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Seasonal Variation in the Trawl Codend Selectivity of Red Mullet (*Mullus barbatus*)

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Abstract

Seasonal changes in the selectivity of 40 mm PE codend were investigated in the Eastern Aegean Sea. Selectivity of the same codend was tested for red mullet (*Mullus barbatus*), by using the same vessel, fishing ground, towing speed and duration. Four sets of data were collected in spring (4-18 April 2002), summer (10-25 July 2002), autumn (26 September-2 October 2002) and winter (22-23 January 2003). Data were obtained by using covered codend technique, and analysed by using logistic equation with the maximum likelihood method. Four sets of selection curves were analysed and compared using the model developed by Fryer. To investigate the seasonal changes in the condition of the fish, length and weight data were collected from samples taken to cover the whole length range in the catch. Results show that estimate of L_{50} in spring is significantly lower than those for other seasons ($P<0.05$). There is about 10% difference between the mean L_{50} values of the best and the poorest seasons, summer (11.1 cm) and spring (10.1 cm), respectively. The L_{50} values of autumn (10.8 cm) and winter (11.0 cm) lay between these two. Fish were in their best condition and the water temperature was at its highest point of the annual cycle in autumn.

Keywords: Trawl selectivity, covered codend, Aegean Sea.

Barbun Balığı (*Mullus barbatus*)'nın Trol Torba Seçiciliğinde Mevsimsel Değişimler

Özet

Bu çalışmada Doğu Ege Denizi'nde 40 mm PE torba seçiciliğinin mevsimsel değişimi araştırılmıştır. Aynı torbanın seçiciliği, aynı gemi, av sahası, çekim hızı ve çekim süresi kullanılarak barbun için denenmiştir. İlkbahar (4-18 Nisan 2002), yaz (10-25 Temmuz 2002), sonbahar (26 Eylül-2 Ekim 2002) ve kış (22-23 Ocak 2003) mevsimlerinde 4 grup veri toplanmıştır. Veriler örtü torba tekniği kullanılarak elde edilmiş ve 'En Yüksek Olabilirlik Yöntemi' ile lojistik denklem kullanılarak analiz edilmiştir. Dört grup seçicilik eğrisi Fryer tarafından geliştirilen model kullanılarak karşılaştırılmıştır. Balığın kondüsyon faktöründeki mevsimsel değişimleri araştırmak amacıyla avdaki tüm boy aralığını kapsayacak şekilde alınan örneklerden boy ve ağırlık verisi toplanmıştır. Sonuçlar ilkbaharda hesaplanan L_{50}'nin diğer mevsimlerdekinden belirgin derecede daha düşük olduğunu göstermektedir ($P<0,05$). En iyi ve en düşük L_{50} değerleri arasında, sırasıyla yaz (11,1 cm) ve ilkbahar (10,1 cm), yaklaşık %10'luk bir fark vardır. Sonbahar (10,8cm) ve kışın (11,0 cm) L_{50} değerleri bu iki değerin arasında kalmaktadır. Sonbaharda balıklar en iyi kondüsyon faktöründe ve su sıcaklığı yıllık döngüsünün en yüksek değerindedir.

Anahtar Kelimeler: Trol seçiciliği, örtü torba, Ege Denizi.

Introduction

Trawling is the most important capture method for exploitation of the demersal fish stocks around the Turkish coasts. Approximately 90% of demersal fish production is harvested by trawlers in Turkey (Tokaç, 2002). However, as common to many trawl fisheries in the world, poor selectivity is one of the most important problems in these fisheries.

There have been more than fifty published demersal trawl codend selectivity studies carried out in the Aegean and the Mediterranean waters of Turkey since mid 1970's. However, although a significant number of these experiments were conducted by using similar codends in very close fishing grounds (mostly in the Izmir Bay), their results for the same species are rather variable (Stewart, 2001). One of the potential reasons for that is likely to be effect of time of the experiments on the results. In most of the publications, dates of the

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individual hauls are not provided and the data were pooled over a variable period of time.

There are not many studies investigating the effect of seasonal variation in codend selectivity. However, Özbilgin *et al*. (2006) reported that selectivity of the same codend for haddock (*Melanogrammus aeglefinus*) in the North Sea showed an increase at the end of the summer feeding period which also coincided with the highest point of the annual cycle of water temperature. On the other hand selectivity decreased in post spawning stage of the fish which takes place in the low temperature range in April. Additionally, Özbilgin *et al*. (2005) for annular sea bream (*Diplodus annularis*), and Özbilgin *et al*. (2007) for picarel (*Spicare smaris*) reported a tendency of decrease in the codend selectivity in the Aegean Sea from summer and autumn, respectively, to spring but not in a statistically significant level.

In this study, seasonal changes in the selectivity of 40 mm nominal mesh size polyethylene (PE) codend commonly used by Turkish demersal trawlers were investigated in Gülbahçe Bay. Selectivity of the same codend attached to the same gear was tested for red mullet (*Mullus barbatus)* by using the same vessel on the same fishing ground for the same towing speed and duration.

Red mullet is a very common species in Turkish waters with a high commercial value. According to the State Institute of Statistics, in 2007, 2,091 t of red mullet were landed in Turkey (Anonymous, 2008a). This species reaches sexual maturity at 14.4 cm length (Akyol *et al*., 2000) and its Minimum Landing Size (MLS) is 13 cm in Turkish Fisheries Regulations (Anonymous, 2008b).

Materials and Methods

To investigate the seasonal changes, four sets of codend selectivity data were collected in spring (4-18 April 2002), summer (10-25 July 2002), autumn (26 September-2 October 2002) and winter (22-23 January 2003). The data collected in April trip was previously used in Özbilgin and Tosunoğlu (2003) to compare the selectivities of double and single codends in the form of combined hauls. Fishing was carried out in Gülbahçe Bay, in the Eastern Aegean Sea, during all the trips. A traditional, 600 meshes round the mouth, commercially used bottom trawl (see Tosunoğlu *et al*. (1996) for drawing), with 40 mm mesh size PE netting codend was used for fishing. This codend had 200 meshes around the circumference and 5 m stretched length. Its mesh size was measured as 42.4 mm (SE. 0.26) by using ICES mesh gauge with 4 kg weight (Tosunoğlu *et al*., 2003a). The same gear was used in all the operations and all the hauls were carried out aboard R/V Egesüf (27 m., 500 HP). Towing duration was standardised as 45 minutes. Towing speed varied between 2.2 and 2.6 knots. Water depth of the fishing area varied between 25 and 30 m. Warp length used in this depth was 150 m. All the tows were carried out during the daylight, mostly between 10 am and 3 pm.

Data were collected by using hooped covered codend method (Willeman *et al*., 1996; Tosunoğlu *et al*., 1997). The cover used was 8 m in length and was made of 24 mm mesh size knotless PA netting. It was supported by two 1.8 m diameter hoops to stop the masking effect of cover netting on codend mesh openings, and to provide a better flow in and around the codend.

After each haul, first cover, then the codend catches were removed and sorted by species. Red mullet and the rest of the codend and cover catches were separately weighed. Total lengths of the target species were measured to the nearest half a centimetre. Selectivity parameters for individual hauls were estimated using CC2000 software (ConStat, Denmark). The data were analysed using a logistic equation with the maximum-likelihood method (Wileman *et al*., 1996). Four sets of selection curves were estimated and compared using the model developed by Fryer (1991), which takes into account the between-haul variation in selectivity by allowing the selectivity curves to vary randomly around a mean selectivity curve according to a multivariate normal distribution. Codend catch size was used as an additional explanatory variable in the analysis, which was conducted by using EC-Model software (ConStat, Denmark).

Additionally, in each season, about a hundred fish selected over the whole length range present in the catch to obtain information on seasonal changes in the condition of the fish. Their total lengths were measured to the nearest millimetre. Then each fish were weighed to the nearest 0.1 g by using a digital scale.

Length-weight, and length-condition factor relationships were analysed and, weight and condition factor of the fish at MLS (13 cm) in each season were calculated by using MS-Excel. Condition factor (K) was calculated from the formulation of

$$K=100 \times (\text{Weight (g)} / \text{Length (cm)}^3)$$

Results

A total of 37 hauls: 9 in spring, 12 in summer, 9 in autumn and 7 in winter were carried out during the trials. Total numbers of red mullet caught in these hauls were 36,962 in codend and 9,597 in cover. The catch was dominated by red mullet in all the seasons. Weight of red mullet, and its percentage in total catch were 149 kg and 40% in spring, 319 kg and 43% in summer, 536 kg and 48% in autumn, 370 kg and 65% in winter, and 1,374 kg and 49% in overall seasons, respectively. Other species usually present in the catch were annular sea bream, picarel, common pandora (*Pagellus erythrinus*), hake (*Merluccius merluccius*), stripped red mullet (*Mullus surmuletus*), gilthead sea bream (*Sparus aurata*), poor cod

(*Trisopterus minutus capelanus*), common sole (*Solea solea*), tub gurnard (*Trigla lucerna*), John Dory (*Zeus faber*), comber (*Serranus cabrilla*), brown comber (*Serranus hepatus*), bogue (*Boops boops*), two banded sea bream (*Diplodus vulgaris*), axillary sea bream (*Pagellus acarne*), black goby (*Gobius niger*), scald fish (*Arnoglossus laterna*), and common eagle ray (*Myliobatis aquila*).

Selectivity and regression parameters with their 95% confidence intervals, variance matrix values and number of the fish caught in codend and cover in each haul as well as mean curves for each season are given in Table 1. Total codend catch weights ranged between 27 and 61 kg in spring, 21 and 98 kg in summer, 59 and 192 kg in autumn, and finally 33 and 104 kg in winter. It was found that the codend catch size did not significantly affect the selectivity parameters (P>0.05). Individual and mean selectivity ogives are separately shown in Figure 1 for each season. The results show that the best selectivity is seen in summer while the poorest was observed in spring (Figure 2). Fifty per cent retention lengths (L_{50}) of the mean curves were found as 10.1 cm in spring, 11.1 cm in summer, 10.8 cm in autumn and 11.0 cm in winter. Selection ranges (SR) were found as 2.1 cm for spring and summer, 2.3 for autumn and 1.9 cm for winter. Seasonal differences were tested both for L_{50} and SR values. L_{50} in spring was found to be significantly lower than all other seasons (P<0.05). No significant difference was detected between the SR values (P>0.05).

Figure 1 also shows the length-frequency

Table 1. Fifty percent retention lengths (L_{50}), selection ranges (SR) and their confidence intervals, regression parameters (v_1 and v_2), variance matrix values (R_{11} R_{12} and R_{22}) and numbers of fish in codend (N-CD) and cover (N-CV) for individual hauls and mean curves

		L_{50}	CI (0.95)	SR	CI (0.95)	v_1	v_2	R_{11}	R_{12}	R_{22}	N-CD	N-CV
SPRING	04 Apr 1	9.7	9.3-10.1	2.4	1.9-2.9	-8.795	0.908	0.9482	-0.0842	0.0075	927	166
	04 Apr 2	9.7	9.3-10.0	2.4	2.0-2.9	-8.735	0.903	0.7852	-0.0694	0.0062	1295	226
	05 Apr 1	8.6	7.7-9.4	3.5	2.5-4.5	-5.384	0.628	0.9253	-0.0800	0.0070	1102	144
	05 Apr 2	9.8	9.5-10.1	1.5	1.1-1.8	-14.518	1.485	3.4457	-0.3154	0.0290	766	76
	10 Apr 1	11.2	11.1-11.4	2.3	2.0-2.6	-10.937	0.972	0.4772	-0.0417	0.0037	902	671
	12 Apr 1	10.9	10.8-11.1	1.4	1.1-1.6	-17.223	1.577	2.3523	-0.2079	0.0185	555	209
	12 Apr 2	10.2	9.4-10.5	1.9	1.5-2.4	-11.597	1.135	1.8633	-0.1683	0.0153	462	129
	18 Apr 1	9.3	8.8-9.8	2.7	1.9-3.4	-7.626	0.823	1.3792	-0.1265	0.0117	654	141
	18 Apr 2	10.2	10.0-10.4	1.5	1.2-1.8	-14.670	1.442	2.2819	-0.2092	0.0193	665	166
	MC Fryer	10.06	9.89-10.23	2.05	1.91-2.19	-10.809	1.074	1.5285	-0.1297	0.0114	7328	1928
	D							12.2210	-1.0294	0.0897		
SUMMER	10 July 1	11.1	10.0-12.3	2.2	1.1-3.3	-11.153	1.003	9.3475	-0.7028	0.0530	404	33
	10 July 2	10.5	9.1-11.9	2.6	1.4-3.9	-8.801	0.839	5.6179	-0.4188	0.0314	670	46
	10 July 3	11.2	10.4-11.9	2.0	1.4-2.7	-12.063	1.082	4.5731	-0.3422	0.0257	1058	70
	10 July 4	10.7	9.6-11.7	2.2	1.4-3.1	-10.541	0.988	5.6882	-0.4280	0.0323	942	54
	11 July 1	12.1	11.7-12.5	1.2	0.8-1.6	-22.067	1.827	12.8722	-0.9755	0.0741	771	45
	11 July 2	11.0	9.2-12.8	1.9	0.6-3.2	-12.642	1.150	24.1480	-1.7916	0.1333	371	14
	11 July 3	11.5	10.7-12.2	1.7	1.1-2.3	-14.685	1.283	8.0120	-0.5992	0.0450	817	45
	11 July 4	12.3	11.9-12.6	1.6	1.2-2.0	-17.117	1.395	4.7139	-0.3508	0.0262	853	115
	24 July 1	10.1	8.2-12.0	2.3	1.2-3.4	-9.516	0.942	8.7499	-0.6259	0.0450	1101	27
	24 July 2	11.1	9.5-12.6	3.1	1.7-4.6	-7.758	0.702	4.7213	-0.3281	0.0229	668	54
	25 July 1	10.5	8.6-12.3	2.7	1.3-4.2	-8.439	0.806	7.6112	-0.5467	0.0395	412	29
	25 July 2	10.2	8.0-12.4	3.3	1.4-5.2	-6.836	0.667	6.6083	-0.4702	0.0336	519	37
	MC Fryer	11.14	11.01-11.27	2.14	2.05-2.23	-11.467	1.029	1.5411	-0.1142	0.0085	8586	569
	D							11.0430	-0.8207	0.0619		
AUTUMN	26 Sep 1	10.2	10.0-10.5	2.4	2.0-2.7	-9.525	0.930	0.3583	-0.0358	0.0037	832	459
	26 Sep 2	10.7	10.5-10.9	2.3	2.0-2.5	-10.406	0.977	0.4130	-0.0402	0.0040	702	536
	26 Sep 3	10.9	10.7-11.1	2.1	1.9-2.3	-11.271	1.031	0.2948	-0.0273	0.0026	1145	712
	26 Sep 4	11.1	10.9-11.3	1.7	1.6-1.9	-14.004	1.258	0.4654	-0.0421	0.0039	1574	803
	27 Sep 1	11.4	11.2-11.6	2.3	2.1-2.5	-10.835	0.954	0.2179	-0.0175	0.0015	1959	561
	27 Sep 2	10.4	10.2-10.6	2.4	2.1-2.7	-9.546	0.917	0.3039	-0.0276	0.0026	1316	308
	27 Sep 3	10.3	10.1-10.6	2.0	1.7-2.4	-11.169	1.081	0.8490	-0.0833	0.0083	1056	455
	02 Oct 2	11.4	11.2-11.6	2.3	2.0-2.5	-10.987	0.968	0.3168	-0.0289	0.0027	719	741
	02 Oct 3	10.1	9.9-10.4	3.1	2.8-3.4	-7.179	0.709	0.1473	-0.0135	0.0013	1297	445
	MC Fryer	10.76	10.64-10.88	2.27	2.18-2.36	-10.408	0.967	0.3732	-0.0291	0.0024	10600	5020
	D							3.0105	-0.2297	0.0183		
WINTER	22 Jan 2	10.4	10.2-10.6	2.4	2.1-2.7	-9.518	0.916	0.4214	-0.0353	0.0030	2249	423
	22 Jan 3	10.4	10.2-10.7	2.2	1.8-2.5	-10.488	1.004	0.8536	-0.0720	0.0061	1225	218
	22 Jan 4	11.1	11.0-11.3	1.7	1.5-1.8	-14.733	1.323	0.7394	-0.0615	0.0051	1821	382
	23 Jan 1	10.9	10.7-11.2	2.2	1.8-2.6	-11.086	1.013	1.1283	-0.0933	0.0078	829	206
	23 Jan 2	10.7	10.4-11.0	2.4	2.0-2.8	-9.847	0.922	0.9039	-0.0754	0.0063	828	202
	23 Jan 3	11.4	11.3-11.5	1.4	1.2-1.5	-18.416	1.616	1.0275	-0.0848	0.0070	2268	374
	23 Jan 4	11.3	11.1-11.5	1.7	1.5-2.0	-14.320	1.269	1.0176	-0.0836	0.0069	1428	275
	MC Fryer	10.95	10.82-11.08	1.91	1.78-2.04	-12.606	1.151	1.5364	-0.1215	0.0096	10648	2080
	D							9.8925	-0.7789	0.0615		

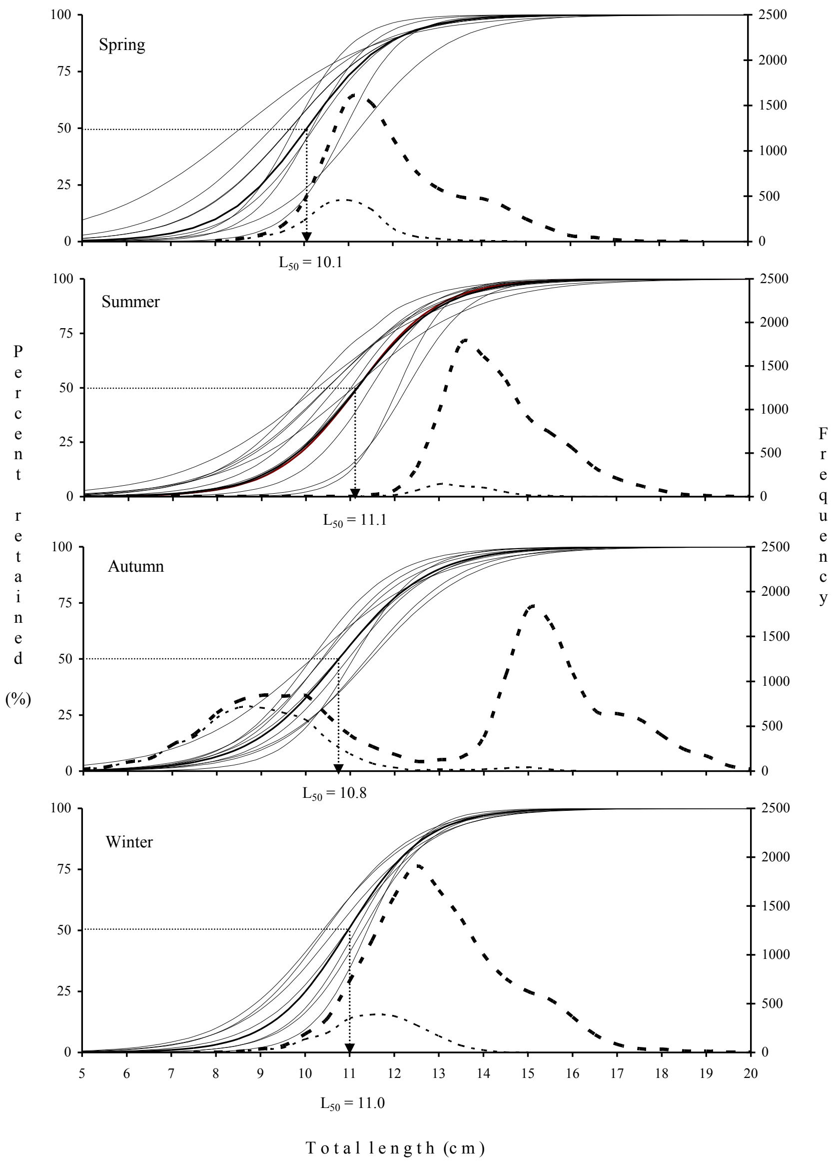

Figure 1. Individual (thin straight line) and mean (thick straight line) selection curves and length frequency distribution of the population entering to the codend (thick broken line) and escaped from the codend (thin broken line) in each season. Mean L_{50} values are also shown in the figure.

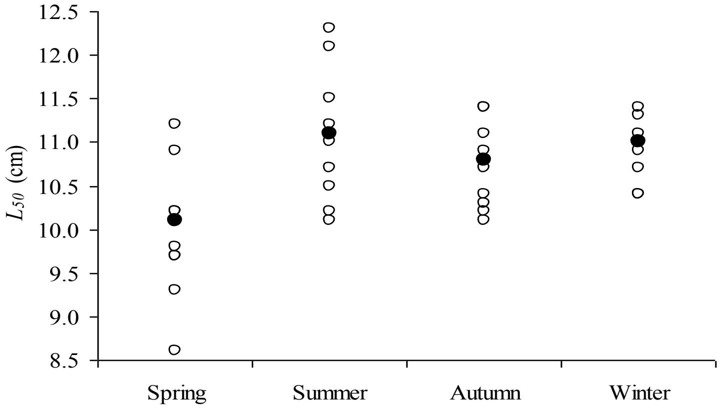

Figure 2. Individual (open circles) and mean (filled circles) L_{50} values of the 40 mm polyethylene codend for red mullet.

distribution of the fish entered to the codend (thick broken line) and fish escaped from the codend (thin broken line) in each season. It can be seen from the figure that in every season except for autumn there is only one distinct peak in the population which is expected to correspond to 1 year old fish. However, in autumn there is also a 0+ year class entering to the codend. Although a great majority of these 0+ year old fish escape, a considerable amount of larger individuals in that year class are observed to retain.

Table 2 summarises the length weight relationships for each season. From these relationships, weights of fish at MLS are calculated as 23.19 g in spring, 23.53 g in summer, 23.65 g in autumn and 22.38 g in winter. Numbers of the individual fish at MLS to make up one tonne of catch are calculated as 43,122, 42,499, 42,283 and 44,683, respectively, in these seasons. In other words, to make up one tonne of fish at MLS, 2400 individuals less is required in autumn than in spring.

Discussion

Results of this study show that there is a seasonal change in the selectivity of 40 mm mesh size PE codend for red mullet. Estimate of L_{50} in spring is significantly lower than those for other seasons ($P<0.05$). There is about 10% difference between the mean L_{50} values of the best and the poorest seasons, summer and spring, respectively. The L_{50} values of autumn and winter lay between these two. Significantly lower L_{50} was previously reported by Özbilgin *et al*. (2006) for the North Sea haddock. Although statistically not significant, lowest L_{50} in spring was also detected for annular sea bream (Özbilgin *et al*., 2005) and picarel (Özbilgin *et al*., 2007). There are several factors such as spawning period, condition of fish, water temperature, and size structure of the population which changes seasonally and are expected to play a role in the selectivity.

Stage of gonad development is not investigated in this study. However, red mullet is known to spawn in June in the study area (Akyol *et al*., 2000). This was also confirmed by a survey carried out by Ege University, Fisheries Faculty on the same fishing ground in 2002 (Metin, 2005). This study indicates that red mullet starts to spawn in late May (GSI=3.50 on 25th May), completes the majority of spawning until late June (GSI=0.51 on 24th June) and some individuals continues to spawn through the summer (GSI=0.27 on 25th July, and 0.11 on 21st August). In other words, red mullet starts and almost completes spawning between the spring and summer selectivity trials of this study.

Condition of the fish is one potential reason that might influence selectivity. Özbilgin *et al.* (2006) reported that the best selectivity for haddock was obtained in September when the fish were in their best condition after summer feeding and the worst selectivity was seen in April when the fish were in their poorest condition at post spawning stage. However, in this study, similar effect is not observed. Because during the summer trip which coincides with post spawning stage, condition of the fish is better than it is in spring. Moreover, although fish are in their best condition in autumn, L_{50} value in this season is lower than both the summer and winter values. Therefore, the changes in fish condition on its own are not enough to explain the variation in selectivity.

Changes in water temperature is another possible reason for the seasonal variation in selectivity. It is well established that an increase in the water temperature is likely to enhance the swimming speed, hence the escape performance of the fish. He (1993) theoretically calculated the escape probabilities of fish from a moving net at various water temperatures. Özbilgin and Wardle (2002) demonstrated that a temperature rise from 7 to 12°C significantly increased the escape speed of haddock. The same effect was also observed for whiting (*Merlangius merlangus*) (Özbilgin, 2002). Similar effect of water temperature is also expected in this study. Water temperature was not recorded during these trials. However, monitoring data collected by *R/V K. Piri Reis* in the study area between 1994 and 2002 show that temperature recorded at the depths of 25 and 26 meters varies between 13.4 and 24.0°C. From this data, it can be estimated that approximate water temperatures in our experiments were 15°C in winter and spring, 19°C in summer, and 21°C in autumn. Therefore, relatively lower selectivities observed in winter and particularly in spring can be partially regarded to lower water temperature. The rise of mean L_{50} from 10.1 cm in spring to 11.1 cm in summer is also likely to be influenced by the temperature increase. However, temperature alone is not enough to explain the variation in selectivity, either. Because

Table 2. Seasonal length-weight relationships, weights (g), condition factors (CF), and number of the individual fish to make up one tonne of catch at minimum landing size (MLS=13.0 cm)

			R^2	N	W_{min}	W_{max}	Weight at MLS	CF at MLS	Number of fish in one tonne of catch
Spring	(12.04.2002)	$W=0.0070\ TL^{3.1601}$	0.95	98	8.6	48.7	23.19	1.0555	43122
Summer	(25.07.2002)	$W=0.0079\ TL^{3.1186}$	0.96	96	16.5	77.1	23.53	1.0710	42499
Autumn	(27.09.2002)	$W=0.0086\ TL^{3.0876}$	0.99	100	4.6	92.4	23.65	1.0765	42283
Winter	(08.01.2003)	$W=0.0077\ TL^{3.1091}$	0.98	100	8.1	47.5	22.38	1.0187	44683

although there is an approximately 2°C increase in temperature from 19°C in summer to 21°C in autumn, mean L_{50} value decreases from 11.1 cm in summer to 10.8 cm in autumn. Finally, although the temperature decreases from autumn to winter, the L_{50} increases from 10.8 to 11.0 cm. In other words, at the best body condition and the highest water temperature in autumn, L_{50} value (10.8 cm) was 0.2 cm lower than the winter L_{50} value (11.0 cm) obtained when the fish were in relatively poorer condition and the water temperature was approximately 6°C lower.

Changes in size structure of the population is another potential reason for the variation in selectivity. Kınacıgil *et al*. (2001) reported that red mullet caught in Izmir Bay distributed between I-III age groups, and age group I was dominant in the catch (62%). They estimated that fork lengths of the fish in age group I-II-III as 10.3, 13.4, and 15.4 cm, respectively. These values were converted to total length by using conversion formulation given by Tosunoğlu *et al*. (2003b) and total lengths for age groups I, II, and III were calculated as 11.7, 15.2 and 17.5 cm, respectively. The populations entering to the codend in this study show a similar age distribution to the findings of Kınacıgil *et al*. (2001). But additionally, there is an age class of IV year old fish at the lengths of 18-20 cm in autumn in the present study. Age class IV red mullet in Izmir Bay was also reported by Toğulga (1976). More distinctly, a new age class (0+) joins to the population in autumn. In conclusion, the population size structure in autumn shows a considerable variation from those in all other seasons.

Özbilgin *et al*. (2006) found the highest L_{50} for the North Sea haddock in autumn when the fish are in their best condition and the water temperature is at the highest point of its annual cycle. However, in this study L_{50} value for red mullet in autumn is lower than those in summer and winter. As described above, abundance of the juveniles in the populations entering to the codend is likely to cause this decline. It can be noted in Figure 1 that there are only 47 individuals smaller than 12 cm in the population entering to the codend in summer whereas in autumn 40% of the fish in terms of number are smaller than 12 cm. Although a great majority of these fish escapes, some of the relatively larger juveniles retain. Importance of size structure of the population on selectivity can also be seen by investigating the percentage of the overall escapes in each season and respective L_{50} values. Although the highest L_{50} (11.1 cm) was observed in summer, the lowest percentage of individuals (6.2%) also escaped in this season, while the lowest L_{50} (10.1 cm) was observed in spring, 20.8% of the individuals escaped from the codends. Although the L_{50} value in autumn (10.8 cm) was smaller than that in summer, the percentage of escapees (32.1%) was five times more than that in summer. Finally, although percentage of escapes in winter was higher (16.3%) than that in summer, the L_{50} value (11.0 cm) was even slightly lower.

There are many studies carried out on the selectivity of red mullet in the Mediterranean and particularly, in the eastern Aegean Sea (Ferretti and Froglia, 1975; Kınıkarslan, 1976; Livadas, 1988; Jukic and Piccinetti, 1988; Gurbet, 1992; Stergiou *et al*., 1994; Gurbet *et al*., 1997; Lök *et al*., 1997; Tokaç and Tosunoğlu, 1997; Tosunoğlu *et al*., 1997; Tokaç *et al*., 1998; Çıra, 1999; Tosunoğlu, 2000; Akyol *et al*., 2000; Kınacıgil *et al*., 2001; Fiorentini and Leonori, 2002; Özbilgin and Tosunoğlu, 2003; Tosunoğlu *et al*., 2003a; Tosunoğlu *et al*., 2003b). Results obtained in these studies are rather variable. However, relatively recent studies which used covered codend method with hoops and tested commercially used codends produced an L_{50} value around 11 cm and a Selection Range (SR) of about 2 cm. For example, Tosunoğlu *et al*. (2003b) carried out a trial in a nearby fishing ground to this study between 9 August and 4 September 2002 by using same material and methodology described in this study and found an L_{50} of 10.6 cm and an SR of 1.7 cm. Tosunoğlu *et al*. (2003a) also carried out a trial between 16 January and 14 February 2002 on the same fishing ground by using the same material and methodology described in this paper and found an L_{50} of 10.7 cm and an SR of 1.9 cm. Both these studies which were carried out by using the same codend described in this study produced L_{50}s which fairly fit to the pattern of seasonal changes in L_{50}s found in this study.

Seasonal variation in the selectivity of commercially used trawl codend (measured as 44 mm by wedge gauge with 4 kgf) was also reported by Kınacıgil *et al*. (2001) in a study carried out in Izmir Bay between January and December 1997. Although the codends used in both the studies have similar mesh sizes, and the both were made of PE, there are significant differences between the results of these two studies. L_{50}s and SRs, respectively, reported by Kınacıgil *et al*. (2001) are as follows; 10.5 and 7.8 cm in spring, 14.1 and 5.1 cm in summer, 11.5 and 2.2 in autumn, and finally 9.1 and 3.1 in winter. The seasonal variations in these selection parameters are much greater than the results reported in the present study. Accept for 1 cm lower L_{50} value in winter and 0.1 cm lower SR in autumn, all the other parameters are relatively much higher in Kınacıgil *et al*. (2001), in which seasonal population age structures were not provided, the data from relatively smaller number of hauls were pooled over each season, and analysed by using a different software (L_{50} Ver:1.0.0 written by Ilkyaz *et al*. (1998)).

Length weight measurements carried out in this study (Table 2) indicates that fish are in their poorest condition in winter. Therefore, in winter relatively higher numbers of individual fish are required to obtain the same amount of weight in comparison to the other seasons.

L_{50}'s found in all the seasons in this study demonstrate that commercially widely used 40 mm nominal mesh size PE codend (although the legal mesh size is 44 mm) is rather unselective for red mullet in the Aegean Sea. During all the trials of this study the L_{50} values were significantly lower than the MLS of 13 cm. Although, the changes in water temperature, stage of gonad development and fish condition might have possible influences on selectivity, position of the dominant age classes in the length frequency figures of red mullet is likely to be the major factor defining the position of the seasonal selection curves of codends used in Turkish demersal trawl fisheries.

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