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Growth and Reproduction of Por's Goatfish (*Upeneus pori* Ben-Tuvia & Golani, 1989) in İskenderun Bay, the Eastern Mediterranean

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Abstract: The age composition, growth parameters, spawning season, sex ratio, length at first sexual maturity and fecundity of por's goatfish (*Upeneus pori*) caught from the Bay of İskenderun in the eastern Mediterranean Sea were investigated. Females and males made up 52.6% and 47.4%, respectively, of the particular population of the species. The total length of females ranged from 7.0 cm to 17.0 cm, and of males from 6.6 cm to 15.1 cm. The length (L) – weight (W) relationships for males and females were estimated as $W = 0.0108 * L^{2.99}$ and $W = 0.0097 * L^{3.03}$, respectively. The age data derived from otolith readings were used to estimate the growth parameters of the von Bertalanffy equation. The estimated parameters were: $L_{\infty} = 19.1$ cm, $K = 0.360$ and $t_0 = -0.812$. The maximum age was 5 for females and 4 for males. The 2-year age group was dominant in both females and males. Males and females matured at a total length of 10 cm. The monthly values of the gonadosomatic index indicated that spawning occurred mainly between May and July. The fecundity (F) - length relationship was $\log F = 0.733 + 3.46 \log L$ ($r = 0.81$).

Key Words: İskenderun Bay, Eastern Mediterranean, por's goatfish, growth, reproduction.

İskenderun Körfezi'nde (Doğu Akdeniz) Nil Barbununun (*Upeneus pori* Ben-Tuvia & Golani, 1989) Büyüme ve Üreme Özellikleri

Özet: İskenderun Körfezi'nden (Doğu Akdeniz) örneklenen Nil Barbununun (*Upeneus pori*) yaş dağılımı, büyüme verileri, yumurtlama zamanı, eşey oranları, ilk cinsi olgunluğa erişme boyları ve yumurta verimliliği (F) araştırılmıştır. Örneklerin % 52,6'nı dişiler, % 47,4'ünü erkekler oluşturmuştur. Dişilerin total boyu 7,0 ile 17,0 cm arasında, erkeklerin ki ise 6,6 ile 15,1 cm arasında değişim göstermektedir. Erkek ve dişilerin boy (L) ve ağırlık (W) ilişkisi sırasıyla $W = 0,0108 * L^{2.99}$ ve $W = 0,0097 * L^{3.03}$ olarak saptanmıştır. Otolitlerden elde edilen yaş verileri von Bertalanffy büyüme verilerinin tahmininde kullanılmıştır. Buna göre hesaplanan veriler; $L_{\infty} = 19,1$ cm, $K = 0,360$, $t_0 = -0,812$ dir. En yüksek yaş, dişiler için 5, erkekler için 4 olarak belirlenmiştir. Erkek ve dişilerin yaş dağılımında 2. yaş grubu baskın bulunmuştur. İlk eşeyse olgunluğa, erkekler ve dişiler 10 cm total boyda ulaşmaktadır. Aylık gonadosomatik indeks değerleri, yumurtlama zamanının yoğun olarak Mayıs ve Temmuz ayları arasında olduğunu göstermiştir. Yumurta verimliliği (F) - boy ilişkisi, $\log F = -0,733 + 3,46 \log L$ ($r = 0,81$) olarak saptanmıştır.

Anahtar Sözcükler: İskenderun Körfezi, Doğu Akdeniz, Nil Barbunu, büyüme, üreme.

Introduction

The por's goatfish (*Upeneus pori*) is a Lessepsian migrant species which penetrates into the Mediterranean Sea through the Suez Channel (Golani and Ben-Tuvia, 1995). The por's goatfish is a commercially important demersal species, living mostly in sand, muddy sand or gravel bottoms at depths ranging from 20 m to 50 m (Golani, 1994). It is a subtropical species, distributed along the western Indian Ocean from the Red Sea to southern Oman (Ben-Tuvia and Golani, 1989).

Lessepsian fish species such as *Upeneus pori*, *Upeneus moluccensis*, *Saurida undosquamis*, *Sphyræna chrysotaenia* have been reported to be important in commercial fishing along the Turkish Mediterranean coast. Studies conducted in İskenderun Bay indicated that about 30% of the species obtained through trawling in İskenderun Bay consisted of two Red Sea colonizers, *Upeneus moluccensis* and *Upeneus pori* (Torcu, 1995). Bingel et al., (1993) reported that the Lessepsian species as goatfish, lizardfish make up the main catch of

the trawl fishery in Mersin and İskenderun bays. Golani and Ben-Tuvia (1995) showed that the Lessepsian migrants contribute greatly to the local Israel fisheries and reported that nearly half of the Israel trawl catch is composed of Lessepsian fish migrants.

The fishes inhabiting the Mediterranean Sea are well known on a global basis (Whitehead et al., 1986; Fischer et al., 1987). The community structure of the Mediterranean Sea, especially coastal zones, are also well documented. However on a regional scale, there are discontinuities in the knowledge, especially on the Lessepsian species of the northeastern Mediterranean Sea. There are only very few attempts to describe the comprehensive biology and ecology of the por's goatfish. Most of the available information on the distribution of the species, except for a few studies (Golani, 1990; Golani and Galil, 1991; Golani 1994; Taskavak and Bilecenoglu, 2001; Cicek et al., 2002) was provided by Ben-Tuvia and Golani (1989), Galil (1993), Gucu et al (1994), Golani and Ben-Tuvia (1995), Mater et al (1995), Golani (1996), Basusta (1997), Golani (1998a). Golani (1990) and Golani and Galil (1991) provided some information on the feeding habits of the species. Golani (1994) dealt with niche separation between colonizing and indigenous goatfishes of the Mediterranean coast of Israel. Taskavak and Bilecenoglu (2001) studied length-weight relationships for 18 Lessepsian immigrant fish species in the eastern Mediterranean coast of Turkey. Cicek et al. (2002) studied population characteristics of the por's goatfish inhabiting in Babadillimanı Bight, Northeastern Mediterranean.

The present work provides information concerning the age and size distribution, growth, sex ratio and reproduction of the por's goatfish in the Bay of İskenderun, in the eastern Mediterranean as a contribution to the management of the fishery exploiting those stocks.

Materials and Methods

A total of 616 por's goatfish specimens were collected from the R/V Mustafa Kemal-1 between May 1999 and April 2000 at 2 stations in the Bay of İskenderun (Figure 1). Monthly trawl surveys were carried out during daytime at depths ranging from 0 m to 50 m. The trawl was equipped with an 18 mm mesh size net at the cod-end. Hauling lasted about 2,5 h at a speed of 1.5 knots.

Total length was measured to the nearest millimetre, and whole body and gonad weights were measured to the nearest gram, all in the laboratory. Age was determined from otolith rings following the procedure described by Holden and Raitt (1974). Otoliths removed from the fish were stored dry in paper envelopes, and were later cleaned and made them transparent. The otoliths were read in glycerin under a stereozoom microscope with reflected light.

The length-weight relationships were determined according to the allometric equation (Sparre et al., 1989):

$$W = aL^b,$$

where W is the total body weight (g), L the total length (cm), and a and b are constants.

Growth was expressed in terms of the von Bertalanffy equation (Beverton and Holt, 1957):

$$L_t = L_{\infty} (1 - e^{-K(t-t_0)}),$$

where L_{∞} is the asymptotic total length, L_t the total length at age t, K the growth curvature parameter and t_0 is the theoretical age when fish would have been at zero total length. Growth parameters were estimated according to the non-linear method by using the FiSAT package program (Sparre et al., 1989).

The sex and maturity stage of each specimen were determined by visual and microscopic examination of the gonads. The stages of maturation were classified according to Holden and Raitt's (1974) scale. The gonadosomatic index (GSI) was calculated monthly by the equation:

$$GSI = (\text{gonad weight/fish weight without gonad}) * 100$$

The ovaries for fecundity estimation were cut longitudinally and stored in Gilson's fluid, which broke down the connective tissue. The egg numbers were estimated using the gravimetric method described by Bagenal (1978). The data were analysed by least squares regression using log10 transformations (Ismen, 1995).

Results

Of the 616 specimens measured, 324 were female (52.6%) and 292 male (47.4%). The total length of females in the Bay of İskenderun ranged from 7.0 cm to 17.0 cm. The range was smaller for males, from 6.6 cm to 15.1 cm (Figure 2). The overall mean total length of females was greater than that of males ($P < 0.01$).

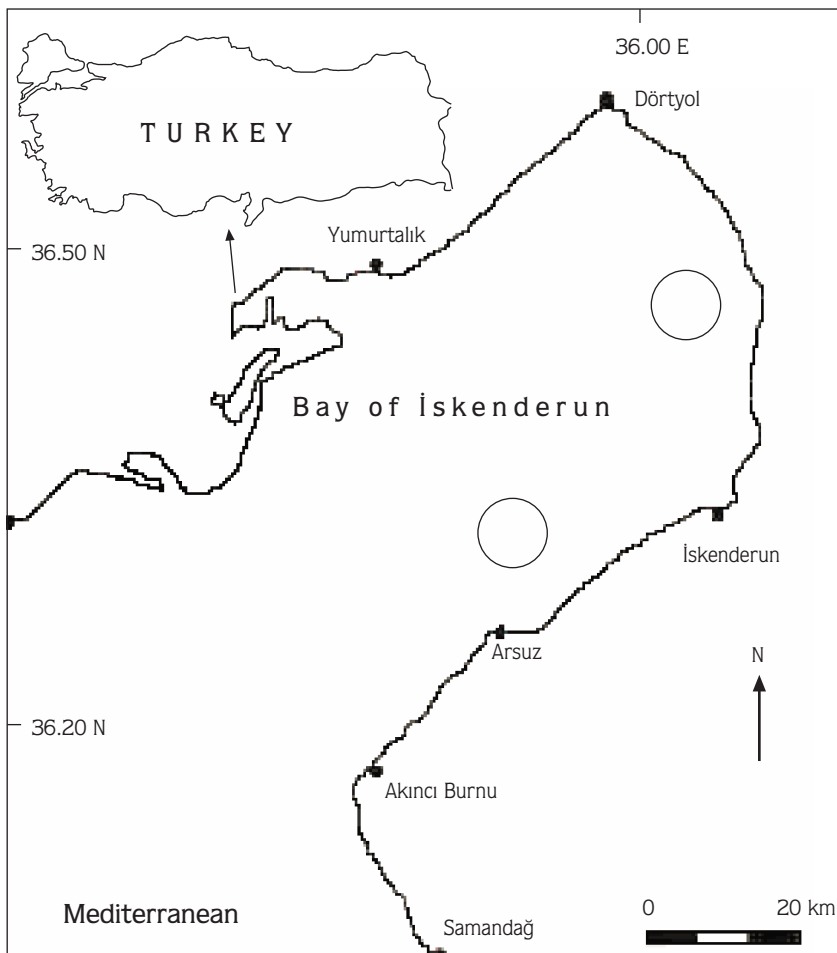


Figure 1. Location of the sampling stations in the Bay of İskenderun (O: sampling station).

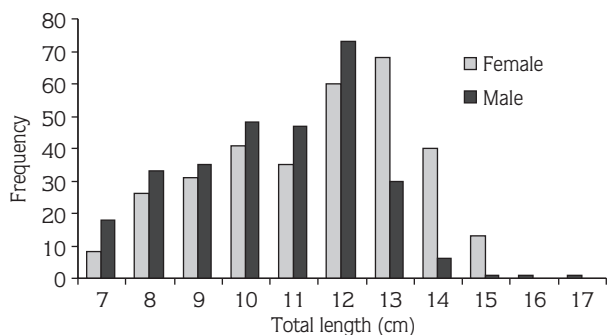


Figure 2. Length-frequency distribution of male and female por's goatfish.

The length-weight relationships were separately evaluated for females and males, and are presented in Figure 3. The exponent *b* demonstrated an isometric growth. Comparing the length-weight relationships of

the sexes using covariance analysis, no significant difference was found. The equation for the relationship was $W = 0.0097 * L^{3.03}$ ($r = 0.99$) for females, and $W = 0.0108 * L^{2.99}$ ($r = 0.99$) for males.

The estimated von Bertalanffy growth parameters for the por's goatfish were;

$L_{\infty} = 19.1$ cm, $K = 0.360$ and $t_0 = -0.812$ for both sexes combined, $L_{\infty} = 18.5$ cm, $K = 0.420$ and $t_0 = -0.630$ for females, and $L_{\infty} = 17.9$ cm, $K = 0.374$ and $t_0 = -0.887$ for males. The calculated and observed total length at age data are presented in Table 1. The observed lengths and growth increments of the sexes were similar at ages 1-3. The por's goatfish attained approximately 48% of its calculated maximum size during the first year of life. After completion of the first year, the annual growth rate ranged between 1 and 3 cm.

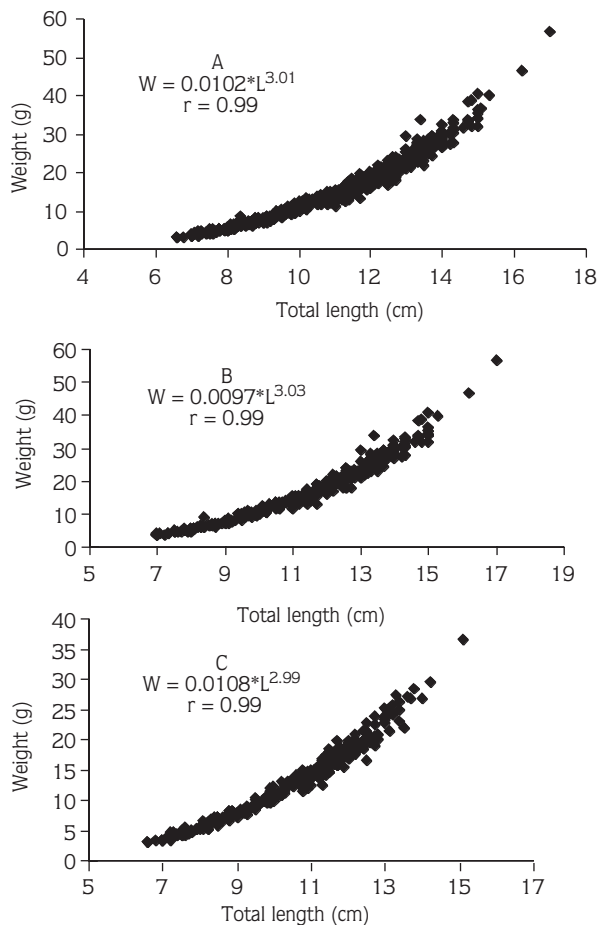


Figure 3. Length-weight relationships (A) pooled, (B) female, (C) male.

The maximum age determined was 5 for females and 4 for males. Age group 2 was dominant in females (53.1%) and males (52.7%). In females, age group 2 was followed by age groups 1 (37%), 3 (9.3%), 4 (0.3%) and 5 (0.3%). In males, age group 1 represented 44.5% of the total.

The overall female to male ratio was determined as 1.1:1.0. The female to male ratios for each month are presented in Table 2. All the monthly samples contained more females than males, excluding October, November and December.

Examination of the male and female maturity stages indicated that males and females of *U. pori* matured at about 10 cm total length (1 years old) (Figure 4). The GSI results revealed that spawning occurred after April, when the GSI for both sexes reached its highest level (Figure 5). However, the presence of mature individuals in September showed that reproduction may continue at a reduced rate during summer.

For the Bay of Iskenderun, data analysis indicated that fecundity is significantly related to length by the relationship :

$$\text{LogF} = 0.733 + 3.46\text{logL} \quad (r = 0.81),$$

where F is fecundity and L is the fish length (cm). Plots of fecundity-length data and the arithmetical form of the relationship are shown in Figure 6. The correlation coefficient (r) is significantly different from zero (P < 0.01).

Table 1. Total length at age values (cm) of the por's goatfish from the Iskenderun Bay

Age groups	Observed			Calculated		
	Female (min-max)	Male (min-max)	Pooled (min-max)	Female	Male	Pooled
1	9.3 ± 1.13 (7.0-11.2)	9.2 ± 1.25 (6.6-11.4)	9.2 ± 1.19 (6.6-11.4)	9.2	9.1	9.2
2	12.5 ± 0.79 (10.5-14.0)	11.9 ± 0.63 (10.7-13.4)	12.2 ± 0.77 (10.5-14.0)	12.4	11.9	12.2
3	14.5 ± 0.45 (13.5-15.3)	13.7 ± 0.35 (13.1-14.2)	14.3 ± 0.49 (13.1-15.3)	14.5	13.8	14.3
4	16.2 ± 0.00 (16.2-)	15.1 ± 0.00 (15.1-)	15.7 ± 1.56 (15.1-16.2)	15.9	15.1	15.7
5	17.0 ± 0.00 (17.0-)	-	17.0 ± 0.00 (17.0-)	16.8	16	16.7

Table 2. Number of female and male por's goatfish by sampling months.

Month	Male	Female	Female/Male ratio
April	8	20	2.50:1.0
May	9	12	1.33:1.0
Jun	8	15	1.88:1.0
July	66	68	1.0:1.0
August	14	27	1.93:1.0
September	80	103	1.29:1.0
October	27	26	1.0:1.0
November	42	38	1.0:1.11
December	38	15	1.0:2.53
Total	292	324	1.11:1.0

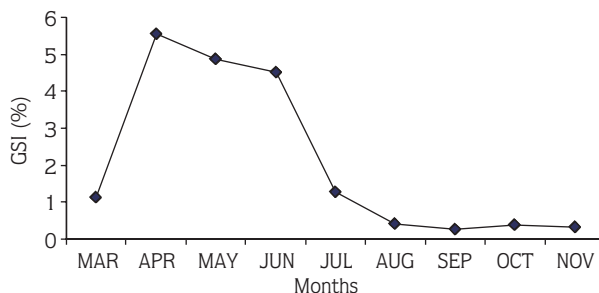


Figure 5. Gonadosomatic index (GSI) values of both sexes of por's goatfish.

Discussion

The passage of Lessepsian species to the Mediterranean is continuing in an even growing trend today. This has had an effect on the ecosystem balances, on the present structure of the species in the Mediterranean in particular. Eventhough there are not sufficient studies conducted, it is observed that the Lessepsian species which entered and rapidly colonizing the Mediterranean competed with the indigenous species in terms of sharing the food and the habitat. Basusta et al. (2002) reported that the por's goatfish, previously misidentified as *Upeneus asymmetricus* (Torcu and Mater, 2000), was first observed in the Northeastern Mediterranean coast of Turkey in the end of 1940's by Koswig (1950). After date, there has been a noticeable increase in the catch of *Upeneus pori* in the fishery along the Turkish coast. However, There is no precise data for

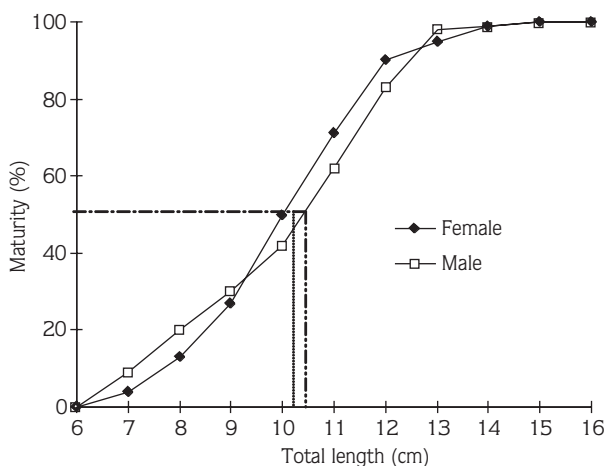


Figure 4. Length at first maturity of males and females of por's goatfish.

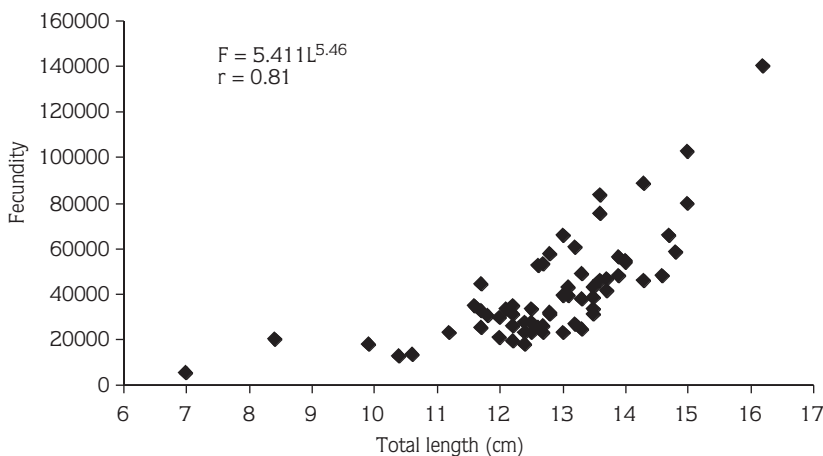


Figure 6. Relationship of fecundity to length for por's goatfish.

the annual catch of por's goatfish because the catches of all mullet of without separation to the species level are recorded in Turkish Fisheries Statistics. Cicek et al (2002) reported that the biomass of por's goatfish in the northeastern Mediterranean coast of Turkey striking increased within the past a few years.

The results of the growth rate in the first year of the por's goatfish reported in the present paper are in agreement with those of Cicek et al. (2002). In the Bay of İskenderun and the Babadillimanı Bight it was found that the first annulus is formed at a length of 9.2 cm and 7.7 cm, respectively. Cicek et al. (2002) reported that the largest female caught in Babadillimanı Bight during the survey was 15.5 cm and that the maximum length was 19 cm in the southern Umman (Randall, 1995). The largest individual caught and the calculated maximum length in the Bay of İskenderun were 17 cm and 19.1 cm, respectively.

The mean annual growth rate for 1-5-years-old fish ranged between 1 and 3.2 cm in this study (Table 1). Growth was rapid in both sexes for the first year and declined gradually over subsequent years. Cicek et al. (2002) reported the mean annual growth rate for 1-5-year-old fish as about 3.1 cm, 1.5 cm, 1.5 cm and 1.6 cm, respectively. The differences in growth rates might be attributed to different bio-ecological conditions.

Comparison of the length growth parameters obtained for Mediterranean por's goatfish applying Munro's phi prime test showed that there is no significant difference ($P>0.05$) between the overall growth performances of the por's goatfish sampled from the İskenderun and Babadillimanı Bight. The calculated value of the growth coefficient K in this study is similar to the value calculated by Cicek et al. (2002) for por's goatfish stocks inhabiting the northeastern Mediterranean Sea. No statistically significant differences have been detected among the growth performances of por's goatfish from two different areas, possibly due to spatial and temporal changes in their different nutritional conditions.

The absence of a 0 age group in the samples was probably due to the selectivity of the cod-end used in the trawl nets. However, the low levels of the older age groups after the age of 2 cannot be related to selectivity, and are more likely to be the outcome of extremely intensive fishing activities. The maximum depth at which por's goatfish were caught during this study was 50 m.

Golani (1994) showed that niche partitioning of the eastern Mediterranean mullets is achieved on the bathymetrical axis; Lessepsian mullets occupy shallow waters (20-30 m) while indigeneous species dominate in greater depths. Cicek et al. (2002) stated that 97.9% of the total biomass of *U. pori* were trawled from less than 50m waters.

Cicek et al. (2002) found the female to male ratio in the Babadillimanı bight in the northeastern Mediterranean to be 0.95:1.0, which is close to that determined in the present study. In this study, sex ratio of around 1:1 and the significant increase in the number of males compared to females in autumn was found. This can probably be attributed to an early departure of the females from the nursery grounds. Seasonal variations in the sex ratio may possibly be due to the difference in the length (or age) of sexual maturity and the difference in length distribution in relation to depth.

Cicek et al. (2002) reported that the spawning of the por's goatfish in the northeastern Mediterranean extends from March to August and the GSI values reached maximum level in April. These are very similar to the present observations. The GSI results revealed that spawning occurred after April, when the GSI reached its highest level. However, the presence of mature individuals in September showed that reproduction may continue at a reduced rate during summer. Males and females of *U. pori* mature at about 10 cm total length (1 years old). Cicek et al. (2002) stated that in Babadillimanı bight, the sexual maturation of females started at about 8 cm total length at age group 1.

Age and back-calculated growth were determined from annual rings in the otoliths. Increase in length is rapid during the first year and slow thereafter. Females have a slightly faster rate of growth than males and live longer. The oldest male was 4 years old and the oldest female found was 5 years old.

The length-weight relationship is the same for both sexes (analysis covariance), but the difference in final age requires 2 equations.

Individuals of both sexes mature for the first time after the first year of life. Fecundity is significantly related to length by the relationship $F = 5.411L^{3.46}$ ($r=0.81$). Cicek et al. (2002) showed that the fecundity-length relationship was $F = 2.721L^{2.29}$.

In conclusion, the available data suggest that the minimum fishing size should be limited to 10 cm for the Mediterranean por's goatfish, and that the fishing season should be restricted from May to September. This extended period covers fishing seasons closed to the use of deep trawls (breeding seasons of the main catch in the Mediterranean). However, Mediterranean fisheries have features of both typical tropical fisheries, and the number of species encountered in the trawl catches is rather high compared to the other temperate areas. Therefore, stock assessment investigations should probably consider the

multispecies situation in cases where single species assessments do not give proper objectives in the eastern Mediterranean Sea.

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