ARAŞTIRMA MAKALESİ/**RESEARCH ARTICLE**

INVESTIGATIONS OF THE GROWTH AND REPRODUCTION OF RED MULLET (*Mullus barbatus* Linnaeus, 1758) POPULATION IN THE BAY OF IZMIR (AEGEAN SEA)

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ABSTRACT

Red mullet (*Mullus barbatus* L.) is one of Turkey's fisheries foremost economical demersal fish species. It has been determined that age of red mullet caught in Izmir Bay ranged from I to IV and the mean fork length values for these age groups were 11.25 cm, 13.44 cm, 15.51 cm and 17.53 cm, respectively. The length - weight relationship calculated for female + male was $W = 0.0063.L^{3.3625}$. The Von Bertalanffy growth parameters were found as $L\infty = 27$ cm, $K = 0.183$, $t_0 = -1.506$ in the total individuals. The highest condition factor was found in the February as 1.807 for all individuals. The reproduction begins in June according to gonadosomatic index values. The first maturity length and age were 12.9 cm (FL) and 1, respectively. The first capture length (Lc) for trawl and beach seine nets were 11.51 cm and 13.43 cm, respectively.

Keywords: Mullus barbatus, growth, condition factor, GSI, first maturity, selectivity, Izmir Bay.

İZMİR KÖRFEZİ (EGE DENİZİ)'NDE BARBUNYA (*Mullus Barbatus* Linnaeus, 1758) POPULASYONUNUN BÜYÜME VE ÜREME ÖZELLİKLERİNİN ARAŞTIRILMASI

ÖZ

Türkiye balıkçılığının en ekonomik demersal balık türlerinden biri olan barbunya (*Mullus barbatus* L.)'nın İzmir Körfezi'nden elde edilen bireylerinin I-IV yaş grubu arasında dağılım gösterdiği, yaşa bağlı çatal boy değerleri ise sırasıyla, 11.25 cm, 13.44 cm, 15.51 cm and 17.53 cm olarak bulunmuştur. Dişi + erkek bireyler için bireyler için hesaplanan boy-ağırlık ilişkisi; $W = 0.0063.L^{3.3625}$ şeklindedir. Von Bertalanffy büyüme parametreleri toplam bireylerde $L\infty = 27$ cm, $K = 0.183$, $t_0 = -1.506$ olarak bulunmuştur. Yine toplam bireylerde kondisyon faktörü (K) 1.807 ile en yüksek Şubat ayında tespit edilmiştir. Gonadosomatik indeks (GSI) değerlerine göre üreme Haziran ayında meydana gelmektedir. İlk üreme boyu 12.9 cm (FL), ilk üreme yaşı 1'dir. Trol ve trata av takımları için optimum yakalama boyu (Lc) sırasıyla 11.51 cm, 13.43 cm total boydur.

Anahtar Kelimeler: Mullus barbatus, büyüme, kondisyon faktörü, GSI, ilk cinsi olgunluk, İzmir Körfezi.

1. INTRODUCTION

Red mullet (Mullus barbatus L., 1758) is one of Turkey's fisheries ·foremost economical demersal fish species and it has been caught all the seas where surrounded of Turkey. The highest catching of red mullet comes from the Aegean Sea among these seas (Anon., 1997). The intensive demersal fishing was done on the species in and around Izmir Bay where the Aegean Sea is one of the most productive areas. In Izmir Bay has been investigated to give some help to previous studies which were made on this species in the region and it was carried out some parameters such as growth, the period of reproduction, the composition of age-sex, the state of condition, the first maturity length and gear selectivity (Geldiay, 1969; Toğulga, 1976; Toğulga and Mater, 1992; Tokaç and Gurbet, 1992; DEÜ-DBTE, 1993; Kınacıgil, 1994).

2. METERIAL AND METHODS

The study material is the species of Mullus barbatus L., 1758 from family of Mullidae. The research vessels "Egesüf" and "Hippocampus" belong to Fisheries Faculty of Ege University were used in the sample surveys during May 1996 to April 1997. In this research, 4990 samples for trawl selectivity, 1196 samples for beach seine net selectivity. Sagittal otoliths were collected from 346 samples and kept dry in envelopes. Fish ages were determined by otoliths using a stereoscopic microscope. In this study, conventional bottom trawl net and beach seine net which have cod-ends in 22 and 18 mm (bar length) mesh size, respectively were used in the sampling area (Figure 1). Covered cod-end (10.5 mm) used for beach seine net while hooped covered cod-end (10.5 mm) technique was using in the experiments of gear selection. For this aim, the frequency of fish, which were retained and escaped in the cod-end, has been classified in the interval of 0.5 cm total length groups. The first capture length (%50) for each species in the experimented cod-end was calculated from formula (Lc)l_{50} = -a/b. The selection curves have been drawn using logistic symmetrical curve. The mathematical statement of this curve is $r[(L) = (\exp(a+b.L)/1+\exp(a+b.L)]$. Where r(L) is retention probability for each length group; L is length group; a and b are estimated parameters obtained by regression analysis (Wileman *et al.*, 1996). ·

The length measurements of samples were carried out using a ruler, which has milimetric scale as total length (TL) for selectivity and fork length (FL) for biometric measurements. An electronic scale in 0.1 g sensitive also carried out the weight measurements. Sex of fish was estimated by gonad examination. In the determination of monthly gonadosomatic index, the formula of GSI = (the weight of gonad*100/the body weight without gonad) (Alheit, 1987) and in the determination of condition factor, the formula of CF = W*100/L^3 have been used (Lagler, 1956). Where W is mean weight; L is mean fork length. The allometric growth formula W = c. L^n was used in the length-weight relationship (Le Cren, 1951).

The computer program Fisat (FAO-ICLARM Stock Assesment Tools) developed by Gayanilo *et al.*, (1994) was used in the determination of growth parameters for infinity length (L∞), the coefficient of growth (K) and the theoretical age (t_0) that the length and weight of fish are 0. The values that were found have been put in the Von Bertalanffy growth formula.

The length in equilibrium ratio 50% has beend determined as first maturity length using mean lengths of individuals which were found in the ripe stage (mature) according to macroscopic determination in the period that the reproduction is extremely concentrated in the determination of firs maturity length (Kohler,. 1960; Waiwood and Buzeta, 1989).

3. RESULTS

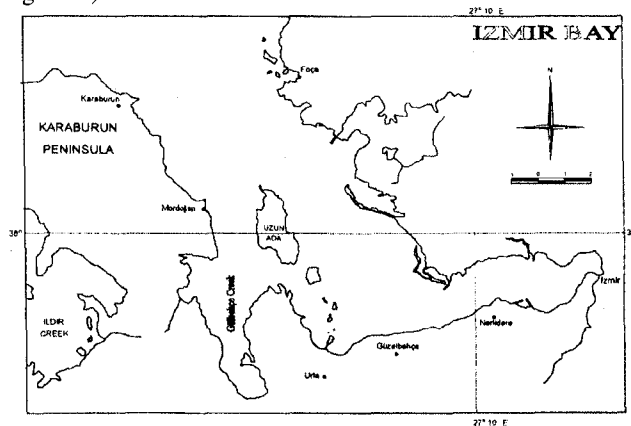It has been found that the measures of fork length for M. Barbatus are concentrated among 10-13 cm (Figure 2).
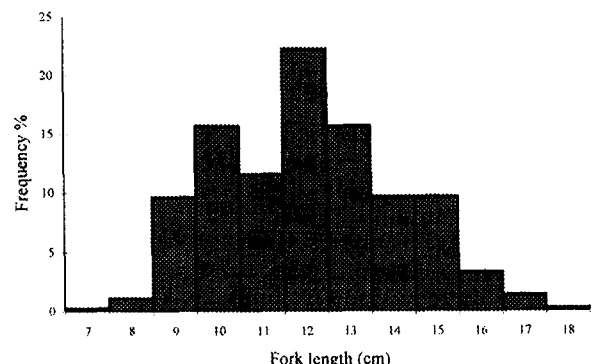

Figure 1. The sampling area.

Figure 2. The values of frequency percentage related to fork length of M. barbatus in Izmir Bay.

Table 1. Age-length key of *M. barbatus*.

Fork length (cm)	I	II	III	IV	Total	%	Cumalative	%
7	1				1	0,29	1	0,29
8	3				3	0,87	4	1,16
9	28				28	8,09	32	9,25
10	53				53	15,32	85	24,57
11	39	1			40	11,56	125	36,13
12	51	27			78	22,54	203	58,67
13	3	54			57	16,47	260	75,14
14		28	6		34	9,83	294	84,97
15		2	32		34	9,82	328	94,79
16			12		12	3,47	340	98,26
17				5	5	1,45	345	99,71
18				1	1	0,29	346	100
N	178	112	50	6	346	100		
X	11,25	13,44	15,51	17,53				
SD	1,02	0,69	0,54	0,47				

(Header spanning I, II, III, IV: AGE GROUPS)

Table 2c. The mean lengths, total weights and confidence intervals of *M. barbatus* samples which were female+male according to age groups.

| Age	N	Min. (cm)	Max. (cm)	x	SD	SE	%95 CI
I	161	8.6	13.1	11.25	1.02	0.08	11.25± 0.15
II	111	11.8	15.1	13.44	0.69	0.06	13.44 ± 0.13
III	50	14.4	16.9	15.51	0.54	0.07	15.51 ± 0.15
IV	6	17.1	18.3	17.53	0.47	0.19	17.53 ± 0.49
Age	N	Min. (g)	Max. (g)	x	SD	SE	%95 CI
I	161	9	40	22.38	7.03	0.55	22.38 ± 1.09
II	111	23	62	39.83	7.81	0.74	39.83 ± 1.46
III	50	46	83	64.12	7.98	1.12	64.12 ± 2.27
IV	6	77	21	99.16	16.76	6.84	99.16 ± 17.59

The value of fork length of *M. barbatus* for I, II, III and IV age groups are 11.25 cm, 13.44 cm, 15.51 cm and 17.53 cm, respectively. It has been determined that the age group of I is the dominant in the population (Table 1).

The intervals of mean fork length and total weight related to age groups of M. barbatus caught from Izmir Bay ranged from 8.6 to 18.3 cm in length and from 9 to 121 g in weight for female individuals (Table 2a).

The intervals of length and weight for male individuals ranged from 9.5-15 cm and 12-51 g, respectively (Table 2b).

It has been determined that the interval of length and weight in both male and female from 8.6 to 18.3 and 9 to 121 g, respectively (Table 2c).

It follows from the examination of age-sex composition and female:male ratio of M. barbatus samples which were caught from Izmir Bay that the females are dominant for all age groups in the population (Table 3; Figure 3).

The length-weight relationships of individuals of sample according to sex were derived from their

Table 2a.The mean fork lengths, total weights and confidence intervals related to age groups of M. barbatus samples which were female (N, number of samples; x, mean; SD, standard deviation; SE, standard error; CI, 95% probability confidence interval).

Age	N	Min. (cm)	Max. (cm)	x	SD	SE	%95 CI
I	85	8.6	13	11.33	1.01	0.1	11.33 ± 0.21
II	78	11.8	15.1	13.54	0.74	0.08	13.54 ± 0.16
III	49	14.4	16.9	15.52	0.54	0.07	15.52 ± 0.15
IV	6	17.1	18.3	17.53	0.47	0.19	17.53 ± 0.49
Age	N	Min. (g)	Max. (g)	x	SD	SE	%95 CI
I	85	9	36	22.71	6.76	0.73	22.71 ± 1.45
II	78	23	62	41.13	8.54	0.96	41.13 ± 1.92
III	49	46	83	64.38	7.84	1.12	64.38 ± 2.25
IV	6	77	121	99.16	16.76	6.84	99.16 ± 17.59

Table 2b. Mean fork lengths, total weights and confidence interval of *M. barbatus* samples which were male for each age group.

Age	N	Min. (cm)	Max. (cm)	x	SD	SE	%95 CI
I	76	9.5	13.1	11.16	1.03	0.11	11.16 ± 0.23
II	83	12	14.1	13.21	0.48	0.08	13.21 ± 0.17
IV	1	15	15	15			15.00 ± 0.00
Age	N	Min. (g)	Max. (g)	x	SD	SE	%95 CI
I	76	12	40	22.01	7.35	0.84	22.01 ± 1.68
II	33	30	46	36.76	4.47	0.77	36.76 ± 1.58
III	1	51	51	51			51.00 ± 0.00

Table 3. The age-sex composition of *M. barbatus* in Izmir Bay.

AGE	Male N	Male %	Female N	Female %	Undefined N	Undefined %	Total N	Total %	F : M ratio
I	76	69.09	85	38.99	17	94.44	178	51.45	1 : 0.89
II	33	30	78	35.78	1	5.56	112	32.37	1 : 0.42
III	1	0.91	49	22.48	-	-	50	14.45	1 : 0.02
IV	-	-	6	2.75	-	-	6	1.73	1 : 0.00
Total	110	31,79	218	63,01	18	5.2	346	100	1 : 0.50
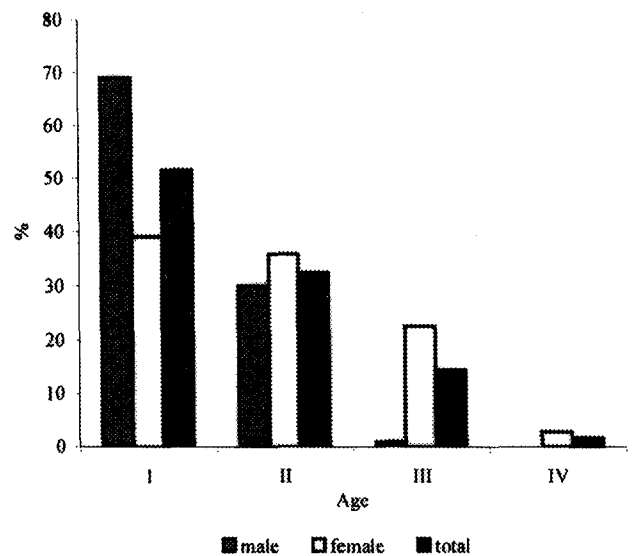
Figure 3. The age-sex percent composition of M. barbatus in Izmir Bay.

growth curves. The small points in the figure 4 are the lengths-weight measures of individuals taken from population for sample. The values found according to sex and total are given below;

For female :$W = 0.0059.L^{3.3916}$; $r = 0.989$,

For male :$W = 0.0077.L^{3.2834}$; $r = 0.975$,
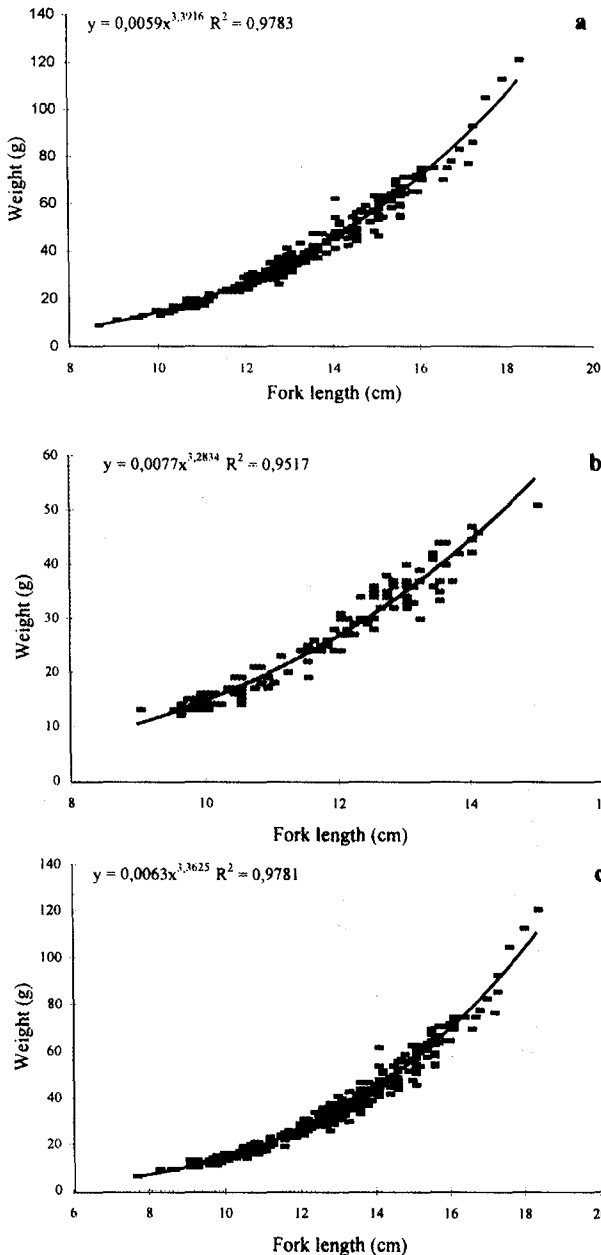
For famale+male :$W = 0.0063.L^{3.3625}$; $r = 0.988$,

The growth parameters of M. barbatus caught from Izmir Bay were put into Von Bertalanffy growth equation and the formula obtained have been calculated one by one according to age groups connected with their sex (Table 4a, Table 4b).

Figure 4. The length-weight relationship of M. barbatus in Izmir Bay (a:female, b:male, c:female+male).

Table 4a. The growth parameter in length of *M. barbatus* in Izmir Bay (VBGP: Von Bertalanffy Growth Parameters).

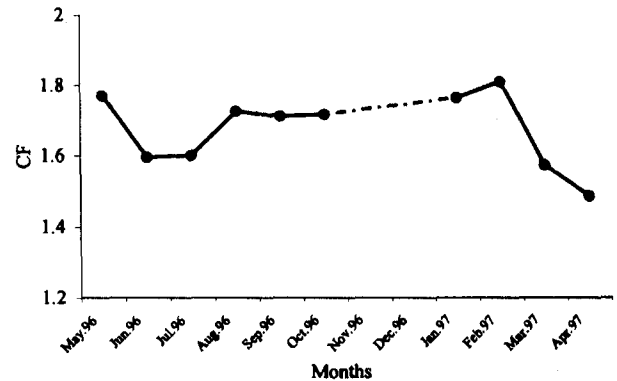| Sex	VBGP			Formula
	$L\infty$	K	t_0	
♂	22.5	0.202	-2.299	$L_{(t)} = 22.5\left[1 - e^{-0.202(t+2.299)}\right]$
♀	27.0	0.172	-1.844	$L_{(t)} = 27.0\left[1 - e^{-0.172(t+1.844)}\right]$
♂ + ♀	27.0	0.183	-1.506	$L_{(t)} = 27.0\left[1 - e^{-0.183(t+1.506)}\right]$

Age	Measured Length (cm)			Calculated		
	♀	♂	♂+♀	♀	♂	♂+♀
I	11.33	11.16	11.25	10.53	11.03	9.99
II	13.54	13.21	13.44	12.96	13.05	12.69
III	15.52	15.00	15.51	15.39	14.85	15.12
IV	17.53		17.53	17.01		17.01

Table 4b. The mean fork length values of *M. barbatus* and the calculated values according to Von Bertalanffy.

Figure 5. The monthly CF values' changes of M. barbatus in Izmir Bay.

The condition factors of red mullets that were caught from Izmir bay have been determined as monthly and the highest value has been found in February with 1.807 (Figure 5).

The sex and maturity of red mullet individuals were examined as macroscopic and the values of gonadosomatic index were shown as monthly in Figure 6. According to this evaluation, 3.502 found the highest values in June.

The logarithmic values of individuals which were achieved sexual maturity caught during reproduction period of red mullet in Izmir Bay have been analyzed of regression and the value which in equivalent 50% has been determined as first capture lenght (Lc) (Figure 7).
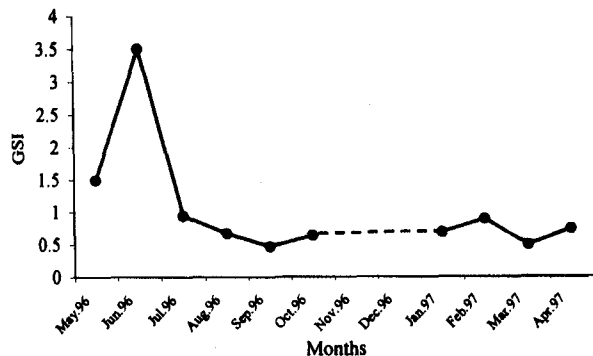
Figure 6. The monthly GSI values' changes of *M. barbatus* in Izmir Bay.
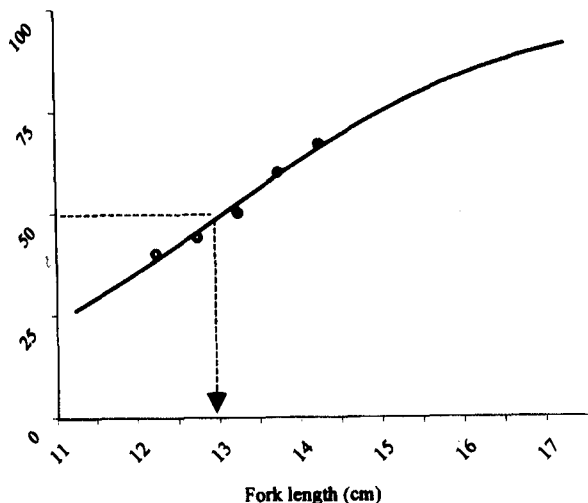

Figure 7. The first capture lenght of *M. barbatus* in Izmir Bay.

Table 5. The selection length and factors of *M. barbatus* according to fishing gear in Izmir Bay.

	a	b	r	l_{25}
Bottom trawl net	-8.333	0.723	0.994	9.99
Beach seine net	-7.156	0.532	0.998	11.36
	l_{50}	l_{75}	SR	SF
Bottom trawl net	11.51	13.03	3.03	2.61
Beach seine net	13.43	15.49	4.12	3.73

When the selection parameters obtained from trawl and beach seine net cod-ends which have 22 mm and 18 mm (bar length) diamond mesh size, respectively examined, the first capture lengths have been found as 11.51 cm for trawl cod-end and 13.43 cm for beach seine net cod-end (Table 5; Figure 8).
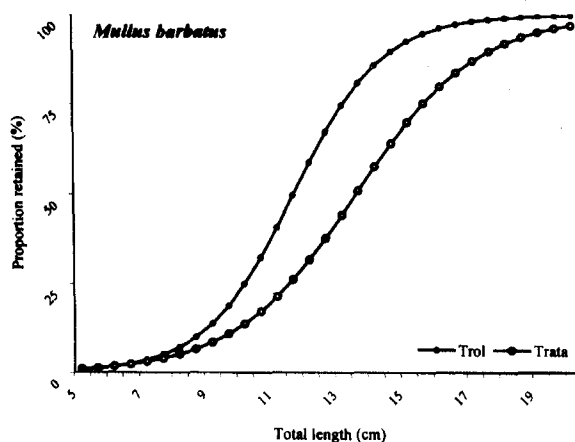

Figure 8. The selection curves of *M. barbatus* according to fishing gear in Izmir Bay.

4. DISCUSSION

The ages of red mullet (Mullus barbatus) caught from Izmir Bay ranged from I-IV and it is seen that the individual in the I age (51.4%) is the dominant group in the population. Toğulga(1976) and Toğulga and Mater (1992) reported that II age and I are the dominant groups among 0-VI age groups in Izmir Bay. Tokaç and Gurbet (1992) found that I age (63.1%) are the dominant group among I-III age groups in Izmir bay. Kınacıgil (1994) obtained similar results in Gülbahçe Bay, as did Tokaç and Gurbet (1992). DUE-DBTE (1993) reported in their seasonal fisheries studies which were carried out in the Aegean sea thet the age group I-II and II-III are the dominant groups for red mullet in spring and in autumn periods, respectively. Türeli and Erdem (1997) says that the age group II (40.8%) is the dominant group among the age group 0-V for red mullet in the coast of Adana. Papaconstantinou *et. al.* (1981) reported that the age group II-III among the age groups 0-VII in Thermaikos Bay and the age group II-III among the age groups 0-XI in Seronikos Bay are the dominant in Greek waters of the Aegean Sea. Vassilopoulou and Papaconstantinou (1992) says that the age groups I-II are the dominant among 0-VIII age groups in the Northern Aegean Sea. It is no doubt that the age was taken into consideration as a function of the growth, the great majority of the fish population in the Aegean Sea and Izmir Bay are from the small fish.

There is some similarity between the results obtained in this study and previous results that were reported by various scientists (Toğulga, 1976; Toğulga and Mater, 1992; Tokaç and Gurbet, 1992; Kınacıgil, 1994) on the values of fork lengths and total weights for red mullet individuals in the different age groups of the population. The state of this indicates that bio-ecological characteristics of Izmir Bay were not much change for years.

When considering the relationship of length-weight for red mullet caught from Izmir Bay. The value of n has been found as 3.3625 allometric. In Izmir bay again, Toğulga (1976), Toğulga and Mater (1992), Tokaç and Gurbet (1992), Kınacıgil (1994) have found this value as 2.9231, 3.376, 3.2459, 3.0109, respectively. DEÜ-DBTE (1993) has reported the value of n as 3.038 and 2.984 in the period of spring and autumn, respectively in their fisheries studies carried out in the Middle Aegean Sea and Izmir Bay. Türeli and Erdem (1997) have also found the value of n as 3.0262 in the coastal of Adana. Papaconstantinou et al. (1981) has reported the monthly values of n as between 2.8142 and 3.332; 2.4814 and 3.4663, respectively in Seronikos Bay and Thermaikos Bay which were located in the Greek Waters of the Aegean sea. Petrakis and Stergio (1995) have found the value of n as 3.0262 in the coastal of Adana. Papaconstantinou at al. (1981) has reported the monthly values of n as between 2.8142 and 3.3332; 2.4814 and 3.4663, respectively in Seronikos Bay and Thermaikos Bay which were located en the Greek Water of the Aegean Sea. Petrakis and Stergio(1995) have found the value of n as 3.085 in the South Euboikos Bay in the Greek Waters while this value was determined as 3.179 for the Aegean Sea by Vassilopoulou and Papaconstantinou (1992). Considering our and other study results, an allometric growth can be mentioned for red mullet in the Aegean Sea.

The growth parameters of red mullet have been determined as $L\infty=27$ cm, $K=0.183$, $t_0 = -1.506$. Toğulga and Mater (1992) have determined these parameters as $L\infty=26.47$ cm, $K=0.1613$ and $t_0 =-2.7016$ these values indicate similarity with our findings. Kınacıgil (1994) found $L\infty=22.41$ cm, $K = 0.089$, $t_0 = -8.124$. Türeli and Erdem (1997) have reported these parameters as $L\infty = 19.1$ cm, $K = 0.175$ and $t_0 = -3.922$ around coastal waters of Adana. Papaconstantinou et al. (1981) have reported the values of parameters in question as $L\infty = 24.4$ cm, $K = 0.135$, $t_0 = -2.9409$ for female, $L\infty = 19.23$ cm, $K = 0.191$, $t_0 =-2.8114$ for male in Seronikos Bay; $L\infty = 27.54$ cm, $K = 0.093$, $t_0= -4.3015$ for female, $L \infty = 20.91$ cm, $K= 0.137$, $t_0 =-4.2505$ for male in Thermaikos Bay. Vassilopoulou and Papaconstantinou (1992) have reported these values as $L \infty = 25.49$ cm, $K = 0.2135$, $t_0 = -2.1335$ for female, $L \infty = 22.71$ cm, $K = 0.2501$, $t_0 = -1.8535$ for male in the Aegean Sea while Vrantzas et al. (1992) reported these values as $L \infty = 23.5$ cm, $K = 0.51$, $t_0 = -0.86$ in Seranikos Bay. The slight differences for different populations of the Aegean Sea have accepted as normally from the point of growth.

The condition factor of red mullet has been examined monthly and the highest value was found as 1.807

in February. Toğulga (1976) was found this value as 1.475 in Izmir Bay and she has said that there is a good nourishment for red mullet in Gülbahçe Bay. Again, Toğulga and Mater (1992) have found this value as 1.418 in the period of spring for Izmir Bay and this value was maximally,. Türeli and Erdem (1997) have determined the condition factor for red mullet in the coastal waters of Adana as 1.791. Therefore, the best nourishment for red mullet in Izmir Bay carried out in the period of winter-spring when the reproduction was not.

It has been decided that when the monthly GSI values for red mullet have been examined, the reproduction carries out in June. Toğulga (1976) and DEU-DBTE (1993) have reported that the reproduction period of red mullet carried out in April-August in the Aegean Sea and this result indicates a similarity with the other study result which was done in the Mediterranean by Whitehead et al. (1986). Fork length value of 12.9 cm, which was determined as first maturity length of red mullet in this study, locates in the age group I in the key of age-length.

The l_{50} values of traditional trawl net and beach seine net that were used in the sampling are 11.51 cm and 13.43 cm in total length, respectively. Hence, it can be say that the beach seine net provides more selectivety than trawl net. In spite of the fact that the trawl net has bigger mesh size than beach seine net, trawl net can not provide adequate ratio of selection because of made of polyethylene material and closing trawls cod-end mesh in a short time by over catching. When the first maturity length of 12.9 cm converted from fork length to total length according to length conversion table (Tosunoğlu, 1998), a length of 14.4 cm is obtained. For this reason, this length value is bigger than optimum selection length for both fishing gear. 13 cm the minimum landing size for red mullet reported in the fishery's regulations circular published by TKB-KKGM (1997) is small then the first maturity length determined in this study. For this reason, the trawl net cod-end of 22 mm and the beach seine net cod-end of 18 mm have been not found adequate ratio of selection according to mesh size.

REFERENCES

Alheit, J., (1987) Variation of batch fecundity of Sprat, *Sprattus sprattus* during the spawning season, *ICES CM*, H44, 7.

Anon, (1997) *Su Ürünleri İstatistikleri 1996*. TC Başbakanlık Devlet İstatistik Enstitüsü, Ankara, 32 s.

DUE-DBTE, (1993) *Ege Denizi Canlı Kaynaklarının Belirlenmesi ve Stoklarının Tespiti Projesi, 1993 yılı raporu*, TUBİTAK-YDEBÇAG 117/G.

Gayanilo, F.C., Sparre, P. and Pauly, D., (1994) *The FAO-ICLARM Stock Assesment Tools (FISAT), User Guide*. FAO Computerized Information Series No. 6, Rome, 186p.

Geldiay, R., (1969) *İzmir Körfezi'nin Başlıca Balıkları ve Muhteme İnvasionları*. E.Ü. Fen Fak. Monografiler Seri II, 135s.

Kınacıgil, H.T., (1994) Gülbahçe Körfezi'ndeki barbunya balığı (Mullus barbatus Lin.,1758) stoklarının yoğunluk dağılımı ve avlanabilirliği üzerine araştırmalar. *E.Ü. Fen Fak. Dergisi Seri B, ek 16/1*.

Kohler, AC, (1960) The growth, length-weigth relationship and maturity of haddock (Melanogrammus aeglefinos L.) from the region of Lockeport N.S., *J. Fish. Res.* BD. Canada, 17(1):41-60.

Lagler, K., (1956) *Freshwater Fishery Biology*. In:Ed. W. Brown Comp. Dubuque, Iowa, 421p.

Le Cren, E.D., (1951) The length-weight relationship and condition in the perch (Perca fluviatilis). *J. Anim. Ecol.*, 20:201-219.

Papaconstantinou, C., Tsiminides, N. and Daoulas, C.H., (1981) Age, growth and reproduction of red mullet (*Mullus barbatus* L., 1758) in the Gulf of Seronikos and Thermaikos. *Thallassographica* 1:4, 39-66.

Petrakis. G. and Stergio, K.I., (1995). Weight-lenght relationship for 33 species in Greek Waters. *Fisheries Research* 21:465-469.

TKB-KKGM., (1997) *Denizlerde ve İçsularda Ticari Amaçlı Su ürünleri Avcılığını düzenleyen 1997-1998 Dönemine aitk 31/1 Nolu sirküler*. TC. Tarım ve Köyişleri Bakanlığı- Koruma ve Kontrol Genel Mdlüğü, Ankara, 79s.

Toğulga, M., (1976) *İzmir Körfezi'nde barbunya balığının (Mullus barbatus Linne) biyolojisi ve populasyon dinamiği üzerine araştırmalar*. Y.Lisans Tezi, E.Ü. Fen Fak. Genel Zooloji Kürsüsü, Bornova, 46s.

Toğulga. m. and Mater, S, (1992) A comparison of data on the population dynamics of *Mullus barbatus* from the Izmir Bay in 1973 and 1990. *E.Ü. J. of Faculty of Sci. series B,* Vol. 14, 2:11-28.

Tokaç, A. ve Gurbet. R., (1992) İzmir Körfezi'ndeki barbunya balığının (*Mullus barbatus* L., 1758) avlanabilirliği. *Su Ürünleri Avlama ve İşleme Tek. Seminer tebliğleri,* Ed: Oray, I.K., Beyoğlu Rotary Kulübü, İstanbul.

Tosunoğlu, Z. (1998) *Türkiye Denizlerinde Kullanılan Dip Trol Ağlarında Torba Seçiciliğini Artırmaya Yönelik Yapısal Uygulamalar*. Doktora Tezi. E.Ü. FBE, Bornova, 121 s.

Türeli, C. ve Erdem, Ü., (1997) Adana İli kıyı yöresinde ekonomik öneme sahip balık türlerinden barbunya (*Mullus barbatus* L., 1758) ve ıskarmoz (*Saurida undosguamis* Richardson, 1848) balıklarının büyüme özellikleri (İskenderun Körfezi, Türkiye). *TUBİTAK J. of Zool.* 21:329-334.

Vassilopoulou, V. and Papaconstantinou, C., (1992) *Aspects of the biology and dynamics of red mullet (Mullus barbatus) in the Aegean Sea*. FAO Gen. Fisheries Counc. for the Medit., Rome, 115-126.

Vratsaz, N., Kalagia, M. and Karlou, C., (1992) *Age, growth and state of stack of red mullet (Mullus barbatus L., 1758) in the Seronikos Gulf of Greece*. FAO Gen. Fish. Counc. for the Medit., Rome, 51-67.

Waiwood, K.G. and Buzeta, M.I., (1989) Reproductive Biology of Southwest Scotian Shelf Haddock (Melonogrammus Aeglefinus). *Can. J. Fish. Aquat. Sci.*, Vol. 46, 153-170 pp.

Whitehead, P.J.B., Bauchot, M.L., Hureau, J.C., Nielsen, J. and Tortonese, E. (eds.), (1986) *Fishes of the North-eastern Atlantic and the Mediterranean*. UNESCO, Vol.II, 878p.

Wileman, D.A., Ferro, R.S.T., Fonteyne, R. and Millar, R.B.(Eds.), (1996) *Manual of Methods of Measuring the Selectivity of Towed Fishing Gears*. ICES Coop. research report No. 215.
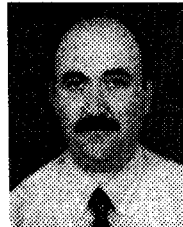
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