Journal of Animal and Veterinary Advances 9 (2): 436-440, 2010
ISSN: 1680-5593

Selectivity of Diamond and Square Mesh Beam Trawl Codends for European Hake and Striped Red Mullet in the Sea of Marmara, Turkey

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Abstract: This study compares the selectivity of 40 mm diamond and square mesh polyethyelene codends for size selectivity of two by-catch species, the European hake *Merluccius merlucius* and the striped red mullet *Mullus surmuletus* commonly captured in the beam trawl fishery in the Sea of Marmara. Data were collected using a conventional rigged twin beam trawl between 26 March and 20 April 2007. Covered codend method was used to obtain the selectivity data which analyzed by means of a logistic equation with the maximum likelihood method. The pooled length at 50% retention, L_{50} was found to increase with squre mesh shape for both species. L_{50} values of 40 mm diamond and square mesh codends were 9.8 and 13.2 cm for striped red mullet, respectively. 40 mm diamond mesh codend is not appropriate for the Minimum Landing Size (MLS) of 11 cm for the striped red mullet. Both the diamond and square mesh codends also retain a significant amount of undersized hake compared to the MLS of 25 cm. Only 40 mm square mesh codend provides satisfactory selection for striped red mullet in the rigged beam trawl fishery of the Sea of Marmara.

Key words: Beam trawl, diamond mesh, square mesh, European hake, striped red mullet, Sea of Marmara

INTRODUCTION

The beam trawl is a very effecient multispecies fishing gear used for catcthing deep water rose shrimp (*Parapenaeus longirostris*) in the Sea of Marmara. The gear also captures European hake, *Merluccuis merluccius*, whiting, *Merlangius merlangus*, striped red mullet, *Mullus surmuletus* and common sole, *Solea solea* as by-catch has been banned for beam trawl fisheries in southern the Sea of Marmara and for bottom trawl fishery in the whole The Sea of Marmara since 1971. There are 125 trawlers and 40 beam-trawlers in the Sea of Marmara (Zengin *et al*., 2004), mainly targeting rose shrimp and 10 other marketable species. In 2008, reported landings for the rose shrimp were 2623 t, the European hake, usually regarded as bay catch, 1252 t, striped red mullet, 1978 t (Anonymous, 2008a). Other highly commercial common by-catch species are tub gurnard, *Trigla lucerna*, the horse mackerel, *Trachurus trachurus* and the whiting, *Merlangius merlangius*. Experiments with square mesh codends in a coastal beam trawl fishery showed no changes in selective properties of the codend for sole (Fonteyne and M'Rabet, 1992). A study on American plaice and flounder showed that square meshes were less selective than diamond meshes (Walsh *et al*., 1992). Commercial practice and prelimary tests showed that certain alteration to the rigging of the gear such as attaching the headline at a lower position on the beam trawl heads could also contribute to a decline in cod catches (van Marlen, 2003). Selectivity studies and the effects of mesh size changes are considered to be of great importance in fisheries management (Jones, 1974; Cardador, 1993; Sobrino *et al*., 2000). The selectivity of Polyamide (PA) codends (legal, increased mesh size and changed to square mesh shape) were investigated by a few study for mainly deep water rose shrimp in the Sea of Marmara (Deval *et al*., 2006; Zengin and Tosunoglu, 2006). Recently, beam trawl fishermen have preferred Polyethylene (PE) netting instead of traditional's PA in theirs gear. Easy repair and good strain of the water and mud through the meshes make the netting useful and convenient among users. The aim of this study is to compare the analyse of the mesh shape selectivity of the diamond and square mesh codends used in beam trawl fishery on two by-catch species, striped red mullet and hake commonly captured in the shrimp fishery in the Sea of Marmara.

MATERIALS AND METHODS

The research cruise was conducted between 26th March and 20th April, 2007. A total of 20 valid hauls with 40 mm DMPE (10 hauls) and 40 mm SMPE (10 hauls) were carried out on the commercial trawler Deniz (LOA 13 m,

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engine power 130 hp), during daylight hours in stable weather and sea conditions. Fishing was performed between Kumbag and Barbaros in the northern Sea of Marmara on the commercial fishing ground at depth from 31-99 m.

The design of the studied beam trawl was explained in detail by Deval *et al.* (2006). Selectivity data were collected by using the covered codend method. Two different codends in nominal mesh sizes of 40 mm diamond and square mesh (multi-monofilament polyethylene Ø 0.40×10) were tested. Overall dimensions of cover was larger than 1.5 times of the width and length of the codends. Each cover was held open by 1.0 m diameter half hoop over the top panel of the codend (Deval *et al.*, 2006). The captured European hake and striped red mullet, those retained in the codend and those escaped into the cover, were weighed and individually measured to nearest milimetre with a ruler, taking the Total Length (TL). Weigthing and measuring were performed directly on fresh material, on the whole catch without subsampling. The retention probability for pooled data was modelled by means of the logistic selectivity curve:

$$r(l) = (\exp(v_1 + v_2 l)/1 + \exp(v_1 + v_2 l))$$

Where:

$r(l)$ = The probability that a fish of length
l = Retained, given that it entered the cod end
$\upsilon = (v_1, v_2)^T$ = The vector of the selectivity parameters
v_1 and v_2 = Regression parameters to be estimated

The maximum likelihood of selectivity parameters for pooled data was estimated using the software CC 2000 (ConStat, 1995).

RESULTS

During the trails, a total of 20 valid hauls (10 for diamond and 10 for square) were carried out. Among the eight marketable species entering the codends rose shrimp was the most abundant (32% in terms of weight) followed by whiting, blue fish, horse mackerel, striped red mullet and hake. Figure 1 shows selection curves based on pooled data of hake catch in 40 mm daimond and square mesh codends. In this Fig. 1, the size range of population caught by all two codends are similar. All of the length frequency distributions showed a major between 10 and 16 cm. The size range of fish extended from 7-37 cm. The proportion retained was different for the two codends (97.7 and 93.8 for diamond and square). Overall, 96.1 and 90.2% of the specimens retained by diamond and square codends, respectively, were below

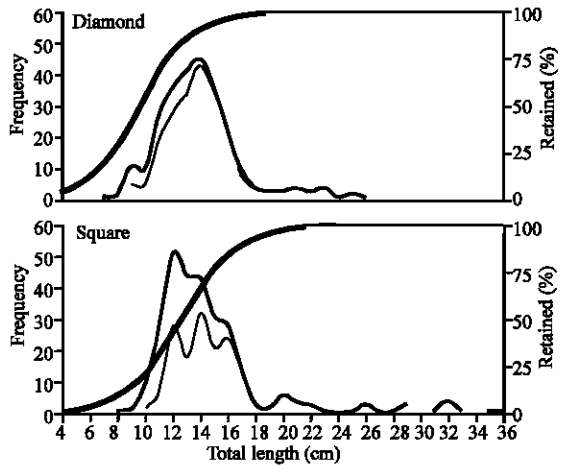

Fig. 1: Selection curves and length frequency distributins of hake (*Merluccius merluccius*) in 40 mm diamond and sqaure mesh codends. Pooled selection curve (bold thick line) and length frequency distribution of the population entering the codend (thick line) and retained in the codend (thin line)

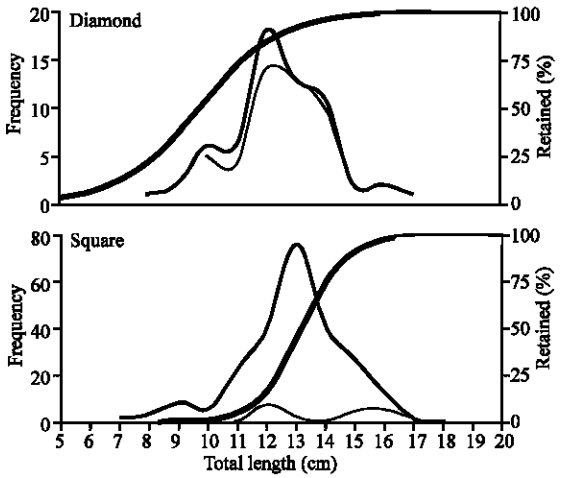

Fig. 2: Selection curves and length frequency distributins of striped red mullet (*Mullus surmuletus*) in 40 mm diamond and sqaure mesh codends. Pooled selection curve (bold thick line) and length frequency distribution of the population entering the codend (thick line) and retained in the codend (thin line)

MLS of 25 cm (Anonymous, 2008b). Results of the selectivity parameter estimation (with their standard errors and variance matrix values) for hake are given in Table 1. The L_{50} values of the pooled curves for hake were

Table 1: Selectivity estimates for striped red mullet (first lines) and hake (second lines) (fifty percent retention Length (L_{50}), Selection Range (SR), regression parameters (v_1 and v_2) and their standart errors in brackects, Covariance matrix values (R_{11}, R_{12}, R_{22}) for selectivity curves based on pooled data)

Codend	L_{50} (SE)	SR (SE)	v_1 (SE)	v_2 (SE)	R_{11}	R_{12}	R_{22}	Codend	Cover
DM40PE	9.8 (0.8)	2.9 (1.0)	-7.27 (2.96)	0.74 (0.25)	8.7941	-0.7578	0.066	51	11
	9.6 (0.5)	4.1 (0.7)	-5.16 (1.15)	0.54 (0.95)	1.3279	-0.1076	0.009	230	44
SM40PE	13.2 (0.2)	3.2 (0.7)	-17.48 (4.46)	1.32 (0.34)	19.9349	-1.5398	0.1193	28	216
	12.6 (0.3)	4.5 (0.7)	-6.16 (1.02)	0.49 (0.08)	1.0443	-0.0779	0.006	184	108

calculated as 9.6 and 12.6 cm in the diamond and square mesh codends, respectively. SRs of these codends are 4.1 and 4.5 cm, respectively. Total lenghts of the majority of individuals striped red mullet caught were between 7 and 19 cm for all codends, with a mode between 11 and 15 cm. The number of individuals that escaped was rather high. Overall, 9.8 and 1.5% of the specimens retained by diamond and squaremesh codends, respectively, were below the MLS of 11 cm total length. The selectivity and regression parameters (with their standard errors and variance matrix values) of diamond and square mesh codends for striped red mullet are given in Table 1. Due to insufficient number of specimens in the individual hauls, results presented in the table were obtained by pooling the data. The mean selectivity together with the observed retention values for all mesh sizes are shown in Fig. 2. The L_{50} of dimond and square mesh codends were found as 9.8 cm (SE 0.7) and 13.2 cm (SE 0.2), respectively. The Srs of these codends were 2.9 and 3.2 cm, respectively.

DISCUSSION

In the present study, selectivity of diamond and square mesh codends were compared for hake and striped red mullet. In the literature there are several studies investigating codend selectivity for hake (Ferreti and Froglia, 1975; Petrakis and Stergiou, 1997; Campos *et al*., 2003; Campos and Fonseca, 2003; Tosunoglu *et al*., 2003; Özbilgin *et al*., 2005), whereas there are also a few gill net selectivity studies for striped red mullet in the Greek waters (Petrakis and Stergiou, 1996) and in the Black Sea (Özekinci, 1997). Tosunoglu *et al*. (2003) estimated L_{50} and SR values of 40 mm nominal mesh size PE material codend for hake in the Aegean Sea as 10.6 and 2.8 cm, respectively. Due to the escapement of very few fish, Özbilgin *et al*. (2005) could not estimate the selection parameters for the fore old codend, but reported the L_{50} and the SR values as 14.3 and 3.4 cm, respectively for 50% narrower codend and 15.3 and 2.9 cm respectively, for a square mesh top panel codend.

Campos *et al*. (2003) estimated selection parameters of 55, 60, 70 mm diamond and 55 mm square mesh codends for hake off the south coast of Portugal. Most of the hake catches were obtained when the 70 mm diamond and 55 mm square codends were used. As only very small percentages were retained, the selectivity could only be estimated for 55 and 60 mm diamond mesh codends using pooled data. In the Campos *et al*. (2003) study, L_{50} increased from 15.9-17.4 cm when the 55 mm codend was replaced by the 60 mm codend, while a small increase in SR from 3.0-3.8 cm was observed, with a constant SF of 2.9.

Petrakis and Stergiou (1997) tested the selectivity of 28 and 40 mm diamond and 40 mm square mesh demersal trawl codends in Hellenic waters and for these codends reported L_{50} values of 4.3, 13.8 and 15.1 cm, respectively. Sf and SR values of the same codends were 3.0, 6.9, 7.6 and 6.8, 7.1, 5.7 cm, respectively. For the twin rigged beam trawl fishery for *P. longirostris* in the Sea of Marmara, Deval *et al*. (2006) compared PE vs. PA codends of 32 mm mesh size and revealed a 13.7% lower L_{50} value for the PE codend. As no literature on the trawl selectivity of striped red mullet could be found, the results obtained in this study could not be compared.

Apparently this is the first study reporting the beam trawl selection for this species, owing to the shape of the body, in all the codends, their retention was rather unselective. The MLS defined by the TFR is 11 cm for the striped red mullet (Anonymous, 2008b). L_{50} of the 40 mm diamond mesh size codend (9.6 cm) is below the MLS and the L_{50} of 40 mm square (12.6 cm) mesh codend are higher than the MLS. From Fig. 2 it can be seen that 9.8 and 1.52% of striped red mullet retained in diamond and square mesh codends, respectively, were below the MLS.

CONCLUSION

The researchers of this study recommend investigation of grid selectivity (Broadhurst, 2000) to reduce capture of the immature specimens of these by-catch species in the Sea of Marmara. This study indicates that the 40 mm diamond mesh codend is rather unselective for the two by-catch species, hake and striped red mullet in the shrimp fishery of Sea of Marmara. Changed mesh shape of 40 mm square improve the escapement of immature specimens.

ACKNOWLEDGEMENTS

The researchers wish to thank the captain and crew of the fishing vessel Deniz for their help in the sea trip. Thanks also to Dr. Z. Tosunoglu, Dr. M. C. Deval for their contributions to the study. This study was financed by the Istanbul University Research Fund, Projects No: 562/23082004.

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