

Determination of the Selectivity of Monofilament Gillnets Used for Catching the Annular Sea Bream (*Diplodus annularis* L., 1758) by Length-Girth Relationships in İzmir Bay (Aegean Sea)

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Abstract: Annular sea bream (*Diplodus annularis* L., 1758) is one of the most abundant species among demersal fishes in the Aegean Sea. The object of this study was to determine the selectivity parameters of 52-54-56 mm stretched mesh size monofilament gillnets used for catching the annular sea bream in the İzmir Bay in the Eastern Aegean Sea. Selectivity curves were determined using Sechin method, which estimates probability of fish retention as a function of morphometric features of the body between head and maximum girth of fish. The estimated selectivity curves corresponded well with size frequencies obtained from each mesh size. The optimum catch length of the monofilament gillnets with 52-54-56 mm mesh size were calculated as 12.5 cm - 13.5 cm and 14 cm, respectively. The result of the study showed that using monofilament gillnets with 52 mm mesh size could have increasing fishing pressure on the *D. annularis* population in İzmir Bay, but monofilament gillnets with 54 and 56 mm mesh sizes would have not such an effect. For sustainable *D. annularis* fisheries, it can be suggested that monofilament gillnet with greater than 52 mm stretched mesh size should be used in İzmir Bay

Key Words: Annular sea bream (*Diplodus annularis*), gillnet selectivity, fish length - girth relationship, Aegean Sea

İzmir Körfezi'nde (Ege Denizi) İsparoz (*Diplodus annularis* L., 1758) Balığı Avcılığında Kullanılan Monofilament Galsama Ağları Seçiciliğinin Boy - Çevre İlişkisi ile Belirlenmesi

Özet: İsparoz balığı (*Diplodus annularis* L., 1758), Ege Denizi'nde demersal balıklar içerisinde en baskın olanlardan biridir. Bu çalışmanın amacı, İzmir Körfezi'nde İsparoz balığı avcılığı için kullanılan 52-54-56 mm ağ göz uzunluğuna sahip monofilament galsama ağlarının seçicilik parametrelerinin belirlenmesidir. Seçicilik eğrileri, balığın yakalanma ihtimalini baş ve maksimum çevresi arasındaki morfometrik özelliklerinin bir fonksiyonu olarak hesaplayan, Sechin methodu kullanılarak belirlenmiştir. Hesaplanan seçicilik eğrileri her ağ göz açıklığında elde edilen boy frekansıyla uyumaktadır. 52-54-56 mm ağ göz uzunluğuna sahip monofilament uzatma ağlarının optimum yakalama boyları sırasıyla, 12,5cm -13,5cm ve 14 cm olarak hesaplanmıştır. Araştırma sonucunda 52 mm'lik ağın, İzmir Körfezinde, isparoz stokları üzerinde artan bir av baskısı oluşturduğu, fakat 54 ve 56 mm'lik ağların aynı etkiyi göstermediği gözlenmiştir. İzmir Körfezinde, sürdürülebilir isparoz balıkçılığı için, 52 mm ağ göz uzunluğundan daha büyük monofilament galsama ağlarının kullanılması önerilebilir.

Anahtar Sözcükler: İsparoz Balığı (*Diplodus annularis*), galsama ağları seçiciliği, balık boy - çevre ilişkisi, Ege Denizi

Introduction

Gill nets are the most efficient fishing gear in catching widely scattered fish and it is classified in set nets (1). They require little investment in manpower and equipment, so they are widely used in small-scale fishing. Even though they sometimes used actively, they are generally left anchored to the seabed and termed a passive fishing gear (1-3). In comparison with other fishing gears many studies showed that gill nets are

highly selective and their selectivity can be arranged by mesh size (4-15).

Generally, commercial fisherman prefer catching the most abundant or economically valuable size classes of the available fish species, so that they employ the most suitable mesh size for their benefits. Nets used changes according to the species and it has got only a few different mesh sizes for the same species in the same area (8).

The mesh size of the gill nets deployed in Turkish coast of the Aegean Sea ranges from 24 mm to 240 mm stretched mesh size (12). The most commonly used mesh sizes to catch the annular sea bream (*Diplodus annularis* L., 1758) are 52-54 mm, but it is retained as by-catch with the other mesh sizes. Fishermen use this net for a period of five months from April to August because trawl and purse seine fishing are prohibited in this period and so that fishermen can sell the annular sea bream with high price.

Fish retained and their size-selectivity by gillnets are related either to the characteristics of the net or of the fish shape (6,7,14-20). The fish length and the fish girth are related to each other linearly. This relationship is also important because the fish girth is the main factor in determining the optimum mesh size (6,20).

The aim of this study was to determine the selectivity parameter of monofilament gillnets with mesh size of 52-54-56 mm (stretched mesh size) used for the annular sea bream in the İzmir Bay. Length-girth information was used to derive selection curve for gillnets.

Materials and methods

This study was carried out in Kuşburnu region in the İzmir Bay from April 2001 to August 2001 (Figure 1). Samples were collected with gill nets that have 52-54-56 mm stretched mesh size. The nets were made of green monofilament polyester twine, and they were rigged with a hanging coefficient of 0.5. The length of each gill net

was 100 m. Twine diameter size of all nets was 0.18 mm. All nets were set and hauled at the certain area 2 hours before the sunset and 2 hours before the sunrise, respectively. The catches of annular sea bream were removed from each net. In the laboratory, the fork length (FL), head girth (G_h) and maximum girth (G_{max}) of annular sea bream samples were measured to the nearest millimeter. Girths were measured using a non-stretchable synthetic measure (Figure 2).

Regression analyses were carried out to find out the relationships between G_h and FL, and G_{max} and FL by using data analysis tools of MS Excel 2000.

Selectivity model

Gillnet selectivity may be estimated directly by using body girth rather than fish length. This approach was theorized to derive selection curves for gillnet by Sechin (21,22) and Kawamura (23). They drew theoretical selectivity curve based on the following assumption that; a) all fish whose girth is greater but head girth is smaller than the mesh perimeter, are fully selected; b) girths among any one length class of fish are distributed normally, with a common variance for all length classes. In this study, I used the Sechin model, modified by Reis and Pawson (8), which has the following equation for the selectivity. The cumulative normal distribution (Φ) was used to determine the percent retained and the percent passing the gill.

The length distribution of fish small enough to enter a mesh beyond the head is expressed as equation 1.

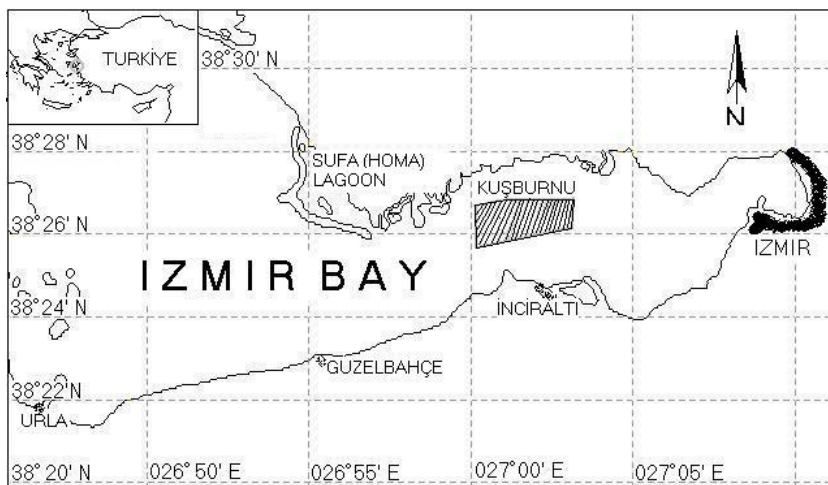


Figure 1. Map of the fishing area.

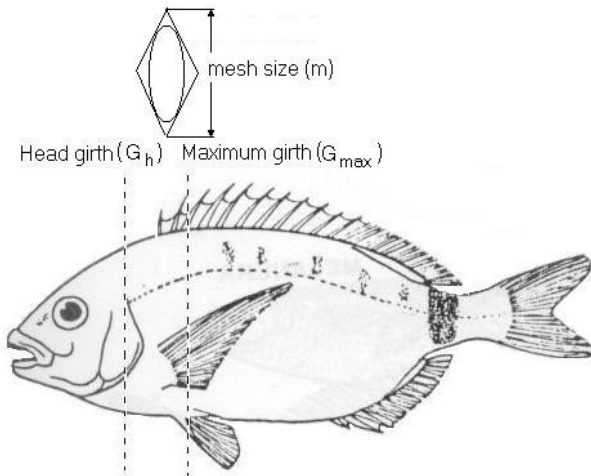


Figure 2. Body profile of annular sea bream and region between head girth (G_h) and maximum girth where fish are retained by gill nets with mesh girth ($2m$)

$$P(G_{hj} \leq 2m_i) = \Phi[(2m - G_{hj})\sigma_{hj}^{-1}] \quad (1)$$

and similarly that of fish too large to pass through the mesh is expressed as

$$P(2m_i \leq G_{maxj}) = 1 - \Phi[(2m - G_{maxj})\sigma_{maxj}^{-1}] \quad (2)$$

Finally, selection curve is determined by equation 3 combining equations 1 and 2.

$$\text{Selection } (S_j) = \Phi[(2m - G_{hj})\sigma_{hj}^{-1}] \{1 - \Phi[(2m - G_{maxj})\sigma_{maxj}^{-1}]\} \quad (3)$$

Nomenclature

- S_j The selectivity in the j th length interval
- G_{hj} mean head girth in the j th length interval
- σ_{hj} standard deviation of head girth
- G_{maxj} mean maximum girth in the j th length interval
- σ_{maxj} standard deviation of maximum girth
- $2m$ mesh perimeter
- Φ cumulative standardized normal distribution function ($\mu = 0$ and $\sigma = 1$)

The cumulative normal distribution (Φ) is called NORMSDIST in Excel spreadsheets, so that calculations are easily performed. Sechin (22) added coefficients to this formula to account for body compressibility at retention point and elasticity of netting material. In this study, these were not used because of the lack of the relevant data.

Results

Data were grouped by mesh size for the whole period and the number of fish caught according to mesh size, means and standard deviations of head girth and maximum girth were shown in the Table.

The relationships between head girth and fork length, and maximum girth and fork length obtained from fitting

Table. Fork length frequency distribution of fish caught according to mesh size, mean and standard deviations of head girth and maximum girth.

Length Class (cm)	Stretched mesh size			Mean Head Girth	Stdev Head Girth	Mean Max. Girth	Stdev Max. Girth
	52 mm	54 mm	56 mm				
10.0	1			7.72		9.57	
10.5	9			8.03	0.52	9.92	0.39
11.0	40	5		8.34	0.51	10.26	0.37
11.5	74	8	2	8.65	0.51	10.61	0.33
12.0	114	75	21	8.96	0.41	10.96	0.62
12.5	109	72	47	9.27	0.42	11.31	0.49
13.0	82	58	53	9.58	0.71	11.65	0.44
13.5	23	20	71	9.89	0.44	12.00	0.79
14.0	8	21	46	10.20	0.38	12.35	0.60
14.5	6	3	16	10.51	0.60	12.69	0.98
15.0	1	0	20	10.82	0.50	13.04	0.57
15.5		1	2	11.13	0.35	13.39	0.14
16.0			1	11.44		13.73	
16.5			1	11.75		14.08	
17.0			1	12.06		14.43	
17.5			1	12.37		14.78	
18				12.68		15.12	
Mean				10,20	0.48	12,34	0.52

the linear regression for the annular sea bream were as follows:

$$G_h = 1.5296 + 0.620 FL \quad r^2 = 0.60$$

$$n = 1012 \quad \sigma_h = 0.48$$

$$G_{max} = 2.635 + 0.694 FL \quad r^2 = 0.59$$

$$n = 1012 \quad \sigma_{max} = 0.52$$

Linear regression lines are shown in Figure 3 for annular sea bream.

Catch length frequency distributions and the calculated selectivity curves for 52, 54 and 56 mm mesh sizes are shown in Figure 4. The optimum catch length of the monofilament gillnets with 52-54-56mm mesh size were calculated as 12.5 cm - 13.5 cm and 14 cm, respectively.

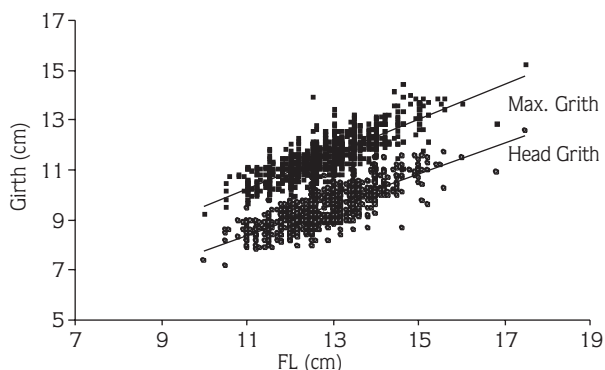


Figure 3. Relationship between “ G_h ” and “FL”, and “ G_{max} ” and “FL” of annular sea bream.

Discussion

The annular sea bream is one of the most abundant species as by-catch in commercial set net fisheries off the Turkish coast of the Aegean Sea. Özbilgin and Tosunoğlu (24) reported that this species was one of the most abundant species in catch composition of trawl fisheries with approximately 25% rates in İzmir Bay. Moreover, Tosunoğlu et al. (25) showed that annular sea bream composes of 90.4% of its family (Sparidae) in trawl catch composition in the same area.

There are studies about gillnet selectivity with different mesh size on the annular sea bream in the Aegean Sea. Petrakis and Stergiou (9) investigated the selectivity of gillnet with 17-19-21 and 23 mesh size (bar length) for annular sea bream at 15 stations in Sought

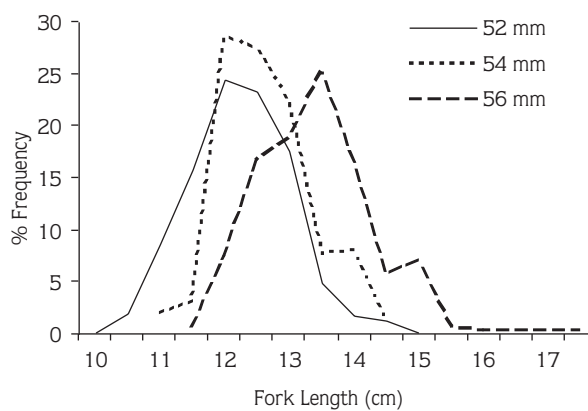
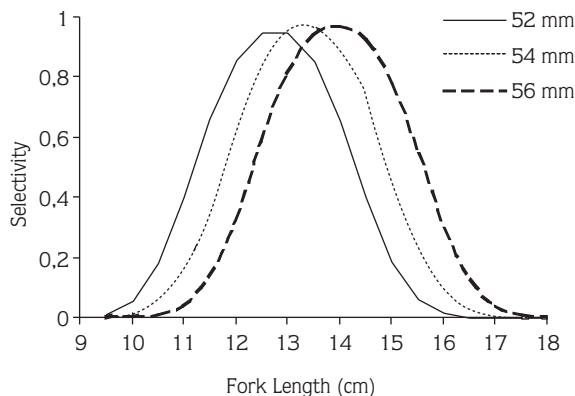


Figure 4. Observed catch length frequency distribution and estimated gillnet selectivity curve for the 52, 54 and 56 mm mesh sizes used in the İzmir Bay.

Euboikos Gulf in Greek Waters. Off the Turkish coast of the Aegean Sea, estimated selectivity for *D. annularis* with 18-20 and 22 mm mesh size (bar length) have been presented by Özekinci (10) and Metin et al. (12). Kara (26) investigated the selectivity of 26-27-28 mm mesh size (bar length) monofilament gillnets used for same species in the İzmir Bay. They used an indirect method proposed by Holt (5) to estimate retention probabilities from length-frequency distributions of fish caught in their studies.

Figures 4 shows that the length-frequency distribution of the corresponding catches is similar to the estimated selectivity curve for annular sea bream. The optimum catch length of the 52 mm net appears to be the greatest for fish in 12.5 cm length group, that of 54 mm at 13.5 cm and that of the 56 mm net at 14 cm. A similar observation has been recorded by Kara (26), who reported that the optimum catch lengths of annular sea bream were 12.66-13.15 and 13.64 cm in 26-27-and

28 mm mesh size (bar length) respectively. Gillnet selectivity range was determined using *D. annularis* girth parameters and ranged from 9.5 to 17 cm for 52 mm mesh size, from 9.5 to 17.5 cm for 54 mm mesh size, and from 10 to 18 cm for 56 mm mesh size. Hence, the selectivity range of the nets encompasses the fish length frequency distribution of the corresponding catches of the experimental gillnets. Other studies also reported that the selectivity of each mesh indicates only the proportion of fish which one mesh size will capture relative to other mesh size (8,17). Hamley (6) reported that gillnets may catch 20% larger or smaller fish than of the optimum catch size. The results of the length classes for *D. annularis* caught by the experimental gillnet were similar to Hamley's (6) findings.

The estimated selectivity curves are assumed to be in the shape of a normal distribution and to be narrow. The shape of selection curve is dependent on the difference between fish girth and mesh girth. If the difference is small, the selection curve will appear narrow, but a large difference will lead to a broader selection curve. This difference may be linked to the morphology of the anterior part of the fish (19). In this study, the estimated selectivity curves were the shape of normal distribution and wide.

Mater (27) reported that the annular sea bream reached first maturity at 13 cm fork length, more recently Metin and Akyol (28) determined that the first

maturity length of the females of this species was 9.5cm fork length in the İzmir Bay in Turkey. Bauchot and Hureau (29) explain that this species reached first maturity at 10 cm fork length and at age I in the Mediterranean.

In the present study, experimental gillnets captured larger fish than the first maturity length reported by Metin and Akyol (28) and by Bauchot and Hureau (29). On the other hand, 70% of the total monofilament gillnet catch of *D. annularis* captured with 52 mm mesh size were smaller than the first maturity length reported by Mater (27). Thus, I can conclude that using monofilament gillnets with 52 mm mesh size could have increasing fishing pressure on the *D. annularis* population in İzmir Bay, but monofilament gillnets with 54 and 56 mm mesh sizes would have not such an effect. A minimum landing size has not been enforced yet for *D. annularis* in the fishing circular in Turkey (30). The results of this study show that, for sustainable *D. annularis* fisheries, it can be suggested that monofilament gillnet with greater than 52 mm stretched mesh size should be used in İzmir Bay.

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