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Selectivity of Fishhooks Used in Blotched Picarel (*Spicara maena*) in Artisanal Fishery in Dardanelles

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Abstract: In the study, selectivity of two different types of (short and long shanked but same gap sized) fishhooks used in Blotched Picarel (*Spicara maena*) in artisanal fishery were determined in Dardanelles. In the calculation of selectivity parameters of fishhooks Holt method was used. The trials were carried out in 3 different regions in the Dardanelles between 12.09.2006-01.16.2008. For hooks gap size of which are 6.10, 7.60 and 9.05 mm, for long shanked hook the optimum catching length was determined as 13.21, 16.46 and 19.60 cm, respectively and for short shanked hook the optimum catching length was determined as 12.69, 15.81 and 18.83, respectively.

Key words: Fishhooks selectivity, Blotched Picarel, *Spicara maena*, artis and fishery, Dardanelles

INTRODUCTION

The most important reason of losses sourced from fishing is non-selective fishing gears (Alverson *et al*., 1994). Although, all fishing gear is somewhat selective in technical meaning, when selectivity concept is evaluated in terms of fishing management, it is defined as (MacLennan, 1992) giving escape chance to others while, catching ones being goaled species and having goaled magnitude (Cira and Tosunoglu, 2001). Lagler (1978) has stated fish net selectivity as in any population the decrease in the capturing probabilities of individuals going far from a length while, individuals of a certain length are catching effectively. Hameed and Boopendranath (2000) gave the name selectivity to the fishing gear or the specialty, of the method that provides the probability of capturing of the prey to change with characteristics of fish.

Catchability of a prey can be affected by the composition of population, its movement depending on length, light and other environmental properties (Henderson and Nepszy, 1992). Selectivity provides long term benefits to the fishing by decreasing fishing pressure over fish being small in length and age in population. In fishing management, the success in the protection of small fish directly depends on selectivity of fishing gear (Sari and Guven, 2000). Knowing of selectivity is very important since it affects population parameters such as length-weight relation, gender ratio, estimate of population size through marking trials and growth and death ratios (Hamley, 1975).

Fishing lines are fishing gear commonly used in the sea and fresh waters with the aim of commerce and recreation. Fishing gear and materials taking place in fishing lines are prepared by bringing together and equipping of fly, body (line), swivel, sinker, floater and guider materials in the frame of suitable amount, length and technical design for the aim (Brandt, 1984; Hossucu, 1991). In the head of the most important factors affecting catching efficiency in fishing with line are fishhook and bait. Fishhooks are the most active gear of fishing tackles. Selectivity studies in Turkish waters are mostly focused on gill and trammel nets (Aydin *et al*., 1997; Ozekinci, 2005; Kara, 2003). However, the number of researches made on the fishing line selectivity is quite low. Selectivity studies based on fishhook dimension are mostly foused on fishhooks used in long line fishing being generally commercial (Alos *et al*., 2008; Cortez-Zaragoza *et al*., 1989; Otway and Craig, 1993; Erzini *et al*., 1996, 1998; Halliday, 2002; Stergiou and Erzini, 2002).

In this study, it was aimed the selectivity of fishhooks used in Blotched Picarel (*Spicara maena*) fishing and having different properties such as number and shape and the determination of the fishhook type, which will provide our catching adult individuals. In the

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future, the determination of the fishhook dimension peculiar to Blotched Picarel in terms of fishing management, this study will give opinion.

MATERIALS AND METHODS

The study was conducted in 3 different regions in the Dardanelles between 12.09.2006-01.16.2008. Dubalar, Havuzlar locations and the front of Kepez Port were chosen as the study location (Fig. 1).

Fishing tackles were made in the way of three hooked hand line. Fishhooks chosen as fishing material compose of fishhooks used by local fishers in Blotched Picarel fishing in Canakkale (Dardanelles) region.

In the study, two different types of fishhooks being short (Youvella brand 1396 model 2, 4, 6 numbers) and long (Crown brand 17104 model 3, 5, 7 numbers) shanked were chosen to determine selectivity of fishhooks. For using in selectivity studies, with the help of a compass, gap width (size) of hooks used in the study was measured as 9.05, 7.60 and 6.10, respectively (Fig. 2 and 3).

The main line of Blotched Picarel rigs used in the research was made of a 0.40 monofilament. Two numbered swivel was used between the main line and snoods. Intermediary lines to which snoods are tied is made of a 0.35 monofilament. About 10-12 cm long 3 snoods were tied on intermediary line with 13-14 cm intervals. The weight of lead (sinker) used at the leader part of the fishing line showed change between 50 and 150 g according to the speed of current in the strait and depth and the region where, the study was made. Fishing operation started 2 h before the sun set and was completed 1 h after the sun set. In artisanal fishing since the difference in the hand skills, sensitivity and fishing experiences are important factors affecting catching efficiency, in this study the fishing tackles were changed among researcher fishermen in every half hour. So, fishing realized in the same times with each fishing line. After fishing, fish caught with a particular hook number were put into pockets pertaining to that number. Length-weight and mouth size measurements of caught fish were recorded. Mouth size namely from fish's lower jaw's beginning to its end was measured with a compass having 0.01 mm intervals.

In the catching of fish, chicken chest and pilchard were used as feed. In the researches since, it was detected a directional proportion between feed size and caught fish size (Lokkeborg and Bjordal, 1992; Bjordal and Lokkeborg, 1996), baits were cut in equal length and weight and prepared for use (2.00±0.53). It was benefited from Kolmogorov Simirnov test in determining if there was a difference between length groups caught by hook types.

Calculation of selectivity parameters: In the calculation of selectivity parameters of fishhooks Holt (1963) method was used. According to Holt (1963) method, natural logarithm of the proportion of fish caught by big fishhook (small numbered hook) to fish caught by small fishhook (big numbered hook) is taken as ln (C2/C1) = a + bL. a (intersection point) and b (curve) in this linear regression

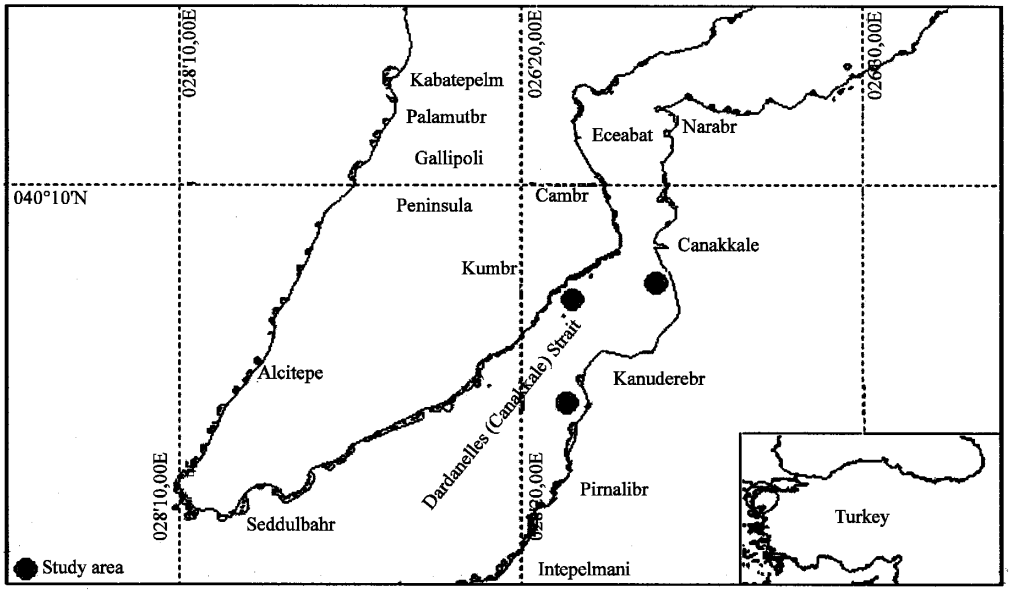

Fig. 1: Study area

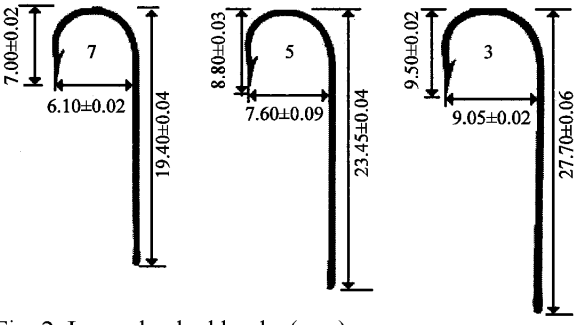

Fig. 2: Long shanked hooks (mm)

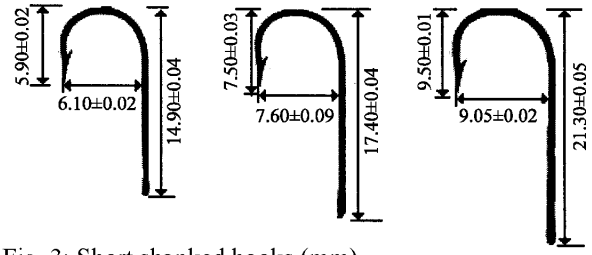

Fig. 3: Short shanked hooks (mm)

equation are found. By benefiting from the same parameters, Mm_1 and Lm_2 optimum catching length and hooks' standard deviations according to each m_1 and m_2 hook numbers are calculated by the help of the Eq. 1-4:

$$Lm_1 = \frac{-2a.m_1}{b.(m_1 + m_2)} \quad (1)$$

$$Lm_2 = \frac{-2a.m_2}{b.(m_1 + m_2)} = \frac{Lm_1 \times m_2}{m_1} \quad (2)$$

Standard deviation and

$$S = \sqrt{\frac{-2a(m_{i+1} - m_i)}{b_i^2(m_i + m_{i+1})}} \quad (3)$$

selectivity factor, by using a (intersection point) and b (curve) got, Selectivity Factor (SF) is calculated.

$$SF = \frac{-(2a)}{b(m_1 + m_2)} \quad (4)$$

In selectivity studies made concerning the fishing line, since, 3 fishhooks having different successive gap size are taken together to the evaluation to be able to make comparisons accurately, common selectivity factor and common standard deviation are calculated.

By using common selectivity factor and common standard deviation values, optimum catching lengths of fishing lines are determined.

If we have fished with fishing lines having hook number >2, common selectivity factor and standard deviation must be found. The Eq. 5 is used for common selectivity factor.

$$SF = -2\left[\sum_{i=1}^{n-1}(a_i/b_i)(m_i + m_{i+1})\right] \Big/ \left[\sum_{i=1}^{n-1}(m_i + m_{i+1})^2\right] \quad (5)$$

Standard deviation of fishing lines is calculated in that way.

$$S = \sqrt{\left(\frac{1}{n-1}\right)\left(\sum_{i=1}^{n-1}\frac{-2a_i(m_{i+1} - m_i}{b_i^2(m_i + m_{i+1})}\right)} \quad (6)$$

Thanks to calculated common selectivity factor, optimum catching length for m_i hook number is calculated through the Eq. 7:

$$Lm = SFxm \quad (7)$$

In drawing of selectivity curves, capturing ratios (S (Li)) as a function of length groups for each fishing line number are calculated and selectivity curves of each fishing line are drawn.

$$S(L)_A = e^{\left[-(L-L_A)\right]^2/2(S)^2}$$
$$S(L)_B = e^{\left[-(L-L_B)\right]^2/2(S)^2} \quad (8)$$

In a fishing line having m_i hook number, minimum and maximum catching length is calculated.

$$L_{min} = Lm_i - \sqrt{(-\ln(0.5)\times 2\times sd)}$$
$$L_{max} = Lm_i + \sqrt{(-\ln(0.5)\times 2\times sd)} \quad (9)$$

In drawing of selectivity curves, it was benefited from Microsoft Excel package program.

RESULTS

Figure 4 shows length-frequency distributions of fish caught by long shanked hooks. While, the highest number of fish caught by hooks with 6.10 and 7.60 mm gap size belong to 16.5 cm size class, those caught by 9.05 mm gap size belongs to 16 cm size class.

Length and weight values of fish caught by long shanked hooks are given in Table 1. Length-frequency distributions of fish caught by short shanked hooks are given in Fig. 5. The highest number of fish caught by hooks with 6.10, 7.60 and 9.05 mm gap size belong to 15.5 cm size class.

Table 1: Minimum, maximum, mean length and weight values of Blotched Picarel fish caught with long shanked hooks having 6.10-7.60 and 9.05 mm gap sizes

Long shank		Total length (cm)			Weight (g)		
Gap size	N	Min.	Max.	M	Min.	Max.	M
6.10 mm	101	12.4	19.0	15.80±1.17	24.00	85.01	48.23±12.06
7.60 mm	75	14.2	17.6	15.94±0.76	31.00	69.00	50.09± 8.50
9.05 mm	55	12.5	19.3	15.97±1.16	22.00	88.00	51.21±12.33

Table 2: Minimum, maximum, mean length and weight values of Blotched Picarel fish caught with short shanked hooks having 6.10, 7.60 and 9.05 mm gap sizes

Short shank		Total length (cm)			Weight (g)		
Gap size	N	Min.	Max.	M	Min.	Max.	M
6.10 mm	106	12.7	18.1	15.51±1.03	27.00	73.00	46.32±10.65
7.60 mm	129	13.3	17.6	15.57±0.84	28.00	70.00	44.89± 8.53
9.05 mm	85	13.0	18.2	15.38±1.00	26.00	71.00	43.48±10.32

N: Individual Number, Min: Minimum, Max: Maximum, M: Mean

Length and weight values of fish caught by short shanked hooks are given in Table 2.

Body length-mouth size relation of caught Blotched Picarel fish: Body Length-mouth size relation of Blotched picarel fish caught was given in Fig. 6. In consequence of the correlation test it was found that the relation between fish lengths and mouth size was important ($p<0.0001$, $r = 0.5551$).

Selectivity parameters of fishing lines used in the study were determined by using Holt (1963) method. Optimum catching lengths of fish caught by long shanked hook and capturing ratios calculated from values logarithm amendment of which had been made were found by using the Eq. 8. Selectivity curves were drawn from these values (Fig. 7).

Regression coefficients values, which were calculated from small gap sizes (m_1) and large gap sizes (m_2) relationships for long shanked hooks were given in Table 3.

Selectivity curves of fish caught by long shanked hooks with gap sizes of 6.10, 7.60 and 9.05 are given in Fig. 7.

For Blotched Picarel caught by long shanked hooks as a result of the study, common selectivity factor, common standard deviation and optimum catching length for each hook mouth opening were given in Table 4.

Regression coefficients values, which were calculated from small gap sizes (m_1) and large gap sizes (m_2) relationships for short shanked hooks were given in Table 5.

Selectivity curves of fish caught by short shanked hooks with gap sizes of 6.10, 7.60 and 9.05 are given in Fig. 8. For Blotched Picarel caught by long shanked hooks as a result of the study.

Table 3: Regression coefficients of long shanked hook couples

m_1 (mm)	m_2 (mm)	a	b	r^2
6.10	7.60	-11.547	0.734	0.98
7.60	9.05	-20.186	1.1676	0.99

m_1: 7 no hook, m_2: 5 no hook, m_3: 3 no hook

Table 4: Common selectivity of long shanked hooks used in the study for Blotched picarel (SF), common Standard Deviation (SD) and optimum catching lengths

SF	SD	$L_{6.10}$	$L_{7.60}$	$L_{9.05}$
2.16	1.27	13.21	16.46	19.60

$L_{6,10}$-$L_{7,60}$-$L_{9,05}$

Table 5: Regression coefficients of short shanked hook couples

m_1 (mm)	m_2 (mm)	a	b	r^2
6.10	7.60	-21.458	1.5041	0.9843
7.60	9.05	-21.228	1.2260	0.9704

m_1: 6 no hook, m_2: 4 no hook, m_3: 2 no hook

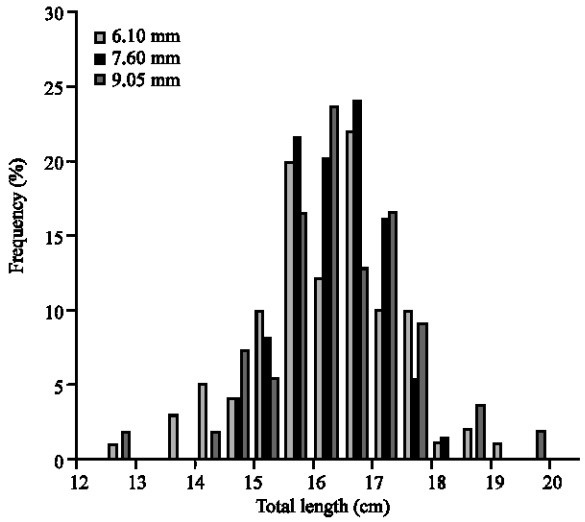

Fig. 4: Length-frequency values of Blotched Picarel caught by long shanked hooks

In consequence of the study, for Blotched Picarel fish caught with short handled hooks, common selectivity

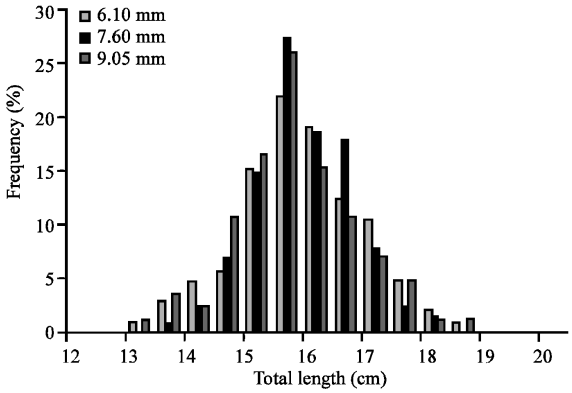

Fig. 5: Length-frequency values of Blotched Picarel caught with short shanked hooks

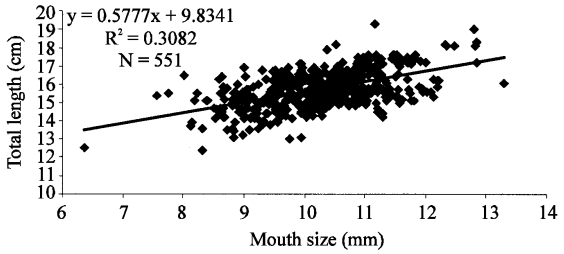

Fig. 6: Body length-mouth size relation of Blotched Picarel fish

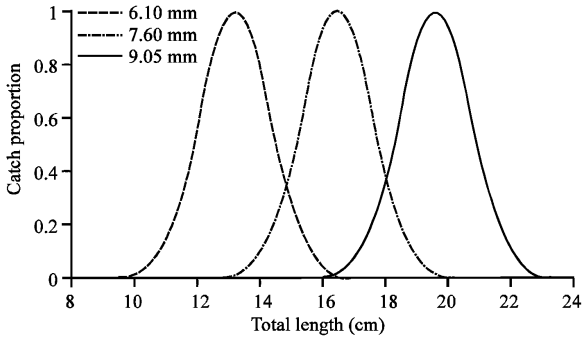

Fig. 7: Selectivity curves of Blotched Picarel caught by long shanked hooks

factor, common standard deviation and optimum catching length for each hook mouth opening were given in Table 6.

In consequence of Kolmogorov-Simirnov test made, it was seen that the difference between length-frequency distributions of Blotched picarel fish caught by 6.10, 7.60 and 9.05 mm gap sized hooks was important (Table 7).

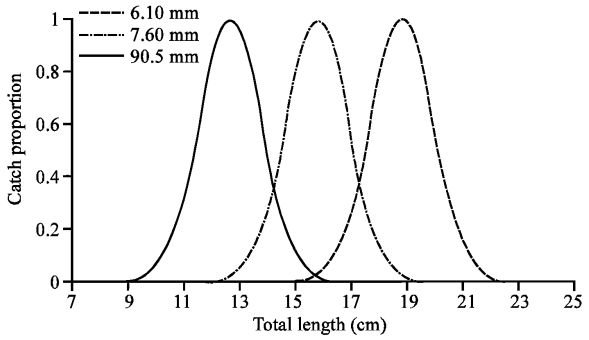

Fig. 8: Selectivity curves of blotched picarel caught with short shanked hooks

Table 6: For Blotched picarel, Common Selectivity Factor (SF), Common Standard Deviation (SD) and optimum catching lengths ($L_{6.10}$-$L_{7.60}$-$L_{9.05}$). of short handled hooks used in the study

SF	SD	$L_{6.10}$	$L_{7.60}$	$L_{9.05}$
2.08	1.23	12.69	15.81	18.75

Table 7: Results of Kolmogorov-Simirnov test used in the comparison of length-frequency distributions

	N			Critical values	
Gap size	Short shank	Long shank	Dmax	x = 0.05	Decision
6.10 mm	106	101	0.117	0.999	H0 rejected
7.60 mm	129	75	0.235	0.672	H0 rejected
9.05 mm	85	55	0.117	0.999	H0 rejected

DISCUSSION

As a result of factors such as increasing fishing effort and unconscious fishing, fish stocks are ruined excessively. The use of selective fishing gear is important for sustainability (giving reproduction chance at least once) of fish stocks. In the study, it was aimed to determine selectivity of short and long shanked hooks having 6.10, 7.60 and 9.05 mm gap width.

Selectivity factor is directly related with the body structure of fish as well as design properties of fishing material in selectivity of nets. While, this value is high in thin and long body shaped namely fusiform fish, this value decreases as far as the body thickens (stubby form) (Hovgard and Lassen, 2000; Kara, 2003). In selectivity of fishhook selectivity factor is related to mouth size of fish. In this study the selectivity factor for Blotched picarel fish caught by short shanked and long shanked hooks was found out 2.08 and 2.16, respectively.

In consequence of calculations made, for hooks gap size of which are 6.10, 7.60 and 9.05 mm, in the calculations made with Holt (1963) method, for long shanked hook the optimum catching length was determined as 13.21, 16.46 and 19.60 cm, respectively and for short shanked hooks the optimum catching length was determined as 12.69, 15.81 and 18.83, respectively. The purpose with optimum

catching length is to state the optimum fish length that can be caught with that hook. However, it couldn't be caught since any individual pertaining to that length group in the environment wasn't found. If there had been any fish >19.30 cm in the environment, it could have been caught so easily with 3 no hook.

When examined total length and weight values of samples, it is seen that they showed change between 12.4-19.3 cm and 22.0-88 g. In all samples, mean length was found 15.76±0.98 cm and mean weight 46.88±10.60 g.

In the study, in consequence of correlation test made by the aim of determining the relation between fish length and mouth size, that r coefficient was 0.5551 in $p<0.0001$ meaningfulness level showed that there was a powerful and positive relation between fish length and fish's mouth width. Nevertheless that studies concerning length-mouth opening are scant increases the importance of studies made, they carry the source quality for researches, which will be made later. Karpouzi and Stergiou (2003), in the study, they made on 18 species, found the relation between mouth length and shape and fish length statistically meaningful.

In this study, within tried hooks it was seen that 7 numbered (6.10 gap sized) long handled hook was the least selective since optimum catching length and selectivity factor were low.

This study shows parallelism with the before studies and Cekic and Basusta (2004) determined that feed type and hook size in long line fishing gear used in Iskenderun Gulf had effect on fish length size and feed variety on fishing ratio. It is seen that with the increase in the hook dimension the capturing of small fish will be difficult and big fish will have escape chance through getting out from small hook. Also, that hook selectivity has direct relation with mouth size of fish, which will be caught can cause the capturing of bigger or smaller fish in different species. For instance, that mouth size of *serranus* sp. is large, even small dimensioned *serranus* sp. can be caught by big hook. To not swallow bait is necessary especially for some fish species (e.g., feed fish necessary to be kept live in the surrounding for making feed to catch bluefish) necessary to be caught lively. If fishhook is swallowed by the fish, that fish becomes dead. This leads to that fish can not be used as bait. So, catching must be made by preventing the hook from going to fish's stomach and must realize in the mouth. In this point, chosen hook should be peculiar to the species. Selectivity studies are of big importance in terms of sustainable fishing. Making these researches for every species will provide big profits.

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