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Some Parameters about Population Biology of the Common Pandora (*Pagellus erythrinus* L., 1758) (Sparidae) in the Edremit Bay (Turkey)

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Özet: Edremit Körfezi'ndeki kırma mercanların (*Pagellus erythrinus *L., 1758) (Sparidae) populasyon biyolojisi hakkında bazı parametreler. Kırma mercan (*Pagellus erythrinus* L., 1758) bireyleri Kasım 1999-Ekim 2000 periyodu boyunca trolle Edremit Körfezi'nden yakalanmıştır. Çatal boy 77-228 mm. arasında değişmektedir. Bu tür protojin hermafroditizm özelliğindedir. Erkeklerin dişiye oranı 1:3.16'dır. Üreme zamanı Nisan-Ekim olup yumurtlama aktivitesindeki pik Ağustos-Eylül arası oluşur. Dişiler %50 olgunluk yaşına 13 mm çatal boyda ulaşır. Boy-ağırlık ilişkisi parametreleri tüm bireyler için: a= 0.00007 ve b= 2.7388 olarak saptanmıştır. Balıklar 0-VIII yaş arasında bulunmuştur. Tüm populasyon için von Bertalanffy büyüme parametreleri: L_∞ =239.95 mm, k= 0.16 yıl^{-1} ve t_0= -2.6 yıl. Dişi, erkek ve tüm bireyler için negatif allometrik büyüme gözlenmiştir. Tüm balıklar için mortalite oranları: Z= 0.764, %Z= %53, M= 0.375, F= 0.398 ve sömürü oranı E= 0.509 olarak saptandı. Bu veriler, Edremit Körfezi'ndeki kırma mercan stoklarının sömürüsünün sınırda olduğunu göstermektedir. Yumurtlama stoklarının ve stoğa katılımın korunması için önlemler alınması gereklidir. Örneğin av yasakları girişimleri veya balık avlama modellerinde çeşitli değişiklikler gibi.

Anahtar Kelimeler: Kırma mercan (*Pagellus erythrinus*), populasyon biyolojisi; Edremit Körfezi.

Abstract: Common pandora (*Pagellus erythrinus* L., 1758) were caught in the Edremit Bay using the trawls during the period of November 1999 to October 2000. The fork length varied between 77 and 228 mm. Protogynous hermaphroditism characterized the species. The overall ratio of males to females was 1:3.16. The duration of the reproductive season was from April to October and a peak in spawning activity occurred in August-September. Females reached fifty percent maturity at a fork length 13 mm. The length-weight relationship for all individuals was described by the following parameters: a= 0.00007 and b= 2.7388. Fish aged 0-VIII years were found. The von Bertalanffy growth parameters for the whole population were: L_∞ = 239.95 mm, k= 0.16 year^{-1} and t_0= -2.6 year. Negative allometric growth was observed for females, males and all individuals. For all fish, the rates of mortality were: Z= 0.764, %Z= %53, M= 0.375, F= 0.398 and the exploitation ratio E= 0.509. This data shows that the stock of the common pandora of the Edremit Bay is being exploited in the limit. It would be desirable to take measures to protect the spawning stock and recruits, for example by introducing a closed season or various changes in fishing patterns.

Key Words: Common pandora (*Pagellus erythrinus*), population biology; Edremit Bay.

Introduction

Pagellus erythrinus (Linnaeus, 1758) is a demersal fish belonging to the Sparid family. Common pandora is common in the Black Sea and the Mediterranean, along the west coast of Europe and Africa from Angola to Norway (Papaconstantinou *et al*., 1988). Bathymetric range of the species extends from the shallow subtidal down to about 300 m, but they are most common at depths from 20-100 m (Santos *et al*., 1995).

In studies by Zei and Zupanovic (1961), Larraneta (1964), Hashem (1981), Ünsal (1984), Relini and Romeo (1985), Papaconstantinou *et al*. (1988), Mytilineou (1989), Ghorbel and Bouain (1990), Santos et al. (1995), Özaydın (1997), Pajuelo and Lorenzo (1998), Erzini *et al*. (2001), some information has been given about population parameters of the common pandora.

The common pandora in the Bay of Edremit and Turkish fishing industry is of great commercial importance. This study was carried out due to the lack of sufficient research on this subject for the Edremit Bay. The aim of this study is to present some parameters on the population biology of the common pandora species obtained from the Edremit Bay.

Materials and Methods

A total of 676 specimens of common pandora were caught monthly for a year, by using bottom trawl (mesh:40mm) at depths ranging from 50 to 80 m in Edremit Bay (Figure 1) between November 1999 and October 2000.

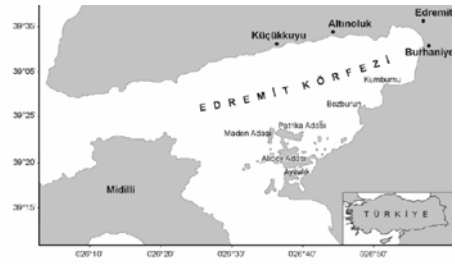

Figure 1. Sampling area.

Specimens were measured to the nearest 1 mm (fork length, FL) and weighed to the nearest 0.01 g (total weight, TW), and their otoliths were removed immediately and stored dry in properly labeled envelopes. We used Chugunova's method (1963) for determining age.

The length-weight relationship is defined as; $W= aL^b$ (Ricker, 1973) where *W* is total body weight (g), *L* is fork length (cm), and *a* and *b* are constants. Growth is expressed in terms of the von Bertalanffy equation (Sparre and Venema, 1992); $L_t=L_\infty [1-\exp^{-k(t-t0)}]$ where L_t is length at age t, L_∞ is maximum asymptotic length, *k* is growth curvature parameter, t_0 is computed age at length and weight equal to zero.

Total mortality (Z) was estimated from the method of survivor rate (Avşar, 1998): $S_{(t)}= N_{(t+1)} / N_{(t)}$ where S is survivor rate; $N_{(t+1)}$ is the number of fish belonging to the age group one year later N(t) is the number of fish belonging to the age group being investigated. Also there is a relationship between S and Z of $S=e^{-Z\ (t)}$ and $Z\%= 100*(1-e^{-Z}\ t)$. The natural mortality rate (M) was estimated from the equation of Tanaka (1960): $M=3/T_{max}$, where T_{max} is the age of the oldest fish sampled. Following estimation of Z and M, the fishing mortality rate (F) was estimated from: F= Z-M, and the exploitation ratio (E) from: E= F/Z The value of the condition factor (CF) was also estimated. $CF= W/L^3$ (Ricker, 1975) where *W* is the mean of body weight (g) without gonad, *L* is the mean of fork lengths (cm).

In this research, gonads belonging to 636 specimens of the common pandora were studied. Sex and maturity stages were then determined macroscopically and weight of the gonads (GW) was recorded to the nearest 0.01g. Gonado somatic index (GSI) was calculated as follows (Le Cren, 1951): GSI=GA*100/TW-GA

Stages of maturation were classified as follows: I, immature; II, resting; III, ripe; IV, running ripe; and V, spent (Pajuelo and Lorenzo, 1998). The 3rd, 4th and 5th stages were considered as mature gonads to estimate the mean lengths at 50% maturity (for only females). According to Saila et al. (1988) the maturity data were fit to the logistic function:

$P= 1/\{1+ \exp [-r(FL-L_{50})]\}$ where *P* is the proportion mature in each size class, *r* is

a parameter controlling the shape of the curve and L_{50} is the size at 50 % maturity (Santos et al.,1995).

Results

Fish ranged in size from 77 to 228 mm, weighing between 8.1 and 239.1 g. Males ranged from 101 to 228 mm in length and from 22.72 to 239.1 g in weight. Length of females ranged between 101 and 190 mm and weight between 10 and 126.9 g. Hermaphrodites ranged in size from 77 to 190 mm, weighing from 8.1 to 121.4 g. Significant difference in the length and weight was not found between males and females (Tukey one-way ANOVA, $F_{0.05\ (1,550)}$= 254, F_{cal}= 21.522 for length; $F_{0.05\ (1,550)}$= 254, F_{cal}= 30.651 for weight). Length-weight regression parameters for females, males and all individuals are presented in Fig 2. Negative allometric growth was observed for females, males and all individuals.

Fish aged 0-VIII years were found (Table 1). The parameters of the von Bertalanffy growth equation for males, females and all individuals are given in Table 2. Females grew faster than males (k=0.30>0.15).

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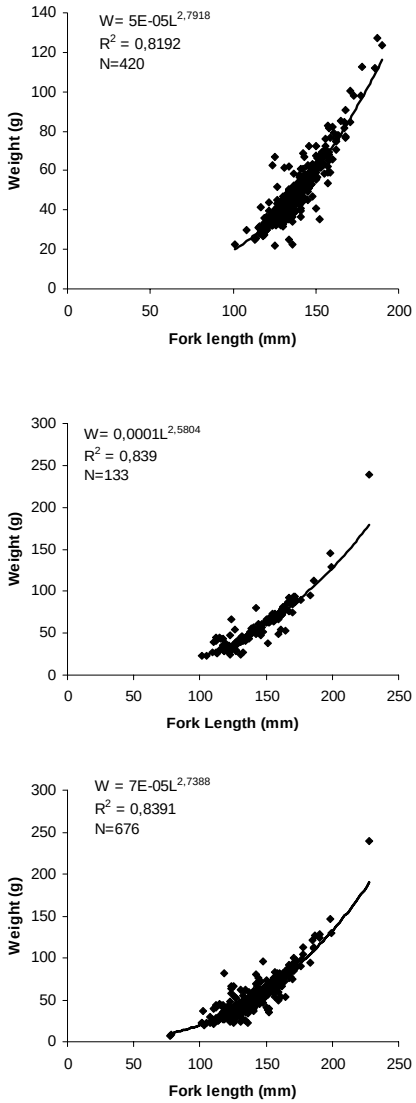

Figure 2. The length-weight relationship of *P. erythrinus* in Edremit Bay (female, male and all individuals).

Table 1. Age-length key for males and females of *P. erythrinus*.

Age	0		1		2		3		4		5		6		7		8	
FL	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
70	1	1																
80																		
90																		
100			1			3												
110			4	2	6	11	7	1										
120			2		18	11	56	7	3	1								
130			1		7	3	86	12	27	2								
140					3		33	4	31	5	10	1	1					
150							4	1	18	8	16	5	5	2		1		
160								1	3	5	2	5	7	6	3			
170									1	1		2	3	4	1	2		
180													1		1	2		
190																	1	2
200																		
210																		
220																		1
N	1	1	8	2	34	28	186	26	83	22	28	13	17	12	5	5	1	3
X	77	78	119.1	117	126.6	118.9	132.2	134.1	143.6	152.1	151.7	159.3	162	165.4	171.6	171.8	190	208.3
SD	0	0	8.8	0	7.6	8.1	7.7	10.1	9.7	11.7	6.3	8.1	11.4	6	10.7	14.2	0	17

Table 2. Parameters of the von Bertalanffy growth equation

	L_∞(mm)	k(year^{-1})	t_0 (year)	r^2
Males	252.78	0.15	-2.77	0.88
Females	192.27	0.30	-0.72	0.73
All Fish	239.95	0.16	-2.6	0.89

Condition factor values for male and female specimens were found at their highest in Autumn, being 1.91 and 1.82 respectively, and at their lowest in the summer months, being 1.77 and 1.76 respectively. It is notable that the condition factor is low in the summer months, when the gonads are most mature, and that it rises in the Autumn, when the gonads are spent (Fig.3).

The total, natural and fishing mortality rates, the exploitation ratio for males, females and all individuals are given in Table 3.

133 of the examined fish were males, 420 were females and 83 were hermaphrodites. An overall ratio of males to females of 1: 3.16 was determined and this was shown to be significant as a result of X^2 analysis (X^2=149>$X^2_{1,\ 0.05}$= 3.84). Females predominated in 120-150 mm size intervals (Fig 4).

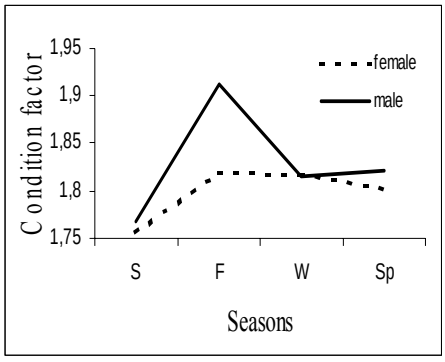

Figure 3. Seasonal variations of condition factor for *P. erythrinus* in the Edremit Bay.

Table 3. Total (Z, %Z), natural (M) and fishing (F) mortality rates, exploitation ratio (E)

	Z	%Z	M	F	E
Males	0.39	32	0.38	0.02	0.05
Females	0.97	62	0.38	0.60	0.61
All Fish	0.76	53	0.38	0.40	0.51

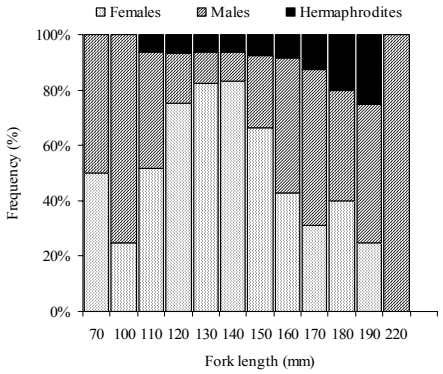

Figure 4. Sex ratio by size intervals of *P. erythrinus* of the Edremit Bay.

The GSI values of females were usually higher than those of males. The highest values occurred in August for females and in September for males (Fig 5).

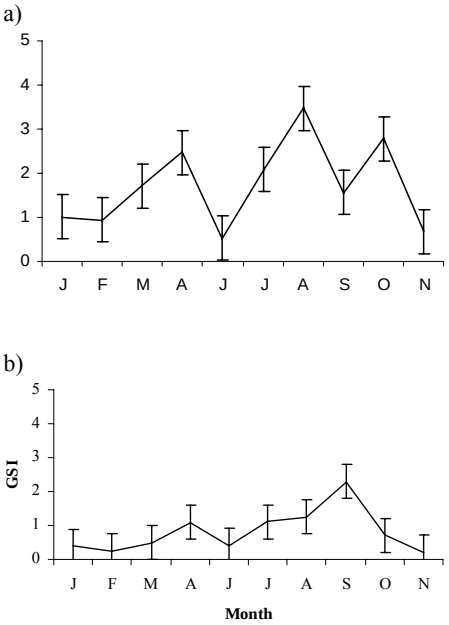

Figure 5. Monthly change in the gonadosomatic index (GSI) for females (a) (n=420) and males (b) (n=133) of *P. erythrinus* in the Edremit Bay.

The fork length at which 50% maturity is reached was 130 mm for females (Fig. 6). The parameters of sexual maturity ogive for females were determined as seen below:

$P_{fem}=1/ \{1 + \exp[-0.8461 (FL-13) \}$ (n=8, $r^2= 0.98$)

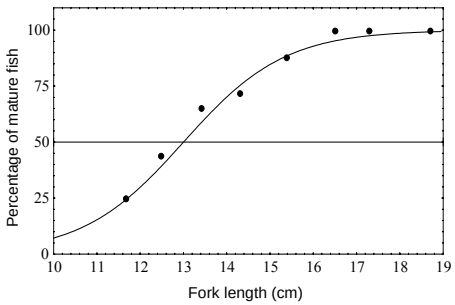

Figure 6. Ogive of 1st maturity for the *P. erythrinus* in the Edremit Bay.

Discussion

Weight increases negative allometrically with length for females, males and all fish. Similar results have been reported from other areas (Özaydın, 1997; Hashem and Gassim, 1981; Papaconstantinou *et al*., 1988; Santos *et al.*, 1995; Andaloro and Giarritta, 1985; Livadas, 1989 (Table 4).

In this study fluctuations in the spawning period are noted. The peaks in April, August and October show that the spawning period of this species is long (April-October) (Ranzi, 1933 and Mater, 1976 according to Ünsal, 1984; Özaydın, 1997). In particular Mytilineou (1989) determined this period in Greek Seas as lasting from April to October, which is in complete agreement with the results of the present study (Table 5).

Length at first maturity in females was found to be 130 mm. This result is in agreement with similar studies (Larraneta, 1964; Mytilineou, 1989; Ünsal, 1984; Ghorbel, 1981). Length at first maturity exhibits a tendency to increase from the Mediterranean towards the Atlantic (Table 5).

Table 4. Length-weight relation parameters for *P. erythrinus* obtained by several authors (TL, total length; SL, standard length; FL, fork length (cm)).

Length range	Length-weight relationship	Area	Author
7-34	$W=0.0188TL^{2.863}$	Libyan waters	Hashem & Gassim, 1981
6.5-26	$W=0.3209SL^{2.09}$	Marmara Sea	Unsal, 1984
7-30	$W=0.0247TL^{2.956}$	Sicily channel	Andaloro &Giarritta, 1985
11-15	$W=0.000027FL^{2.956}$	Greek Seas	Vassilopoulou *et al*., 1986
4.3-32.2	$W=0.00002FL^{2.979}$	Western Greece	Papacons. *et al.*, 1988
11-22	$W=0.0236TL^{2.818}$	Cyprus Seas	Livadas, 1989
5-25	$W=0.00004FL^{2.83}$	Aegean Sea	JICA, 1993
15-28	$W=0.0189TL^{2.881}$	South Portugal	Santos *et al*., 1995
8.8-25.6	$W=0.0242FL^{2.985}$	Aegean Sea	Özaydın, 1997
7.7-22.8	$W=0.00007FL^{2.738}$	Aegean Sea	Present study

Table 5. Spawning period and length at first maturity for females (cm) according to several authors (TL, total length; SL, standard length)

Spawning period	First maturity	Area	Author
May-June	13.5 (TL)	Castellon	Larraneta, 1964
June-Aug.	14-17 (TL)	Gulf of Lion	Girardin, 1978
May-Aug	13.9 (TL)	Gulf of Gabes	Ghorbel, 1981
-	13 (TL)	Libyan waters	Hashem&Gassim, 1981
May-July	10.5-12.5 (SL)	Marmara Sea	Ünsal, 1984
June-July	17.4 (TL)	Canary Islands	Pajuelo&Lorenzo, 1988
April-Oct.	15 (TL)	Greece	Mytilineou, 1989
May-Aug.	18.03 (TL)	Algarve (Portugal)	Santos *et al*, 1995
April-Oct.	13 (TL)	Gulf of Edremit (N.Aegean Sea)	Present study

The theoretical maximal length value (L_∞= 239.95 mm) was close to the size of the largest fish examined and the growth coefficient value (k= 0.16 $year^{-1}$) indicated that the growth was lower than other results, which have been reported by Girardin (1981), Girardin and Quignard (1985), Livadas (1989). However our results were similar to those of Andaloro and Giarritta, 1985 (Table 6). The theoretical age when fish would have been at zero fork length (t_0= -2.6) was found lower than Özaydın (1997) and Erzini *et al*. (2001) however it was higher than the other results (Table 6). It shows certain differences from the growth parameters given by other investigators. These differences may be related to the regional differences in the environmental factors.

The exploitation ratio for all fish (E= 0.51) in the present study indicates that the population is optimally exploited (E= 0.50) (Pajuelo and Lorenzo, 1998). It shows that the stock of the common pandora of the Edremit Bay is being exploited in the limit. Özaydın (1997) this value was determined as 0.21 for the Aegean Sea. But the exploitation ratio for females is higher than males. The result is related to the fact that the sex ratio of males to females was 1:3.16. In previous studies also the sex ratio of females is much higher when compared with males (Özaydın, 1997; Mytilineou, 1989; Ünsal, 1984; Hashem and Gassim, 1981). The fact that the ratio of males to females is so low may be related to protogynous hermaphroditism. According to Pajuela and Lorenzo (1998) the predominance of females has also been observed in the Mediterranean by Vassilopoulou *et al*. (1986), and the absence of females in the largest size implies that sex conversion occurs in all fish.

Table 6. Parameters of the von Bertalanffy growth equation for *P. erythrinus* in different areas.

L_∞ (mm)	K (year^{-1})	T_0 (year)	Area	Author
405	0.24	-	Gulf of Lyon	Girardin, 1981
379	0.20	-	Adriatic Sea	Juckic & Piccinetti, 1981*
367	0.16	-	Sicilia	Andaloro & Giarritta, 1985
345	0.33	-	Gulf of Lyon	Girardin & Quignard, 1985
326	0.18	-	Greece	Papaconstantinouetall, 1988
482	0.06	-	Greece	Mytilineou, 1989
300	0.20	-	Cyprus	Livadas, 1989
277	0.14	-1.63	Gulf of Gabes	Ghorbel & Bouain, 1990
314	0.12	-2.84	Aegean Sea	Özaydın, 1997
417	0.20	-0.55	Canary Islands	Pajuelo & Lorenzo, 1998
471	0.08	-4.42	South Portugal	Erzini *et al*., 2001
240	0.16	-2.6	Gulf of Edremit	Present study

**According to Pajuelo and Lorenzo (1998).*

Seasonal fluctuation in the condition factor for both sexes was found lower in the present study in the summer months because of the fish expend a great deal of energy for gonad development as in Papaconstantinou *et al*. (1988) and Özaydın (1997).

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