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RESEARCH PAPER

Codends Selectivity for Bogue (*Boops boops* L., 1758) in the Eastern Mediterranean Demersal Trawl Fishery

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Abstract

This study investigated the selectivity of 90° turned meshes of 40 mm mesh size with 165 meshes around codend circumferences (40T1), 44 mm meshes size with 300 meshes around codend circumferences (44T1) and 44 mm mesh sizes with 150 meshes around codend circumferences (44T2). Experiments were carried out in the Kuşadası Bay of the Eastern Mediterranean, between 19 January and 29 March 2015 with commercial stern trawler. Selectivity data were collected using the covered codend method and analysed by means of a logistic equation with the maximum likelihood method. Individual hauls and mean selectivity parameter were estimated by using the CC2000 and EC-Modeller software, respectively. The mean 50% retention total length values (L_{50}) and selection range (SR) were 12.7 cm and 2.3 cm for 40T1, 13.2 cm and 3.5 cm for 44T1 and 13.8 cm and 3.0 for 44T2, respectively. Significant differences were determined among the L_{50} values of the codends (between 40T1 and 44T2) ($P<0.05$). However, there are no statistical difference between the 40T1 and 44T1, 44T1 and 44T2 ($P>0.05$). On the other hand, L_{50} values of 40T1 and 44T1 are very close considered to the 13 cm length at first maturity size of the species.

Keywords: *Boops boops*, demersal trawl, size selectivity, codend, turned meshes.

Introduction

The Mediterranean fisheries are multi-species character and trawl is one of the most important fishing techniques obtaining demersal and semi pelagic fish species. Selectivity is the most useful tool for management of exploitation of the trawl net and the main components of a stock assessment for Mediterranean fisheries (Stewart, 2002; Rinelli, Giordano, Perdichizzi, Greco, & Ragonese, 2005). Studies have shown that effective escapement can occur while a trawl is being towed, and that the codend is the primary selective part of the net (Wileman, Ferro, Fonteyne, & Millar, 1996). Therefore, many studies have conducted on the relationship between codend mesh size and the size of the target species escaping.

There are many selectivity studies carried out with different mesh size, material and shape in the Turkish seas. Recent studies have shown that the selectivity of diamond mesh codend used commercially (nominal 40 mm or 44 mm diamond) by Turkish demersal trawlers is rather poor (Özbilgin & Tosunoğlu, 2003; Tosunoğlu, Özbilgin & Tokaç, 2003a; Tosunoğlu, Doğanyilmaz & Özbilgin, 2003b; Tokaç, Özbilgin & Tosunoğlu, 2004). Turkish Fisheries Regulations (TFR) allow trawlers to use a minimum of 40 and 44 mm codend diamond mesh size in the Black Sea and the remain Turkish waters, respectively. 40 mm square meshes codend was adopted in September 2008 as an alternative for the 44 mm diamond mesh codend (Anonymous, 2008). In addition, in order to improve selectivity and reduce fishing mortality, from August 2013 TFR also defines a new regulation for codend circumference that number of the codend meshes shall not be more than half of the number of meshes around the tunnel (Anonymous, 2012). Unfortunately, this regulation was removed from the notification (Anonymous, 2016). On the other hand, T90 codends, in which standard diamond mesh netting is turned 90° could potentially improve size selective properties compared with traditional codends made of the same netting. As standard conventional netting can be used, a T90 codend is a very simple way to potentially improve the size selectivity of the fishing gear (Madsen, 2007). T90 mesh codend was initially tested for determination of selectivity of cod (Moderhak, 1997) and then this netting has been the focus of increased scientific interest in recent years (ICES,

2011). It was included in the legislation for the Baltic Sea cod (*Gadus morhua*) fishery in 2006 (ICES, 2011).

Bogue, (*Boops boops* Linnaeus, 1758) is a commercial species and living on all types of bottom, as well as semi-pelagic, and sometimes in coastal waters. It is caught on line gear, with bottom trawls and purse seine; also with beach seines and trammel nets (FAO, 2016). The species distribution whole of Mediterranean, rare in Black Sea. Eastern Atlantic from Norway (occasional) to Angola, and oceanic islands (Azores, Madeira, Canary, Cape Verde, Sao Tome-Principe) (Monteiro *et al*., 2006; Froese & Pauly, 2015). Bogue is common and important landed seabreams, having reached 2226.6 tonnes (t) in Turkey (TUIK, 2015). The total landing of bogue distributed as 1666.2, 548 and 511.5 tons for Aegean Sea, Mediterranean Cost of Turkish Sea and Sea of Marmara, respectively. Although bogue has a market value as 1 Euro for per kg, there is no minimum landing size (MLS) regulation for the species in Turkish seas. On the other hand, various lengths at first maturity (LFM) were reported from different countries; combined sex LFM were presented as 13 cm from western Mediterranean (Bauchot & Hureau, 1986), 15 cm from Gulf of Lion (Girardin, 1981), 14 cm from Portugal (Gordo, 1995), 15.5 cm from Portugal (Monteiro *et al*., 2006) and 11.2 cm from Aegean Sea (Kınacıgil *et al*., 2008).

There are many selectivity studies carried out with different mesh size, material for fish and crustaceans in the Turkish demersal trawl (ICES, 2006). However, there is very little information for bogue selectivity. Ateş, Deval, Bök, and Tosunoğlu (2010) present the 44 mm polyamide (PA) diamond mesh codend and 40 mm polyethylene (PE) square mesh codend. Eryaşar *et al*. (2014) gave L_{50} values for standard nominal 44 mm PE mesh codend (300 meshes on its circumference) and narrowed (150 mesh) codends for the species. Both studies were conducted on Mediterranean coast of Turkish seas.

This study was aimed to investigate the selectivity of 90° turned meshes of 40 mm mesh size with 165 meshes around codend circumferences (40T1), 44 mm meshes size with 300 meshes around codend circumferences (44T1) and 44 mm mesh sizes with 150 meshes around codend circumferences (44T2) for bogue. This paper presents the first selectivity results of the 40 and 44 mm turned mesh codend for bogue from the Aegean Sea.

Materials and Methods

Experiments were carried out in the Kuşadası Bay of the Eastern Mediterranean, between 19 January and 29 March 2015 with commercial stern trawler "Efsane G" (19.85 m LAO and 500HP engine power) on an international water of commercial fishing ground. Sampling depths ranging from 65 to 215 m. The average haul duration and trawling speed were 178.1 minutes (110-250 min) and 2.8 knots (2.5 - 2.9), respectively. A modified 900 meshes fishing circle demersal trawl net was used in the sampling (Figure 1).

Three different codend were tested;

a) 90° turned meshes of 40 mm mesh size with 165 meshes around codend circumferences (40T1),

b) 44 mm meshes size with 300 meshes around codend circumferences (44T1),

c) 44 mm mesh sizes with 150 meshes around codend circumferences (44T2).

All codends were knotted PE 380d /21 no and 5 m in length. The codends were mounted end of the tunnel consisted of 44 mm mesh size of 300 meshes in circumferences. The mean mesh size of each codends was measured with an OMEGA mesh gauge (Fonteyne, Buglioni, Leonori, O'Neill, & Fryer, 2007) at 50 N when the netting was wet. The mean values were found 40.4±0.17 mm for 40T1 and 45.4±0.20 mm for both 44T1 and 44T2. A protective bag was laced around the codend (made of 5.0 mm polypropylene (PP) twine, nominal 130 mm mesh sizes, 65 meshes on its circumference, and about 5 m in stretched length). The aft ends of the codend used and of the protective net were tied together in the operation.

Selectivity experiments were performed using the covered codend method (Wileman *et al*., 1996). A small mesh (24 mm polyamide knotless netting) cover, which was 8 m in length, was used to retain escapes from the codend. In order to prevent a masking effect, the cover was supported with a hoop 1.5 m in diameter. The hoop was made of PVC material, 50 mm in diameter, and mounted at a distance of 4 m from the ends of the funnel.

After each tow, catches from codend and cover were emptied on the deck separately. From the cover catch, the target species, *Boops boops* was sorted and the rest then weighed. Meanwhile, the crew of the fishing vessel manually sorted the marketable codend catch by species and left the discard on deck. In order to estimate L_{50} values, total lengths of all individuals were measured to the nearest cm.

Selectivity curves of the individual hauls were obtained by fitting the logistic function: $r(l) = \exp(v_1 + v_2 l) / [1 + \exp(v_1 + v_2 l)]$ by means of the maximum likelihood method as in Wileman *et al*. (1996), where the parameters v_1 *and* v_2 are the intercept and slope of the linear logistic function, respectively. Selectivity parameters for individual hauls were estimated by using the CC2000 software (ConStat, 1995). The mean selectivity of the individual hauls was calculated by taking into account between-haul variation according to Fryer (1991) using the ECModeller software which adopts the REML method (residual maximum likelihood) presented by Fryer (1991).

The choice of the model best-fitting the data was based on the lowest value for the Akaikes Information Criterion-AIC (Akaike, 1974) defined to be AIC =−2

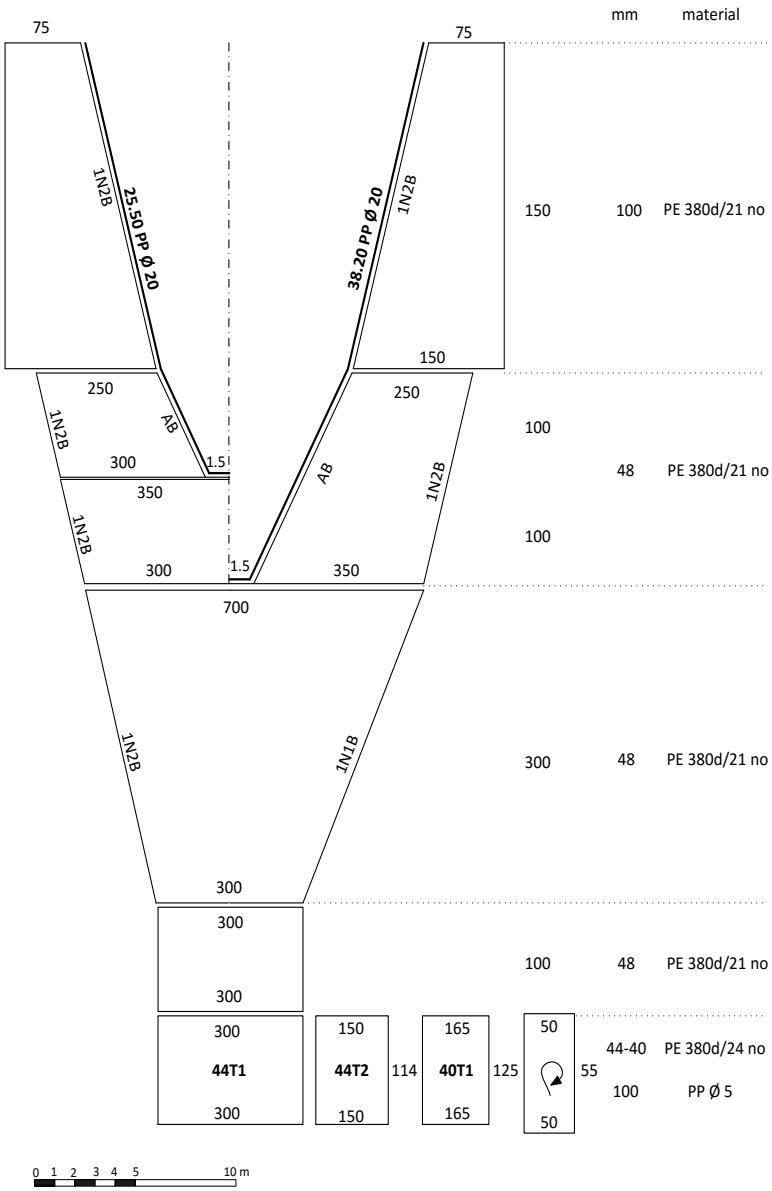

Figure 1. Trawl net and codends used in experiments.

log likelihood + 2 *np*, where *np* is the number of parameters (ConStat, 1995). The selectivity data was modelled according to Fryer (1991), by estimating the individual contribution of some explanatory variables to the selectivity parameters. Under these conditions ˆυi ~ N (Xiα, Ri + D) with an expected mean value:

$$E\,(vi) = E\,(\begin{matrix} vi1 \\ vi2 \end{matrix}) = Xi\alpha$$

where X_i *i*s the design matrix of the q explanatory variables for haul *i*:

$$X_i = (\begin{matrix} xi11 & xi12 & \dots & xi1q \\ xi12 & xi22 & \dots & xi2q \end{matrix})$$

and $(\alpha 1, \alpha 2, \dots, \alpha q)^T$ is the vector that determines the direction and magnitude of the influence of these variables on the selectivity parameters. Some of the explanatory variables effect on the L_{50} and SR values such as the mesh configuration, the total catch (codend and cover), the codend catch, the species catch and the haul duration were tested.

Results

A total catch biomass of 5.02 t, 1.73 t with 40T1 (12 hauls), 0.93 t with 44T1 (11 hauls 2.36 t with and 44T2 (11 hauls) and, during 100.9 trawling hours. Total catch obtained from all test codends is given in Table 1.

A total number of 6835 bogue was caught in the 40T1. While 78% of the specimens were retained with sizes ranging from 11 to 22 cm, 22% (1474) escaped ranging from 10 to 18.5 cm (Figure 2). In the 44T1 a

total number of 1559 specimens were caught: 62% (973) with a size range from 11 to 20 cm, and 38% (586) escaped, from 8 to 18 cm (Figure 3). In the 44T2 a total number of 1669 specimens were caught; 65% (1086) with a size range from 11 to 22 cm, and 35% (583) escaped, from 9 to 18.5 cm (Figure 4).

The size ranges of the bogue retained by all codends are multimodal. All length distributions show major peak at about 15-17 cm. However, the length distributions of the covers show only one peak, at 12-12.5 cm for the codends. A total of 14, 24.5 and 19.8% specimens were found below LFM in 40T1, 44T1 and 44T2, respectively.

Table 2 shows individual and mean 50 percent retention lengths (L_{50}), selection ranges (SR), and regression parameters with confidence interval for the test codends. The mean L_{50} values and SR were 12.7±0.11 cm total length and 2.3±0.14 cm for 40T1

Table 1. Catch composition of test codends

	40T1			44T1			44T2		
	Codend	Cover	Total	Codend	Cover	Total	Codend	Cover	Total
Weight (kg)	1398.4	336.4	1734.8	730.5	182.2	932.7	2138.0	219.3	2357.3
Horse mackerel (%)	20.1	30.9	23.5	8.7	16.8	10.2	3.1	19.9	4.6
Bogue (%)	10.2	9.8	10.4	4.9	7.0	5.3	1.7	7.4	2.2
Morocco dentex (%)	7.7	0.0	6.3	7.1	0.0	5.7	3.6	0.0	3.3
Red mullet (%)	6.3	5.7	6.3	10.3	10.3	10.3	4.0	16.2	5.0
European hake (%)	4.0	0.1	3.2	11.1	0.0	8.9	2.5	0.2	2.3
Deepwater rose shrimp (%)	3.3	9.0	4.6	5.9	16.5	7.9	0.6	5.3	1.0
Others (%)	48.4	44.5	45.7	52.2	49.4	51.6	84.5	51.0	81.6

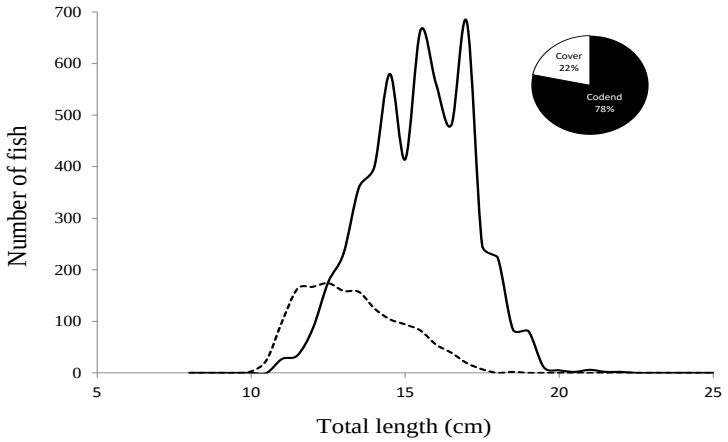

Figure 2. Length-frequency distribution of bogue in 40T1, (drawn lines: codend specimens, broken lines: cover specimens) and also circle diagrams percentages of the species in terms of number.

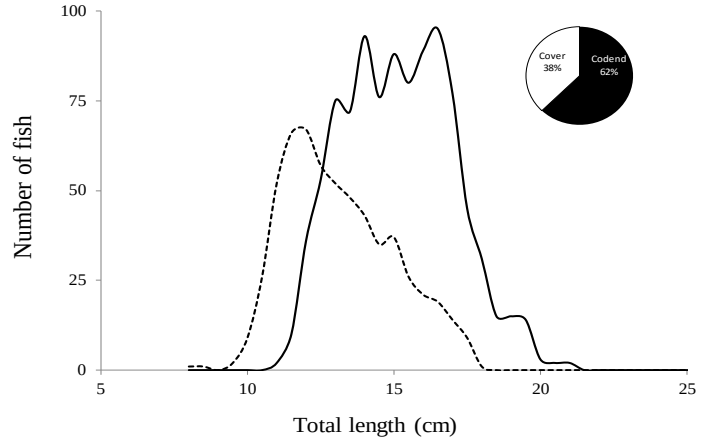

Figure 3. Length-frequency distribution of boguein 44T1, (drawn lines: codend specimens, broken lines: cover specimens) and also circle diagrams percentages of the species in terms of number.

(Figure 5), 13.2±0.18 cm total length and 3.5±0.38 cm for 44T1 (Figure 6) and 13.8±0.11 cm total length and 3.0±0.19 cm for 44T2 (Figure 7), respectively. Significant differences were determined among the L_{50} values of 40T1 and 44T2 the codends ($P<0.05$). However, there are no statistical difference between the 40T1 and 44T1, 44T1 and 44T2 ($P>0.05$). The size at LFM (taken to be 13 cm) is drawn by a vertical broken line in figure 5, 6 and 7. L_{50} values of 40T1 and 44T1 are very close considered to the 13 cm length at first maturity size of the species. The retention percentages of individuals below the LFM in codends were 6% for 40T1, 10.4% for 44T1 and 4.4% for 44T2. The percentage of individuals below the LFM in the cover was determined as 42.8 %, 48.0% and 48.5 % for 40T1, 44T1 and 44T2, respectively.

Discussion

This study present for first time selectivity of turned mesh codend for the bogue in the Eastern Mediterranean Demersal Trawl Fishery. The lowest L_{50} value was obtained from 40T1 which has 165 meshes around circumference codend. In addition, the 44T1 (300 meshes around circumference) L_{50} value was lower than 44T2 (150 meshes around circumference). When decrease number of meshes around circumference from 300 to 150 meshes, L_{50} values improve almost 0.6 cm for the species. On the other hand, 40 mm turned mesh codend L_{50} result close to 44 mm turned meshes with 300 meshes around circumferences. It was due to the number of meshes around codend circumference as in 40T1 and 44T2. Findings from narrow codends provide higher L_{50} values like for some other species given by different study conducted in the Mediterranean waters (Lök, Tokaç, Tosunoğlu, Metin, & Ferro, 1997; Özbilgin, Tosunoğlu, Aydin, Kaykaç, & Tokaç, 2005; Sala, Priour, & Herrmann, 2006; Kaykaç, 2007; Sala & Luchetti, 2010 and 2011). On the other hand, 40T1 and 44T1 showed to come close to the length at first capture value of L_{50} 12.7 and 13.2 cm, considering the size at LFM (13 cm) of bogue. In addition, the L_{50} value of 44T2 (13.8 cm) higher than that of given

Table 2. Estimated selectivity parameters of individual and mean hauls (according to Fryer, 1991) for bogue, 1846) in 40T1, 44T1 and 44T2 (H.N.; haul numbers, L_{50}; fifty percent retention length, CI; confidence interval, SR; selection range; v_1 and v_2 regression parameters, R_{11}, R_{22} and R_{22}; variance matrix values, dof; degree of fredom)

	H.N	L_{50}	CI low-CI high	SR	CI low-CI high	v_1	v_2	R_{11}	R_{12}	R_{22}	deviance	dof	pvalue
40T1	1	14.3	13.7-15.0	1.9	0.8-3.1	-16.356	1.142	0.092	-0.008	0.297	44.99	15	0.000
	2	13.7	13.3-14.0	1.4	0.9-2.0	-20.720	1.517	0.021	-0.004	0.061	6.81	15	0.963
	3	11.7	7.5-15.9	4.8	-1.3-10.9	-5.374	0.459	3.812	-4.680	7.964	27.65	13	0.010
	4	13.3	13.0-13.6	1.7	1.3-2.1	-16.981	1.276	0.024	-0.012	0.041	16.40	16	0.425
	5	11.1	9.2-13.0	4.7	1.5-7.8	-5.221	0.470	0.823	-1.158	2.217	146.50	15	0.000
	6	11.6	10.4-12.9	4.2	2.0-6.4	-6.101	0.524	0.372	-0.497	1.071	42.75	16	0.000
	7	12.9	12.4-13.4	3.6	2.6-4.7	-7.816	0.605	0.063	-0.018	0.265	24.74	19	0.169
	8	12.3	11.7-12.9	3.1	2.2-4.1	-8.584	0.699	0.082	-0.073	0.189	14.37	16	0.571
	9	13.4	13.0-13.9	1.8	1.2-2.4	-16.321	1.214	0.042	-0.031	0.071	164.05	16	0.000
	10	12.5	11.7-13.2	2.2	1.4-2.9	-12.752	1.022	0.124	-0.-91	0.122	14.38	15	0.497
	11	12.8	10.8-14.9	5.8	1.5-10.1	-4.869	0.379	0.937	-1.417	4.219	41.64	17	0.001
	12	11.8	10.7-12.9	2.7	1.5-3.9	-9.512	0.805	0.260	-0.213	0.314	48.99	14	0.000
	Mean	*12.7*	*12.5-12.9*	*2.3*	*2.5-3.1*	*-9.784*	*0.773*						
44T1	1	13.4	11.6-15.2	9.2	1.0-17.3	-3.206	0.239	0.748	-1.870	14.592	34.32	15	0.003
	2	12.1	10.9-13.3	2.9	1.5-4.4	-9.056	0.749	0.322	-0.273	0.485	6.68	19	0.996
	3	12.4	12.1-12.7	1.3	0.9-1.8	-20.280	1.641	0.020	-0.003	0.042	7.98	17	0.967
	4	14.4	8.1-20.8	4.3	-6.2-14.9	-7.360	0.510	7.168	10.905	20.004	17.91	7	0.012
	5	13.3	12.9-14.6	3.8	1.0-7.2	-7590	0.57	1	0.0001	5.1416	3.58	3	0.3101
	6	13.4	12.5-14.3	1.6	0.7-2.6	-17.878	1.334	0.180	-0.144	0.216	6.16	17	0.992
	7	12.2	11.5-13.0	2.5	1.5-3.5	-10.625	0.869	0.132	-0.112	0.218	11.93	17	0.805
	8	13.7	12.9-14.6	4.8	2.3-7.2	-6.332	0.461	0.155	-0.167	1.345	23.82	18	0.161
	9	15.0	14.2-15.7	2.4	1.2-3.6	-13.620	0.911	0.120	-0.031	0.345	5.10	18	0.999
	10	12.5	11.9-13.1	3.4	2.2-4.6	-8.155	0.653	0.089	-0.084	0.321	18.06	19	0.518
	11	14.6	14.0-15.2	2.8	1.8-3.8	-11.297	0.773	0.084	0.058	0.220	8.83	14	0.842
	Mean	*13.2*	*12.9-13.6*	*3.8*	*3.0-4.6*	*-7.591*	*0.574*						
44T2	1	14.9	14.2-15.5	3.4	2.0-4.7	-9.723	0.653	0.101	0.002	0.403	21.03	22	0.519
	2	12.1	11.4-12.7	1.7	0.8-2.6	-15.494	1.284	0.088	-0.046	0.177	16.63	17	0.480
	3	14.7	13.5-15.8	3.4	1.4-5.4	-9.356	0.638	0.312	0.161	0.908	11.88	18	0.853
	4	15.7	15.1-16.2	2.6	1.6-3.5	-13.41	0.856	0.073	0.003	0.221	10.57	22	0.980
	5	13.5	12.8-14.3	2.6	1.4-3.7	-11.492	0.85	0.121	-0.080	0.303	36.6	17	0.004
	6	15.0	13.9-16.1	4.1	0.7-7.4	-8.115	0.542	0.277	0.195	2.412	4.81	14	0.988
	7	13.8	13.2-14.5	3.2	2.0-4.5	-9.374	0.678	0.099	-0.021	0.337	8.2	19	0.985
	8	13.2	12.0-14.3	1.8	0.8-2.8	-16.138	1.227	0.266	-0.189	0.215	30.66	14	0.006
	9	14.7	14.1-15.2	3.3	2.4-4.3	-9.69	0.66	0.070	-0.002	0.200	24.28	18	0.146
	10	13.2	12.5-13.9	1.8	0.9-2.7	-16.325	1.237	0.110	-0.039	0.196	12.9	19	0.844
	11	13.8	13.1-14.4	4.0	2.6-5.4	-7.55	0.548	0.092	0.012	0.458	13.75	16	0.617
	Mean	*13.8*	*13.6-14.0*	*3.0*	*2.6-3.4*	*-10.106*	*0.732*						

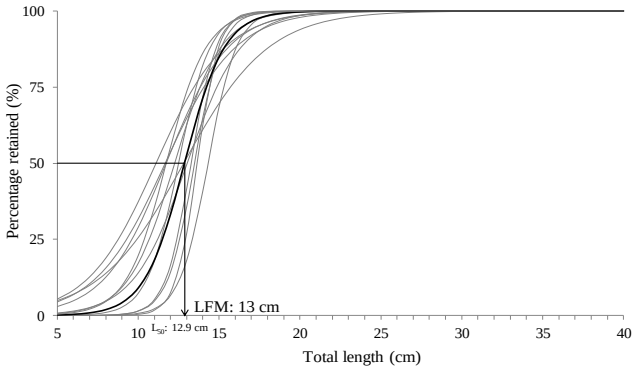

Figure 5. Percentage retained for selection curves of 44T1 (thick drawn lines, mean selection curve; thin drawn lines: individual selection curves.

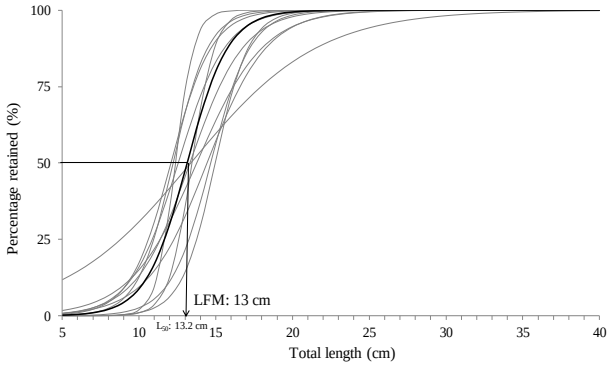

Figure 6. Percentage retained for selection curves of 44T1 (thick drawn lines, mean selection curve; thin drawn lines: individual selection curves.

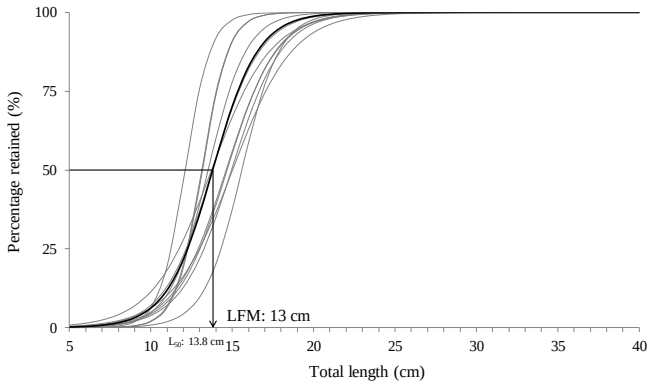

Figure 7. Percentage retained for selection curves of 44T2 (thick drawn lines, mean selection curve; thin drawn lines: individual selection curves.

LFM.

L_{50} values of bogue estimated in the present study for all codend are slightly lower from found by Ateş *et al*. (2010) 44 mm PA codend with 300 meshes around the circumferences as 14.2 cm from Antalya Bay. Ateş *et al*. (2010) also presented that changing mesh configuration from diamond to square, L_{50} values was increase even decrease mesh size from 44 to 40 mm. They found that polyethylene 40 mm square mesh codend L_{50} values as 17.5 cm. These differences may be due to the experimental region and season, populations fished mesh, mesh material and towing duration etc. On the other hand, Eryaşar *et al*. (2014) estimated L_{50} values as 6.81 cm and 7.56 cm from hand-woven 300 mesh and 150 mesh in circumference narrow slack knotted codend, respectively. When SRs were compared, the values for 40T1(2.3 cm), 44T1(3.5 cm) and 44T2 (3.0 cm)

are close to those determined by Ateş *et al*. (2010) as 3.0 and 2.1 for 44 mm diamond and 40 mm square mesh codend, respectively and Eryaşar *et al*. (2014) as 3.1 and 3.5 cm with standard and narrowed codend, respectively.

In conclusion, the L_{50} values of the 40T1 and 44T1 for bogue are close to each other. L_{50} results of 44T1 and 44T2 codends were sufficient enough when considering LFM of bogue. However, there are 5% differences between 44T1 and 44T2. These differences possible to the number of mesh around codend circumferences. In further studies, some of the explanatory variables effect on the L_{50} and SR values such as the total and species catch, towing speed and time etc. should be taken into account.

References

Akaike, H. (1974). A New Look at The Statistical Model Identification. *IEEE Transactions on Automatic Control*, 19(6), 716-723.

Anonymous (2008). The Commercial Fish Catching Regulations in Seas and Inland Waters in 2008–2012 Fishing Period: Circular No. 2008/48 (in Turkish). Republic of Turkey. Minister of Agriculture and Rural Affair, General Directorate of Conservation and Inspection, Ankara, 108 pp.

Anonymous (2012). Notification 3/1 Regulating Commercial Fishing (in Turkish). Republic of Turkey, Minister of Agriculture and Rural Affair, General Directorate of Conservation and Inspection, Ankara, 112 pp.

Anonymous (2016). Notification 4/1 Regulating Commercial Fishing (in Turkish). Republic of Turkey, Minister of Agriculture and Rural Affair, General Directorate of Conservation and Inspection, Ankara, 68 pp.

Ateş, C., Deval, M.C., Bök, T., & Tosunoğlu, Z. (2010). Selectivity of Diamond (pa) and Square (pe) Mesh Codends for Commercially Important Fish Species in the Antalya Bay, Eastern Mediterranean. *Journal of Applied Ichthyology*, 26(3), 465. http://dx.doi.org/10.1111/j.1439-0426.2010.01462.x

Bauchot, M.L., & Hureau, J.C. (1986). Sparidae. In P. J. P. Whitehead, M.L. Bauchot, J.C. Hureau, J. Nielsen & E. Tortonese (Eds) *Fishes of the Northeastern Atlantic and the Mediterranean*. vol. II. UNESCO, Paris, 883-907 pp.

ConStat (1995). CC selectivity. Granspaettevej 10, DK-9800 Hjjlarring, Denmark.

Eryaşar, A.R., Özbilgin, H., Gökce, G., Özbilgin, Y.D., Saygu, İ., Bozaoğlu, A.S., & Kalecik, E. (2014). The Effect of Codend Circumference on Selectivity of Hand-Woven Slack Knotted Codend in The North Eastern Mediterranean Demersal Trawl Fishery. *Turkish Journal of Fisheries and Aquatic Sciences*, 14(2), 463-470. http://dx.doi.org/10.4194/1303-2712-v14_2_17

FAO. (2016). FAO FishFinder. Retrieved from http://www.fao.org/fishery/species/2385/en

Fonteyne, R., Buglioni, G., Leonori, I., O'Neill, F.G., & Fryer, R.J. (2007). Laboratory and Field Trials of Omega, a New Objective Mesh Gauge. *Fisheries Research*, 85(1-2), 197-201. http://dx.doi.org/10.1016/j.fishres.2007.02.006

Froese, R., & Pauly, D. (2015). FishBase version (12/2007). Retrieved from http://www.fishbase.org

Fryer, R.J. (1991). A Model of Between-Haul Variation In Selectivity. *ICES Journal of Marine Science*, 48(3), 281-290. http://dx.doi.org/10.1093/icesjms/48.3.281

Girardin, M. (1981). *Pagellus erythrinus* (Linnaeus, 1758) et *Boops boops* (Linnaeus, 1758) Sparidae (Pisces, Sparidae) du Golfe du Lyon (PhD Thesis). Universite´ des Sciences et Techniques du Languedoc, Montpellier, France.

Gordo, L.S. (1995). Gametogenesis in *Boops boops* (L., 1758). *Boletim Instituto Portugues de Investigacao Maritima*, 1(1), 79-91.

ICES. (2006). Report of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB), 3-7 April 2006, Izmir, Turkey. ICES CM 2006/FTC:06, Ref. ACFM. 180 pp.

ICES. (2011). Report of the Study Group on Turned 90º Codend Selectivity, Focusing Baltic Cod Selectivity (SGTCOD), 4-6 May 2011, IMR, Reykjavik, Iceland. ICES CM 2011/SSGESST: 08.

Kaykaç, M.H. (2007). Selectivity of Standard and Narrow Trawl Codends for The Red Mullet (*Mullus barbatus* L., 1758) and Annular Sea Bream (*Diplodus annularis* L., 1758). *Ege Journal of Fisheries and Aquatic Sciences*, 24(3-4), 261-266.

Kinacigil, H.T., İlkyaz, A.T., Metin, G., Ulaş, A., Soykan, O., Akyol, O., & Gurbet, R. (2008). Determination of the First Maturity Length/Age and Growth Parameters of Demersal Fish Stock in the Aegean Sea from the Fishery Management Point of View. By The Scientific and Technical Research Council of Turkey (TUBITAK). 357 pp.

Lök, A., Tokaç, A., Tosunoğlu, Z., Metin, C., & Ferro, R.S.T. (1997). Effects of Different Cod-End Design on Bottom Trawl Selectivity in Turkish Fisheries of The Aegean Sea. *Fisheries Research*, 32(2), 149-156.

Madsen, N. (2007). Selectivity of Fishing Gears Used in The Baltic Sea Cod Fishery. *Reviews in Fish Biology and Fisheries*, 17(4), 517-544. http://dx.doi.org/10.1007/s11160-007-9053-y

Moderhak, W. (1997). Determination of Selectivity of Cod Codends Made of Netting Turned Through 90°. *Bulletin of the Sea Fisheries Institute Gdynia*, 1(40), 4-14.

Monteiro, P., Bentes, L., Coelho, R., Correia, C., Gonc, J. M., Alves, S., … Erzini, K. (2006). Age and Growth, Mortality, Reproduction and Relative Yield Per Recruit of The Bogue, *Boops Boops* Linne, 1758 (Sparidae), from The Algarve (South of Portugal) Longline Fishery. *Journal of Applied Ichthyology*, 22(5), 345-352. http://dx.doi.org/10.1111/j.1439-0426.2006.007 56.x

Özbilgin, H., & Tosunoğlu, Z. (2003). Comparison of The Selectivity of Double and Single Codends. *Fisheries Research*, 63(1), 143-147. http://dx.doi.org/10.1016/S0165-7836(03)00005-5

Özbilgin, H., Tosunoğlu, Z., Aydin, C., Kaykaç, H., & Tokaç, A. (2005). Selectivity of Standard, Narrow and Square Mesh Panel Trawl Codends for Hake (*Merluccius merluccius*) and Poor Cod (*Trisopterus minutus capelanus*). *Turkish Journal of Veterinary and Animal Sciences*, 29(4), 967-973.

Rinelli, P., Giordano, D., Perdichizzi, F., Greco, S., & Ragonese, S. (2005). Trawl Gear Selectivity on The Deep-Water Rose Shrimp (*Parapenaeus longirostris*, Lucas, 1846) in the Southern Tyrrhenian Sea (Central

Mediterranean). *Cahiers de Biologie Marine*, 46(1), 1-7.

Sala, A., Priour, D., & Herrmann, B. (2006). Experimental and Theoretical Study of Red Mullet (*Mullus barbatus*) Selectivity in Codends of Mediterranean Bottom Trawls. *Aquatic Living Resources*, 19(4), 317-327. http://dx.doi.org/10.1051/alr.2007002

Sala, A., & Luchetti, A. (2010). The Effect of Mesh Configuration and Codend Circumference on Selectivity in The Mediterranean Trawl Nephrops Fishery. *Fisheries Research*, 103, 63-72. http://dx.doi.org/10.1016/j.fishres.2010.02.003

Sala, A., & Luchetti, A. (2011). Effect of Mesh Size and Codend Circumference on Selectivity in The Mediterranean Demersal Trawl Fisheries. *Fisheries Research*, 110(2), 252-258. http://dx.doi.org/10.1016/j.fishres.2011.04.012

Stewart, P.A.M. (2002). A Review of Studies of Fishing Gear Selectivity in the Mediterranean. FAO COPEMED, 57 pp.

Tokaç, A., Özbilgin, H., & Tosunoğlu, Z. (2004). Effect of PA and PE Material on Codend Selectivity in Turkish Bottom Trawl. *Fisheries Research*, 67(3), 317-327. http://dx.doi.org/10.1016/j.fishres.2003.10.001

Tosunoğlu, Z., Özbilgin, H., & Tokaç, A. (2003a). Effects of The Protective Bags on The Cod-End Selectivity in Turkish Bottom Trawl Fishery. *Archive of Fishery and Marine Research*, 50(3), 239-252.

Tosunoğlu, Z., Doğanyilmaz, Y., & Özbilgin, H. (2003b). Body Shape and Trawl Codend Selectivity for Nine Commercial Fish Species. *Journal of the Marine Biological Association of the United Kingdom*, 83(6), 1309-1313. http://dx.doi.org/10.1017/S0025315403008737

TUIK. (2015). Fishery Statistics 2014. State Institute of Statistics Prime Ministry Republic of Turkey. 75 pp.

Wileman, D.A., Ferro, R.S.T., Fonteyne, R., & Millar R.B. (1996). Manual of methods of measuring the selectivity of towed fishing gears (Report No. 215). Copenhagen, Denmark, ICES Cooperative Research. 126 pp.