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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Comparison of selectivity of the trawl codends for whiting (*Merlangius merlangus euxinus*) in the Black Sea

Karadeniz'de Mezgit (*Merlangius merlangus euxinus*) avcılığındaki trol torba seçiciliklerinin karşılaştırılması

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Abstract: A large part of the total whiting (*Merlangius merlangus euxinus*) fishing in the Black Sea is carried out with the traditional bottom trawl nets along the coast of Turkey. Diamond mesh shape with 40 mm mesh size (40D) has been used in the codends of these trawls. In this study, the traditional trawl codend (40D) and square-mesh codend with different size (36S and 40S) were compared for whiting size selectivity in August 2014. Selectivity data were collected by using a covered codend method and analysed taking between haul variations in to account. The selectivity parameters were estimated by using CC2000 software. Results showed that commercially used 40D trawl codend is not selective enough to release immature of whiting. However, the net change in square mesh (36S and 40S) instead of a diamond-shaped (40D) mesh significantly improved the mesh selectivity for whiting. The 40S trawl codend is even higher than the first maturity size (L_{M50}) with a length at fifty percent retention (L_{50}) of 15.74 cm. In conclusion all square mesh codends with different mesh size tested here supplied appropriate selection considering minimum landing size (MLS) of whiting.

Keywords: *The Black Sea, whiting, codend selectivity, diamond mesh, square mesh*

Öz: Karadeniz'de toplam mezgit (*Merlangius merlangus euxinus*) balığı avcılığının büyük bir kısmı, Türkiye kıyılarındaki geleneksel dip trol ağları ile gerçekleştirilmektedir. 40 mm ağ göz büyüklüğünde (40D) baklava gözlü ağlar bu trollerin torbalarında kullanılmaktadır. Bu çalışmada, geleneksel dip trol torbası (40D) ve farklı ağ göz büyüklüğündeki kare gözlü (36S ve 40S) trol torbaları mezgit balığının boy seçiciliği için mukayese edildi. Seçicilik verileri bir örtü torba yöntemi kullanılarak toplandı ve çekimler arası varyasyonlar hesaba katılarak analiz edildi. Seçicilik parametreleri CC2000 programı kullanılarak hesaplandı. Sonuçlar ticari olarak kullanılan 40D trol torbasının mezgit balığının olgunlaşmamış bireyleri için seçici olmadığını göstermiştir. Oysa baklava gözlü (40D) trol torbası yerine kare gözlü torba (36S ve 40D) değişikliği mezgit balığı için ağ göz seçiciliğini önemli ölçüde artırmıştır. 40S trol torbası 15,74 cm yüzde elli yakalanma oranı (L_{50}) ile ilk üreme boyundan daha yüksektir (L_{M50}). Sonuç olarak çalışmada denemeye alınan farklı ağ göz boyundaki tüm kare gözlü torbalar, mezgit balığının karaya çıkarılma büyüklüğü (MLS) göz önünde bulundurulduğunda uygun seçicilik sağlamıştır.

Anahtar Kelimeler: *Karadeniz, mezgit, torba seçiciliği, baklava gözlü ağ, kare gözlü ağ*

INTRODUCTION

In 2016, the amount of whiting landed by countries in the Black Sea is 10997.5 tons. Approximately 99% of this amount is captured by Turkey (STECF, 2017). It is a bento-pelagic species also called Black Sea whiting is caught by different fishing gears such as bottom trawl, gill nets and fishing lines. Some studies report that the length of the first maturity (L_{M50}) of whiting is 12.9-14.7 cm for females and 12.5-13.9 cm for males (İşmen, 2002; Bilgin et al., 2012). At the same time, the Minimum Landing Size (MLS) of this species is stated to be 13 cm (Anonymous, 2016). In the 1980s, while the amount of whiting landed was 30 thousand tons, it has decreased about three times in the last 10 years. In parallel with this decreasing, the mean total length of landing whiting has reduced from 19.7 cm in 1990 to 8.9 cm in 2011(Gümüş and Zengin 2011). Among the most important reasons for this decrease in length groups are increased fishing effort and illegal fishing (infringements of time, area and mesh size) (Santiago et al., 2015; Veiga et al., 2016).

A good fishing management wishes to use fishing gears that allow small individual to escape while large individuals are caught (Armstrong et al., 1990). This describes the selectivity of the fishing gear, depending on such factors as age, height and species (McLennan, 1992). Selectivity is also an important means of reducing mortality from fisheries and increasing the growth potential of the stock (Metin et al., 2005; Macher et al., 2008). The most effective way to increase selectivity is to increase the mesh size and to make changes in the form of mesh shape (Özbilgin et al., 2005a; Sala et al., 2008; Sala et al., 2015; Tosunoğlu et al., 2009; Aydın and Tosunoğlu 2010; Brčić et al., 2018). Besides, European Council Regulation (EC) No 1967/2006, concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean advised that it is legal to use two different codend designs in the demersal trawl fisheries: a square mesh codend with a minimum 40 mm mesh size or if the ship owner makes a justified request, a diamond mesh codend with a minimum 50 mm mesh size.

Turkish Fisheries Regulations (TFR) allow using 40 and 44 mm diamond mesh in the codend for the Black Sea and for the Aegean and Mediterranean Seas, respectively or optional fisherman can use 40 mm square mesh codend (Anonymous, 2016). Many studies have shown that this traditional trawl codend is rather poor selective (Özbilgin and Tosunoğlu 2003; Tokaç et al., 2004; Özbilgin et al., 2005a; Özbilgin et al., 2012; Tosunoğlu et al., 2008; Deval et al., 2009; Ateş et al., 2010; Aydın et al., 2011). Many external and internal factors (such as mesh size, twine material, towing speed and catch weight) affect codend selectivity; moreover, diamond mesh tends to close under the effect of towing, causing a reduction in the opening angle (Robertson and Stewart 1988). Many researchers supported the use of square-mesh codend to increase trawl selectivity, especially for round-shaped fish (Bahamon et al., 2006; Ordines et al., 2006; Sardà et al., 2006; Sala et al., 2008; Aydın and Tokaç, 2015).

The General Fisheries Commission for the Mediterranean (GFCM) has supported scientists to carried out selectivity studies and investigate the biological and socio-economic effects of 40 mm square mesh and 50 mm diamond mesh in demersal trawl fleets (GFCM, 2010). Although most of the whiting are landed by demersal trawls in the Black Sea, there has a limited number of studies related to trawl selectivity according to the selectivity studies in other regions (Mediterranean and Aegean Sea) (Zengin and Düzgüneş, 1999; Özdemir et al., 2012). The use of optionally square mesh in the Black Sea is given to the fisherman by the Turkish Fisheries Regulations (Anonymous, 2016). However, neither the Black Sea trawler nor scientists have studied with full 40 mm square mesh codends. For this reason, *M. merlangus euxinus* selectivity of current trawl codend (40D) was compared with two different square mesh size (36S and 40S) codends.

MATERIAL AND METHODS

Selectivity experiments were conducted between August 22 and 26, 2014 on board the commercial bottom trawler "*Malkoç Bey*" (31 LOA, 1300 HP main engine) in the coastal water of Samsun, the southern Black Sea (Turkey) (Figure 1). The trawl (with 900 meshes around the circumference of the mouth) was a typical commercial bottom trawl used by the demersal fishery in this region (Figure 2). All hauls were carried out at depths ranging from 30 to 51 m during daylight hours, and a towing duration of between 60 and 85 minutes. The towing speed ranged from 2.8 to 3.0 knots (approximately 5.2-5.6 kmh^{-1}) as in commercial trawling.

The selectivity of trawl codends with different mesh size (36 and 40 mm) and mesh shape (diamond and square) were compared in 16 valid hauls. In total three trawl codends made of knotted polyethylene (PE) material was tested. The control codend was a commercially used codend having 40 mm mesh opening and 300 meshes on its circumference. The test codends were square mesh codends with 36 mm and 40 mm nominal mesh opening respectively (36S and 40S), and 150 meshes (bar) on the circumference. They were attached to the extension piece which had 300 meshes in its circumference and was made of 40 mm nominal mesh size PE netting. All the codends were approximately 4-4.5 m in stretched lengths. They were attached to the end of the funnel which was 300 meshes in its circumference and made of 40 mm mesh size PE netting.

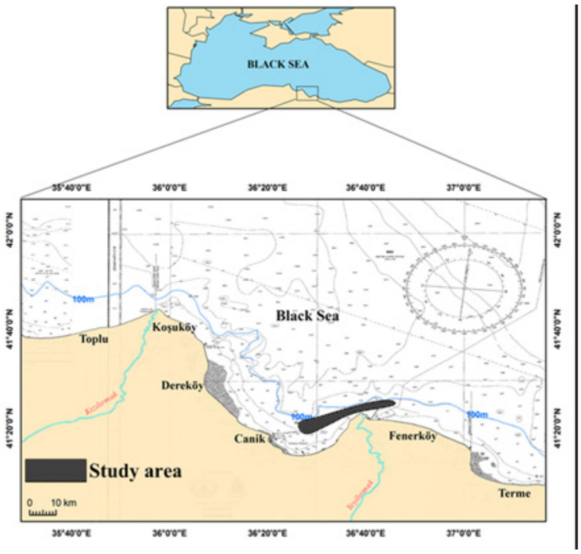

Figure 1. Trawl operation area for whiting

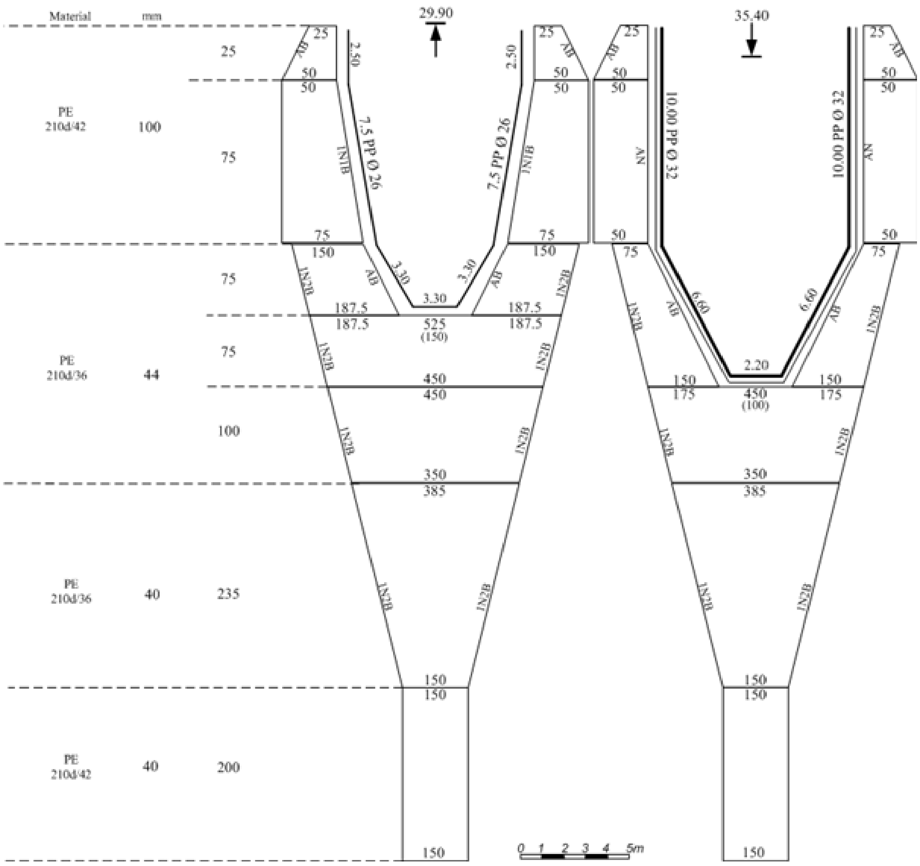

Figure 2. Technical drawing of 900 meshes in conventional bottom trawl

Selectivity was measured using the covered codend technique, where a PA cover with a nominal mesh opening of 24 mm and 8.2 m in length was used to collect the individuals that escaped the codend (Wileman et al., 1996). The cover was supported by two circular hoops (PVC Ø 1.6 m) to keep it clear off the codend, to avoid the masking effect and to provide water flow between the codend and the cover. These hoops were mounted on the cover at distances of 2.2 and 5.2 meters from the attachment point at the end of the funnel. At the end of each tow, once the net was hauled onboard, the cover catch was first emptied; the catch was sorted by species, and then weighed. The same procedure was followed for the codend catch. Total lengths of full or subsamples of the target species were then measured to the nearest cm below. Logistic selection curves in each haul were obtained by fitting the logic function:

$$r(l) = \exp(v_1 + v_2 l) / \left[1 + \exp(v_1 + v_2 l)\right]$$

where *r(l)* is the retained proportion of length class *l*, given that it entered the codend (Wileman et al., 1996), and v= $(v_1, v_2)^T$ is the vector of the selectivity parameters. The length at fifty percent retention (L_{50}) were estimated from the expressions:

$$L_{50} = \frac{-v_1}{v_2}$$

These parameters were calculated with CC 2000 software (ConStat, 1995). Mean selectivity curves for whiting in each haul were estimated taking into account the between haul variation of the selectivity parameters v_1 and v_2 according to Fryer (1991). Between haul variation model (Fryer, 1991) was used for modeling the selectivity data by estimating the individual contribution of mesh configuration (m_i), nominal mesh size (s_i), haul duration (t_i), trawling depth (d_i), and catch size (c_i), to the selectivity parameters for whiting. EC Modeller software (ConStat, 1995), which adopts residual maximum likelihood (REML) method proposed by Fryer (1991) was used for models, including between haul variation. The model that best fitted the data was chosen according to the lowest value of Akaike's Information Criterion-AIC (Fryer and Shepherd, 1996).

RESULTS

All of the 16 valid hauls were used in the individual haul analysis: 5 hauls for 36S, 6 hauls for 40S and 5 hauls for 40D. Whiting was the dominant species with approximately 80% by weight among the species caught for depth above 30 m in all codend. As can be seen in Table 1, red mullet which is one of the important commercial species of Black Sea has hardly ever been caught in these areas. However, it has been observed that other dominant species are stingray species (Table 1).

Whiting discard ratios of both the weight and the number of commercial trawl codend (40D) are between 20-25%. It was determined that discard rate of the species in the 36S and 40S codends was 1% or less. Whiting was caught an average of 334.4 kgh^{-1} for each haul during about 20 hours total operation. In the trials, a total of 364631 whiting individuals were captured. The number of this value were 16%, 46%, and 39% 36S, 40S and 40D codends, respectively. 53% of the whiting caught with the 40D trawl codend were found to be composed of individuals below the MLS value. The same was calculated as 27% for 36S and 5% for 40S.

Selectivity and regression parameters with their standard errors, variance matrix values and the number of the fish caught in the codend and cover every single haul as well as mean curves for each codend are given Table 2. Mean L_{50} values of 13.55, 15.74, and 10.18 cm and mean SR values of 1.61, 1.81, and 2.59 cm were estimated for 36S, 40S, and 40D, respectively (Table 2). The L_{50} values obtained for each valid hauls in the 40D trawl codend test are very low for both MLS and L_{M50}.

Looking at Figure 3, there are obvious differences between the confidence intervals of the L_{50} values of the codends. It is observed that there is a significant difference between the values of square and diamond mesh trawl codends (Figure 3).

Table 1: Total weights (kg) of some species caught in each codend (separately as Marketed-M, Discarded-D and Escaped-E) and cover were recorded for each valid haul

Species	36S			40S			40D		
	Codend		Cover	Codend		Cover	Codend		Cover
	M	*D*	*E*	*M*	*D*	*E*	*M*	*D*	*E*
M.merlangius euxinus	**116.4**	**6.5**	**675.3**	**283.5**	**2.9**	**2160.0**	**1217.0**	**423.0**	**485.9**
M. barbatus	0.6								
Psetta maxima	33.5	4.0		16.9	2.6		11.9	0.6	
Platichthyis flesus	2.5	1.3		2.7	1.8		0.7	1.0	
Raja clavata		179.0			188.5			56.9	
Dasyatis pastinaca		6.0			5.6				
Aurelia aurita		28.8			0.1				
Spratus spratus								9.5	234.0
Mesogobius batrachocephalus								0.5	
Neogobius melanostomus		10.4	14.0	0.1	2.4			2.7	
Gobius niger		7.6	57.0		1.2			2.7	
Others	1.6	12.1			17.9		0.1	20.2	14.3
Total	**154.5**	**255.7**	**746.3**	**303.2**	**223.0**	**2160.0**	**1229.7**	**517.0**	**734.2**

Table 2: Selectivity parameter estimates and number of specimens in the codend and cover for whiting in 36S, 40S, and 40D codends [L_{50} (cm), length at 50% retention; SR (cm) selection range; SE standard error; v_1 and v_2 maximum likelihood estimators of selectivity parameters; R_{11}, R_{12}, and R_{22} variance matrix measuring within haul-variation; d.f. degrees of freedom]

	Haul no	L_{50}	(SE)	SR	(SE)	v_1	v_2	R_{11}	R_{12}	R_{22}	Deviance	d.f.	p-value	Codend	Cover
36S	1	**13.86**	(0.12)	**1.81**	(0.12)	-16.863	1.217	1.0190	-0.0807	0.0064	223.49	18	0.00	2040	25220
	2	**14.26**	(0.23)	**1.76**	(0.20)	-17.823	1.250	3.2546	-0.2547	0.0201	235.18	18	0.00	593	13395
	3	**13.69**	(0.10)	**1.27**	(0.13)	-23.641	1.727	5.4488	-0.4069	0.0305	305.93	21	0.00	1580	7363
	4	**12.93**	(0.12)	**1.78**	(0.16)	-15.944	1.233	2.0620	-0.1622	0.0129	110.43	21	0.00	771	1718
	5	**13.05**	(0.11)	**1.55**	(0.12)	-18.540	1.421	1.7709	-0.1416	0.0114	111.42	22	0.00	745	4284
	Mean (Fryer)	**13.55**	(0.11)	**1.61**	(0.04)	-18.069	1.334	1.0508	-0.0729	0.0056				5728	51980
40S	1	**14.21**	(0.21)	**1.58**	(0.15)	-19.755	1.390	2.5960	-0.2053	0.0165	225.59	23	0.00	373	38409
	2	**15.88**	(0.16)	**2.01**	(0.16)	-17.335	1.092	1.5965	-0.1088	0.0075	211.23	25	0.00	853	18920
	3	**16.14**	(0.21)	**1.64**	(0.21)	-21.644	1.341	6.3561	-0.4239	0.0284	970.37	24	0.00	1785	37177
	4	**15.85**	(0.21)	**2.70**	(0.29)	-12.901	0.814	1.6592	-0.1127	0.0077	259.68	19	0.00	1425	6021
	5	**16.11**	(0.10)	**1.20**	(0.10)	-29.417	1.826	5.2799	-0.3427	0.0223	309.16	23	0.00	1376	23332
	6	**15.83**	(0.08)	**1.94**	(0.09)	-17.945	1.134	0.6669	-0.0449	0.0030	247.35	24	0.00	4066	32315
	Mean (Fryer)	**15.74**	(0.29)	**1.81**	(0.08)	-19.388	1.232	4.8587	-0.2938	0.0181				9878	156174
40D	1	**9.92**	(0.12)	**2.09**	(0.19)	-10.412	1.050	1.0027	-0.0952	0.0092	333.17	21	0.00	7572	2520
	2	**10.04**	(0.17)	**3.01**	(0.27)	-7.321	0.729	0.5021	-0.0450	0.0041	1294.51	21	0.00	28729	9968
	3	**10.43**	(0.13)	**3.72**	(0.29)	-6.166	0.591	0.2522	-0.0225	0.0021	852.03	23	0.00	22494	14023
	4	**10.06**	(0.10)	**1.62**	(0.17)	-13.621	1.353	1.9849	-0.2003	0.0204	1960.99	24	0.00	18689	17670
	5	**10.53**	(0.11)	**2.78**	(0.20)	-8.338	0.792	0.3637	-0.0337	0.0032	473.44	21	0.00	10807	8400
	Mean (Fryer)	**10.18**	(0.05)	**2.59**	(0.16)	-9.047	0.889	1.5366	-0.1577	0.0162				88291	52581

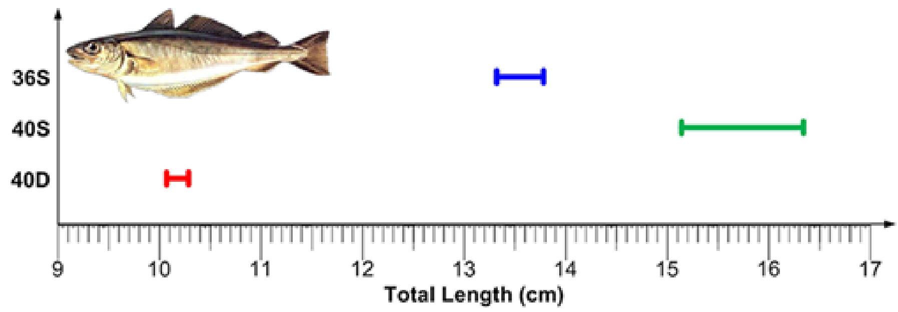

Figure 3. An illustration of the confidence intervals of the L_{50} values in the codends

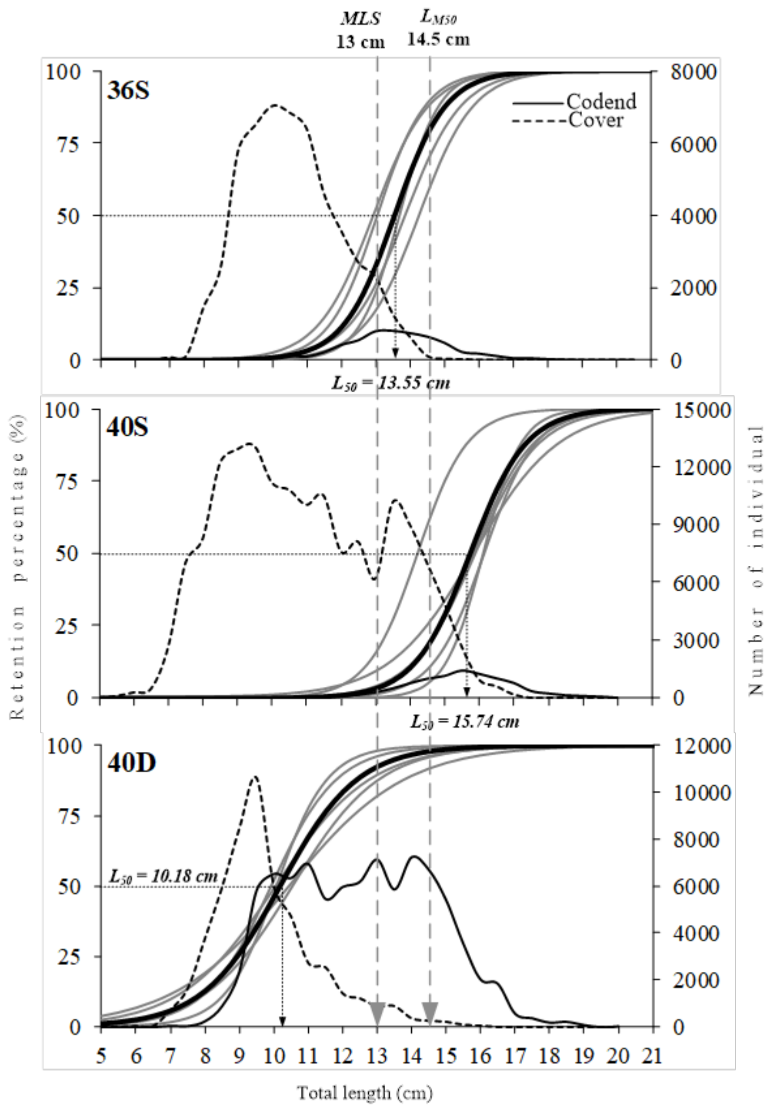

Figure 4. Individual (grey line) and mean selective curves (black line) with L_{50} values for all codends, and length frequency distributions of whiting in codend and covers

Figure 4 shows individual hauls, mean selectivity curves and L_{50} values for all codends as well as the length frequency distributions of observed in the two compartments (cover and codend). The population was generally dominated by specimens below the MLS and L_{M50} values. Length frequency distribution of whiting were bimodal with a major peak at about 8-11 cm and a minor peak at about 13-15 cm (Figure 4). For the 40D, 36S and 40S trawl codends in the study, the average size of the whiting fish obtained was 11.52, 11.04 and 11.58 cm, respectively. According to the L_{50} value, the 36S and 40S codends were 33% and 55% better than the 40D codend, respectively. The 40S codend gave the best results for the whiting of both the MLS and L_{M50} values. Lower SR values were obtained with square-mesh codends (36S and 40S) compared to 40D codend.

$$E\begin{pmatrix} L_{50} \\ SR \end{pmatrix} = \begin{pmatrix} \alpha_1 + \alpha_2 m_i + \alpha_3 s_i \\ \alpha_4 s_i + \alpha_5 c_i \end{pmatrix}$$

where mesh configuration (m_i), nominal mesh size (s_i), codend catch weight (c_i) and $\boldsymbol{\alpha}$ is the vector that determines the direction and magnitude of the influence of the explanatory variables on the selectivity parameters (L_{50} and SR). The result of the alpha parameters estimates is given in Table 3. Mesh configuration and mesh size had a significantly positive effect on L_{50} (P =0.000). On the SR value, the mesh size (P= 0.000) and the catch size (P= 0.002) were effective. But haul duration and trawling depth variables did not contribute significantly to the model. The use of square mesh codend instead of diamond mesh codend significantly increased the L_{50} value.

DISCUSSION

In this study, the selectivity of diamond (40D) and square mesh (36S and 40S) trawl codends for whiting, the target species of Black Sea bottom trawl fishery, was investigated. Commercially used 40D trawl codend is not selective enough to release immature of whiting.

The L_{50} value of the 40D trawl codend is lower 21.7% and 29.8% than MLS and L_{M50}, respectively (Figure 4). However, the net change in square mesh (36S and 40S) instead of a diamond-shaped (40D) mesh significantly improved the mesh selectivity for whiting. The 40S trawl codend is even higher than the L_{M50} with an L_{50} of 15.74 cm. As a result, it has been determined that the use of square mesh in the trawl codend would be beneficial for whiting selection.

There are very few studies on the selection of whiting the most important target species of the bottom trawl fishery in the region (Zengin and Düzgüneş, 1999; Genç et al., 2002, Özdemir et al., 2012). Only Zengin and Düzgüneş (1999) was studied selectivity of square and diamond mesh codend. Özdemir et al., (2012) compared the selectivity of the traditional codend (40D) and square mesh panels (38 and 40 mm) while Genç et al., (2002) examined the effect of different mesh sizes (28, 32 and 40 mm diamond mesh) on the whiting selectivity (Table 4). Factors such as the analysis methods, the methodology, the season in which the experiments are carried out, the internal (twine material and thickness, codend circumference, etc.) and the external factors (haul duration, towing speed, depth, catch size etc.) used in the selection studies can affect selectivity (Dahm et al., 2002; Tokaç et al., 2004; Herrmann, 2005; Sala et al., 2007; Broadhurst and Millar, 2009; Wienbeck et al.; 2011). The difference between the L_{50} values of the 40D trawl codend in the current and previous studies may be due to the above factors.

Table 3. Alpha parameter estimates, standard deviation (S.D.), t-Values, degrees of freedom (d.f.) and p-Values. α is the vector determining direction and influence magnitude of explanatory variables on selectivity parameters (L_{50} and SR)

		Estimate	S.D.	*t*-Value	d.f.	*p*-Value
α_1	(L_{50}, constant)	**-11.097**	3.306	-3.356	24	0.003
α_2	(L_{50}, m_i)	**5.467**	0.330	16.592	24	0.000
α_3	(L_{50}, s_i)	**0.533**	0.082	6.460	24	0.000
α_4	(SR, s_i)	**0.039**	0.004	8.822	24	0.000
α_5	(SR, c_i)	**0.003**	0.001	3.573	24	0.002

Table 4. Results of previous selectivity studies and the current work for whiting in the Black Sea coast of Turkey

References	Material	Mesh size	Mesh shape	L_{50} (cm)	SR (cm)
Zengin and Düzgüneş (1999)	PE	36	D	13.1	5.10
	PE	40	D	14.8	4.20
	PE	44	D	15.1	4.20
	PE	40	S	15.4	3.90
Genç et al. (2002)	PE	28	D	10.76	3.43
	PE	32	D	12.68	5.42
	PE	40	D	13.54	3.32
Özdemir et al. (2012)	PE	40	D	12.57	3.45
	PE	38	S	12.71	3.12
	PE	40	S	13.55	3.70
Current study	**PE**	**40**	**D**	**10.18**	**2.59**
	PE	**36**	**S**	**13.55**	**1.61**
	PE	**40**	**S**	**15.74**	**1.81**

Ceylan et al., (2014) stated that some of the fishermen in the Black Sea are using small diamond mesh size in their trawl codends cause lower selectivity. In previous studies (Zengin and Düzgüneş, 1999; Özdemir et al., 2012), selectivity of whiting improved by the use of various type of square mesh codend (square mesh window and panels). Similar results were obtained in the present study (36S and 40S). Whiting is a round-shaped fish, which makes it easier to escape from square-mesh nets. In many studies it is reported that square mesh nets in round-shaped fish are more selective than diamond mesh in the same mesh size (Stewart, 2002; Sala et al., 2008). Because, under low load, diamond meshes are easier to close than square meshes, so they do not allow small individuals to escape (Robertson and Stewart, 1988; Guijarro and Massuti, 2006). Tokaç et al., (2016) report that mesh openness value is an important factor for selectivity, and squared mesh are more selective for this reason. At the beginning of the most effective way to improve the selectivity in the trawl codend, there are applications to be done in the form of mesh configuration and mesh size (Sala et al., 2015). In this study, the model results are statistically significant on L_{50} both in mesh size and mesh configuration (P = 0.000). Many studies have clearly demonstrated that square mesh codends capture fewer juveniles than diamond mesh codends (Sala et al., 2008; Aydın et al., 2011; Özbilgin et al., 2012; Tokaç et al., 2016; Tosunoğlu et al., 2009). In this study, the number of small whiting that escape from the 36S and 40S is more than the 40D. However, L_{50} values in the 40S can cause a major economic loss for fishermen. Eryaşar and Özbilgin (2015) point out that the transition from the diamond to the square mesh (40S) has a 40% economic loss for the fisherman. The fisherman is convinced to use a square mesh in the codend, but may prefer a smaller mesh than 40S because of economic loss. Even the 36S selectivity results in the study are better than 40D compared to the MLS value. On the other hand, full square mesh cod-ends are unpopular with the fishing industry because they lack strength, the knots can be unstable and the nets are awkward to handle and repair (Graham et al., 2003; Metin et al., 2005).

In the last 20 years, it is the first study on codend selection with full square meshes for whiting in the Black Sea. The results of the study showed that square-mesh codends for sustainable whiting fisheries in the Black Sea of bottom trawl fishery are more useful than traditional codend. The region has a special structure due to the depth contours of whiting (> 50m) and red mullet (50 <) (İşmen, 2002; Yıldız and Karakulak, 2017). Whiting, which is a cold water fish, is generally found deeper than 40-45 m throughout the year, whereas red mullet is more common in shallow water than 30 m (Zengin et al., 2015). Kaykaç et al., (2018) indicates that a 40S trawl codend will contribute to the preservation of the red mullet stocks. These results support the use of square mesh codends for whiting and red mullet in the region. But it is undeniable that fishermen would prefer a square codend with smaller mesh instead of 40S. However, the results indicate that the 40S codend is more effective in terms of selectivity and sustainability of these species. Therefore, there is a need to study the economic losses of the fisherman as well as selectivity study.

In recent years, escape mortality (due to skin injures and exhaustion) as well as selectivity of trawl codends is of great importance (Düzbastılar et al., 2015; Düzbastılar et al., 2017). It is thought that changes in morphology may also have an effect on selectivity due to features such as reproduction period and behaviours of fish. Several factors, such as spawning period, condition of fish, water temperature, and size structure of the population, change seasonally and are expected to play a role in selectivity (Özbilgin et al., 2005b). For this reasons, in subsequent studies, it is required that square-mesh codend selection trials are carried out in the all fishing season, that the behaviour of the species in the trawl codend is known and that the survival rates of these species must be ascertained.

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