Growth parameters of Red Mullet (*Mullus barbatus* L.,1758) and seasonal cod-end selectivity of traditional bottom trawl nets in Izmir Bay (Aegean Sea)

H.Tuncay KINACIGİL[1], Akın T. İLKYAZ [1] , Okan AKYOL[1],
Gülnur METİN[1], Ejbel ÇIRA[2] and Adnan AYAZ[1]

[1]*Ege University, Faculty of Fisheries, 35100, Bornova, Izmir, Turkey*
[2] *Aegean Sea Regional Command of Turkish Coast Guard, Izmir, Turkey*
E-mail: tkinacigl@sufak.ege.edu.tr

Red mullet is one of the most important species due to its highly economical value in Turkish fishery. The individuals obtained from Izmir Bay in the study are between I-III age year classes and fork lengths are 10.3, 13.4 and 15.4 cm by age, respectively. Weight - length relationship of the male+female specimen was $W=0.0071L^{3.29}$. Von BERTALANFFY growth parameters were determined as $L_∞=19.036$, $W=115.1$, $K=0.438$, $t_o= -0.777$. The TL_{50} retention length of commercial bottom trawl net having 44 mm mesh size were obtained totally as 12.98 cm for red mullet and the net was found as unselective.

Keywords: red mullet, *Mullus barbatus*, growth parameters, bottom trawl selectivity, Izmir Bay

INTRODUCTION

Red mullet, a demersal species having significant economical value in Turkish fishery and the Aegean Sea supplies 27% of total annual production, which was 3000 tons in 1997 (DIE, 1998). There are limited numbers of studies on red mullet in the Aegean Sea. The first one is a systematical study, performed by DEVEJIYAN (1915). Various studies on biological and morphological characteristics (GELDIAY, 1969), growth parameters in Edremit Bay and selectivity (KINIKARSLAN, 1972; 1976), biology (TOĞULGA, 1977), population dynamics and biology (TOĞULGA and MATER, 1992) were performed in the following years. KARA and GURBET (1990), TOKAÇ et al. (1991) reported that stock size of the red mullet while researching stock distribution of economically important demersal species of northern part of the Aegean Sea and Izmir Bay. TOKAÇ and GURBET (1992) carried out a similar study on the catchability of red mullet in İzmir Bay. KINACIGİL (1994) researched on stock distribution and catchability of red mullet stock. University of Dokuz Eylül, Institute of Marine Science (DEU-IMST, 1993) also studied on red mullet stocks in the project of living marine resources in the Aegean Sea. LÖK et al. (1997) and TOKAÇ et al. (1998) made investigations on selectivity of commer-

cial and modified bottom trawl nets for red mullet in Aegean coast of Turkey.

All of the other studies carried out on red mullet in the Aegean Sea are Greek originated. ANANIADIS (1949), PAPACONSTANTINOU *et al.*(1981), VRANTSAZ *et al.*(1992), VASSILOPOULOU and PAPACONSTANTINOU (1992), PETRAKIS and STERGIOU (1995) performed several studies on biology and bio-ecology of the species.

This study aims to asses the seasonal changes in the selectivity parameters of commercial bottom trawl nets, which were used in the outer part of Izmir Bay, and to estimate the growth parameters of red mullet.

MATERIAL AND METHODS

The study was carried out monthly in Izmir Bay between January-December 1997 (Fig. 1). 26 valid hauls (6 in spring, 5 in summer, 9 in autumn, 6 in winter) were made.

The haul duration was 1 hour. The towing speed was 2.5 knots. A commercial trawler BALİK I (16 meters long and 240 HP) and a commercial bottom trawl net with 44 mm codend mesh opening size measured by Wedge gauge (4 kg.f) and made of polyethylene material (PE), was used in the study (Fig. 2).

In order to estimate cod-end selectivity, a codend cover with 21 mm mesh opening and made of PE material was used as in TOKAÇ *et al.* (1998). L50 Ver:1.0.0 computer program (ILKYAZ *et al.*, 1998) with logit model option was used to estimate selectivity parameters and to obtain selectivity curves. The model was checked by the residual analysis. Statistical population analysis and estimation of growth parameters were performed by using von BERTALANFFY growth model in BBP Ver:1.0 computer program (ILKYAZ and KINACIGİL, 1998). Length - frequency, length – weight and age – growth graphics were drawn in MS Excel Ver:97 computer program.
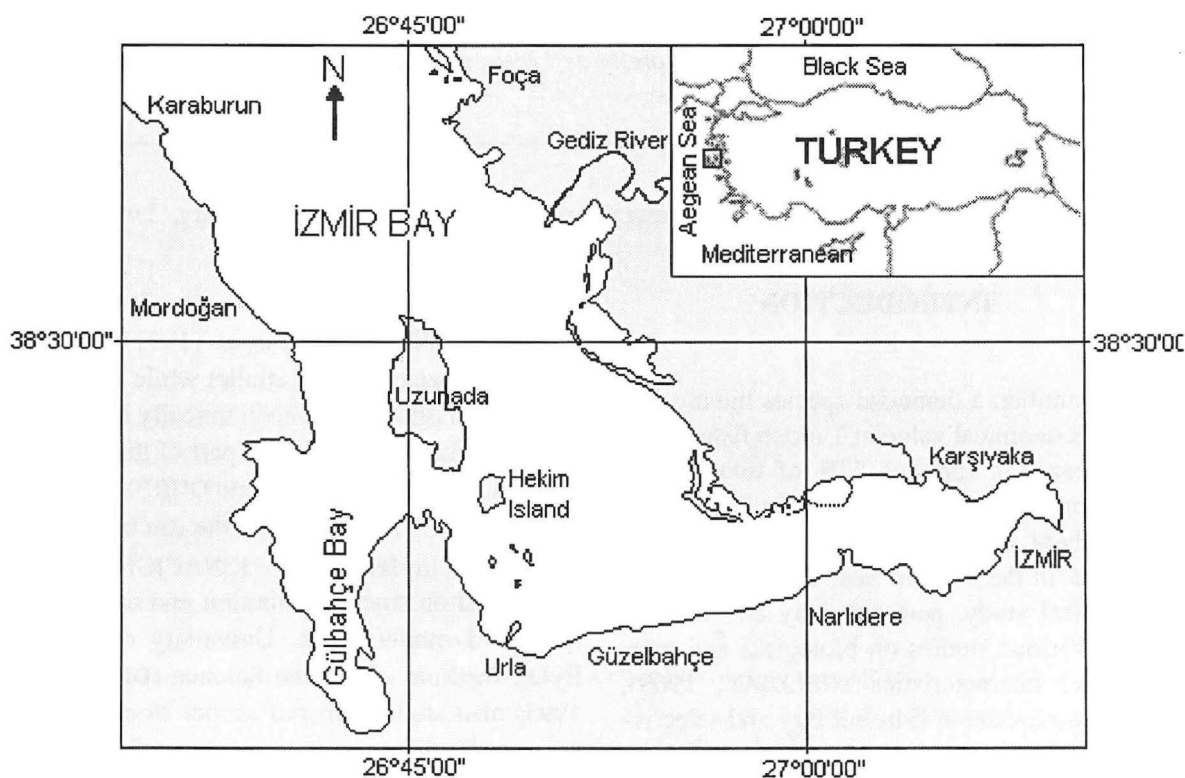

Fig. 1. Sampling area

A total of 10977 fish were measured to esti-
mate cod-end selectivity and 221 for biological
properties. Biometric measurements were taken
as fork length with 0.1 cm intervals. Length
measurements for selectivity parameters were
made in 0.5 cm length groups as total length.
The linear convert formula for red mullet (as
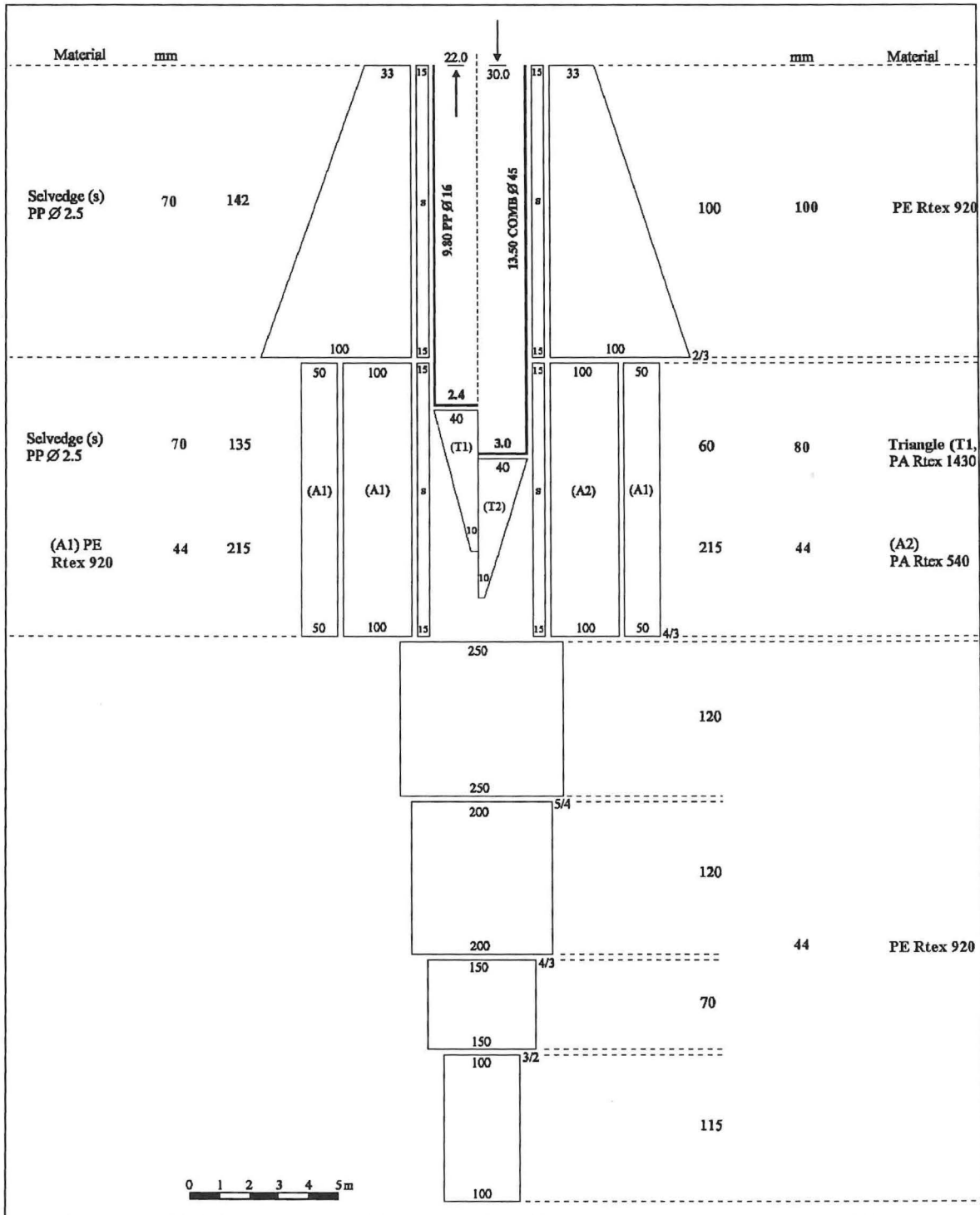$TL=0.23+1.07FL$)   was   presented   by

Fig. 2. Commercial bottom trawl net used in sampling (Redrawn from TOSUNOĞLU et al. , 1996)

TOSUNOGLU (1998). The weight measurements were done with an electronic scale of 0.1g sensitivity.

Only cod-end specimens used in biometrical procedures. Age determination of 221 individuals was estimated on sagittal otoliths (HOLDEN and RAITT, 1974).

RESULTS

Monthly fork length frequency for red mullets was obtained in Izmir Bay. First recruitment to the population was observed in August (Fig. 3). Fork length and total weight of the age class-es of I, II and III are 10.3 cm-16.2 g, 13.4 cm-38.2 g and 19.4 cm-57.7 g, respectively. Age group I apparently dominate (Table 1). The broadest range between maximum and minimum values and a sharp increase in length are observed in first year class (Fig. 4).

Length-weight relationship according to sex of the specimens obtained from growth curves (Fig. 5). Following values were obtained allometrically;

Females : $W=0.0073L^{3.28}$
Males : $W=0.0077L^{3.25}$
Females + Males : $W=0.0071L^{3.29}$

Table 1. *Average fork lengths and total weight of red mullet by age groups and confidence intervals (N: Number, SD: Standard Deviation, CI: Confidence Interval 95%)*

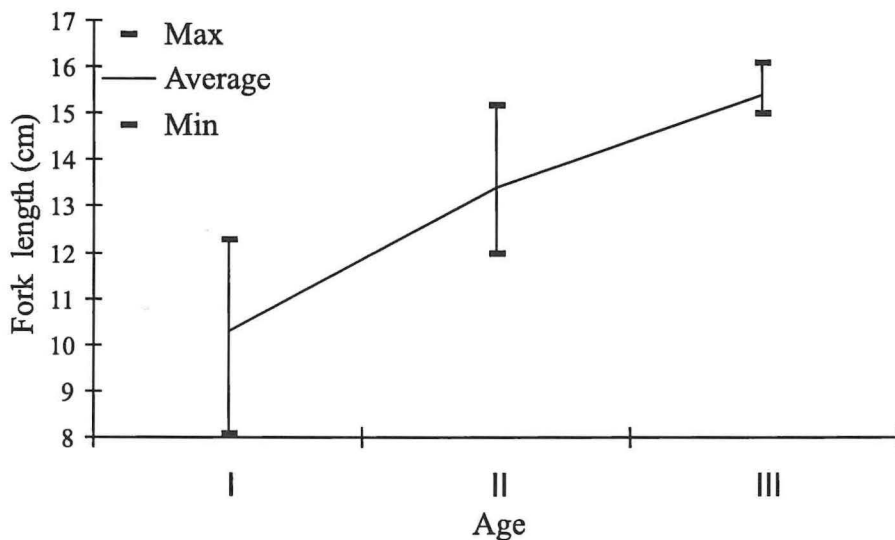| Age	N	Fork Length (cm)					Weight (g)				
		Min	Max	Aver.	St.Dev.	95% CI	Min	Max	Aver.	St.Dev.	95% CI
I	137	8.1	12.3	10.349	0.924	10.35±0.16	7	28	16.215	4.571	16.22±0.77
II	72	12	15.2	13.447	0.848	13.45±0.20	25	60	38.222	13.836	38.22±3.25
III	12	15	16.1	15.383	0.386	15.38±0.24	45	66	57.667	22.047	57.67±14.0

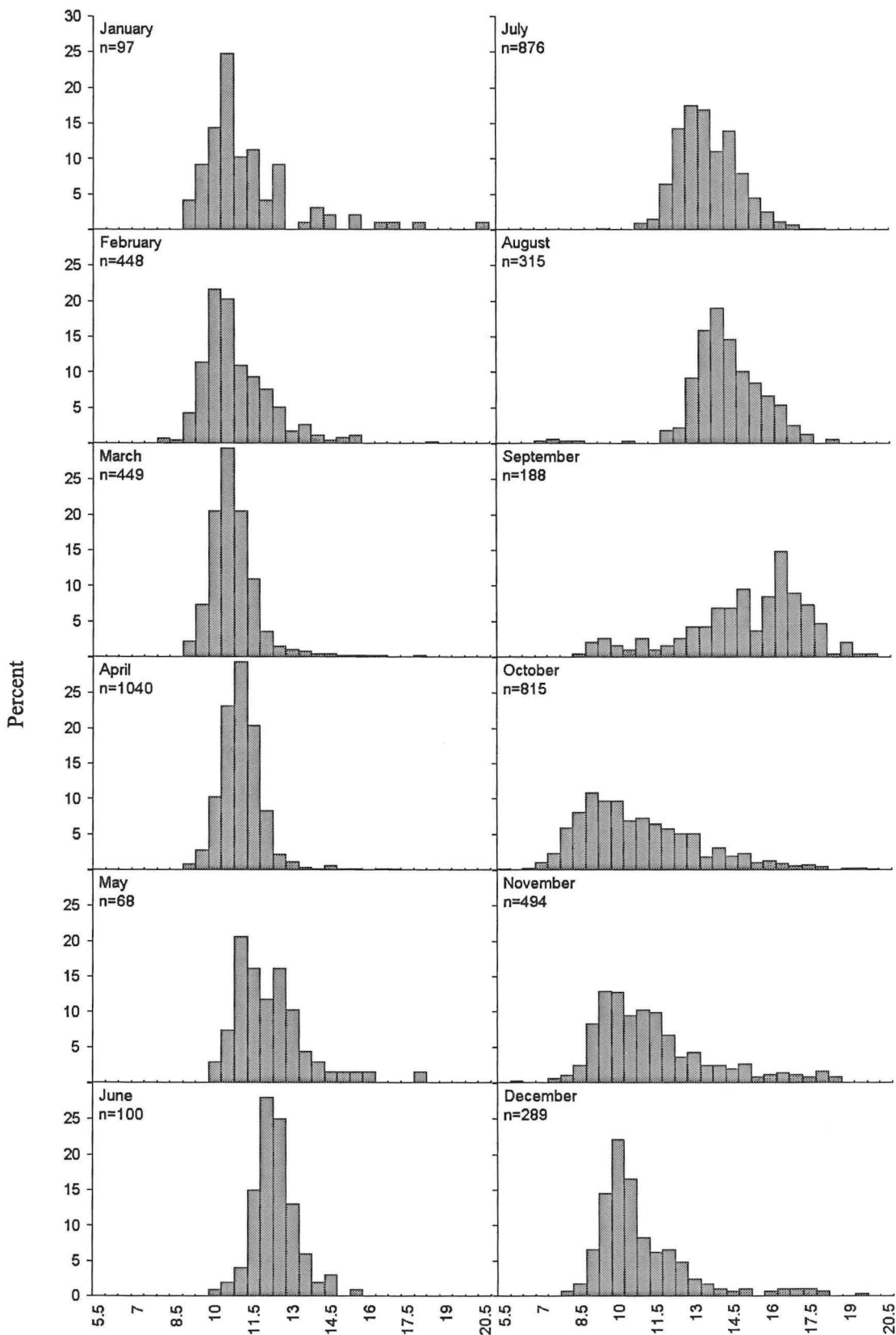Fig. 4. *Growth curve depending on age groups in red mullet*

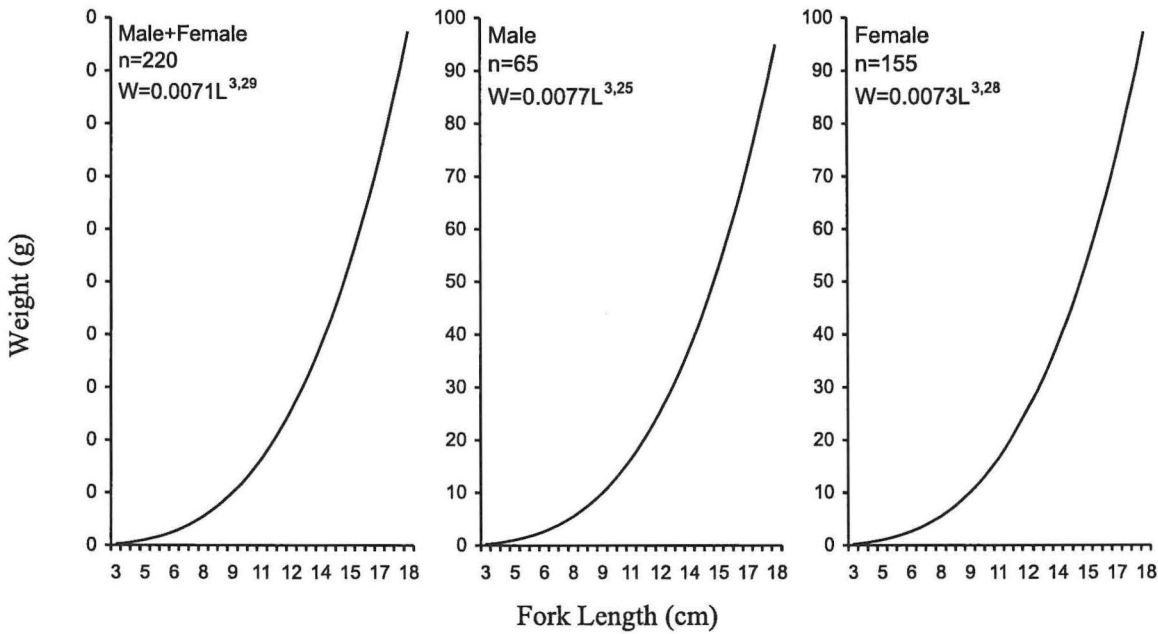*Fig. 3. Length frequency distribution of red mullet by months*

Fig. 5. *Length-weight relationship of red mullet*

Growth of red mullet caught in Izmir Bay is fast in first year class, slowing by time and approaching endless length asymptotically (Fig. 6). Growth parameters of male+female are obtained as $L=19.036$ cm, $K=0.438$, $W=115.1$ g, $t_0= -0.777$.

Examining the seasonal selectivity parameters, which were obtained by commercial bot-

tom trawl cod-end with legal mesh opening size (44 mm, diamond shape), L50 is found 10.47 cm in spring, 14.11 cm in summer, 11.54 cm in autumn and, 9.06 cm in winter (Tables 2, 3, Fig. 7). The result of residual analysis is appropriate to logit model (Fig. 8).
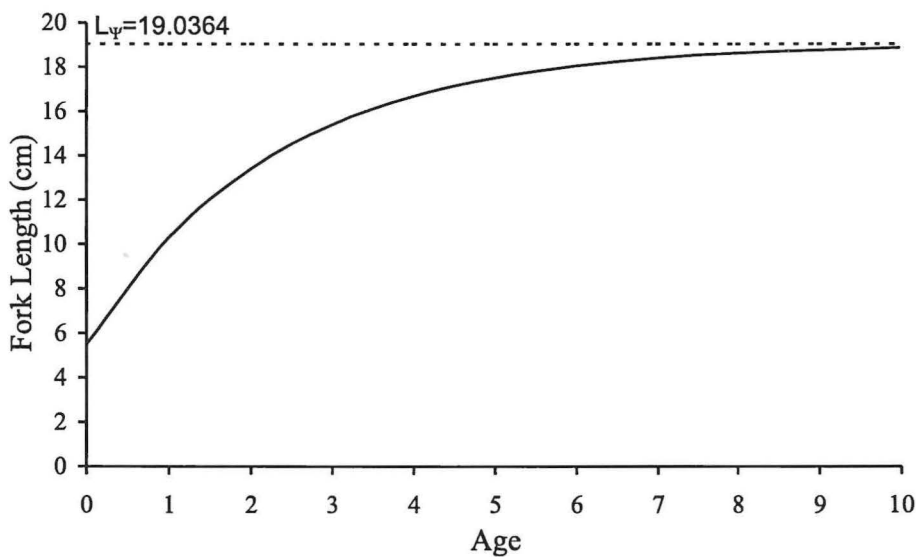

Fig. 6. *Age-length relationship of red mullet*

Table 2. The seasonal descriptive statistics of red mullet

	Total		Spring		Summer		Autumn		Winter	
	Cod-end	Cover	Cod-end	Cover	Cod-end	Cover	Cod-end	Cover	Cod-end	Cover
Aver.	11.69	10.60	10.74	10.77	14.75	14.03	15.22	10.39	10.94	9.73
St.Dev.	2.27	1.67	1.04	0.92	1.35	2.08	2.02	2.39	1.91	0.91
95% CI	±0.15	±0.09	±0.10	±0.08	±0.27	±0.39	±0.41	±0.68	±0.22	±0.08

Table 3. The seasonal selectivity parameters of red mullet

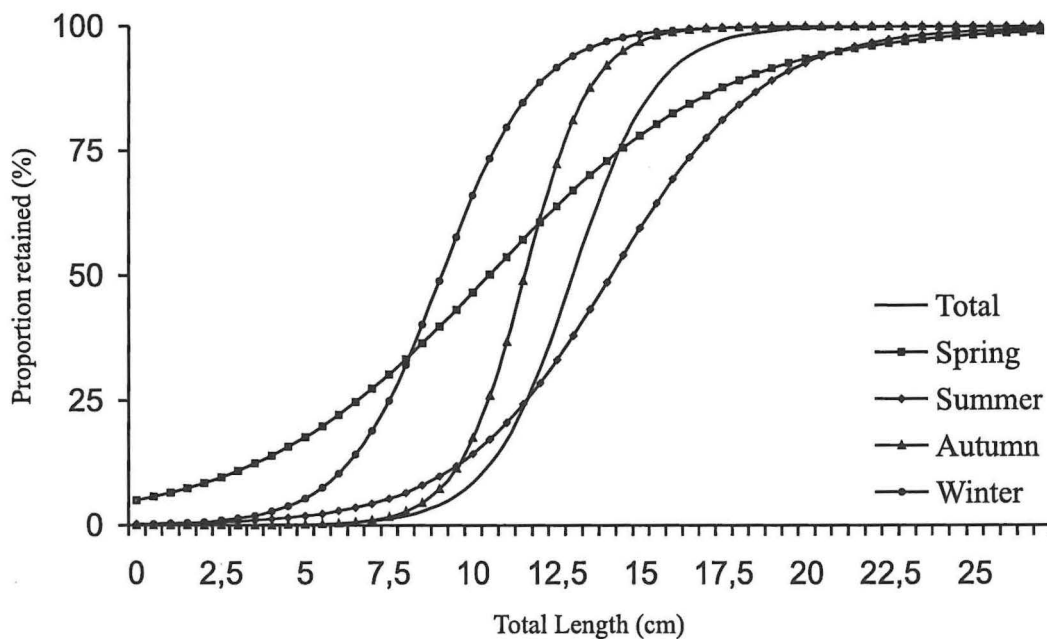|		Total	Spring	Summer	Autumn	Winter
	a	-10.282	-2.936	-6.114	-11.570	-6.376
	b	0.792	0.281	0.433	1.002	0.704
	r	0.63	0.306	0.345	0.542	0.505
	L_{25}	11.594	6.551	11.581	10.446	7.497
	L_{50}	12.981	10.468	14.117	11.542	9.058
	L_{75}	14.368	14.384	16.654	12.638	10.618
	Selection factor	2.95	2.379	3.208	2.623	2.059
	Selection range	2.774	7.833	5.073	2.192	3.121
n	Codend	6189	1655	1490	1951	1093
	Cover	4788	1103	599	1509	1577

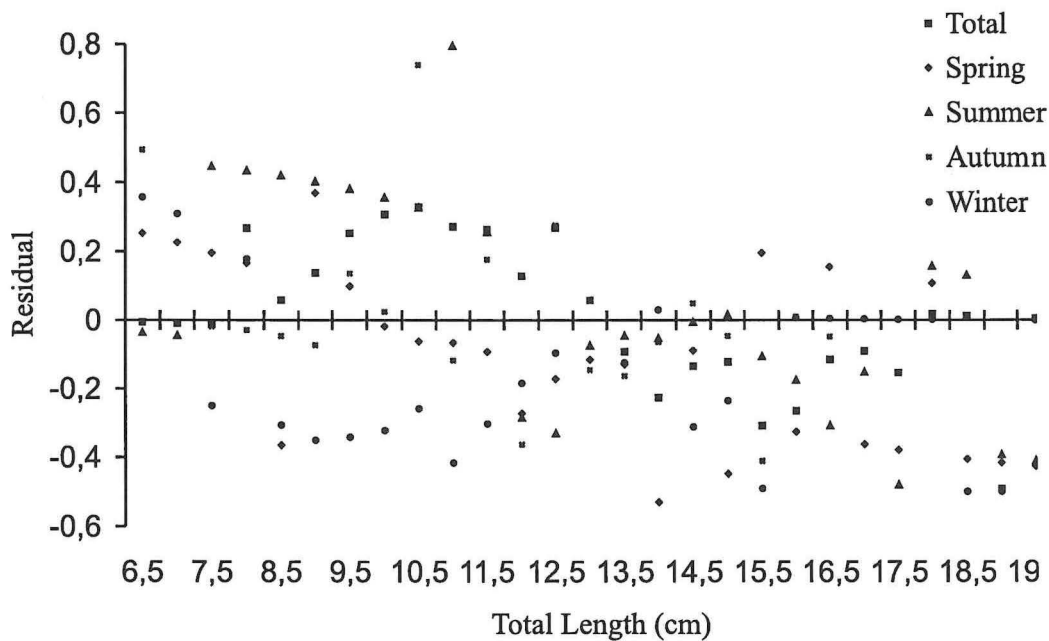*Fig. 7. The seasonal selectivity curve of red mullet*

Fig. 8. The seasonal selectivity residual analysis of red mullet

DISCUSSION

Red mullet caught in Izmir Bay, distributed between I-III age groups and I age group was the dominant (62%). Average fork length and total weights for age group I, II and III are 10.3 cm - 16.2 g, 13.4 cm - 38.2 g, 15.4 cm - 57.7 g, respectively. TOĞULGA (1977) concluded that average fork lengths were 11 cm, 12.68 cm,

16.55 cm, 18.55 cm and 20 cm for age groups I-IV, respectively. TOĞULGA and MATER (1992) assessed the lengths for age groups 0-VI as 9.35 cm, 11.94 cm, 20.15 cm, and age groups I-II were clearly dominant.

TOKAÇ and GURBET (1992) and KINACIGİL (1994) indicated that age group I was dominant among age classes I-III in the same area. These results are similar to our

Table 4. Growth parameters of red mullet given by the various authors in the Aegean Sea

Authors	Locality	$L\infty$	K	t_o	Sex
PAPACONSTANTINOU et al.(1981)	Saronikos Bay (Aegean Sea, Greece)	24 19.23	0.135 0.191	-2.9409 -2.8114	♀ ♂
PAPACONSTANTINOU et al.(1981)	Thermaikos Bay (Aegean Sea, Greece)	27.54 20.91	0.093 0.137	-4.3015 -4.2505	♀ ♂
VRANTZAS et al.(1992)	Saronikos Bay (Aegean Sea, Greece)	23.5	0.51	-0.86	♀+♂
VASSILOPOULOU and PAPACONSTANTINOU (1992)	Aegean Sea	25.49 22.71	0.2135	-2.1335 -1.8535	♀ ♂
TOĞULGA and MATER (1992)	Izmir Bay (Aegean Sea, Turkey)	26.47	0.1613	-2.7016	♀+♂
This Study	Izmir Bay (Aegean Sea, Turkey)	19.036	0.438	-0.777	♀+♂

results. On the other side of the Aegean Sea, PAPACONSTANTINOU *et al.* (1981) indicated that II and III year classes were dominant among 0-VIII year classes in Thermaikos Bay. VASSILIPOULOU and PAPACONSTANTINOU (1992) declared that I-II year classes were dominant in 0-VIII age groups in the northern part of the Aegean Sea. Depending on these conclusions, it is possible to argue about a population consisted of juvenile individuals in the Aegean Sea and especially in Izmir Bay. This is likely to be caused by overfishing. Growth parameters that were found by several other authors are given in Table 4.

TIRAŞIN (1993) indicated that growth parameters differed depending on species, population, and age groups in the same population and even sexes. So the differences seen in different locations may be accepted as normal.

In this study, when the average value of $L50$ is used in order to express seasonal selectivity of commercial bottom trawl net with 44-mm mesh size, 12.98 cm total length is found as average seasonal selectivity. The seasonal selectivity values were 10.47 cm in spring, 14.12 cm in summer, 11.54 cm in autumn and 9.06 cm in winter. Although the selectivity was relatively low in all the seasons, the lowest selectivity was in autumn and the highest selectivity was in summer. LÖK *et al.* (1997) in their research about bottom trawl selectivity at the Aegean Sea have found the value of $L50$ for red mullet as 13.68 cm using the same mesh size. TOKAÇ *et al.* (1998) doing the same research have a result as 13.50 cm. The differing results of the value of $L50$ might be an outcome of net construction and material used in the net. In the study, a bottom trawl net with PE material designed by a fisherman was used. The difference can also depend on the intensive fish catching resulting from fish, blocking the fish net mesh size.

CONCLUSIONS

In the study, we concluded that the trawl nets with 44-mm legal mesh size used in commercial fishing were not selective, and caught a considerable amount of undersized fish. Because minimum landing size by Ministry of Agriculture as 13 cm for red mullet (Turkish Ministry of Agriculture, General Directory of Protection and Control of Marine Resources=TMA-GDPD). Consequently, it would be useful to study whether legal mesh size was suitable for protecting red mullet stocks or not.

REFERENCES

ANANIADIS, K. 1949. Study on the biology of the red mullet (*M. barbatus*) from Typica page in the Aegean Sea. Practica of the Hydrobiological Inst., Athens, 3 (2): 13 pp.

DEVEJIYAN, K. 1915. Fish and fisheries (in Turkish), Technical bulletin, İstanbul, 74 pp.

DEU-IMST. 1993. The stocks assesment and identification of marine resources in Aegean Sea (in Turkish). Institute of Marine Science and Technology, Report of 1993. The Scientific and Technical Research Council of Turkey, Earth Marine Atmospherical Sciences and Environmental Researches Grant Group, 117/G.

D.I.E. 1998. The fishery statistics of Turkey (in Turkish). The State Institute of Statistics, Prime Ministry, Republic of Turkey, Ankara, No.2154.

GELDİAY, R. 1969. The marine fish in İzmir Bay (in Turkish). Ege University, Journal of Faculty of Science, Series II., 135 pp.

HOLDEN, M.J. and D. F. S. RAITT. 1974. Manual of Fisheries Science Part-2, Methods of Resource Investigation and their Application. FAO Tech. Paper No.115, Rev.1, 214 pp.

İLKYAZ, A.T., C. METİN and H. T. KINACIGİL. 1998. A Computer Program About The Calculation of The Selectivity Parameters In Towed Fishing Gear Illustrated With

Cover Cod-End Method (L50 Version:1.0.0) (in Turkish). Journal of Fisheries and Aquatic Sciences, Ege University, Fisheries Faculty, Bornova, Izmir, Turkey, 15 (3-4): 305-314.

İLKYAZ, A.T. and H. T. KINACIGİL. 1999. A Study About Evaluation of Some Growth Parameters in Fish with a MS-Windows Computer Program (BBP Version: 1.00) (in Turkish). Journal of Fisheries and Aquatic Sciences, Ege University, Fisheries Faculty, Bornova, Izmir, Turkey, 16 (3-4) :245-256.

KARA, Ö.F. and R. GURBET. 1990.The studies on the stocks assesment of commercial fish in North Aegean Sea (in Turkish). Ege University Research Fund Project No.1998/003, İzmir, 43 pp.

KINACIGİL, H. T. 1994. The studies on the distribution abundance and catchability of red mullet (Mullus barbatus Lin.,1758) stocks in Gülbahçe Bay (in Turkish). Ege University, Journal of Faculty of Science, Series B, app.16/1:13 pp.

KINIKARSLAN, N. 1972. The studies on growth index and annual growth parameters of red mullet (Mullus barbatus Lin.,1758) in Edremit Bay (in Turkish). Istanbul University, Faculty of Science, Research Institution, İstanbul., No.8:12 pp.

KINIKARSLAN, N. 1976. The investigation of selectivity qualification of trawl net mesh size on red mullet (Mullus barbatus L.) (in Turkish). Istanbul University, Faculty of Science, Research Institution İstanbul, No.16:1-12.

LÖK, A., A. TOKAÇ, Z. TOSUNOĞLU, C. METİN, and R. S. T. FERRO. 1997. The effects of different cod-end design on bottom trawl selectivity in Turkish fisheries of the Aegean Sea. Fisheries Research, 32:149-156.

PAPACONSTANTINOU, C., N. TSIMINIDES AND C. H. DAOULAS. 1981. Age, growth and reproduction of red mullet (Mullus barbatus Linnaeus,1758) in the Gulf of Saronikos and Thermaikos. Thalassographica, 1 (4): 39-66.

PETRAKIS, G. and K. I. STERGIO. 1995. Weight-length relationship for 33 species in Greek Waters. Fisheries Research, 21:465-469.

TIRAŞIN, M. 1993. The studies on growth parameters of fish population (in Turkish). The Scientific and Technical Research Council of Turkey. Journal of Zoology, C.29:29-82.

TMA-GDPD. 1997. The circular (33/1) regulating commercial fisheries in seas and inland waters (in Turkish). Ankara, 121 pp.

TOĞULGA, M. 1977. The studies on population dynamics of red mullet (Mullus barbatus Lin. 1758) in İzmir Bay (in Turkish). Ege University, Journal of Faculty of Science, Series B, C.I, S.2:175-194.

TOĞULGA, M. and S. MATER. 1992. A comparison of data on the population dynamics of Mullus barbatus L. from the Izmir Bay in 1973 and 1990. Ege University, Journal of Faculty of Science, Series B, 14(2):11-28.

TOKAÇ, A., R. GURBET, A. LÖK and C. METİN. 1991. The studies on demersal fish stocks assesment in İzmir Bay. Ege University, Faculty of Fisheries, The Book of Fisheries Symposium, İzmir, pp. 638-654.

TOKAÇ, A. and R. GURBET. 1992. The studies on catchability of red mullet (Mullus barbatus Lin.,1758) in İzmir Bay (in Turkish). The Seminer Book of Fishing and Prosessing Tecnology, Rtn. Işık Oray (Editor). İstanbul Beyoğlu Rotary Club, İstanbul, 7 pp.

TOKAÇ, A., A. LÖK, Z. TOSUNOĞLU, C. METİN and R. S. T. FERRO. 1998. Cod-end selectivities of a modified bottom trawl for three fish species in the Aegean Sea. Fisheries Research, 39:17-31.

TOSUNOĞLU, Z., H. KAYKAÇ, C. AYDIN and A. TOKAÇ. 1996. Bottom trawl nets used in fishery researches of Ege University, Faculty of Fisheries (in Turkish) . Journal of Fisheries and Aquatic Sciences, Ege University, Fisheries Faculty, Bornova, Izmir, Turkey,13 (3-4): 485-498.

TOSUNOĞLU, Z. 1998. Structural modification to improve cod-end selectivity at the bottom trawl nets used in Turkish Seas (in Turkish). PhD Thesis. E.Ü., Graduate School of Natural and Applied Sciences,

Department of Fisheries and Processing Technology, Bornova, İzmir, 121pp.

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

VRANTSAZ, N., M. KALAGIA and C. KARLOU. 1992. Age, growth and state of stock of red mullet *(Mullus barbatus* Lin.,1758) in the Saronikos Gulf of Greece. FAO Gen. Fisheries Counc. for the Medit. Rome, pp.51-67.

Parametri rasta trlje blatarice (*Mullus barbatus* L.,1758) i sezonski odabir pridneno povlačnih mreža tradicionalnih koća u Izmirskom zaljevu (Egejsko more)

H.Tuncay KINACIGIL[1], Akın T. İLKYAZ [1], Okan AKYOL[1], Gülnur METİN[1], Ejbel ÇIRA[2] i Adnan AYAZ[1]

[1]*Egejsko Sveučilište, Fakultet ribarstva, 35100, Bornova, Izmir, Turska*

[2] *Područno zapovjedništvo turske obalne straže u Egejskom moru, Izmir, Turska*

E-mail: tkinacigil@sufak.ege.edu.tr

SAŽETAK

Trlja blatarica (*Mullus barbatus* L., 1758) je jedna od najvažnijih vrsta zbog njezine izrazito velike gospodarske vrijednosti u turskom ribarstvu. Istraživane su jedinke uhvaćene u Izmirskom zaljevu u dobi između I-III godišta čija duljina tijela (fork length) iznosi 10.2, 13.4 i 15.4 cm ovisno o starosti. Dužinsko-težinski odnos uzoraka oba spola je iznosio $W=0.0071L^{3.29}$. Parametri rasta prema von BERTALANFFY-evoj jednadžbi iznosili su: $L_\infty=19.036$, $W_\infty=115.1$, $K=0.438$, $t_o=-0.777$. Oko 50% populacije trlje blatarice se zadržava pri duljini od 12.98 cm u pridneno povlačnoj mreži (koća) koja ima veličinu oka 44 mm, te se stoga smatra neselektivnom mrežom.