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Determination of Size Selectivity of Traps for Blue Crab (*Callinectes sapidus* Rathbun, 1896) in the Mediterranean Sea

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ABSTRACT

This study investigates the effects of trap selectivity of various mesh size on escape success of the blue crab (*Callinectes sapidus*). The study was carried out Çamlık Lagoon of Yumurtalık Gulf in the Mediterranean Sea and total of 1051 blue crabs were caught by rectangular baited trap. Using traps constructed with 30, 35, 40, 45 and 50 mm square mesh the proportion of crabs escaping through each mesh size was measured for each half centimetre carapace width (CW) class. A logistic model was fitted to the size frequency data of the retained and escaped blue crabs for each mesh size in the experiment. L_{50} and selection range (SR) for the 30, 35, 40, 45 and 50 mm (bar length) square meshes tested in this study was 8.47 cm and 0.85 cm; 9.31 cm and 0.39 cm; 10.40 cm and 0.31 cm; 11.72 cm and 1.17 cm; 13.17 cm and 0.89 cm respectively. The 50 mm square mesh of the trap showed relatively better selectivity considering the size at 50% sexual maturity of blue crab *Callinectes sapidus*, and the high rate of immature escapers.

Keywords: Blue crab *Callinectes sapidus*; Trap; Size selectivity; Mediterranean Sea

Akdenizde Mavi Yengeç (*Callinectes sapidus* Rathbun, 1896) Tuzaklarının Boy Seçiciliğinin Belirlenmesi

ESER BİLGİSİ

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ÖZET

Bu çalışmada mavi yengeç (*Callinectes sapidus*)'in tuzaktan kaçma başarısı üzerinde çeşitli göz açıklığına sahip tuzakların seçicilik etkileri incelenmiştir. Araştırma Akdeniz'de Yumurtalık körfezi, Çamlık Lagününde yürütülmüş dikdörtgen şekilli yemli tuzaklar kullanılarak toplam 1051 adet mavi yengeç yakalanmıştır. 30, 35, 40, 45 ve 50 mm kare gözlü ağ ile donatılmış tuzaklarla her bir tuzaktan kaçan yengeçlerin oranı 0.5 cm lik karapaks genişlik (CW) sınıfında ölçülerek tespit edilmiştir. Denemede her göz açıklığı için tuzaklarda kalan ve kaçan mavi yengeçlerin boy frekans

verilerine göre lojistik bir model kullanılmıştır. Araştırmada kullanılan 30, 35, 40, 45 ve 50 mm'lik kare gözlü ağların % 50 seçicilik boyu (L_{50}) ve seçicilik aralığı (SR) sırasıyla 8.47 cm ve 0.85 cm; 9.31 cm ve 0.39 cm; 10.40 cm ve 0.31 cm; 11.72 cm ve 1.17 cm; 13.17 cm ve 0.89 cm olarak belirlenmiştir. Tuzaktan kaçan ergin olmayan mavi yengeçlerin yüksek oranı ve % 50 cinsi olgunluk boyu dikkate alındığında 50 mm'lik kare gözlü ağa sahip tuzak, diğer tuzaklara göre daha yüksek seçicilik göstermiştir.

Anahtar Kelimeler: Mavi yengeç *Callinectes sapidus*; Tuzak; Boy seçiciliği; Akdeniz

1. Introduction

The blue crab is an important commercial species that inhabits coastal areas, estuaries, and lagoons throughout the southern part of Turkey (Enzenross et al 1997; Türeli 1999). The maximum Carapace Width (CW) of blue crab reported in Turkey is 18.1 cm and mean CW is 12 cm for both female and male crabs (Türeli 1999; Atar & Seçer 2003). Reported size at first maturity is 6.05 cm for female and 4.48 cm for male individuals (Türeli 1999). Hexagonal or square mesh wire traps with a small mesh size are currently used by commercial fishermen to catch blue crabs in Turkish lagoons. In Turkish fishery regulations, there is a Minimum Landing Size (MLS) of 13 cm CW with a 5% tolerance of smaller individuals for the blue crab (TFG 2012). However, there is no required mesh shape, nor a minimum mesh size limit for traps, which constitute the most commonly used fishing gear in crab fisheries. Mesh size selection is crucial, because it determines the size composition of catch and consequently, the sub-legal to legal ratio (Guillory & Prejean 1997). Unacceptable numbers of sub-legal blue crab and immature fish, which are commonly abundant in lagoons, will be retained if the mesh size is too small; conversely, the legal catch of blue crabs will be reduced if the mesh is too large.

In fisheries management, size selectivity curves are important for estimates of incidental mortality, recruitment in yield-per-recruit analysis, and age- and length-based population models (Millar & Fryer 1999). Notably, size selectivity can be used to evaluate the MLS and the effects of changing escape vent or mesh size regulations on the future productivity of this resource (Treble et al 1998). This

study investigates the trap mesh selectivity of five different square mesh (30, 35, 40, 45 mm and 50 mm bar length) size on the escape success of blue crabs.

2. Material and Methods

The study was carried out Çamlık Lagoon of Yumurtalık Gulf in the Mediterranean (Figure 1). A total of 1051 crabs were caught by rectangular baited trap. Experiments were carried out using rectangular shape traps (70x50x50 cm). A total of 30 traps with 6 different trap groups were used in the experiment (Figure 2).

The groups were consist of a smaller mesh size (10 mm) control traps and the rest were experimental traps which mesh sizes were 30, 35, 40, 45 and 50 mm bar length square mesh. The setting of the traps were made randomly and baited with 4 whole sardines, *Sardina pilchardus*.

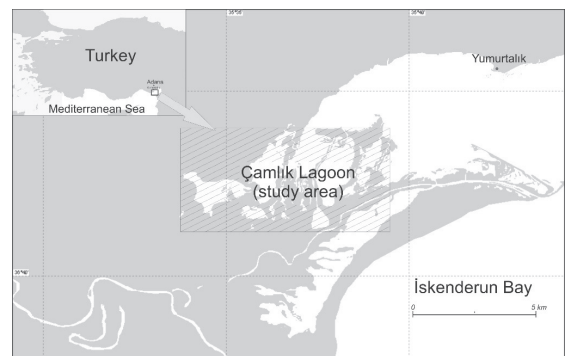


Figure 1- Study area (Çamlık Lagoon of Yumurtalık Gulf)

Şekil 1- Araştırma sahası (Yumurtalık körfezi-Çamlık Lagünü)

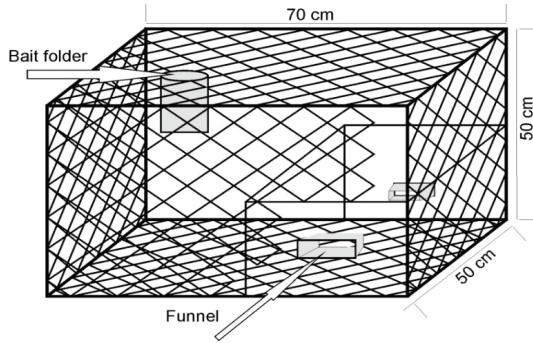


Figure 2- Rectangular baited trap

Şekil 2- Dikdörtgen şekilli yemli tuzak

The relationship between size and escape probability was investigated using SELECT methods for selectivity experiments developed for analyzing data from selectivity experiments using comparative catches from 2 or more gears especially for the trap selectivity (Millar 1992; Millar & Fryer 1999). Size frequency was established by classifying the CW data into classes of 0.5 cm each. Here SELECT model was used to fit data to the most commonly used logistic function

$$r(l) = \frac{\exp(a + bl)}{1 + (\exp(a + bl))} \quad (1)$$

Where; $r(l)$ is the probability that a fish of size l will be retained, and parameters a and b are estimated, with $a < 0$ and $b > 0$. The length at 50% retention, L_{50} , is given by:

$$L_{50} = \frac{-a}{b} \quad (2)$$

Split parameter, p , is also a model of SELECT method. The parameter described as relative fishing power and can be split into: (i) relative fishing effort, and; (ii) relative fishing efficiency of the trap types, given that all crabs captured were measured.

Selectivity parameters were estimated for each trial using the "SOLVER" tool in MS-Excel (Tokai 1997). Results of the selection analysis for each class are presented in Table I, giving the estimated parameters a and b of the fitted logistic curves for all individual trials, and pooled curves with the respective variance-covariance matrix R_i ,

which estimates within-variation in the parameters. Friedmans ANOVA non-parametric statistic tests were used to examine differences between the pooled CW frequencies of the tested mesh sizes.

3. Results and Discussion

The number of specimens caught in the traps was 1051 blue crabs during the selectivity study, with sizes ranging from 6 to 16 cm carapace width (CW). The total numbers of the blue crabs caught by the traps; control, 30 mm, 35 mm, 40 mm, 45 mm and 50 mm bar lengths were 259, 238, 200, 171, 139 and 44 respectively (Table 1).

Mean L_{50} and SR of blue crabs were found as 8.47 cm and 0.85 cm for 30 mm bar length, 9.31 cm and 0.39 cm for 35 mm bar length, 10.40 cm and 0.31 cm for 40 mm bar length, 11.72 cm and 0.81 cm for 45 mm bar length, 13.17 cm and 0.89 cm for 50 mm bar length respectively. When the L_{50} is compared to those of other traps it can be seen that 50 mm bar length traps increases the L_{50} for blue crab. Table 2 showed parameters estimates of SELECT model of each mesh size for pooled blue crab, data escaping through five different square mesh sizes (30, 35, 40, 45, and 50 mm bar length).

Table1- Number of blue crabs (*Callinectes sapidus*), caught in traps. Carapace width (CW), control sampling (CS)

Çizelge 1- Tuzaklarla yakalanan mavi yengeçlerin (*Callinectes sapidus*) sayısı. Karapaks genişliği (CW), kontrol örnekleri (CS)

CW (cm)	Trap mesh size (mm)					
	CS	30	35	40	45	50
6	1	0	0	0	0	0
7	2	0	0	0	0	0
8	9	2	0	0	0	0
9	16	13	2	0	0	0
10	40	36	35	2	0	0
11	50	48	45	52	11	0
12	69	64	59	58	58	4
13	57	60	40	43	55	25
14	9	8	14	13	9	8
15	5	5	4	2	6	6
16	1	2	1	1	0	1
Total	259	238	200	171	139	44

Table 2- Parameters estimates of select model of each mesh size for pooled blue crab, data escaping through five different square mesh sizes (30, 35, 40, 45 and 50 mm bar length). Fifty percent retention lengths (L_{50}), selection ranges (SR), regression parameters (a and b) (Pooled)

Çizelge 2- Mavi yengeç için 5 farklı göz açıklığındaki (30, 35, 40, 45 ve 50 mm) tuzaklara ait tahmin edilen seçicilik parametreleri. % 50 seçicilik boyu (L_{50}), seçicilik aralığı (SR), regresyon parametreleri (a ve b)

Parameters	Mesh size (mm)									
	30		35		40		45		50	
	P= 0.5	P estimates	P= 0.5	P estimates	P= 0.5	P estimates	P= 0.5	P estimates	P= 0.5	P estimates
a	-22.78	-21.93	-37.60	-52.34	-102.22	-72.56	-43.07	-22.01	-35.27	-32.50
b	2.69	2.59	3.96	5.62	9.93	6.98	3.79	1.88	2.70	2.47
p	0.50	0.49	0.50	0.46	0.50	0.47	0.50	0.53	0.50	0.52
L_{50}	8.48	8.47	9.50	9.31	10.30	10.40	11.36	11.72	13.08	13.17
SR	0.82	0.85	0.56	0.39	0.22	0.31	0.58	1.17	0.81	0.89
MLL	-17.65	-17.60	-17.75	-16.65	-15.10	-14.50	-11.52	-13.51	-8.02	-8.05
AIC	39.30	41.20	39.50	39.29	34.21	34.99	27.05	33.01	20.04	22.11

Figure 3 also demonstrates selection curves of 30, 35, 40, 45 and 50 mm bar length square mesh traps for blue crab. To examine the validity of the estimated selectivity curve of each mesh size, carapace widths for 50% retention in Table 2 were plotted against mesh size in Figure 4. Carapace widths of each retention probability appear to have linear relationship to mesh size (Figure 4). From the carapace widths of 50% retention for 30, 35, 40, 45 and 50 mm mesh size, the following regression equation was obtained as follow.

$$L_{50} = 0.2362M + 1.166 \quad (r^2 = 0.9892) \quad (3)$$

Where; M indicates mesh size in mm.

The biology (Türelı 1999), the weight-length relationship (Atar & Seçer 2002; Gökçe et al 2006), catching efficiency of different capture methods (Atar et al 2001) and experimental mesh selectivity (Gökçe et al 2007) have already been studied for the blue crab in Turkish waters. However, there was no specific study on blue crab trap mesh selectivity concerned with the Northeastern Mediterranean Sea. The most common measure to protect fish stocks in Turkey, as in many countries, is the minimum mesh size regulation. However, there is no minimum mesh size for trap fisheries according to Turkish Fisheries Regulation (TFG 2012). Regulations differ between countries. According to the Turkish

regulation MLS for blue crab is 13 cm CW. MLS for blue crabs in Delaware, U.S.A. is 12.7 cm CW (Guillory & Prejean 1997). Türelı (1999) reported that the size at first maturity for male blue crabs was 4.48 cm CW and for the female 6.05 cm CW in İskenderun Bay, Turkey. However, Helser & Khan (2001) reported that there was no mature individual under 10 cm CW, and size at 50% maturity size was approximately 12.5 cm CW.

Here, we used 13 cm CW as a comparison point for the escape success of the blue crab through five different mesh sizes. Guillory & Prejean (1997) report that unacceptable numbers of sub-legal blue crabs will be retained if the mesh size is too small; conversely, the legal catch of blue crabs will be reduced if the mesh is too large. This statement is confirmed by our results. Using 50 mm square mesh, more than half the number of crabs at MLS will be retained ($L_{50} = 13.08$ cm).

4. Conclusions

The 50 mm mesh size of the trap showed relatively better selectivity considering the size at 50% sexual maturity of blue crab and the high rate of immature escapers. The effects of enhanced mesh size used are considered of great importance in increasing the size selectivity of the gear, and in reducing the

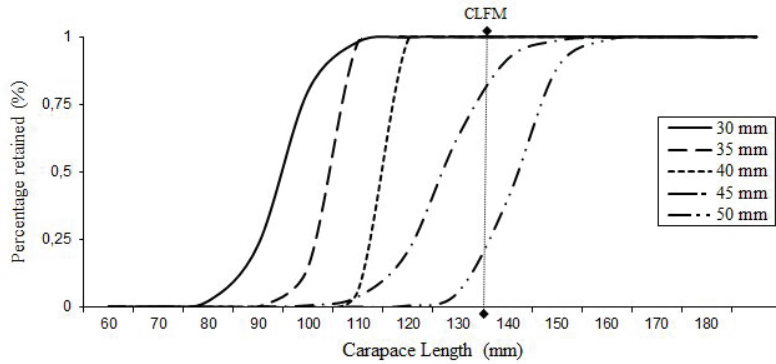


Figure 3- Selection curves for 30, 35, 40, 45 and 50 mm bar length square mesh traps. The estimated L_{50} values and carapace width at first maturity (CWFM)

Şekil 3- 30, 35, 40, 45 ve 50 mm kenar uzunluğunda kare gözlü ağa sahip tuzakların seçicilik eğrileri. Tahmin edilen L_{50} değerleri ve ilk üreme karapaks boyu (CWFM)

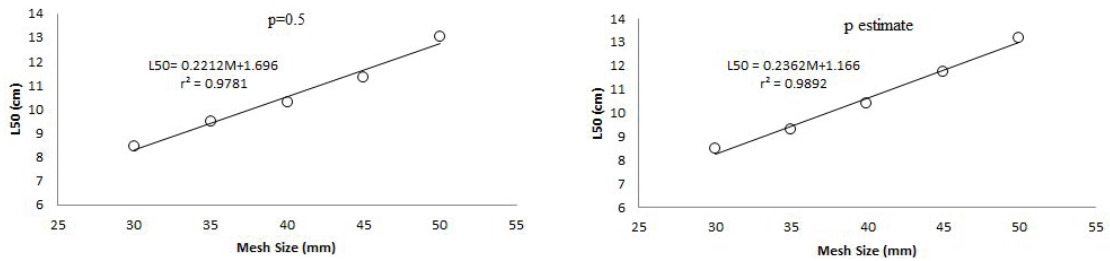


Figure 4- Relationship between mesh size and carapace width of 50% retention in the $p=0.5$ and p estimate. For the 30, 35, 40, 45 and 50 mm mesh size, the line indicates regression line for carapace width of 50% retention

Şekil 4- Karapaks genişliği % 50 yakalanma oranı ve ağ gözü boyutu arasındaki ilişki ($P=0.5$ ve P tahmin edilen). Çizgiler 30, 35, 40, 45 ve 50 mm ağların karapaks genişliği % 50 yakalama oranı regresyon çizgisini göstermektedir

amount of undersized target species. Therefore, selectivity of the trap is essential to maintaining a sustainable crab fishery. In order to optimize the overall selection performance in such fishery, 50 mm square mesh with baited trap can be used.

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