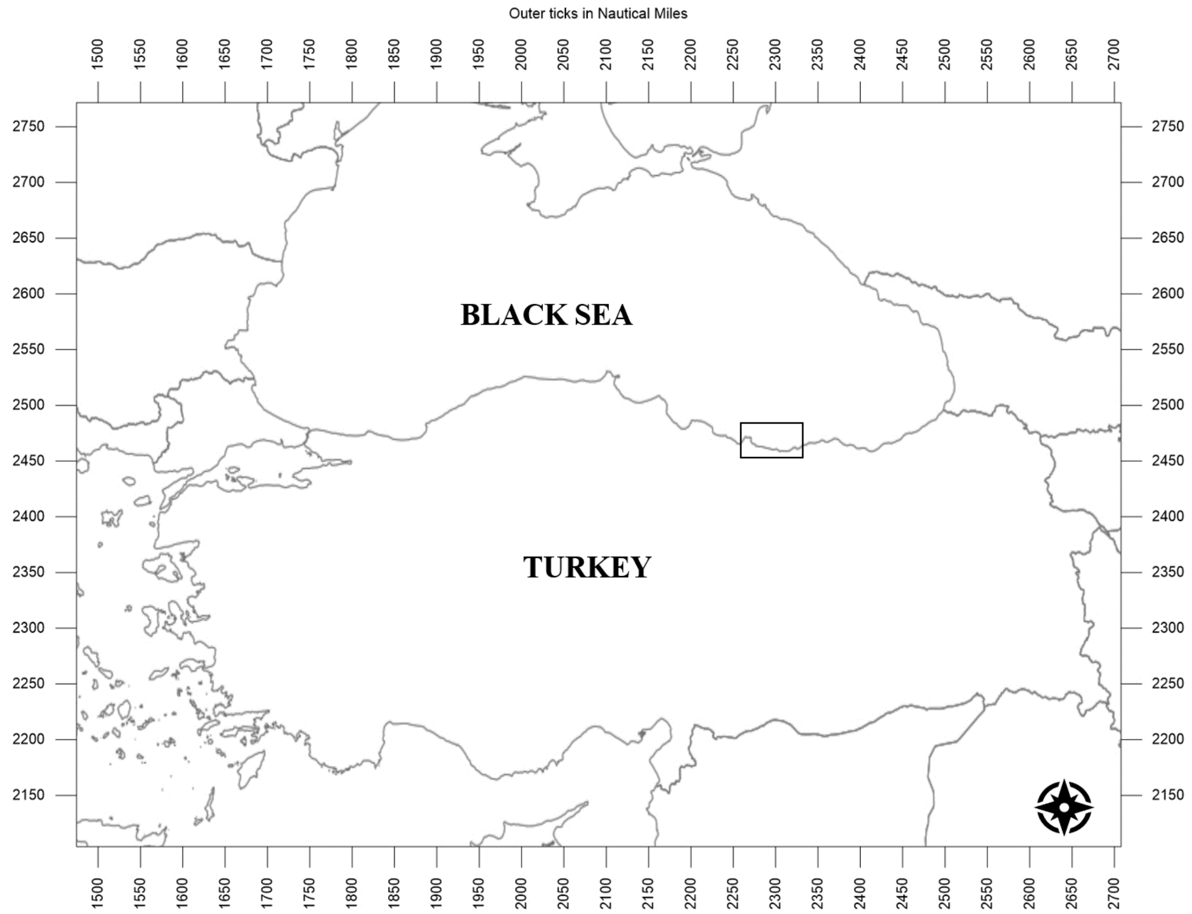

Figure 1. Map of the study area

The LWR was calculated by using the power relationship in the following equation:

$$W = aL^b$$

Where; W is the total weight (g); L is the total length (cm), a and b are constants for each species or population. The b constant was estimated by using the logarithm transformation of the LWR dataset. The LWR was estimated for all, each sex and season. The “b” value, which indicates growth tendency, was tested to verify whether it differs from the isometry at a 0.05 significance level.

All prey items found in the stomach were identified to the lowest possible taxonomic level. Analyses on diet comparison were made between sexes. To evaluate the importance of each prey item percentage index of relative importance (IRI%) was calculated (Hyslop, 1980).

$$IRI_i = F_i\% \ (W_i\% + N_i\%)$$

$$IRI_i\% = \frac{100.IRI_j}{\sum_{j=1}^{n} IRI_j}$$

Where; N% percentage by number, W% percentage by weight, F% frequency of occurrence, IRI is relative importance, and IRI% percentage index of relative importance. For each species, vacuity indices were calculated from the ratio of the number of stomachs with prey items and total examined individuals.

Trophic levels of all individuals as well as for both sexes, all and each season were estimated. All taxa found in the stomachs of examined individuals were classed under the prey categories as Crustacean, Teleost, and Mollusca for easy comparison. The trophic level of identified groups was taken from FishBase (http://www.fishbase.org) (Froese and Pauly, 2019) (Palomares and Pauly n.d.). The IRI% of each taxon was used to calculate the proportional contribution of each taxon in a group. The contribution of each taxon and their trophic levels were then used to calculate the weighted average trophic level of each prey group.

Afterwards, trophic levels of examined species were calculated by;

$$1 + \sum_{j=1}^{G} \mathrm{IRI}_{ij} * \mathrm{troph}_j$$

Where; IRI_{IJ} is the fraction of prey (j) in the diet of the species (i), $troph_j$ is the trophic level of j, and G is the number of groups in the diet of i (Pauly et al., 2000). All statistical analyses were performed using Windows Office Excel software.

RESULTS

A total of 217 individuals, 98 males, and 119 females were obtained during the study period. Length of the individuals ranged from 11.70-48.20 cm, and weight ranged from 16.43-1934.48 g. Descriptive statistics of length and weight, as well as LWR parameters of all individuals and both sexes by seasons, are given in Table 2.

Table 2. Table of descriptive statistics of length and weight measurements, and LWR parameters of all individuals and both sexes by seasons (♂: male; ♀: female; Σ: overall; S: Sex; N= Number of individuals, Min: Minimum; Max: Maximum; Ave: Average; a: and b:population constants; R^2: Regression coefficient; SE: Standard error; Sp: Spring; Sum: Summer; Win: Winter)

	S	N	Length (cm)			Weight (g)			LWR			
			Min	**Max**	**Ave**	**Min**	**Max**	**Ave**	**a**	**b**	**R^2**	**SE**
ALL	♂	98	11.7	46.0	27.0	16.43	1300	324.32	0.0060	3.23	0.981	0.046
	♀	119	15.7	48.2	29.9	47.67	1934.48	454.55	0.0059	3.24	0.976	0.047
	∑	217	11.7	48.2	28.6	16.43	1934.48	395.62	0.0057	3.25	0.979	0.032
Sp	♂	37	19.8	45.0	27.0	82.00	1300	302.56	0.0031	3.42	0.955	0.126
	♀	38	17.3	46.3	31.0	57.71	1481	486.94	0.0051	3.27	0.972	0.092
	∑	75	17.3	46.3	29.0	57.71	1481	395.98	0.0040	3.34	0.970	0.072
Sum	♂	34	14.3	44.5	24.2	33.19	1127.70	248.29	0.0072	3.17	0.992	0.049
	♀	24	18.4	48.2	25.4	76.72	1814.01	286.18	0.0060	3.23	0.990	0.079
	∑	58	14.3	48.2	24.2	33.19	1814.01	248.29	0.0068	3.19	0.992	0.039
Fall	♂	18	11.7	46.0	30.4	16.43	1289.80	475.23	0.0072	3.19	0.992	0.003
	♀	47	15.7	47.9	31.0	47.67	1934.48	511.97	0.0060	3.25	0.978	0.072
	∑	65	11.7	47.9	30.8	16.43	1934.48	501.80	0.0065	3.22	0.984	0.052
Win	♂	8	21.2	34.9	30.5	133.16	553.87	399.21	0.0219	2.85	0.995	0.073
	♀	10	23.2	39.1	31.5	210.46	823.13	463.02	0.0597	2.58	0.933	0.245
	∑	18	21.2	39.1	30.9	133.16	823.13	430.11	0.0323	2.75	0.960	0.136

According to IRI % analysis, the primary prey group is crustaceans for all individuals and each sex. The secondary prey group was teleost and the third was mollusks. Though the IRI % ratios varied, the prey importance in the diet did not change among seasons. The IRI % with a list of prey and trophic levels of all, female and male individuals overall and for each season are given in Table 3.

Table 3. Table of IRI % and trophic level of all individuals and both sexes by seasons (TL: Trophic level; Σ: overall; Sp: Spring; Sum: Summer; Win: Winter)

	All (TL: 3.21)					**Female (TL: 3.27)**					**Males (TL: 3.18)**				
Species	**Σ%**	**Sp %**	**Sum %**	**Fall %**	**Win %**	**Σ%**	**Sp %**	**Sum %**	**Fall %**	**Win %**	**Σ%**	**Sp %**	**Sum %**	**Fall %**	**Win %**
Crustacea	**95.46**	**90.96**	**98.41**	**88.77**	**97.63**	**92.42**	**65.32**	**94.31**	**90.99**	**100.00**	**97.09**	**99.93**	**98.82**	**73.70**	**93.62**
Carcinus aestuarii	0.30	0.00	0.00	0.68	3.53	0.12	0.00	0.00	0.00	12.31	0.61	0.00	0.00	5.27	0.00
Brachynotus sexdentatus	0.09	0.00	0.11	0.29	0.00	0.11	0.00	0.71	0.06	0.00	0.06	0.00	0.00	1.61	0.00
Crangon crangon	2.70	1.60	2.19	2.48	0.00	4.02	1.92	2.27	3.85	0.00	1.09	1.36	1.80	0.00	0.00
Eriphia verrucosa	0.79	4.96	0.26	0.00	0.00	1.23	6.81	1.70	0.00	0.00	0.26	1.73	0.00	0.00	0.00
Isopoda	40.70	58.12	44.66	13.48	0.00	29.99	23.67	34.98	18.39	0.00	50.51	65.74	42.23	0.00	0.00
Liocarcinus depurator	0.79	1.14	0.00	1.96	0.00	1.77	4.38	0.00	1.84	0.00	0.06	0.00	0.00	1.08	0.00
Liocarcinus navigator	0.05	0.00	0.25	0.04	0.00	0.16	0.00	1.36	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Pachygrapsus marmoratus	4.20	1.61	2.41	7.93	0.00	3.27	1.39	11.66	1.52	0.00	5.14	0.46	0.00	29.47	0.00
Palaemon elegans	0.03	0.00	0.00	0.06	1.17	0.11	0.00	0.00	0.09	3.83	0.00	0.00	0.00	0.00	0.00
Palaemon serratus	2.68	0.00	0.77	7.91	16.34	6.56	0.00	4.72	6.76	54.26	0.22	0.00	0.00	5.19	0.00
Pilumnus hirtellus	0.02	0.00	0.20	0.00	0.00	0.07	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pisidia longimana	1.11	0.20	3.06	0.63	0.00	0.34	0.00	5.68	0.00	0.00	2.45	0.68	1.54	10.28	0.00
Upogebia pusilla	17.27	12.57	0.00	30.72	75.32	17.77	1.47	0.00	40.61	25.35	15.63	28.75	0.00	2.56	93.62
Xantho poressa	24.73	10.75	44.50	22.59	1.28	26.89	25.67	29.91	17.81	4.25	21.04	1.21	53.24	18.25	0.00
Teleost	**4.49**	**9.01**	**1.16**	**11.23**	**2.37**	**7.58**	**34.68**	**5.69**	**9.01**	**0.00**	**2.71**	**0.00**	**0.00**	**26.30**	**6.38**
Diplodus puntazzo	0.01	0.00	0.00	0.09	0.00	0.04	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Gobius niger	0.85	1.12	0.00	1.91	0.00	2.50	3.31	0.00	3.12	0.00	0.00	0.00	0.00	0.00	0.00
Merlangius merlangus	0.01	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	1.01	0.00
Mullus barbatus	0.05	0.00	0.00	0.34	0.00	0.15	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00
Neogobius melanostomus	0.06	0.00	0.00	0.38	0.00	0.02	0.00	0.00	0.06	0.00	0.12	0.00	0.00	1.48	0.00
Parablennius tentacularis	0.02	0.00	0.00	0.21	0.00	0.08	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00
Scorpaena porcus	0.34	0.00	0.00	2.19	0.00	1.01	0.00	0.00	3.62	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus melops	1.52	0.00	1.16	5.87	0.00	1.18	0.00	5.69	1.27	0.00	1.98	0.00	0.00	22.16	0.00
Trachurus mediterraneus	1.64	7.88	0.00	0.17	2.37	2.60	31.37	0.00	0.00	0.00	0.55	0.00	0.00	1.66	6.38
Mollusca	**0.04**	**0.04**	**0.44**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.21**	**0.07**	**1.18**	**0.00**	**0.00**
Mytilus galloprovincialis	0.04	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	1.18	0.00	0.00
Tritia neritae	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.00	0.00

DISCUSSION

Though it is reported that different types of length measurements alter "a" but not "b"; remarkably (Froese, 2006), environmental factors, food availability, and maturity stage is known to affect the growth of fish (Mommsen, 1998). The LWR studies conducted on brown meagre are given in Table 4. When compared regionally, the b value of the LWR showed mostly positive allometry along the Turkish seas, in the Mediterranean Sea, the northwestern Adriatic Sea, and the western Mediterranean (except by Crechriou et al., 2013). In only three studies were reported negative allometric growth (Karachle and Stergiou, 2008; Maci et al., 2009; Crechriou et al., 2013) and in a study was reported isometric growth (Keskin and Gaygusuz, 2010). Since there is no regional pattern for negative allometry (Table 4) it can be said that methodologic differences (sampling gear, using standard length rather than total length for LWR and number of individuals) are the main reasons for such variations.

Table 4. Previously reported LWRs of *Sciaena umbra* collected from the Black Sea and some different locations (SE: Standard Error)

Study	N	LWR				Location
		Equation	R^2	SE (b)	Allometry	
This study	217	$W=0.0057TL^{3.25}$	0.979	0.032	+	S Black Sea
Dulčić & Kraljević (1996)	26	$W=0.0000315TL^{3.048}$	0.964	0.121	+	E Adriatic
Morey et al., 2003	233	$W=0.0053TL^{3.2542}$	0.952	0.136	+	W Mediterranean
Dulcic & Glamuzina, 2006	39	$W=0.0354TL^{3.050}$	0.98		+	E Adriatic Sea
Karachle & Stergiou, 2008	11	$W=0.0242TL^{2.7080}$	0.93	0.252	-	NW Aegean Sea
La Mesa et al., 2008	532	$W=7.15x10^{-3}TL^{3.200}$	0.98	0.017	+	NW Adriatic Sea
Engin & Seyhan, 2009	329	$W=0.0045TL^{3.3024}$	0.96		+	SE Black Sea
Grau et al., 2009	160	$W=0.041TL^{3.322}$	0.96		+	W Mediterranean
Maci et al., 2009	203	$W=0.0343SL^{2.891}$	0.952	0.089	-	SW Adriatic
Keskin & Gaygusuz, 2010	12	$W=0.0069TL^{3.16}$	0.98	0.338	isometry	Sea of Marmara
Crechriou et al., 2013	16	$W=0.0018TL^{2.91}$	0.908		-	W Mediterranean
Bilge et al., 2014	54	$W=0.0136TL^{3.0038}$	0.979	0.196	+	SE Aegean Sea

According to Artüz (2006), decapod crustaceans and teleost fish were the main food groups by weight and in terms of occurrence frequency, the order changed as teleost fish and crustaceans in the Sea of Marmara. The main food taxon identified in this study differs from Artüz (2006)'s results. Parallel to this study, a study conducted from the southeastern Black Sea by Engin and Seyhan (2009) reported that throughout the year crustaceans and teleost fish were the main food groups, and mollusks and polychaetas contributed in small portions to the diet, as well. A study conducted from the coasts of Italy in the central Adriatic Sea also reported that the main food item for brown meagre was crustaceans, especially decapods, which were followed by amphipods, polychaetas, and benthic fish (Fabi et al., 1998). Moreover, Fabi et al., (1998) and Engin and Seyhan (2009) stomach content results along with a study by Karachle and Stergiou (2017) all support the result of crustaceans being the main food source contrary to Artüz (2006) which may also indicate a localized dietary habit in the Sea of Marmara. Additionally, the trophic levels that were estimated within this study ranged between 3.27-3.18 and the total lengths between 11.7 48.2. Though it is lower than previously reported from the Mediterranean Sea (trophic level estimated by Stergiou and Karpouzi (2002) was 3.80 and Karachle and Stergiou (2017) reported a range between 3.50-3.80) the length range that was estimated from is narrower (total lengths ranged between 13-37 in the study conducted by Stergiou and Karpouzi, 2002) than this study. Besides the length group that it was estimated from estimated lower trophic levels within this study may be related to ecological differences of the Black and Mediterranean Sea.

Overfishing has long been the cause of the depletion of fish populations in the Mediterranean Sea, as in many other aquatic environments, which induce changes in the trophic levels of communities and the functioning of coastal ecosystems (Harmelin-Vivien et al., 2015). Additionally, other factors such as ghost fishing, pollution, and climate change are also stressors on a fish population. A study conducted in the Sea of Marmara reported that as a result of increasing pollution in the eastern Sea of Marmara, the numbers of brown meagre have decreased but the population in the western Sea of Marmara has remained stable (Artüz, 2006). In conclusion, such reports, along with the declining numbers in TUIK reports, raise questions on the brown meagre' population sustainability. Therefore, it is imperative to monitor the current state of other populations amongst other Turkish seas, such as the Black Sea. This study extends the current knowledge of length and weight relationships and dietary habits of the near-threatened brown meagre for its long required sustainable management, especially in the Black Sea.

REFERENCES

Artüz, M. L. (2006). Abundance and growth observations of *Sciaena umbra* Linnaeus, 1758 in Sea of Marmara. *Hidrobiologica*, 124-128.

Aydın, M., Karadurmus, U., & Mutlu, C. (2013). The crab species of the Middle and East Black Sea (Turkey). *The Black Sea Journal of Sciences*, *3*, 1-16.

Bilge, G., Yapıcı, S., Filiz, H., & Cerim, H. (2014). Weight-length relations for 103 fish species from the Southern Aegean Sea, Turkey. *Acta ichthyologica et piscatoria*, *44*(3), 263–269

Chakroun-Marzouk, N., & Ktari, M. H. (2003). The brown meagre from Tunisian coasts, *Sciaena umbra* (Sciaenidae): sexual cycle, age and growth. *Cybium*, *27*(Suppl. 3), 211–225.

Chao, L. (2015). *Sciaena umbra*. The IUCN Red List of Threatened Species 2015: e.T198707A83232286.

Chater, I., Romdhani-Dhahri, A., Dufour, J. L., Mahé, K., & Chakroun-Marzouk, N. (2018). Age, growth and mortality of *Sciaena umbra* (Sciaenidae) in the Gulf of Tunis. *Scientia Marina*, *82*(1), 17-25.

Crec'hriou, R., Neveu, R., & Lenfant, P. (2012). Length–weight relationship of main commercial fishes from the French Catalan coast. *Journal of Applied Ichthyology*, *28*(5), 861-862.

Dulčić, J., & Glamuzina, B. (2006). Length–weight relationships for selected fish species from three eastern Adriatic estuarine systems (Croatia). *Journal of Applied Ichthyology*, *22*(4), 254-256.

Dulčić, J., & Kraljević, M. (1996). Weight-length relationships for 40 fish species in the eastern Adriatic (Croatian waters). *Fisheries research*, *28*(3), 243-251.

Engin, S., & Seyhan, K. (2009). Age, growth, sexual maturity and food composition of *Sciaena umbra* in the south-eastern Black Sea, Turkey. *Journal of Applied Ichthyology*, *25*(1), 96-99.

Fabi, G., Panfili, M., & Spagnolo, A. (1998). Note on feeding of *Sciaena umbra* L. (Osteichthyes: Sciaenidae) in the central Adriatic sea. Rapport du 35e *Congrès de la Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée*, *35*, 426-427.

Fischer, W., Bauchot, M.L., & Schneider M. (1987). *Fiches FAO d'identification pour les besoins de la peche revision 1.* Mediterranee et mer Noire. Zone de peche 37, vol. 2: Vertebres, Rome, FAO, pp. 761-1530.

Froese, R., & Pauly, D. (Eds) (2019). FishBase. World Wide Web electronic publication. https://www.fishbase.de/summary/1749 .

García-Rubies, A., Hereu, B., & Zabala, M. (2013). Long-term recovery patterns and limited spillover of large predatory fish in a Mediterranean MPA. *PLoS One*, *8*(9), 1-10

Grau, A., Linde, M., & Grau, A. M. (2009). Reproductive biology of the vulnerable species *Sciaena umbra* Linnaeus, 1758 (Pisces: Sciaenidae). *Scientia Marina*, *73*(1), 67-81.

Harmelin, J.G. & Ruitton, S. (2007). La population de corb (*Sciaena umbra*: Pisces) du Parc national de Port-Cros (France), état en 2005 et évolution depuis 1990: un indicateur halieutique et biogéographique pertinent. *Scientific Reports of the Port-Cros National Park*, *22*, 49–65.

Harmelin-Vivien, M., Cottalorda, J. M., Dominici, J. M., Harmelin, J. G., Le Diréach, L., & Ruitton, S. (2015). Effects of reserve protection level on the vulnerable fish species *Sciaena umbra* and implications for fishing management and policy. *Global Ecology and Conservation*, *3*, 279-287.

Hyslop, E.J. (1980). Stomach contents analysis-a review of methods and their application. *Journal of Fish Biology*, *17*, 411-429. https://doi.org/10.1111/j.1095-8649.1980.tb02775.x

Karachle, P. K., & Stergiou, K. I. (2008). Length–length and length–weight relationships of several fish species from the North Aegean Sea (Greece). *Journal of Biological Research*, *10*, 149-157.

Karachle, P. K., & Stergiou, K. I. (2017). An update on the feeding habits of fish in the Mediterranean Sea (2002-2015). *Mediterranean Marine Science*, *18*(1), 43-52.

Karakulak, F. S., Erk, H., & Bilgin, B. (2006). Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *Journal of Applied Ichthyology*, *22*(4), 274-278.

Keskin, Ç., & Gaygusuz, Ö. (2010). Length-weight relationships of fishes in shallow waters of Erdek Bay (Sea of Marmara, Turkey). *European Journal of Biology*, *69*(2), 87-94.

La Mesa, M., Colella, S., Giannetti, G., & Arneri, E. (2008). Age and growth of brown meagre *Sciaena umbra* (Sciaenidae) in the Adriatic Sea. *Aquatic Living Resources*, *21*(2), 153-161.

Maci, S., Longo, E., & Basset, A. (2012). Length-weight relationships for 24 selected fish species from a non-tidal lagoon of the southern Adriatic Sea (Italy). *Transitional Waters Bulletin, 3*(3), 1-9.

Mommsen, T.P. (1998). Growth and metabolism. In: Evans, D.H. (Ed.), *The Physiology of Fishes*. CRC Press, New York, pp. 65-97.

Morey, G., Moranta, J., Massutı, E., Grau, A., Linde, M., Riera, F., & Morales-Nin, B. (2003). Weight–length relationships of littoral to lower slope fishes from the western Mediterranean. *Fisheries Research, 62*(1), 89-96.

Mouillot, D., Culioli, J. M., & Do Chi, T. (2002). Indicator species analysis as a test of non-random distribution of species in the context of marine protected areas. *Environmental conservation*, *29*(3), 385-390. https://doi.org/10.1017/S0376892902000267

Pauly, D., Froese, R., Sa-a, P. S., Palomares, M. L., Christensen, V., & Rius, J. (2000). TrophLab manual. *ICLARM, Manila*.

Ragonese, S., Gancitano, S., Camilleri, M., & Levi, D. (2004). An integrate analysis of size at age data of *Sciaena umbra* L. 1758 (Osteichthyes, Sciaenidae) of the central Mediterranean Sea. *Biologia Marina Mediterranea*, *11*(2), 612-616.

Stergiou, K. I., & Karpouzi, V. S. (2002). Feeding habits and trophic levels of Mediterranean fish. *Reviews in Fish Biology and Fisheries*, *11*(3), 217-254.

TUIK, 2019. Turkish Statistical Institute, Ankara, Turkiye. (www.tuik.gov.tr).