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Growth and reproduction of blotched picarel (*Spicara maena* Linnaeus, 1758) in the central Aegean Sea, Turkey

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Abstract: Growth and reproduction of the blotched picarel, *Spicara maena* (Linnaeus, 1758), were determined based on specimens (n = 2547) collected from the central Aegean Sea between July 2004 and June 2007. The samples consisted of 71.9% females, 16.2% males, and 11.9% immature individuals. The sex ratio of females to males was 1:0.23. The length-weight relationship was $W = 0.011L^{3.02}$, $W = 0.011L^{3.00}$, and $W = 0.011L^{2.99}$ for the combined sexes, females, and males, respectively. For all samples and both sexes the length-weight relationship showed isometric growth. The von Bertalanffy growth equation was fitted on the basis of mean length-at-age data, resulting in parameter values of L_∞ = 21.99 cm, k = 0.255 year^{-1}, and t_o = -1.165 year, and weight at infinity (W_∞) was calculated as 123.35 g. Length at first maturity was 8.1 cm in males and 8.5 cm in females. On the other hand, first reproduction length was 11.51 cm and 13.12 cm for females and males, respectively, both corresponding to 2 years of age. It was observed that spawning occurred between March and June.

Key words: Blotched picarel, *Spicara maena*, age, reproduction, sexual maturity length, sex inversion length

Orta Ege Denizi izmarit balığı'nın (*Spicara maena* Linnaeus, 1758) büyüme ve üreme özellikleri

Özet: İzmarit balığının (*Spicara maena* Linnaeus, 1758) büyüme ve üreme özellikleri, Temmuz 2004 ve Haziran 2007 tarihleri arasında orta Ege Denizi'nden elde edilen bireylerle (n = 2547) tespit edilmiştir. Örneklerin; % 71,9'unu dişi, % 16,2'sını erkek ve % 11,9'unun ise eşeysel olgunluğa erişmemiş bireylerden oluştuğu tespit edilmiştir. Stoğun dişi:erkek oranı 1:0,23 olarak hesaplanmıştır. Boy-ağırlık ilişkisi tüm bireyler için $W = 0{,}011L^{3.02}$, dişiler için $W = 0{,}011L^{3.00}$, erkekler için $W = 0{,}011L^{2.99}$ olarak tespit edilmiştir. Her iki cinsiyet ve tüm bireyler izometrik büyüme göstermişlerdir. Yaştaki ortalama boy temeline dayanan von Bertalanffy büyüme eşitliği parametreleri, L_∞ = 21,99 cm, k = 0,255 y^{-1}, t_o = -1,165 y ve bireyin sonsuzda ulaşabileceği ağırlık (W_∞) 123,35 g olarak hesaplanmıştır. İlk olgunluk boyu erkeklerde 8,1 ve dişilerde 8,5 cm'de tespit edilmiştir. Diğer taraftan ilk üreme boyunun dişilerde 11,51, erkeklerde 13,12 cm'de olduğu ve her ikisinin de 2 yaşa karşılık geldiği saptanmıştır. Yumurtlamanın Mart ve Haziran ayları arasında gerçekleştiği belirlenmiştir.

Anahtar sözcükler: İzmarit, *Spicara maena*, yaş, büyüme, üreme, eşeysel olgunluk boyu, cinsiyet dönüşüm boyu, orta Ege Denizi

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Introduction

Blotched picarel, *Spicara maena*, of the family Centracanthidae, is a commercial species inhabiting the Mediterranean Sea, the Black Sea, and the European and African coasts of the Atlantic Ocean, from Morocco to Portugal and the Canary Islands (UNESCO, 1996). This species commonly occurs over *Posidonia* beds and sandy or muddy bottoms, and is distributed at depths of up to 100 m. The blotched picarel is a poorly defined species and the species' classification is generally confused with that of *Spicara smaris*. The blotched picarel has many synonyms, including *Maena chryselis*, *M. jusculum*, *M. maena*, *M. vomerina*, *M. vulgaris*, *Merolepis chryselis*, *Merolepsis maena*, *Smaris cagarella*, *S. chryselis*, *S. gagarella*, *Sparus maena*, *S. osbeck*, *S. tricuspidatus*, *S. zebra*, *Spicara chryselis*, *S. flexuosa*, *S. maena*, *S. maena flexuosa*, and *S. maena maena* (Froese and Pauly, 2009).

Generally, the growth of fish depends on increases in length and weight; therefore, regarding population parameters, the length-weight relationship is one of the most important criteria that affect growth and reproduction parameters, such as maturity and sex inversion length in hermaphrodites. Studies about this species are limited in number. Dulčić et al. (2000) reported the age, growth, and mortality of this species in the Adriatic, and Çiçek et al. (2007) studied the population characteristics and growth of blotched picarel in the northeastern Mediterranean. Moutopoulos and Stergiou (2002) presented data on the length-weight relationship in Greek waters, as did Valle et al. (2003) in the western Mediterranean, Cherif et al. (2008) along the Tunisian coast of the Mediterranean, and Karakulak et al. (2006) in the north Aegean Sea. The purpose of the present study was to obtain new data on the growth and reproduction of blotched picarel in the central Aegean Sea.

Materials and methods

Blotched picarel samples were collected by trawl hauls from İzmir Bay (Figure 1) at depths of 30-70 m on the R/V EGESÜF (26.8 m length, 463 HP engine, and 110 gross weights) between July 2004 and June 2007. A commercial bottom trawl was used for sampling. The cod-end used was knotless diamond-shaped and made of polyamide (PA) with 22-mm stretched mesh netting.

Fish samples were brought to the laboratory and total length (*TL*) was measured in the natural body position to the nearest millimeter. Total weight (*W*) and gonad weight (W_g) were measured to the nearest 0.01 g, and sex was recorded. Fish length was classified in 0.5-cm group intervals and length-frequency diagrams were drawn yearly using pooled data. Sagittal otolith pairs were removed for each length group, cleaned, and stored in dry conditions inside a U-plate.

Sex and maturity were determined via macroscopic analysis of the gonads. Maturity stages were assessed according to Gunderson's (1993) scale: stage I immature, stage II resting, stage III developing, stage IV ripe, and stage V spent. The female to male (F:M) ratio was calculated using only mature individuals. The chi-square (x^2) test was used to determine the significance of the male to female ratio.

The relationship between length and weight was established as $W = aL^b$, where W is total body weight (g), L is total length (cm), and a and b are coefficients (Ricker, 1973). The parameters a and b of the length-weight relationship were estimated according to linear regression analysis of log-transformed data. The degree of association between variables was calculated by the determination coefficient (R^2).

The otoliths of 336 individuals, covering all size classes sampled, were used to determine age. Age determination was performed using a stereoscopic zoom microscope under reflected light against a black background. Opaque and transparent rings were counted; 1 opaque zone together with 1 transparent zone was considered the annual growth indicator. Age estimations were made by 2 independent readers.

Growth was analyzed by fitting the von Bertalanffy growth function to size-at-age data using standard nonlinear optimization methods (Sparre and Venema, 1998). The function $L_t = L_\infty[1 - e^{-k(t - to)}]$ was applied to the data, where L_t is the fish length (cm) at time t (year), L_∞ is the asymptotic length (cm), k is the growth coefficient (year^{-1}), and t_o (year) is the hypothetical time at which the length is equal to zero. The accuracy of the growth parameters was tested

using Munro's growth performance index ($\varphi' = \log(k) + 2\log(L_\infty)$) and the t-test (Pauly and Munro, 1984).

The spawning period was established based on monthly variation in the gonadosomatic index (*GSI*) using the equation $GSI = [W_g/(W - W_g)] \times 100$, where W_g is the gonad weight (g) and W is the total weight (g) of the fish (Ricker, 1975). Length at first maturity (L_m) was defined as the length at which 50% of the population investigated was near spawning (King, 1996). The length at 50% maturity was determined with the L50 computer program LogLog function (İlkyaz et al., 1998). The equations $r(l) = \exp(-\exp(-(a + bl)))$ and $L_m = (-\ln(-\ln(0.5)) - a)/b$ were applied, where $r(l)$ is the proportion of matures in each length class (%), l is the fish length (cm), L_m is the mean length at sexual maturity (50%, cm), a is intercept, and b is slope. The sex inversion length (FM_{50}) was estimated as the length at which the sex ratio equaled female and male. For this estimation the CLogLog function was used with the same computer program. The equations $r(l) = 1 - \exp(-\exp(a + bl))$ and $FM_{50} = (\ln(-\ln(0.5)) - a)/b$ were applied.

Results

Age and growth

In all, 336 specimens were aged, with a range between 1 and 7 years. The estimated von Bertalanffy growth constants were $L_\infty = 21.99$ cm, $W_\infty = 123.35$ g, $k = 0.255$ year^{-1}, and $t_o = -1.165$ year ($a = 4.950$, $b = 0.775$, $R^2 = 0.969$). The growth performance index (φ') was calculated as 2.091. Furthermore, a graph of the growth is presented in Figure 2. The value of L_∞ is higher than the maximum observed length.

Length-weight relationship

The length of 2547 individuals ranged from 7.5 to 20.0 cm (Figure 3). The smallest individual (total length 7.5 cm) was caught in June, while the largest one (total length 20.0 cm) was caught in April. Mean length of the overall stock was 13.0 ± 0.04 cm ($\bar{x} \pm Se$). The calculated length-weight equation for all individuals was $W = 0.011L^{3.02}$ ($R^2 = 0.961$), versus $W = 0.011L^{3.00}$ ($R^2 = 0.930$) for females and $W = 0.011L^{2.99}$ ($R^2 = 0.955$) for males. Growth was isometric for males, females, and for overall individuals. The length-weight relationship parameters are presented in Table 1; in addition, the calculated length-weight relationship curve is shown in Figure 4.

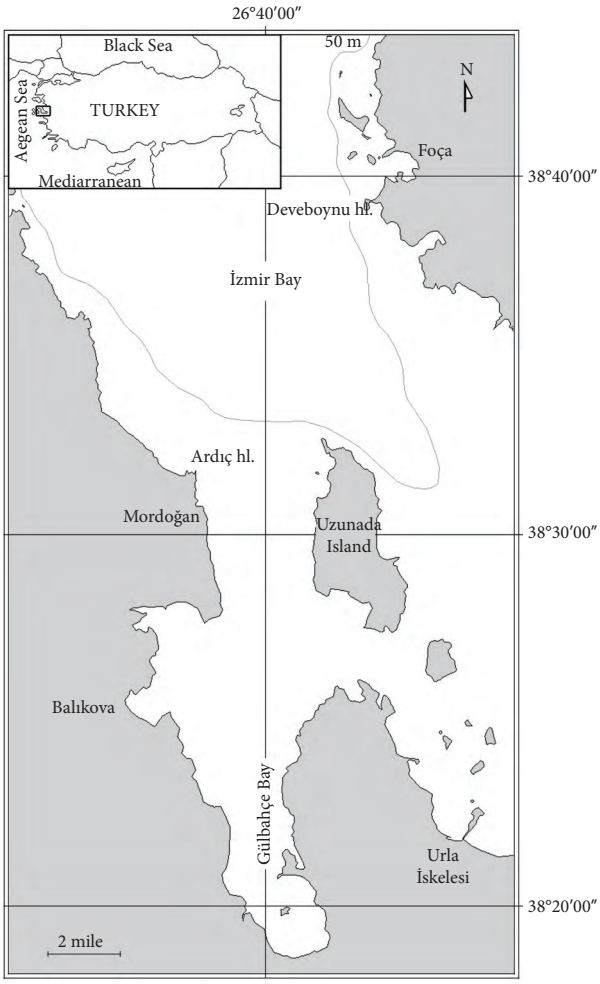

Figure 1. The study area.

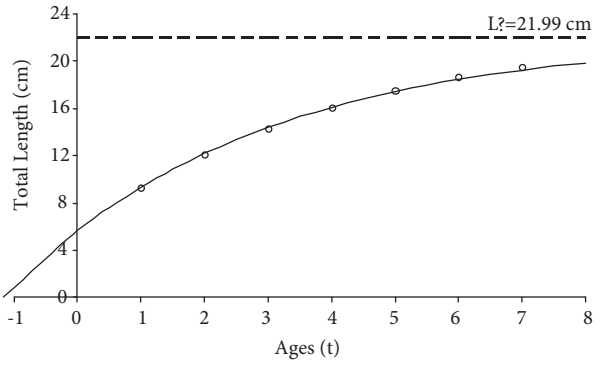

Figure 2. The von Bertalanffy growth curve for the blotched picarel.

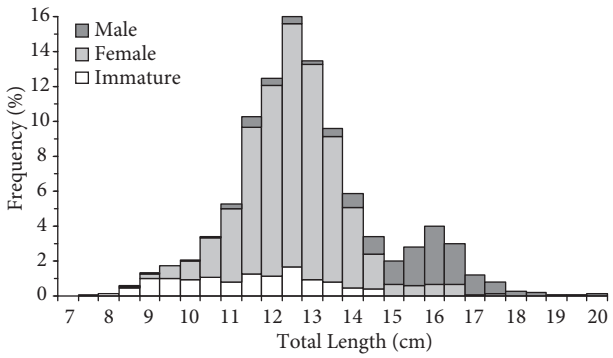

Figure 3. Total length-frequency distribution of the blotched picarel immature, female, and male samples.

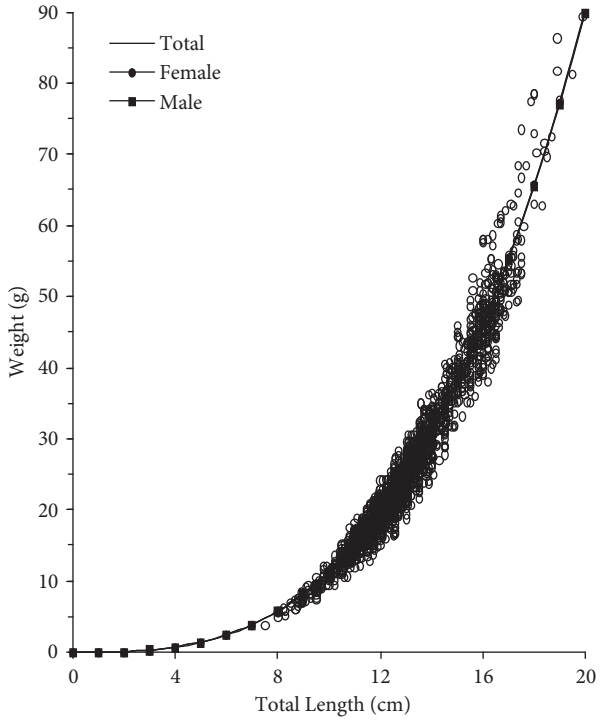

Figure 4. The length-weight relationships of the blotched picarel.

Reproduction

Of the 2547 specimens, 1766 (71.9%) were female, 398 (16.2%) were male, and 293 (11.9%) were immature. Thus, the sex ratio of females to males in the stock was 1:0.23. A significant difference was observed between the individual number of females and males, according to chi-square test results (x^2, $P < 0.05$). Gonadosomatic index percentages for females and males are shown in Figure 5. According to the graph, it was determined that spawning occurred between March and June. It was observed that the gonadosomatic index peaked in March and then gradually declined until June. Moreover, March loomed large, having the highest number of spawning ready individuals. Primary gonad formation occurred at 8.1 and 8.5 cm total length in males and females, respectively. Nevertheless, length at first maturity (L_m) was 11.51 cm and 2 years of age (a = -21.982, b = 1.910, R^2 = 0.926) for females, and 13.12 cm and 2 years of age (a = -21.289, b = 1.622, R^2 = 0.903) for males. Estimation of blotched picarel length at first maturity is presented in Figure 6. It was observed that individuals larger than 18.0 cm were male and sex inversion occurred between 14.5 cm and 15.0 cm TL (Figure 7).

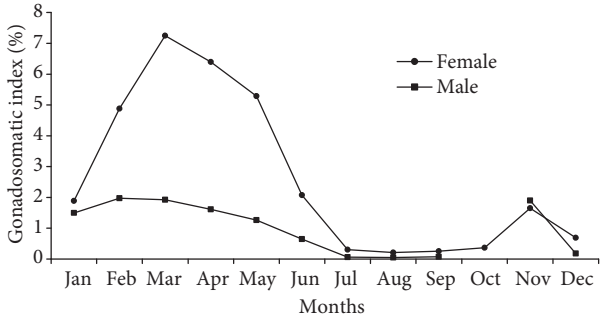

Figure 5. Gonadosomatic index values (%) of males and females by month for the blotched picarel.

Table 1. The length-weight relationships of the blotched picarel.

	n	*a*	*b*	R^2	SE_b	*95% CL of b*
Total	2457	0.011	3.02	0.961	0.012	2.99 - 3.04
Female	1766	0.011	3.00	0.930	0.020	2.97 - 3.04
Male	398	0.011	2.99	0.955	0.033	2.93 - 3.06

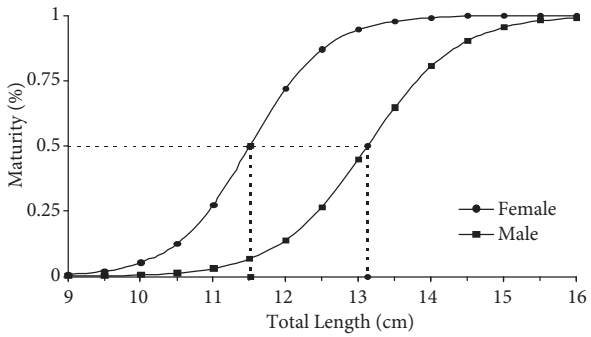

Figure 6. Length at first maturity estimation of the blotched picarel.

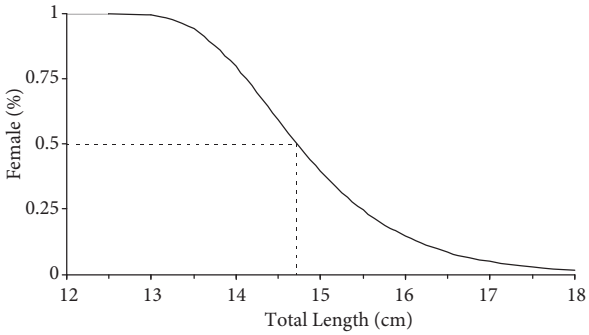

Figure 7. Percentage of sex inversion for the blotched picarel.

Discussion

Growth and reproduction characteristics of blotched picarel inhabiting the central Aegean Sea were investigated in the present study. Recent studies on length-weight relationship parameters are shown in Table 2. The findings of the present study are similar to those reported by other researchers. On the other hand, some differences were observed: Moutopoulos and Stergiou (2002) reported a maximum observed length of 26.0 cm, Dulčić et al. (2000) reported 27.5 cm, and Valle et al. (2003) reported a minimum length of 4.7 cm. The likely reasons for these differences are that they used different sampling instruments (gill nets, longlines, beach seine, and beam trawl) and collected samples from different areas and depths. Furthermore, the present study included the highest *n* value, ensuring precise calculations. A theoretical maximum length of 21.99 cm is quite realistic because the largest specimen during the surveys was 20.0 cm. Geographic locations and associated environmental conditions, such as seasonality (date and time of capture), growth increment, differences in age and stage of maturity, stomach fullness, disease, and parasite load, can affect the length-weight relationship (Shepherd and Grimes, 1983; Weatherly and Gill, 1987).

Low quality data on the population parameters of blotched picarel do not allow for a comprehensive discussion or comparison of the growth and reproduction of the species. Nonetheless, Dulčić et al. (2000) reported growth constants as L_∞ = 24.82 cm, k = 0.532 year^{-1}, t_o = 0.089 year, and φ' = 2.52. Çiçek et al. (2007) reported that the growth parameters of blotched picarel were L_∞ = 21.72 cm, k = 0.385 year^{-1}, t_o = -0.135 year, and φ' = 2.26. In addition, the present study's findings are similar to those reported by Çiçek et al. (2007), as follows: L_∞ = 21.99 cm, k = 0.255 year^{-1}, t_o = -1.165 year, and φ' = 2.09. The t-test results

Table 2. The length-weight relationships of the blotched picarel from the central Aegean Sea and from different locations.

n	Length	*a*	*b*	R^2	Location	Author
33	11.7-18.4	0.000083	2.663	0.90	Greece	Petrakis and Stergiou, 1995
808	14.3-26.0	0.01040	3.096	0.88	Greece	Moutopoulos and Stergiou, 2002
1380	5.3-17.8	0.0076	3.137	0.987	Turkey	Çiçek et al., 2007
92	4.7-21.2	0.0054	3.2618	0.997	Spain	Valle et al., 2003
830	11.0-22.0	0.0028	3.505	0.916	Turkey	Karakulak et al., 2006
330	9.5-20.0	0.014	2.87	0.96	Tunisia	Cherif et al., 2008
1130	7.8-27.5	0.00895	3.12	0.9906	Croatia	Dulčić et al., 2000
2457	7.5-20.0	0.011	3.02	0.961	Turkey	Present study.

showed that there was no significant difference between the growth performance indexes (φ') recorded from other areas ($P > 0.05$).

The spawning period of blotched picarel was observed to occur between March and June in the present study, which is in agreement with that reported by Çiçek et al. (2007) (between March and May). In the present study age of the species varied from 1 to 7 years; however, Çiçek et al. (2007) reported a range of 1-4 years, and Dulčić et al. (2000) reported a range of 1-8 years, and that the oldest male was 8 years old and the oldest female was 3 years old. Furthermore, protogynous hermaphroditism is common among the family Centrachantidae (Zei, 1951) and blotched picarel is a protogynous hermaphrodite species (Lepori, 1960; Reinboth, 1962; Jardas, 1996). In the present study individuals longer than 18.0 cm were all males and sex inversion occurred between 14.5 and 15.0 cm total length, while Salekhova (1979) reported that sex inversion occurred between 12.1 and 15.0 cm in the Lampedusa Island population, and Dulčić et al. (2000) reported that sex reversal occurred between 17.5 and 18.0 cm total length. They also determined that samples longer than 19.8 cm were all males. These differences may be due to geographical differences and the consequent differences in several factors, such as temperature and food availability (Dulčić et al. [2000] carried out their research in the Adriatic Sea). Çiçek et al. (2007) reported a sex reversal age of over 10.9 cm total length for blotched picarel in the northeastern Mediterranean.

The sex ratio of blotched picarel was reported as 1:1.41 (F:M) in favor of males (Dulčić et al., 2000). Lepori (1960) reported a female to male ratio of 1:2. On the other hand, the overall female to male ratio, as determined by Çiçek et al. (2007), was 1:0.28. The female to male ratio observed in the present study was 1:0.23 and conforms to the ratio reported by Çiçek et al. (2007). The likely reason for the differences in reported sex ratios of the species could be that Lepori (1960) and Dulčić et al. (2000) sampled longer individuals, which were all male as a result of protogynous hermaphroditism.

Although there are some differences between the findings reported by various researchers regarding the length-weight relationship, growth parameters, and reproduction of blotched picarel, the results are generally in agreement. The possible cause of these discrepancies were attributed to different geographic locations and the associated differences in environmental conditions. The present study aimed to investigate the length distribution, sex ratio, sex inversion length, length-weight relationship, age, growth, spawning period, first maturity age, and length of blotched picarel in the central Aegean Sea, and to compare these results to those of previous studies. Furthermore, additional research is required in order to expand our knowledge of the biology and ecology of this commercial and poorly known species.

References

Cherif, M., Zarrad, R., Gharbi, H., Missaoui, H. and Jarboui, O. 2008. Length-weight relationships for 11 fish species from the Gulf of Tunis (SW Mediterranean Sea, Tunisia). Pan-American Journal of Aquatic Sciences 3: 1-5.

Çiçek, E., Avşar, D., Yeldan, H. and Manaşırlı, M. 2007. Population characteristics and growth of *Spicara maena* (Linnaeus, 1758) inhabiting in Babadillimani Bight (northeastern Mediterranean-Turkey). International Journal of Natural and Engineering Sciences 1: 15-18.

Dulčić, J., Kraljević, M., Grbec, B. and Cetinić, P. 2000. Age, growth and mortality of blotched picarel *Spicara maena* L. (Pisces: Centracanthidae) in the eastern central Adriatic. Fisheries Research. 48: 69-78.

Froese, R. and Pauly, D. 2009. FishBase version (06/2009). World Wide Web electronic publication. http://www.fishbase.org (June 2009).

Gunderson, D.R. 1993. Surveys of Fisheries Resources. John Wiley and Sons, New York.

İlkyaz, A., Metin, C. and Kınacıgil, H.T. 1998. Örtü torba yöntemi ile örneklenen sürütme ağlarında seçicilik parametrelerinin hesaplanması üzerine bir bilgisayar programı (L50 sürüm 1.0.0). Su Ürünleri dergisi. 15: 305-314.

Jardas, I. 1996. Jadranska ihtiofauna. Školska knjiga, Zagreb (in Croatian).

Karakulak, F.S., Erk, H. and Bilgin, B. 2006. Length-weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. J. Appl. Ichthyol. 22: 274-278.

King, M. 1996. Fisheries Biology Assessment and Management. Fishing News Books, England.

Lepori, N.G. 1960. Ermafroditismo proteroginico in Maena Maena (L.) ed in Maena chryselis (Cuv. e Val.) (Perciformes, Centracanthidae). Boll. Pesca Piscicolt. Idrobiol. (N.S.) 14: 155-165.

Moutupoulos, D.K. and Stergiou, K.I. 2002. Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). Journal of Applied Ichthyology. 18: 200-203.

Pauly, D. and Munro, J.L. 1984. Once more on growth comparison in fish and invertebrates. ICLARM. Fishbyte 2: 21.

Petrakis, G. and Stergiou, K.I. 1995. Weight-length relationships for 33 fish species in Greek waters. Fisheries Research 21: 465-469.

Reinboth, R. 1962. Morphologische und funktionelle Zweiggeschlechtlichteitbei marinen Teleostieren (Serranidae, Sparidae, Centracanthidae, Labridae). Zool. Jahrb. Abt. Allgem. Zool. Physiol. Tierre. 69: 405-480.

Ricker, W.E. 1973. Linear regressions in fishery research. Fish. Res. Board Can. 30: 409-434.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 1-382.

Salekhova, L.P. 1979. Picarels (Spicara spp.) in the Mediterranean Basin (in Russian). Kiev Academy of Science, Kier, pp. 1-172.

Shepherd, G. and Grimes, C.B. 1983. Geographic and historic variations in growth of weakfish (*Cynoscion regalis*) in the middle Atlantic Bight. Fishery Bulletin 81: 803-813.

Sparre, P. and Venema, S.C. 1998. Introduction to tropical fish stock assessment - Part 1: Manual, 306/1, Rev. 2. FAO Fish. Tech. Pap., Rome, pp. 465.

UNESCO 1996. Fishes of the North-Eastern Atlantic and the Mediterranean, CD-ROM electronic publication version 1.0 (ed. J.C. Hureau). ETI BioInformatics, Amsterdam.

Vale, C., Bayle, J.T. and Ramos, A.A. 2003. Weight-length relationships for selected fish species of the western Mediterranean Sea. Journal of Applied Ichthyology 19: 261-262.

Weatherly, A.H. and Gill, H.S. 1987. The Biology of Fish Growth. Academic Press, London, UK.

Zei, M. 1951. Jadranske girice (Maenidae). Monografska studija. Monography of the Adriatic species of Maenidae. Slovenska Akademija Znanosti in Umetnosti. Razred za prirodoslovne in medicinske vede. Insœtitut za biologijo, Ljubljana, 127 pp.