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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Catch and selectivity of 40 and 44 mm trammel nets in small-scale fisheries in the Antalya Bay, Eastern Mediterranean

Antalya Körfezinde (Doğu Akdeniz) küçük ölçekli balıkçılıkta kullanılan 40 ve 44 mm fanyalı uzatma ağlarının av ve seçiciliği

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Özet: Çalışma Mayıs-Haziran 2012 tarihleri arasında 10-55 m derinliklerde Antalya Körfezi'nde gerçekleştirildi. Üç önemli ekonomik balık türü için (*Pagellus acarne*, *Pagellus erythrinus* ve *Mullus barbatus*) fanyalı ağların (40 ve 44 mm) boyut seçicilikleri tahmin edildi. ANOVA ve *K-S* testleri bu üç türün ortalama uzunluk ve boy frekans dağılımlarının kullanılan ağlara göre farklı olduğunu ortaya koymuştur. Seçicilik verilerinin tahmininde GILLNET bilgisayar programı kullanılarak dört tek-modlu (normal scale, normal location, gamma ve log-normal) ve bir de iki-modlu (bi-normal) modeller uygulandı. Kullanılan fanyalı ağ verileri için en iyi uyumu bi-normal model vermiştir. Av verimi açısından iki ağ arasında belirgin bir fark bulunmuştur. 40 mm'lik ağ ekonomik türleri, 44 mm'lik ağ ise ıskarta türleri diğerlerinden daha çok avlamaktadır. Bi-normal model kullanılarak, 40 ve 44 mm fanyalı ağlarda yakalanan barbun, kırma mercan ve yabani mercan türlerinin optimum yakalanma boyları sırasıyla, 17.0 ve 18.7, 13.9 ve 15.3, 15.7 ve 17.5 cm olarak belirlendi.

Anahtar kelime: Fanyalı ağ, boy seçiciliği, *Pagellus acarne*, *Pagellus erythrinus*, *Mullus barbatus*, select methodu, Antalya Körfezi.

Abstract: The study was carried out between May and June 2012 in a coastal area with 10-55 m depth in the Antalya Bay. Size selectivity of two trammel nets (40 mm and 44 mm) was studied for three important targeted species (*Pagellus acarne*, *Pagellus erythrinus* and *Mullus barbatus*). The ANOVA test and the Kolmogorov-Smirnov test indicated the mean length and length frequency distribution by pairwise comparisons between different mesh sizes, which were significantly different for each species. Four uni-modal (normal scale, normal location, gamma and log-normal) and single bi-modal (bi-normal) models were fitted to the data. The bi-modal model selectivity curve gave the best fit for the trammel nets data. A clear difference was found in catching efficiency. The higher economical catch rate was obtained with a mesh size of 40 mm, while the 44 mm mesh caught more discard species than other. For red mullet, common pandora, and axillary sea bream, modal lengths in the 40 and 44 mm mesh sizes, using the bi-modal model were, 17.0 and 18.7, 13.9 and 15.3, 15.7 and 17.5 cm, respectively.

Keywords: Trammel net, size selectivity, *Pagellus acarne*, *Pagellus erythrinus*, *Mullus barbatus*, select method, Antalya Bay.

INTRODUCTION

Setnets are passive fishing gears, consisting of vertical walls of netting kept upright in water columns by means of float and sinkers and set perpendicular to the direction of the movement of the target fish (Hameed and Boopendranath, 2000). The gear, due to the simplicity of its design, construction, operation and low investment cost has been very popular among small-scale fishers (Dinçer and Bahar, 2008).

Antalya city has 640 km of coastal length and small-scale fisheries has an important role. There are 690 fishing vessels and 97% of them, are smaller than 12 m length (Anonymous, 2011). Small-scale fishers use mainly gill and trammel nets with different mesh sizes. The quantity of netting used in the gill and trammel net fisheries has traditionally been 15 - 30 panels per boat with a crew of two or three. Trammel nets are used in the fisheries to catch a variety of demersal species, with different combinations of gear characteristics (mesh size, net height) fishing areas, depth and seasons.

The trammel net design enables the catching of fish by two different processes: (a) gilling and entangling, like conventional gill nets, and (b) trapping large fish in the bags of the inner netting (Karakulak and Erk, 2008). Trammel nets are generally considered to be less size selective than gill nets. If a significant proportion of individual fish are pocketed or trammeled, then the selectivity curve may not fall to zero or even have a descending limb, implying that very few fish escape after coming into contact with the trammel net (Erzini *et al.,* 2006).

In Turkish seas, numerous selectivity studies have focused mainly on gill nets (Aydın *et al.,* 1997; Özekinci, 2005; Kara, 2003; Özyurt and Avşar, 2005; Aydın and Metin, 2008; Dinçer and Bahar, 2008; Ayaz *et al.,* 2011), and there are few reports dealing with trammel nets. However, there are only three published studies on trammel nets used in Turkish seas. The SELECT method was used to estimate the selectivity of trammel nets used for the five most economically important species, bogue (*Boops boops*), annular sea bream (*Diplodus annularis*), striped red mullet (*Mullus surmuletus*), axillary sea bream (*Pagellus acarne*) and blotched picarel (*Spicara maena*) in the northern Aegean Sea (Karakulak and Erk, 2008), the gilthead bream (*Sparus aurata*) in the İskenderun Bay (Akamca *et al.,* 2010) and the common dentex (*Dentex dentex*) in the southern Aegean Sea (Aydın and Sümer, 2010). There is no published study on the size selectivity of either gill or trammel nets in the Antalya Bay.

The aim of the present study was to determine the catch amounts and the selectivity of two multifilament trammel nets (40 and 44 mm), by providing information that is required for the evaluation of appropriate regulatory controls. These controls aim to ensure a sustainable fishery for three economically important species for small scale fisheries in the Antalya Bay; the axillary sea bream *Pagellus acarne*, common pandora *Pagellus erythrinus* and red mullet *Mullus barbatus*.

MATERIALS AND METHOD

Sampling Area and Gears

This study was carried out between May and June 2012 in a coastal area with 10-55 m depth in the Antalya Bay, Eastern Mediterranean. A commercial vessel "*Melisa K.*", 7.0 m in length with an engine power of 11.5 HP, was used for the trials.

A total of 1400 m (2x700 m) of multifilament trammel nets with two different mesh sizes for the inner panel (40 and 44 mm) were used for the study. Other than the mesh sizes, all other specifications (length, hanging ratio, twines and colors) of the trammel nets were identical. The inner panels of the trammel net had a depth of 50 meshes, the twine was 210d/2 no and, with a hanging ratio of 0.50 on the float rope and 0.52 on the lead rope. The outer panels of the trammel nets had a mesh size of 200 mm with a depth of 5 meshes; the twine was 210d/4 no. The vertical slack of the trammel nets was 0.50.

The two nets were tied end-to-end in a single gang and their position was changed at each trial to achieve similar catch probability (Fabi *et al.,* 2002). The trammel nets were lowered into the sea before sunset, generally parallel to the bathymetric line, and retrieved before sunrise. The fishing trials lasted between 10 and 12 hours. During the study period a total of 15 trammel net samplings were conducted.

The total catch was transported in an ice box for further identification in the laboratory. In the laboratory, all species, whether they were commercial or not, were sorted out by mesh, identified according to species level, and weighed. Total lengths (TL) were measured to the nearest millimeter.

Data analysis

To determine whether the mean total lengths of the retained fish species increases with mesh size, a two-way ANOVA analysis was performed using the General Linear Model procedure in SPSS (Version 18). In order to evaluate the differences between size frequency distributions of the species against nets, the Kolmogorov-Smirnov goodness-of-fit test (*K-S*) for two samples [$H0=FA(x)=FB(x)$] was applied, with a significance level of ±95% (α = 0.05) (Zar, 1996).

The SELECT method (Millar, 1992; Millar and Holst, 1997; Millar and Fryer, 1999) was used to estimate the selectivity of the trammel nets. For a given length class, *l*, the numbers of fish, n_{lj}, that encounter the trammel net *j* are assumed to be observations of independent

Poisson random variables,

$n_{lj} \approx \text{Pois}\,(p_j\, \lambda_l\, r_j(l))$

where the expected count, $p_j\, \lambda_l$, is the product of the abundance of length class *l* fish, λ_l, and the relative fishing intensity of the trammel net *j*, p_j. Relative fishing intensity of a trammel net is a combined measure of fishing effort and fishing power (Millar and Holst, 1997).

The log-likelihood of n_{lj} is

$\Sigma_l\, \Sigma_j\, \{\, n_l \log\, [p_j\, \lambda l\, r_j\, (l)] - p_j\, \lambda l\, r_j\, (l)\, \}$

Four uni-modal and the single bi-modal (bi-normal) models were calculated using the GILLNET (Generalised Including Log-Linear *N* Estimation Technique) (ConStat, 1998) computer program.

Each selection curve was fitted twice, first under the assumption of equal fishing power of the trammel nets and then again, assuming fishing power to be proportional to mesh size. Each mesh size was fished with equal effort and hence fishing power is the same as fishing intensity. The lower value of model deviance indicated a better fit for both normal selection curve models (fixed and proportional spread) (Millar and Holst, 1997; Millar and Fryer, 1999).

Once a model has been fitted, the standard maximum likelihood theory provides various tools for validation of the goodness of fit. The most important single statistic is the deviance, *D*. As a general rule of thumb the deviance and the degrees of freedom (*df*) should be within the same order of magnitude. If *D/df* > 1 datas are said to be over-dispersed (Holst, 1996). A more detailed source of information on *how* the fit can be disadvantageous can be found by looking at residual plots. A good fit is characterised by *"small"* and *"randomly"* distributed residuals (Holst, 1996). Goodness of fit was evaluated by comparing the value of *D/df* and examining the deviance residual plots, with the lowest value for the ratio *D*/*df* corresponding to the best fitting model (Fonseca *et al.,* 2005).

RESULTS

Fifteen successful trials yielded a total weight of about 106.1 kg of 22 marketable species. Among the marketable species caught in the trammel nets, the axillary sea bream *Pagellus acarne* was the most abundant species (29.4% of the catch in weight), followed by 14.0% common pandora *Pagellus erythrinus* and 13.0% red mullet *Mullus barbatus*. 69.5% of the total catch was obtained from the 40 mm net, and the rest of the 30.5% catch was obtained from the 44 mm net. Mean CPUE for two nets were 0.70 kg/100 m and 0.31 kg/100 m, respectively. Table 1 presents the number and weight caught per net for each of the twenty-two commercial species separately. Table 2 presents the number and weight caught per net for each of the thirteen discarded species separately. 64% of the 11.30 kg total discard was obtained from the 44 mm net while the rest of the 36% was obtained from the 40 mm net.

Table 1. Catch data for commercial species for two trammel nets.

		40 mm		44 mm	
	Species	**N**	**kg**	**N**	**gr**
Bony fishes	*Mullus barbatus*	247	13.797	166	11.284
	Pagellus erithrinus	369	14.883	196	9.192
	Pagellus acarne	774	31.219	164	6.209
	Boops boops	64	3.896	9	0.315
	Saurida undosquamis	12	1.288	6	0.625
	Trachurus trachurus	13	0.698	4	0.243
	Spicara sp.	29	0.810	22	0.497
	Esox sp.	1	0.110	-	-
	Upeneus moluccensis	16	0.589	11	0.490
	Mullus surmeletus	18	1.588	8	0.736
	Scomber japonicus	9	0.353	6	0.147
	Scorpaena porcus	1	0.111	1	0.121
Crustaceas	*Parapenaus longirostris*	5	0.025	3	0.018
	Penaeus semisulcatus	2	0.067	4	0.156
	Melicertus hathor	79	1.572	12	0.184
	Penaeus japonicus	15	0.419	6	0.208
	Aristeus antennatus	2	0.046	1	0.014
	Metapenaeus monoceros	6	0.102	3	0.042
	Parapandalus narval	4	0.023	-	-
	Callinectes sapidus	1	0.257	1	0.230
Cephalopods	*Octopus vulgaris*	1	1.400	1	1.500
	Sepia officinalis	4	0.567	1	0.114
	∑=	1.672	73.821	625	32.326

Table 2. Catch data for discards species for two trammel nets.

		40 mm		44 mm	
	Species	**N**	**kg**	**N**	**kg**
Bony fishes	*Citharus linguatula*	35	0.959	70	2.079
	Serranus cabrilla	26	1.023	12	0.462
	Trachinus draco	5	0.167	2	0.063
	Botus podas	12	0.113	10	0.102
	Uranoscopus scaber	1	0.278	2	0.541
	Equulites klunzingeri	4	0.044	3	0.034
Crustacea	*Erugosquilla massavensis*	30	0.496	18	0.346
	Charybdis longicollis	18	0.216	25	0.235
	Calappa calappa	1	0.337	1	0.334
	Myra subgranulata	1	0.015	2	0.025
Elasmobranches	*Torpedo marmorata*	-	-	6	2.125
	Torpedo torpedo	-	-	1	0.425
Molluscs	*Illex sp.*	1	0.437	1	0.450
	∑=	133	4.085	153	7.223

The results from the two-way ANOVA revealed that the mean total lengths increased with the mesh size for tree fish species. The two sample *K-S* tests indicated that the pairwise comparisons between different mesh sizes were significantly different for different species (Table 3).

Pagellus acarne was the most abundant fish species with 938 specimens. The majority of *P. acarne* were concentrated within the range of 12–16 cm, thus below the 15 cm first maturation size (FMS: 14.5 cm, Kınacıgil *et al.,* 2008); length frequency distribution was bi-modal with a minor peak at 8 cm and a major peak at 14 cm (Figure 1a). They were mostly captured in the 40 mm mesh panels, with about 61% of the catch constituted by undersized fish, and for the 44 mm panels this percentage was about 54%.

Common pandora was the second most abundant species with 565 specimens. *P. erythrinus* had a length range of approx. 11.75 - 19.75 cm, with the majority of specimens between 12 and 16 cm (Figure 2a). For common pandora, a uni-modal distribution clearly showed a peak at 14 cm. More than 65% and 55% of *P. erythrinus* below a 15 cm minimum landing size (MLS) were retained, for the 40 and 44 mm mesh panels, respectively.

A total of 413 red mullet were caught in the trials and most fish (60%) were caught using the 40 mm mesh size. Length frequency distributions were unimodal with the mode at 16 cm (Figure 3a). The majority of red mullet were 15 - 20 cm in length in both trammel nets, with a length class range of 10.75–22.25 cm. The proportion of the specimens retained below the MLS of 13 cm were from the 40 and 44 mm nets, 1% and 6%, respectively.

Data were too scarce for haul-by-haul selectivity estimation and therefore data were pooled for all species. However, for three of the species (red mullet *Mullus barbatus*, common pandora *Pagellus erythrinus* and axillary sea bream *Pagellus acarne*), a pooled estimation of the selectivity was able to be carried out.

Table 4 shows the results of the fits for the four uni-modal and the single bi-modal models, while the modal lengths and spread values of the selection curves corresponding to the best fit model are shown in Table 5. The fitted selectivity curves for the two trammel net mesh sizes for *M.barbatus, P. eriythrinus* and *P. acarne* are shown in Figures 1b, 2b, and 3b, as well as the corresponding deviance residuals for each species (Fig. 1c, 2c, and 3c).

The bi-normal model provided the best fit and yielded the lowest values of *D*/*df* for *M. barbatus*, *P. erythrinus* and *P. acarne*, with 1.61, 1.0 and 1.1, respectively. The value of *D/df* for *P. erythrinus* and *P. acarne* does not indicate an over dispersion, but for *M.barbatus* it does indicate a slight over dispersion and/or severe lack of fit. Model deviance of bi-normal selection curves for three species were not influenced by the fishing power assumption. Mesh size had an effect on the selectivity and the modal lengths of three species and the spread values increased with mesh sizes. For red mullet, common pandora, and axillary sea bream, modal lengths in the 40 and 44 mm mesh sizes, using the bi-modal model were, 17.0 and 18.7, 13.9 and 15.3, 15.7 and 17.5 cm, respectively.

Table 3. Mean total lengths and their standard errors (SE) of tree species, the results of two-way ANOVA pairwise comparisons and Kolmogorov–Smirnov (*K-S*) test results for comparing length frequency distributions between nets.

	Mesh	N	Mean (±SD)	Mesh	N	Mean (±SD)	*t*-test	*K-S* test
M. barbatus	40F	247	16.3±2.00	44	166	17.5±2.53	4.922, p<0.05	0.362 > 0.136, p<0.05
P. erythrinus	40F	369	14.5±1.20	44	196	15.1±1.02	6.049, p<0.05	0.280 > 0.121, p<0.05
P. acarne	40F	774	13.2±1.01	44	164	13.9±3.29	4.238, p<0.05	0.306 > 0.119, p<0.05

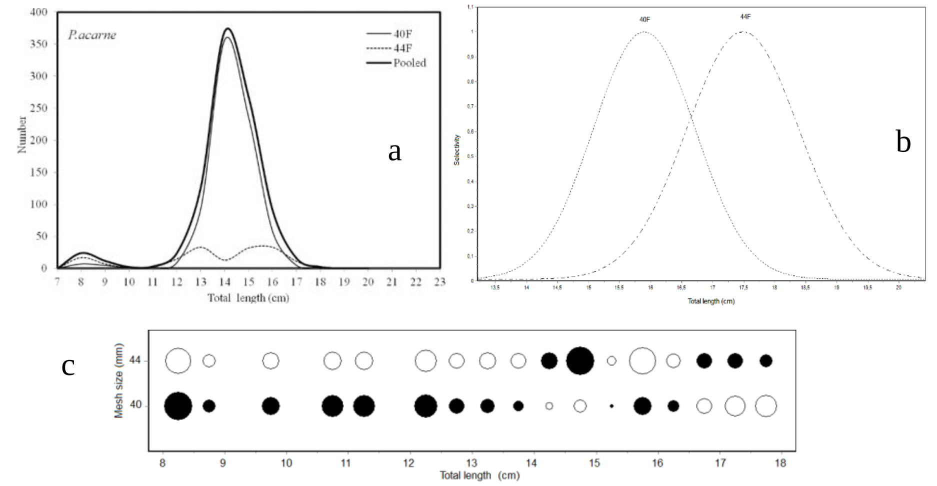

Figure 1. *P. acarne*: (a) Length frequency distributions, (b): Selectivity curves of trammel nets, (c): Deviance residual plot. Open circle indicates a positive residual and full circle indicates a negative residual.

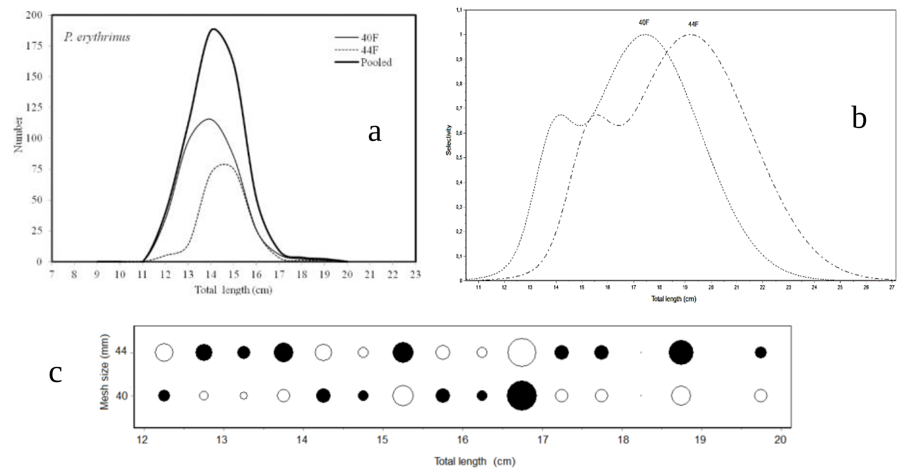

Figure 2. *P. erythrinus*: (a) Length frequency distributions, (b): Selectivity curves of trammel nets, (c): Deviance residual plot. Open circle indicates a positive residual and full circle indicates a negative residual.

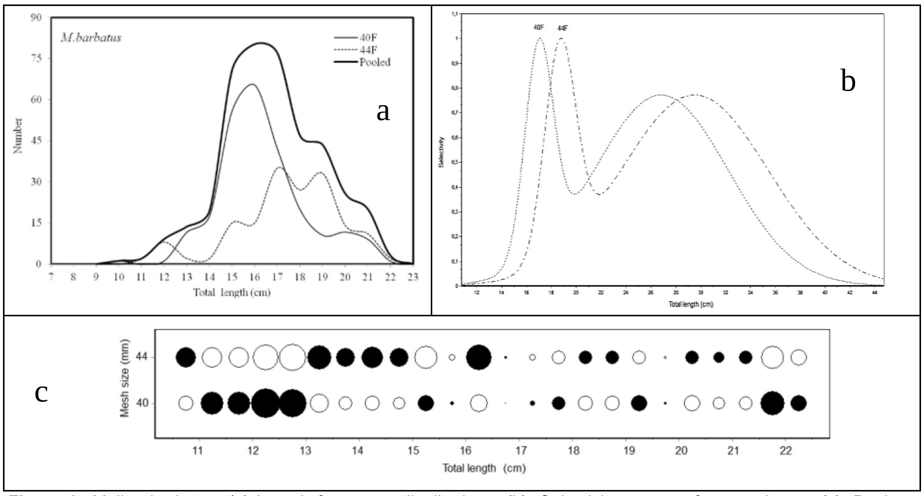

Figure 3. *Mullus barbatus*: (a) Length frequency distributions, (b): Selectivity curves of trammel nets, (c): Deviance residual plot. Open circle indicates a positive residual and full circle indicates a negative residual.

Table 4. Selection parameters for *M. barbatus*, *P. erythrinus* and *P. acarne* estimated by the SELECT method (MD: Model deviance, df: degree of freedom).

		Equal fishing powers		Fishing power α mesh-size			
Species	**Model**	**Parametrelers**	**M.D.**	**Parametrelers**	**M.D.**	**df**	**p-value**
	Normal scale	(k_1, k_2) = (0.45167, 0.05509)	63.7	(k_1, k_2) = (0.37563, 0.03939)	63.6	22	0.0000
	Normal location	(k, σ) = (0.44910, 2.56953)	67.7	(k, σ) = (0.37289, 1.68820)	67.7	22	0.0000
	Gamma	(k, a) = (0.00835, 54.84526)	67.7	(k, a) = (0.00434, 87.99562)	67.7	22	0.0000
M. barbatus	Log normal	(μ_1, σ) = (2.91311, 0.14670)	70.8	(μ_1, σ) = (2.72531, 0.10958)	70.8	22	0.0000
	Bi-normal	(k_1,k_2,k_3,k_4,c) = (0.42321, 0.02845, 0.65042, 0.14232, 0.60070)	30.8	(k_1,k_2,k_3,k_4,c) = (0.34388, 0.01601, 0.41407, 0.04806, 2.07397)	30.7	19	0.0437
	Normal scale	(k_1, k_2) = (0.38516, 0.04079)	33.2	(k, σ) = (0.38942, 0.04052)	33.2	13	0.0217
	Normal location	(k, σ) = (0.38221, 1.76846)	27.6	(k_1, k_2) = (0.38685, 1.77917)	27.6	13	0.0053
	Gamma	(k, a) = (0.00465, 83.33448)	27.5	(k, a) = (0.00465, 84.33448)	27.6	13	0.0217
P. erythrinus	Log normal	(μ_1, σ) = (2.73880, 0.0.11772)	25.4	(μ_1, σ) = (2.75151, 0.11272)	25.3	13	0.0364
	Bi-normal	(k_1,k_2,k_3,k_4,c) = (0.34665, 0.01774, 0.43628, 0.05347, 2.49643)	10.0	(k_1,k_2,k_3,k_4,c) = (0.34759, 0.01774, 0.44277, 0.05296, 3.15928)	10.0	10	0.4558
	Normal scale	(k_1, k_2) = (0.42557, 0.03477)	28.1	(k_1, k_2) = (0.42829, 0.03461)	28.1	16	0.0310
	Normal location	(k, σ) = (0.45209, 1.97370)	37.0	(k, σ) = (0.45698, 1.98434)	37.0	16	0.0021
	Gamma	(k, a) = (0.00490, 93.48117)	37.0	(k, a) = (0.00490, 94.48117)	37.0	16	0.0021
P. acarne	Log normal	(μ_1, σ) = (2.97968, 0.0.12560)	41.2	(μ_1, σ) = (2.99545, 0.12560)	41.2	16	0.0005
	Bi-normal	(k_1,k_2,k_3,k_4,c) = (0.39579, 0.02151, 0.50278, 0.05848, 2.31129)	13.9	(k_1,k_2,k_3,k_4,c) = (0.39689, 0.02144, 0.50709, 0.05741, 2.87191)	13.9	13	0.3806

Table 5. Modal length and spread values for the best-fitting model of trammel net selectivity curves.

		40 mm mesh		44 mm mesh	
Species	**Model**	**Modal Length**	**Spread**	**Modal Length**	**Spread**
M.barbatus	Bi-normal	17.0	1.14	18.7	1.25
P. erythrinus	Bi-normal	13.9	0.71	15.3	0.78
P. acerna	Bi-normal	15.7	0.86	17.5	0.94

DISCUSSION

The fish caught methods (gilled, wedged, trammeled and pocketed) determine the length frequency distribution range and the optimum selectivity model (Erzini *et al.,* 2006). Uni-modal selectivity curves (normal scale, normal location, gamma and log normal) are useful for curves described as bell shaped curves and the length distribution range is narrower. Bi-modal curves are especially appropriate if the fish are caught by two or more methods, and the length distribution range is wider (Millar and Holst, 1997; Hovgard *et al.,* 1999). These trap mechanisms were reflected in the shapes of the size distributions (skewed to the right, bi-modal or multi-modal) and in the selectivity models that revealed the best fits. The smaller mode tends to correspond to the smaller types that are gilled or wedged while the larger mode is associated with the trammeling or pocketing of larger ones. (Erzini *et al.,* 2006).

In the present study, the SELECT method was used to estimate size selectivity of *P. erythrinus*, *P. acarne* and *M. barbatus* caught by trammel nets. Bi-normal model selectivity curves provided the best fit according to trammel net data comparison. The estimated modal lengths of three species compared with previous studies in the Mediterranean Sea are shown in Table 6. The differences between the optimum length may be due to the season, the characteristics of the nets, (stretching ratio, thickness, mesh size, etc.) and different selectivity methods. According to our results, shown in Table 6, it is the opinion of the authors , that size selectivity was clearly a function of the smaller mesh of the inner panels, with modal length generally increasing with inner panel mesh size for many species. Other authors also report that the catches and the size selectivity of trammel nets depend primarily on the mesh size of the inner net (Erzini *et al.,* 2006). In contrast, Stergiou et al. (2006) find that the outer panel mesh size does not significantly affect species' selectivity and catch rates.

Many studies with gill and trammel net selectivity trials (Dinçer and Bahar, 2008; Petrakis and Stergiou, 1995, 1996; Karakulak and Erk, 2008; Madsen *et al.,* 1999; Fujimori and Tokai, 2001; Dos Santos *et al.,* 2003; Erzini *et al.,* 2003; Hovgård, 1996; Erzini *et al.*, 2006; Park *et al.,* 2004; Sbrana *et al.,* 2007) reported that the bi-modal model was clearly the best selectivity model for many fish species according to the obtained data. However, other studies (Stergio and Erzini, 2002; Erzini *et al.,* 2003; Fonseka *et al.,* 2005; Karakulak and Erk, 2008) showed that normal scale, log-normal and gamma models were also useful for fish species.

A total of 35 species were caught, including 22 target species. When considering the number of target species and individual specimens caught by trammel nets with mesh sizes of 40 and 44 mm, there were 22 species and a total of 1672 specimens for the 40 mm mesh, 21 species and 625 specimens for the 44 mm mesh. Regarding the discarded species and individual specimens caught, there were 11 species and 133 specimens for the 40 mm mesh, 13 species and 153 specimens for the 44 mm mesh. The trammel net with a mesh size of 40 mm caught fewer discarded species and specimens, and more commercial species and specimens than the 44 mm mesh sizes. The value of CPUE (100 m/kg/day) of trammel nets according to the mesh sizes were 0.7 kg and 0.31 kg, for the 40 mm and 44 mm mesh size, respectively.

Table 6. Results of the selection data obtained in the present study and in other studies carried out in the Mediterranean Seas and North-eastern Atlantic. (LF: Length frequency distribution, MS: Mesh size; UM: Used mesh)

Species	Area	LF (cm)	Selectivity method/ model	MS (mm)	Used mesh	Modal Length(cm)	Spread	Referans
M.barbatus	Aegean (Greece)	11-23	HOLT/normal	38	GN	15.4	1.05	Petrakis and Stergiou,1996
				42	GN	17.1		
				46	GN	18.8		
	Aegean (Turkey)	-	HOLT/normal	40	GN	14.4		Özekinci, 1997
				44	GN	15.0		
	Aegean (Greece)	12-30	SELECT/log-normal	44	GN	20.2	2.24	Stergio and Erzini, 2002
	Adriatik Sea	14-19	SECHİN model	45	GN	16.7		Fabi et al., 2002
	Aegean (Turkey)	6-19	Direkt method	44	GN	17.3		İlkyaz, 2005
	East Black Sea	11-20	SELECT/bi-normal	40	GN	17.8		Dinçer and Bahar, 2008
				44	GN	19.8		
	Antalya Bay	10-22	SELECT/normal scala	40	TN	17.0	1.14	This study
				44	TN	18.7	1.25	
P. erythrinus	Aegean (Greece)		HOLT/normal	46	GN	14.4 (FL)		Petrakis and Stergiou, 1996
	Aegean (Greece)		SELECT/bi-normal	40	TN	~11.0		Erzini et al.,2006
	Antalya Bay	11-19	SELECT/bi-normal	40	TN	13.9	0.71	This study
				44	TN	15.3	0.78	
P.acerna	Portugal	13-34	SELECT/normal scala	60	GN	23.1	2.73	Erzini et al., 2003
	Aegean (Greece)	10-23	HOLT/normal	42	GN	15.4	1.08	Petrakis and Stergiou, 1996
				46	GN	16.9		
		16-36	SELECT/bi-normal	60	GN	21.3	1.61	Petrakis and Stergiou, 1995
	Aegean (Turkey)	10-16	Direkt method	44	GN	13.7		İlkyaz, 2005
	Aegean (Turkey)	9-17	SELECT/bi-normal	40	GN	15.2	0.63	Karakulak and Erk, 2008
				44	GN	16.8	0.69	
		12-19	SELECT/bi-normal	40	TN	17.7	2.21	
				44	TN	19.5	2.21	
	Antalya Bay	8-18	SELECT/bi-normal	40	TN	15.7	0.86	This study
				44	TN	17.5	0.94	

When evaluating the length of captured specimens, by considering the Minimum Landing Sizes (MLS: 13 cm TL for M.barbatus; 15 cm TL for P. erythrinus) and first maturity size (14 cm TL for P.acarne), we can say that the estimated modal lengths of 40 mm and 44 mm trammel nets were bigger than the MLS of M. barbatus. But, at the specimens of P. acarne and P. erythrinus, the ratio of undersized fish captured by the 40 mm and 44 mm meshes were 65% - 55%, and 61% - 54%, respectively.

There have been few studies on the selectivity of trammel nets in European waters and there are only two previous studies on trammel net selectivity of the three species examined in the present study. Fabi *et al.* (2002), using the Sechin method for estimating selectivity, reported that the optimal catch size of *M. barbatus* was 16.7 cm, captured by trammel nets with a mesh size of 45 mm in Adriatic and Ligurian waters. In another study (Karakulak and Erk, 2008), using the SELECT model for estimating selectivity of 40 and 44 mm trammel nets, optimum lengths for *P. acarne* were 17.7 cm and 19.5 cm, respectively.

In Turkish fishery management, control over these gill net and trammel net fisheries is very limited. In order to make regulations for better management, the gill and trammel net fisheries should be strictly controlled (Karakulak and Erk, 2008). In the fishing activities of the Antalya Bay, 36, 40 and 44 mm mesh sized gill and trammel nets are used for targeting different species (red mullets, sea breams, blotched picarel, shrimp species, etc.) during the year. In Antalya Bay, it is very difficult to manage multi-species fisheries based only on mesh size and/or trammel adjustments, since the optimal mesh varies considerably according to the different target species.

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