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# Population parameters of red mullet *Mullus barbatus ponticus* Essipov, 1927, in the south-eastern Black Sea, Turkey

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## ABSTRACT

In this study, the population parameters of red mullet *Mullus barbatus ponticus* Essipov, 1927in the south-eastern Black Sea were studied. A total of 965 specimens were studied between November 2017 and September 2018. The total length of the specimens ranged from 9.5 to 21.0 cm (13.74±0.048 cm), while weight varied between 9.00 and 111.14 g (28.00±0.349 g). Their ages were between 1 to 4 and 79% of fish were 2 and 3 years old. Sex ratio (M:F) was determined as 1:1.42. The mean condition factor K was 1.03±0.003. Length-weight relationship and von Bertalanffy growth equations were $W=0.0059*L^{3.2166}$ and $Lt=36[1-e^{-0.0741(t+3.9775)}]$ respectively. Total, natural and fishing mortality rates were $Z=0.878$ year$^{-1}$, $M=0.238$ year$^{-1}$ and $F=0.640$ year$^{-1}$, respectively. The exploitation rate was calculated to be $E=0.729$, which is above the optimum exploitation level.

Keywords: Exploitation, Growth, Length-weight relationship, Mortality, Stock assessment

## Introduction

Red mullet *Mullus barbatus ponticus* Essipov, 1927 is a demersal species that inhabits sandy and muddy bottoms of the continental shelf of the Mediterranean Sea, including the Black Sea and also the eastern Atlantic from Scandinavia to Senegal (Fischer *et al.*, 1987). It is a commerially important fishery resource in Turkey, exploited by bottom trawling and small-scale fisheries in the Black Sea and has significant economic value. In 2017, the total catch of red mullet was 1476 t which was 11.4% of the demersal fish production of Turkey (TUIK, 2018).

Various aspects of its biology and population dynamics have been documented, including studies on reproduction, age, growth and stock identification (Sahin and Akbulut, 1997; Genc, 2000, 2002; Metin, 2005; Polat *et al.*, 2005; Saygun *et al.*, 2006; Kalaycı and Cicek, 2012; Erdem, 2018; Yıldız *et al.*, 2018). Age and growth parameter estimation are fundamental prerequisities for stock assesment (Castro and Lawing, 1995). This study attempts to update information on age and sex distribution, growth, condition, mortality and exploitation rate of *M. barbatus ponticus* population in the south-eastern Black Sea system to aid better management practices for sustainable use of this localised fishery resource.

## Materials and methods

Samples of red mullets (*M. barbatus ponticus*) were collected monthly from commercial coastal gillnets operated along the south-eastern Black Sea coast of Turkey (especially landing at Ordu fishing port) between November 2017 and September 2018 (Fig. 1). Total length and weight of the samples were measured to the nearest 0.1 cm and 0.01 g and sex was determined by gonadal examination. The sagittal otoliths for age determination were removed, wiped clean and stored dry. Otoliths were immersed in alcohol in a petridish with a black background and observed under a stereoscopic microscope.

Length-weight relationship (LWR) was estimated using the formula: $W=a*TL^b$, where L is total length (cm), W is weight (g), a and b are constants (Ricker, 1975). The Student's t-test was used for comparison of derived slopes with the isometric value, 3 (Zar, 1999). Fulton's Condition Factor (K) was calculated from the equation given by Fulton (1902): $K=(W/L^3)*100$. Growth in length was computed using the von Bertalanffy equation (VBGF) (Beverton and Holt, 1957; Ricker, 1975): $L_t=L_\infty[1-e^{(-k(t-t_0))}]$, where $L_t$ is the total length at age t, $L_\infty$ is asymptotic length (cm), k is the growth rate (year$^{-1}$), t is the age (year) and $t_0$ is the hypothetical age (year) at zero length (Sparre and Venema, 1992; King, 1995). The growth performance index (Φ') was estimated using the equation given by Munro and Pauly (1983): $\Phi'=\log K+2*\log L_\infty$, where K and $L_\infty$ are VBGF parameters.

Natural mortality of *M. barbatus ponticus* was computed from multiple regression formula: $\ln M=-0.0152-0.279*\ln L_\infty+0.6543*\ln K+0.463*\ln T$ (Pauly, 1980), where M is natural mortality in a given stock, $L_\infty$ and K are VBGF parameters and T is the annual mean temperature (ºC)

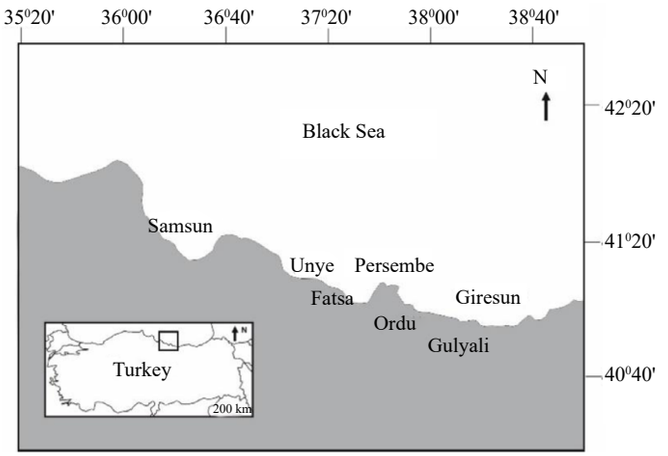


Fig. 1. Map showing the study area

of the seawater, taken as 16ºC. Total mortality (Z) was estimated from the mean size in the catch following Beverton and Holt (1957) from the equation Z=K ($L_\infty$-$L_{mean}$)/($L_{mean}$-$L_c$) where $L_c$=L'. $L_{mean}$ (Erkoyuncu, 1995) and L' were assumed as 14.8 and 13.0 cm respectively. Fishing mortality (F) was estimated from F=Z-M. Exploitation rate (E) was computed as E=F/Z. All the means were given with standard error (±SE).

## Results

A total of 965 fish were sampled within the study period and females (58.7%) were more abundant than males (41.3%). The sex ratio (M:F) was found as 1:1.42 and this difference was not statistically significant according to the Chi-square test, so it can be said that sex ratio is 1:1 in the red mullet population.

The samples were grouped densely between 12 and 15 cm (Fig. 2). Females were abundant in majority of length groups. Mean lengths and weights for female, male and both sexes were calculated as 13.88±0.07 cm (9.5-21.0), 29.96±0.50 g (9.55-111.14); 13.53±0.07 cm (10.0-19.0), 25.21±0.43 g (9.00-66.22) and 13.74±0.05 cm (9.5-21.0), 28.00±0.35 g (9.00-111.14), respectively (Table 1).

Length-weight relationship was derived as $W=0.0071*L^{3.1542}$ for females, $W=0.0057*L^{3.2064}$ for males and $W=0.0059*L^{3.2166}$ for sexes pooled (Fig. 3). The slopes (b) of the LWR differed significantly between sexes ($p<0.05$).

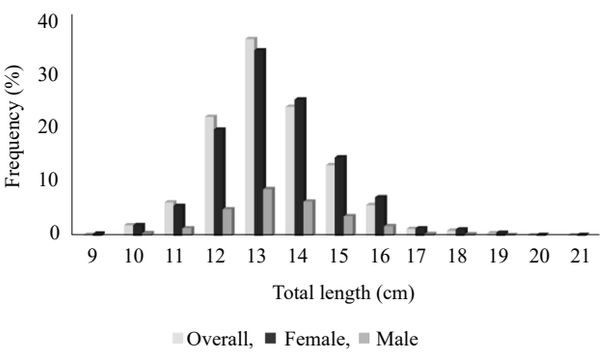


Fig. 2. Length-frequency distribution of red mullet

Table 1. Age, mean total length and weight of red mullet

| Age (Year) | Sex | N | Length (cm) | | Weight (g) | |
|---|---|---|---|---|---|---|
| | | | Mean±SE | Min-Max | Mean±SE | Min-Max |
| 1 | F | 34 | 11.45±0.16 | 9.5-12.8 | 15.66±0.62 | 9.55-21.86 |
| | M | 45 | 11.62±0.11 | 10.0-13.0 | 14.92±0.43 | 9.00-19.89 |
| 2 | F | 203 | 13.05±0.06 | 10.5-15.0 | 23.09±0.30 | 12.01-31.85 |
| | M | 200 | 13.12±0.05 | 11.0-14.5 | 21.68±0.25 | 11.8-30.92 |
| 3 | F | 237 | 14.04±0.06 | 12.0-17.0 | 30.55±0.37 | 17.72-48.95 |
| | M | 123 | 14.26±0.08 | 12.4-16.5 | 29.88±0.47 | 18.58-43.45 |
| 4 | F | 92 | 16.18±0.14 | 14.5-21.0 | 48.90±1.42 | 35.15-111.14 |
| | M | 31 | 16.11±0.21 | 14.6-19.0 | 44.41±1.62 | 34.17-66.22 |
| Total | F | 566 | 13.88±0.07 | 9.5-21.0 | 29.96±0.50 | 9.55-111.14 |
| | M | 399 | 13.53±0.07 | 10.0-19.0 | 25.21±0.43 | 9.00-66.22 |
| | F+M | 965 | 13.74±0.05 | 9.5-21.0 | 28.00±0.35 | 9.00-111.14 |

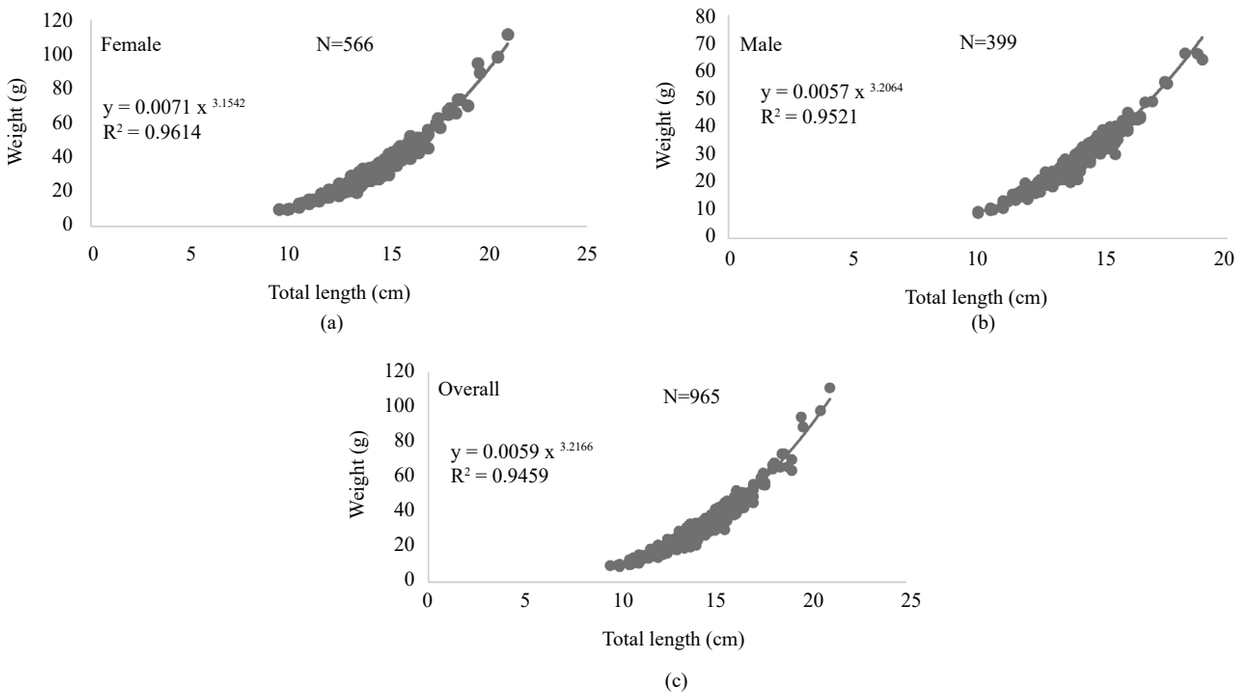


Fig. 3. Length-weight relationships of *M. barbatus ponticus* population

The value of b for males, females and sexes combined were significantly different from 3 ($p<0.05$) and were >3, indicating positive allometric growth in red mullet.

Age groups of red mullet samples varied between 1 and 4 and 79.07% were 2 and 3 years old (Table 2). Females were dominant in age group 3 (24.6%), followed by the age groups 2 (21.0%), 4 (9.5%) and 1 (3.5%). Males were abundant in age 2 (20.7%), followed by the ages 3 (12.7%), 1 (4.7%) and 4 (3.2%) (Table 1). Mean lengths (cm) of ages 1, 2, 3 and 4 were 11.55±0.092, 13.09±0.040, 14.11±0.048 and 16.16±0.114, respectively. Differences between the mean lengths of male and female red mullets were found statistically non-significant ($p>0.05$) for the same ages.

Table 2. Age-length key of *M. barbatus ponticus*

| Total length (cm) | Age groups | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Total |
| 9 | 2 | | | | 2 |
| 10 | 14 | 3 | | | 17 |
| 11 | 30 | 23 | | | 53 |
| 12 | 31 | 128 | 30 | | 189 |
| 13 | 2 | 181 | 130 | | 313 |
| 14 | | 66 | 127 | 12 | 205 |
| 15 | | 2 | 59 | 51 | 112 |
| 16 | | | 13 | 36 | 49 |
| 17 | | | 1 | 10 | 11 |
| 18 | | | | 8 | 8 |
| 19 | | | | 4 | 4 |
| 20 | | | | 1 | 1 |
| 21 | | | | 1 | 1 |
| Total | 79 | 403 | 360 | 123 | 965 |

The von Bertalanffy growth equation was derived as $Lt=36[1-e^{-0.0741(t+3.9775)}]$. Growth performance index was calculated as $\Phi'=1.98$. The age-length and age-weight relationships of *M. barbatus ponticus* are shown in Fig. 4. The relationships between length-at-age data (observed mean lengths) and von Bertalanffy growth curves (expected mean lengths) are given in Table 3. Observed and expected values were not significantly different from each other for overall samples ($p>0.05$).

Mean values of Fulton's condition factor (K) at different age groups for *M. barbatus ponticus* are shown in Table 4. Mean values of the condition factors were 1.07±0.003 for female, 0.98±0.004 for male and 1.03±0.003 for both sexes. Differences between K values of red mullet for female, male and overall were found statistically non-significant ($p>0.05$).

Table 3. Observed and calculated mean lengths of *M. barbatus ponticus*

| Age | N | Observed length (cm) | Calculated length (cm) |
|---|---|---|---|
| 1 | 79 | 11.6 | 11.1 |
| 2 | 403 | 13.1 | 12.9 |
| 3 | 360 | 14.1 | 14.5 |
| 4 | 123 | 16.2 | 16.1 |

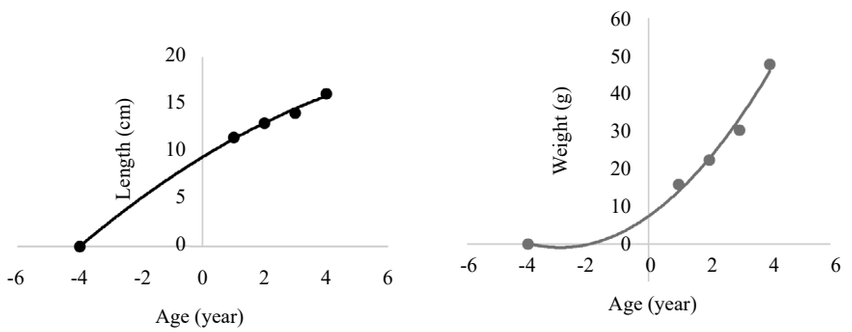


Fig. 4. von Bertalanffy age-length and age-weight growth curves of *M. barbatus ponticus* population

Table 4. Age composition and Fulton's condition factor in different ages for red mullet

| | | Age (Years) | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| N | | 79 | 403 | 360 | 123 |
| Age (%) | | 8.19 | 41.76 | 37.31 | 12.75 |
| K | F | 1.03 | 1.03 | 1.09 | 1.13 |
| | M | 0.94 | 0.95 | 1.02 | 1.05 |
| | Overall | 0.98 | 0.99 | 1.07 | 1.11 |

Mortalities (M, F and Z) and exploitation rate (E) of red mullet were 0.238 year$^{-1}$, 0.640 year$^{-1}$, 0.878 year$^{-1}$ and 0.729, respectively.

## Discussion

Sex ratio in fish varies considerably from species to species but in the majority of species it is close to 1:1. It differs from one population to another of the same species and may vary from year to year in the same population (Nikolsky, 1963). In the present study, sex ratio was 1:1.42. The sex ratio of red mullet was reported as 1:1.5 by Turker and Bal (2018); 1.08:1 by Yıldız and Karakulak (2016); 1:0.85 by Erdem (2018) and 1:0.81 by Talet *et al.* (2016) for some populations of the same species.

Average total length and weight was determined as 13.74±0.05 cm and 28.00±0.35 g. The maximum recorded total length was 21 cm in the present study. The maximum length was reported as 21.9 cm by Ak *et al.* (2009) and 21.5 cm by Aydın and Karadurmus (2013) for red mullet from Black Sea (Table 5). The LWR estimated in the present study indicated positive allometric growth, which is in agreement with earlier observations (Table 5) which reported 'b' values between 2.9717 and 3.21.

The red mullet is a moderately short-lived demersal fish and catches consist predominately of younger ages (Yıldız and Karakulak, 2016). The age composition of red mullets in the present study ranged from 1 to 4 and 2 and 3 ages accounted for the majority of the population. Aydın and Karadurmus (2013) reported similar results that age groups of 2 and 3 accounted for majority of the red mullet population in the Eastern Black Sea. The oldest indivudual in this study was 4 years whereas in previous studies the age of the oldest fish was reported as 9 years by Genc (2000) and 7 years by Aydın and Karadurmus (2013) in the Eastern Black Sea.

The $L_\infty$ value obtained in our study was considerably higher than the values reported in previous studies (Table 6). On the contrary, the k value (0.0741 year$^{-1}$) was found to be very low. The k values between 0.05 year$^{-1}$ and 0.15 year$^{-1}$ indicate slow growth of fish population (Froese and Pauly, 2009). These comparisons show that the red mullet population in the south-eastern Black Sea exhibits slower growth compared to populations of the same species in many other habitats. The growth performance index (Φ') in earlier reports ranged between 1.99 and 4.50 (Table 6). The Φ' value (1.98) estimated in the present study conforms to these observations.

Natural mortality is related to all possible causes of death, except fishing. A species can present different rates of natural mortality in different areas depending on the density of predators and/or competitors whose abundance may also be influenced by fishing activities (Sparre and Venema, 1998). The mortality rate (M) in this study is lower than that reported in previous studies (Table 7). However, the fishing mortality and exploitation rate were higher, indicating that the red mullet population in the south-eastern Black Sea is likely overexploited.

These results of the present study indicate that the red mullet is exposed to high fishing pressure in the south-eastern Black Sea. Due to its high commercial value, management plans to sustain the stock of *M. barbatus ponticus* in the region are needed. Further studies involving stock assessment and continuous monitoring of the fishing pressure are recommended.

Table 5. LWR records of *M. barbatus ponticus* in the South-eastern Black Sea

| Authors | N | $L_{min-max}$ | $W_{min-max}$ | a | b | $r^2$ | Growth |
|---|---|---|---|---|---|---|---|
| Ak *et al.* (2009) | 714 | 6.1-21.9 | 2.08-161.14 | 0.007 | 3.139 | 0.990 | - |
| Aksu *et al.* (2011) | 699 | 7.3-18.7 | 17.91±0.51 | 0.0107 | 2.9717 | 0.99 | - |
| Aydın and Karadurmuş (2013) | 1435 | 6.4-21.5 | 2.09-105.40 | 0.0088 | 3.0338 | 0.97 | - |
| Kasapoglu and Duzgunes (2014) | 2693 | 5.3-19.0 | 1.20-73.40 | 0.0074 | 3.123 | 0.962 | - |
| Yıldız and Karakulak (2016) | 4928 | 6.3-18.9 | 3.62-62.42 | 0.0109 | 2.9886 | 0.94 | Isometric |
| Samsun (2017) | 1301 | 8.2-20.2 | 5.6-86.5 | 0.008 | 3.1076 | 0.9591 | Positive allometric |
| Samsun *et al.* (2017) | 1602 | 8.2-19.8 | 5.6-86.5 | 0.007 | 3.15 | 0.95 | Isometric |
| Erdem (2018) | 229 | 8.7-14.4 | 6.4-29.4 | 0.0102 | 2.9903 | 0.979 | - |
| Turker and Bal (2018) | 1021 | 6.9-14.5 | 2.60-31.36 | 0.0059 | 3.21 | 0.93 | Positive allometric |
| Present study | 965 | 9.5-21.0 | 9.00-111.14 | 0.0059 | 3.2166 | 0.95 | Positive allometric |

Table 6. von Bertalanffy growth parameters and growth performance index values (Φ') of red mullet from different studies

| Reference | $L_\infty$ | k | $t_0$ | Φ' | Study period |
|---|---|---|---|---|---|
| Samsun and Ozdamar (1995) | 29.49 | 0.104 | -3.222 | 4.50 | 1994-1995 |
| Celik and Torcu (2000) | 26.08 | 0.127 | -3.5354 | - | 1996-1997 |
| Genc *et al.* (2002) | 24.22 | 0.218 | -1.710 | 2.10 | 2000 |
| Ozbilgin *et al.* (2004) | 24.26 | 0.565 | -0.305 | 2.52 | 2002 |
| Aydın and Karadurmuş (2013) | 27.40 | 0.140 | -2.351 | 2.02 | 2010-2011 |
| Yıldız and Karakulak (2016) | 24.10 | 0.171 | -1.981 | 1.99 | 2012-2014 |
| Samsun (2017) | 19.21 | 0.68 | -0.13 | - | 2016-2017 |
| Present study | 36.00 | 0.0741 | -3.9775 | 1.98 | 2017-2018 |

Table 7. The natural, fishing, total mortality and exploitation rates of red mullet derived from different studies

| Authors | Natural mortality M ($year^{-1}$) | Fishing mortality F ($year^{-1}$) | Total mortality Z ($year^{-1}$) | Exploitation rate E ($year^{-1}$) |
|---|---|---|---|---|
| Genç *et al.* (2002) | 0.37 | 1.93 | 2.30 | 0.84 |
| Aksu *et al.* (2011) | 0.68 | 0.60 | 1.28 | 0.47 |
| Yıldız and Karakulak (2016) | 0.45 | 0.86 | 1.32 | 0.65 |
| Talet *et al.* (2016) | 0.794 | 0.786 | 1.580 | 0.49 |
| Samsun (2017) | 0.335 | 0.398 | 0.733 | 0.54 |
| Present study | 0.238 | 0.640 | 0.878 | 0.729 |

## References


Ak, O., Kutlu, S. and Aydın, I. 2009. Length-weight relationship for 16 fish species from the eastern Black Sea, Turkey. *Turk. J. Fish. Aquat. Sci.,* 9: 125-126.

Aksu, H., Erdem, Y., Ozdemir, S. and Erdem, E. 2011. Estimation of some population parameters of red mullet (*Mullus barbatus ponticus*, Essipov, 1927) caught in the Black Sea. *Journal of Fisheries Sciences.com*, 5(4): 345-353. DOI: 10.3153/jfscom.2011039.

Aydın, M. and Karadurmus, U. 2013. An investigation on age, growth and biological characteristics of red mullet (*Mullus barbatus ponticus*, Essipov, 1927) in the Eastern Black Sea. *Iran. J. Fish. Sci.,* 12(2): 277-288.

Beverton, R. J. H. and Holt, S. J. 1957. On the dynamics of exploited fish populations. *Fisheries Investigations, 19*, UK Ministry of Agriculture and Fisheries, 533 pp.

Castro, M. and Lawing, W. 1995. A study of sampling strategies for estimating growth parameters in fish populations. *Fish. Res.,* 22: 59-75. https://doi.org/10.1016/0165-7836(94) 00309-K.

Celik, O. and Torcu, H. 2000. Investigations on the biology of red mullet (*Mullus barbatus* Linnaeus, 1758) in Edremit Bay, Aegean Sea, Turkey. *Turk. J. Vet. Anim. Sci.,* 24: 287-295.

Erdem, Y. 2018. Estimation of size at first maturity of Black Sea red mullet (*Mullus barbatus ponticus*). *Journal of Advances in VetBio Science and Techniques*, 3(2): 30-37.

Erkoyuncu, I. 1995. *Fisheries biology and population dynamics*, Ondokuz Mayıs University Publication No. 95, 265 pp (in Turkish).

Fischer, W., Schneider, M. and Bauchot, M. L. 1987. *FAO species identification sheets for fishing purposes. Mediterranean and Black Sea. Fishing Zone 37. Volume II: Vertebrates.* Food and Agrıculture Organısatıon of the United Nations, Rome, Italy, 769 pp.

Froese, R. and Pauly, D. 2009. *FishBase*. World Wide Web electronic publication. www.fishbase.org, version (10/2009).

Genc, Y. 2000. *Bio-ecological and population parameters for red mullet (Mullus barbatus ponticus, Ess. 1927) in the Eastern Black Sea Coastal*. Ph. D Thesis. Black Sea Technical University, Department of Fisheries Technology Engineering, Trabzon.

Genc, Y. 2002. Reproduction of five ımportant demersal fishes in the Eastern Black Sea. *CFRI Yunus Research Bulletin*, 2(4): 9-10.

Genc, Y., Mutlu C., Zengin, M., Aydin, I., Zengin, B. and Tabak, I. 2002. *Determination of the effect of catch effort on demersal fish stocks in the Eastern Black Sea*. *TAGEM Final Report.* Agricultural and Rural Affairs, Turkey, 122 pp (in Turkish).

Kalaycı, F. and Cicek, T. 2012. Investigation of the selectivity of trammel nets used in red mullet (*Mullus barbatus*) fishery in the Eastern Black Sea, Turkey. *Turk. J. Fish. Aquat. Sci.,* 12: 937-945. DOI: 10.4194/1303-2712-v12_4_21.

Kasapoglu, N. and Duzgunes, E. 2014. Length-weight relationships of marine species caught by five gears from the Black Sea. *Mediterranean Marine Science*, 15/1: 95-100. DOI:http://dx.doi.org/10.12681/mms.463.

King, M. 1995. *Fisheries biology*. Assesment and Management. Osney Mead, Oxford, England, 400 pp.

Metin, G. 2005. Reproduction characteristics of red mullet (*Mullus barbatus* L., 1758) in Izmir Bay. *Ege Journal of Fisheries and Aquatic Sciences*, 22(1-2): 225-228.

Munro, J. L. and Pauly, D. 1983. A simple method for comparing the growth of fishes and invertebrates. *Fishbyte*, 1(1): 5-6.

Nikolsky, G. 1963. *The ecology of fishes*. Academic press. London, 352 pp.

Pauly, D. 1980. A selection of simple methods for the assessment of tropical fish stocks. *FAO Fisheries Circular No. 729.* Food and Agrıculture Organısatıon of the United Nations, Rome, Italy, 54 pp.

Pauly, D. and Soriano, M. L. 1986. Some practical extensions to Beverton and Holt's relative yield-perrecruit model, In: Maclean, J. L., Dizon, L. B., Hosillo, L. V. (Eds.). *Proceedings of the First Asian Fisheries Forum,* 26-31 May 1986. Asian Fisheries Society, Manila, Philippines, p. 491-496.

Polat, N., Bostancı, D. and Yılmaz, S. 2005. Differences between whole otolith and broken-burnt otolith ages of red mullet (*Mullus barbatus ponticus* Essipov, 1927) Sampled from the Black Sea (Samsun, Turkey). *Turk. J. Vet. Anim. Sci.,* 29: 429-433.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish population. *Bull. Fish. Res. Canada*, 191: 1-382.

Samsun, O. and Ozdamar, E. 1995. Estimation of some population parameters for *Mullus barbatus ponticus* Es., 1927 at 1994-1995 fisheries season in the Samsun Bay Ondokuz Mayıs University, *Science Faculty, Sciences Journal*, 5(1): 90:96.

Samsun, O. 2017. Length-weight relationship and mortalities of *Mullus barbatus ponticus* Essipov, 1927 in the Central Black Sea, Turkey. *Turkish Journal of Maritime and Marine Sciences*, 3(2): 75-80.

Samsun, O., Akyol, O., Ceyhan, T. and Erdem, Y. 2017. Length-weight relationships for 11 fish species from the Central Black Sea, Turkey. *Ege Journal of Fisheries and Aquatic Sciences*, 34(4): 455-458. DOI: 10.12714/egejfas. 2017.34.4.13.

Saygun, S., Karayücel, I. and Bircan, R. 2006. Karyological observation of red mullet (*Mullus barbatus* Linnaeus, 1758). *Turk. J. Biol.,* 30: 235-238.

Sparre, P. and Venema, S. C. 1992. *Introduction to tropical fish stock assessments, Part 1: Manual.*, *FAO Fisheries Technical Paper No. 306(1)*. Food and Agrıculture Organısatıon of the United Nations, Rome, Italy, 376 pp.

Sparre, P. and Venema, S. C. 1998. *Introduction to tropical fish stock assessments, Part 1: Manual*. *FAO Fisheries Technical Paper No. 306 (1)*. Food and Agrıculture Organısatıon of the United Nations, Rome, Italy, 407 pp.

Sahin, T. and Akbulut, B. 1997. Some biological characteristics of *Mullus barbatus poncticus* Essipov, 1927 in the Eastern Black Sea coast of Turkey. *Turk. J. Zool.,* 21(2): 179-185.

Talet, L. B., Talet, A. B. and Boutiba, Z. 2016. Population dynamic parameters of the red mullet *Mullus barbatus* (Mullidae) in the Arzew Gulf, Algeria. *Int. J. Aquat. Biol.,* 4(1):1-10. DOI:http://dx.doi.org/10.7508/ijab.2016.01.001.

Turker, D. and Bal, H. 2018. Length-weight relationship and condition factor of red mullet (*Mullus barbatus barbatus* Linnaeus, 1758) from the Western Black Sea, Turkey. *Natural and Engineering Sciences*, 3(2): 120-127. DOI:10.28978/nesciences.424653.

TUIK 2018. *Fishery Statistics 2018*. www.tarimorman.gov.tr.

Yıldız, T. and Karakulak, F. S. 2016. An investigation of age, growth and mortality of the red mullet *Mullus barbatus* Linnaeus, 1758 in the western Black Sea. *Cahiers de Biologie Marine,* 57: 415-425. DOI: 10.21411/CBM.A.6F F6FFB7 (In French).

Yıldız, T., Zengin, M., Uzer, U., Akpınar, I. O. and Karakulak, S. 2018. Length-weight relationships for 24 fish species collected from the western Black Sea (Turkey). *Marine Biology Notebooks,* 59: 159-165 (In French).

Zar, J. H. 1999. *Biostatistical analysis*. Prentice Hall, Upper Saddle River, New Jersey, USA, 267 pp.

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