Turk J Vet Anim Sci
28 (2004) 289-295

Scientific Report

Age, Growth and Reproduction of Tub Gurnard (*Chelidonichthys lucerna* L. 1758) in the Bay of İskenderun in the Eastern Mediterranean

Ali İŞMEN, Pınar İŞMEN
Çanakkale Onsekiz Mart University, Faculty of Fisheries, P.O.Box. 56, 17100 Çanakkale - TURKEY
Nuri BAŞUSTA
Mustafa Kemal University, Faculty of Fisheries, 31100 Hatay - TURKEY

Received: 04.04.2002

Abstract: The age composition, growth parameters, spawning season, sex ratio, length at first sexual maturity and fecundity of tub gurnard (*Chelidonichthys lucerna*) caught from the Bay of İskenderun in the eastern Mediterranean Sea were investigated. Females and males made up 58.2% and 41.8%, respectively, of the particular population of the species. The total length of females ranged from 8.0 cm to 30.3 cm, and of males from 8.3 cm to 21.2 cm. The length (L) – weight (W) relationships for males and females were estimated as $W = 0.0089*L^{3.01}$ and $W = 0.0095*L^{2.99}$, respectively. The age data derived from otolith readings were used to estimate the growth parameters of the von Bertalanffy equation. The estimated parameters were: $L_\infty = 45.0$ cm, $K = 0.221$ and $t_o = -0.581$. The maximum age was 4 for females and 3 for males. The 1-year age group was dominant in both females and males. Males matured at a total length of 18 cm, while females matured at 20 cm. The monthly values of the gonadosomatic index indicated that spawning occurred mainly between December and May. The fecundity (F) - length relationship was $\log F = -2.512 + 5.58 \log L$ ($r = 0.94$).

Key Words: Bay of İskenderun, eastern Mediterranean, tub gurnard, age, growth, reproduction

İskenderun Körfezi'nde (Doğu Akdeniz) Kırlangıç Balığının (*Chelidonichthys lucerna* L. 1758) Yaş Kompozisyonu, Büyüme ve Üreme Özellikleri

Özet: İskenderun Körfezi'nden (Doğu Akdeniz) örneklenen Kırlangıç balığının (*Chelidonichthys lucerna*) yaş kompozisyonu, büyüme parametreleri, yumurtlama zamanı, cinsiyet oranları, ilk cinsi olgunluğa erişme boyları ve fekonditesi araştırılmıştır. Örneklerin % 58,2'sini dişiler, % 41,8'ini erkekler oluşturmuştur. Dişilerin total boyu 8,0 ile 30,3 cm arasında, erkeklerinki ise 8,3 ile 21,2 cm arasında değişim göstermektedir. Erkek ve dişilerin boy (L) ve ağırlık (W) ilişkisi sırasıyla $W = 0{,}0089*L^{3.01}$ ve $W = 0{,}0095*L^{2.99}$ olarak saptanmıştır. Otolitlerden elde edilen yaş verileri von Bertalanffy büyüme parametrelerinin tahmininde kullanılmıştır. Hesaplanan parametreler; $L_\infty = 45{,}0$ cm, $K = 0{,}221$, $t_o = -0{,}581$'dir. Maksimum yaş, dişiler için 4, erkekler için 3 olarak tespit edilmiştir. Erkek ve dişilerde 1 yaş grubu baskın bulunmuştur. İlk cinsi olgunluğa, erkekler 18 cm, dişiler ise 20 cm total boyda ulaşmaktadır. Aylık gonadosomatik indeks değerleri, yumurtlama zamanının yoğun olarak Aralık ve Mayıs ayları arasında olduğunu göstermiştir. Fekondite (F) - boy ilişkisi, $\log F = -2{,}512 + 5{,}58 \log L$ ($r = 0.94$) olarak saptanmıştır.

Anahtar Sözcükler: İskenderun Körfezi, Doğu Akdeniz, kırlangıç, yaş, büyüme, üreme

Introduction

The tub gurnard (*Chelidonichthys lucerna*) is a commercially important demersal species, living in shoals and mostly in sand, muddy sand or gravel bottoms at depths ranging from 20 m to 300 m. It is a Mediterranean-Atlantic species, distributed along the Mediterranean Sea, the Black Sea and the eastern Atlantic Ocean from Norway to the west African coast (1). The tub gurnard exhibits a particular pattern of migratory movement within its overall depth range during the year. It shows a pronounced concentration the shallow depths in spring and summer and then moves progressively to deeper waters in winter.

The Bay of İskenderun is situated in southern Turkey and is characterised by shallow depths (up to 90 m) and high salinity (0.39%). The general circulation characteristics of the bay are affected by the prevailing currents in the open sea (north-eastern Mediterranean),

because of its outlet through a wide opening, and by the regional and local winds (2). The bay is overfished (trawlers, purse seines etc.) (3).

Published information on the comprehensive biology and ecology of this species in the Turkish coast of the eastern Mediterranean Sea is scarce. However, the tub gurnard in the other regions of the Mediterranenan were studied satisfactorily by many researchers during recent years. Most of the available information on the distribution of the species, except for a few studies (4 - 11) was provided by Collignon (12), Rizzi and Bello (13), Akşıray (14), Jardas (15), Tsimenides et al. (16), Bingel et al. (3), Matarrese et al. (17), Quero and Cendrero (18) and Başusta (19). Nouvel (4) and Reys (5) provided some information on the feeding behaviour of the species. Mouneimne (6) studied its age, growth, food and distribution in the Catalan Sea. Papaconstantinou (8) studied the age, growth, reproduction and distribution of fish stocks in the Thermaikos Gulf (north-west Aegean Sea). Altun (10) dealt with age and growth in Yumurtalık Bight in the Bay of İskenderun. In that study, length and weight were examined in respect of absolute and relative growth. The relationships between age and length, and length and weight were determined by using data obtained from commercial catches.

The present work is a contribution to our knowledge of the age and size distribution, growth, sex ratio and reproduction of the tub gurnard in the Bay of İskenderun, in the eastern Mediterranean. Data for estimation of growth parameters and reproduction were obtained from monthly sampling.

Materials and Methods

A total of 342 tub gurnard specimens were collected from the R/V Mustafa Kemal-1 between April 1999 and February 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 Papaconstantinou (8). Otoliths removed from the fish

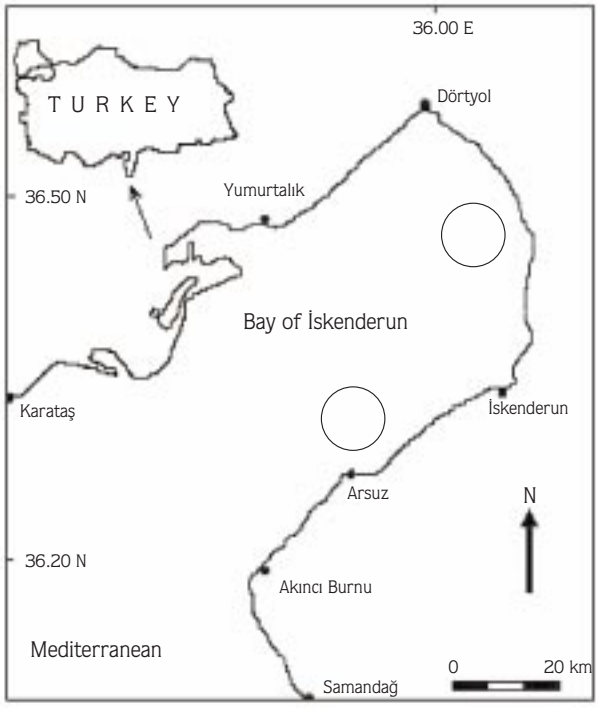

Figure 1. Location of the sampling stations in the Bay of İskenderun (O: sampling station).

were stored dry in paper envelopes, and were later burnt at about 450 ºC for 2 min, after which a series of brown rings appeared. The burnt otoliths were read in glycerin under a stereozoom microscope with reflected light. The burning enchances the visibility of the annuli, since the hyaline zones turn brown while the opaque zones remain white.

The length-weight relationships were determined according to the allometric equation (20):

$$W = aL^b ,$$

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 (21):

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

where L_∞ is the asymtotic total length, L_t the total length at age t, K the growth curvature parameter and t_o 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 (20).

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 (22) scale. The gonadosomatic index (GSI) was calculated monthly by the equation:

GSI = (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 (23). The data were analysed by least squares regression using $\log_{10}$ transformations (24).

Results

Of the 342 specimens measured, 199 were female (58.2%) and 143 male (41.8%). The total length of females in the Bay of İskenderun ranged from 8.0 cm to 30.3 cm. The range was smaller for males, from 8.3 cm to 21.2 cm (Figure 2). The overall mean total length of females was greater than that of males ($P < 0.01$).

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 $W = 0.0095*L^{2.99}$ ($r = 0.98$) for females, and $W = 0.0089*L^{3.01}$ ($r = 0.99$) for males.

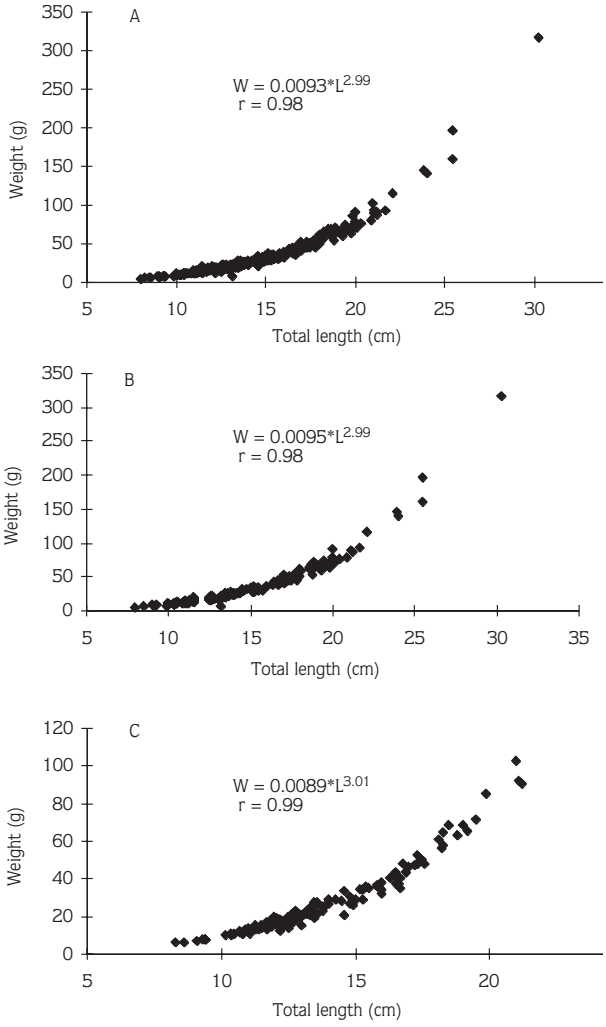

Figure 3. Length-weight relationships (A) pooled, (B) female, (C) male.

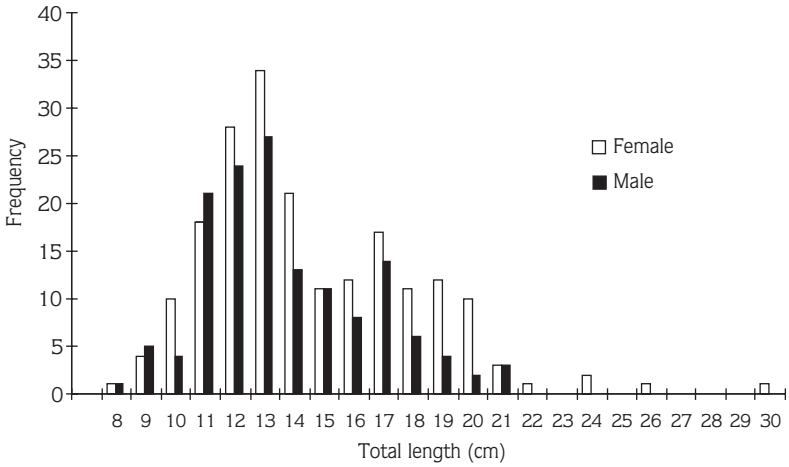

Figure 2. Length-frequency distribution of male and female tub gurnard.

The estimated von Bertalanffy growth parameters for the tub gurnard were;

L_∞ = 45.0 cm, K = 0.221 and t_0 = -0.581 for both sexes combined, L_∞ = 45.6 cm, K = 0.223 and t_0 = -0.602 for females, and L_∞ = 36.0 cm, K = 0.309 and t_0 = -0.478 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 tub gurnard attained approximately 17% of its calculated maximum size during the first year of life. After completion of the first year, the annual growth rate ranged between 4 and 6 cm.

The maximum age determined was 4 for females and 3 for males. Age group 1 was dominant in females (84.8%) and males (90.3%). In females, age group 1 was followed by age groups 2 (13.1%), 3 (1.5%) and 4 (0.5%). In males, age group 2 represented 9.0% of the total.

The overall female to male ratio was determined as 1.4:1.0. The female to male ratios for each month are presented in Table 2. All the monthly samples contained more females than males, excluding December.

Examination of the male and female maturity stages indicated that males of *C. lucerna* matured at about 18 cm total length (2 years old) and females at about 20 cm total length (2 years old) (Figure 4). The GSI results revealed that spawning occurred after December, when the GSI for both sexes reached its highest level (Figure 5). However, the presence of mature individuals in July showed that reproduction may continue at a reduced rate during summer.

Table 2. Number of female and male tub gurnard by sampling months.

Month	Male	Female	Female/Male ratio
May	-	10	100:1.0
July	102	113	1.1:1.0
September	17	33	1.94:1.0
October	2	9	4.5:1.0
November	8	21	2.6:1.0
December	14	13	1.0:1.1
Total	143	199	1.4:1.0

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

LogF = -2.512 + 5.58logL (r = 0.94),

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 ($P < 0.01$).

Discussion

The results of the growth rate in the first year of the tub gurnard reported in the present paper are in good agreement with those of Mouneimne (6), but differ from those of Collignon (12) and Papaconstantinou (8). In the Bay of İskenderun and the Catalan Sea it was found that the first annulus is formed at a length of 13.3 cm and

Table 1. Total length at age values (cm) of the tub gurnard from the Bay of İskenderun.

Age groups	Observed			Calculated		
	Female (min-max)	Male (min-max)	Pooled (min-max)	Female	Male	Pooled
1	13.4 ± 2.03 (8.0-18.7)	13.2 ± 1.78 (8.3-18.3)	13.2 ± 1.92 (8.0-18.7)	13.7	13.2	13.3
2	19.7 ± 0.8 (17.0-22.1)	19.1 ± 1.02 (16.9-21.2)	19.6 ± 0.91 (16.9-22.1)	20.1	19.3	19.6
3	24.8 ± 0.78 (23.9-25.5)	24.0 ± 0.00 (24.0-)	24.6 ± 0.74 (23.9-25.5)	25.2	23.7	24.6
4	30.3 ± 0.00 (30.3-)	–	30.3 ± 0.00 (30.3-)	29.3	26.7	28.7

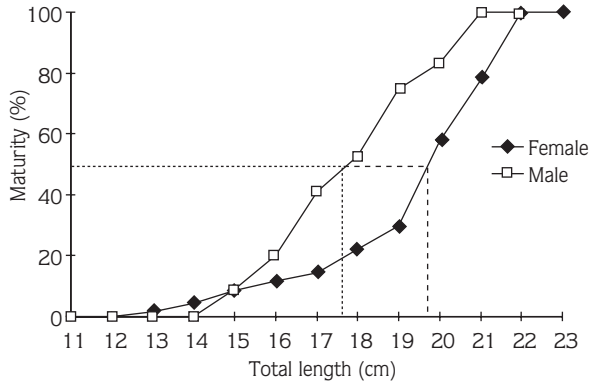

Figure 4. Length at first maturity of males and females of *C. Lucerna.*

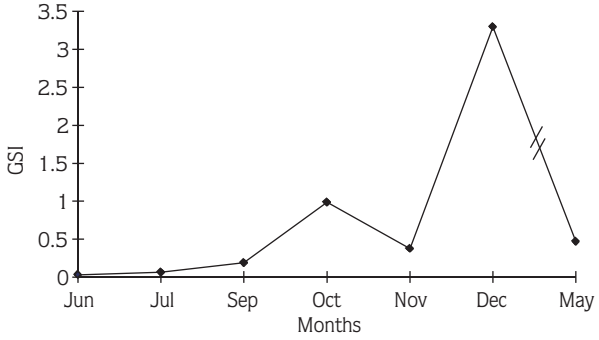

Figure 5. Gonadosomatic index (GSI) values of both sexes of tub gurnard.

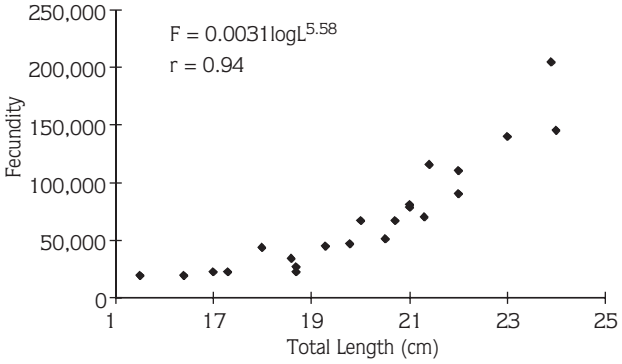

Figure 6. Relationship of fecundity to length for tub gurnard.

12.6 cm, respectively, whereas off the Moroccan and Greek coasts it is formed at a length of 17 cm. However, the length distribution of the age groups reported by Papaconstantinou (8) shows a considerable overlap between age groups 0 and 1. The author reported that the largest female caught in Thermaikos during the survey was 76.7 cm and that the maximum length was about 60 cm and 70 cm in the Black Sea and Adriatic Sea, respectively. The largest individual caught and the calculated maximum length in the Bay of İskenderun were 30.3 cm and 45.0 cm, respectively. Altun (10), who studied the growth of *Trigla lucerna* in Yumurtalık Bight in the Bay of İskenderun also found that mean length in age group 1 was 14.8 cm. He reported that the largest specimen caught and the calculated maximum length in Yumurtalık Bight were 26.9 cm and 40.9 cm, respectively.

The mean annual growth rate for 1-4-year-old fish ranged between 4 and 6 cm in this study (Table 1). Growth was rapid in both sexes for the first year and declined gradually over subsequent years. Collignon (12), Mouneimne (6) and Papaconstantinou (8) reported the mean annual growth rate for 1-5-year-old fish as about 5.5 cm, 3.1 cm and 4.2 cm, respectively. Altun (10) stated that the mean annual growth rate for 1-5-year-old fish was about 2.6 cm, 2.5 cm, 4.6 cm and 1.1 cm, respectively. The differences in growth rates might be attributed to different bio-ecological conditions.

Comparison of the length growth parameters obtained for Mediterranean tub gurnard applying Munro's phi prime test showed that there is no significant difference ($P > 0.05$) between the overall growth performances of the tub gurnard sampled from the French, Greek, Moroccan and Turkish coasts (Table 3). The calculated value of the growth coefficient K in this study lies in the mid-range of those calculated by several authors for various tub gurnard stocks inhabiting the Mediterranean Sea. However, in agreement with previous studies, no statistically significant differences have been detected among the growth performances of tub gurnard from 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 tub gurnard were caught during this study was 30 m. Papaconstantinou (8) and Tsimenides et al. (16) stated that the larger fish migrate to greater depths and that

Table 3. Von Bertalanffy length-growth constants and ϕ' values of the tub gurnard.

Author	Location	L_∞	K	t_0	ϕ'
Baron (9)	France	66.8	0.320	-0.460	3.15
	France	48.4	0.460	-0.410	3.03
	Morocco	65.0	0.148	-1.110	2.80
Papaconstantinou et al. (25)	Greece	71.3	1.567	-0.103	3.90
Altun (10)	Turkey	40.9	0.138	-2.268	5.43
Present study	Turkey	45.0	0.221	-0.581	6.10

this is more evident among females, mainly because of their greater length and life-span.

Collignon (12) found the female to male ratio off the Moroccan coast to be 1.65:1.0, which is close to that determined in the present study. Papaconstantinou (8) reported a sex ratio of around 1:1 in the Thermaikos Gulf, and that females were more numerous in age group 4. He also stated that the significant increase in the number of males compared to females in spring (1.0:1.34) can probably be attributed to an early darparture 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.

Bini (26) and Tortonese (27) stated that the spawning season occurs along the Italian coast between December and May, whilst off the French Mediterranean coast it takes place between January and April (6). Papaconstantinou (7) studied the ecology of gurnards (pisces, Triglidae) in Greek seas and stated that tub gurnard (*T. lucerna*) in Greek seas reproduce all year around, especially from autumn to spring. Papaconstantinou (8) reported that the spawning of the tub gurnard in the Thermaikos Gulf extends from January to May, and that mature individuals appear in October and July and that therefore reproduction may take place during these months. These are very similar to the present observations. Males of *C. lucerna* mature at about 18 cm total length (2 years old) and females at about 20 cm total length (2 years old). Papaconstantinou (8) stated that in the Thermaikos Gulf, females mature for the first time in the fourth year of life and males in the third. However, mature individuals of both sexes can be found after the first year. Mouneimne (6) reported that individuals of both sexes mature at a greater length than 18 cm (2 years old) in the Catalan Sea.

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 3 years old and the oldest female found was 4 years old.

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

Males mature at a total length of 18 cm, and females at 20 cm. Individuals of both sexes mature for the first time in the second year of life. Spawning occurs mainly between December and May. Fecundity is significantly related to length by the relationship $F = 0.0031 \log L^{5.58}$ (0.94).

In conclusion, control of fishing activity is achieved by enforcement of the current system and covers restrictions on species, fish sizes, mesh sizes, locations, breeding seasons, etc. The available data suggest that the minimum fishing size should be limited to 20 cm for the Mediterranean tub gurnard, and that the fishing season should be restricted from May to December. 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 other temperate areas. Therefore, stock assessment investigations should probably consider the multispecies stiuation in cases where single species assessments do not give proper objectives in the eastern Mediterranean Sea.

References

1. Richards, W.J., Saksena, V.P.: Triglidae. In: Quero, J. C., Hureau, J. C., Karrer, C.A.P., Saldanha, L. (Eds). Check-List of the Fishes of the Eastern Tropical Atlantic (CLOFETA). JNICT, Lisbon: SEI, Paris and UNESCO, Paris, 1990; Vol. 2, 680-684.
2. Yılmaz, A., Baştürk, Ö., Saydam, C., Ediger, D.Y., Hatipoğlu, E.: Eutrophication in Iskenderun Bay, north-eastern Mediterranean. Science of the Total Environment, Supplement, Elsevier Science Publisher B.V., Amsterdam, 1992; 705-717.
3. Bingel, F., Özsoy, E., Ünlüata, U.: A Review of the State of the Fisheries and the Environment of the Northeastern Mediterranean (Northern Levantine Basin). Studies and Reviews, General Fisheries Council for the Mediterranean. No. 65. Rome, 1993; FAO, 74p.
4. Nouvel, H.: Recherches sur la Nourriture de Quelques Trigles du Golfe de Gascogne au Large d'Arcachon. Bull. Inst. Oceanogr. Monaco, 1950; No. 964, 12p.
5. Reys, J.P.: Etude de la Nourriture de Quelques Poissons Demersaux du Golfe du Lion. Recl. Trav. Stn. Mar. Endoume, 1960; 33: 65-97.
6. Mouneimne, N.: Les triglidae de la mer Catalane. Thesis, Université de Paris, France, 1971; 151p.
7. Papaconstantinou, C.: Observations on the Ecology of Gurnards (Pisces, Triglidae) of the Greek Seas. Cybium, 1983; 7: 71-88.
8. Papaconstantinou, C.: Age and Growth of the Yellow Gurnard (*Trigla lucerna* L. 1758) from the Thermaikos Gulf (Greece) with Some Comments on Its Biology. Fish. Res., 1984; 2: 243-255.
9. Baron, J.: Les Triglides (Teleosteens, Scorpaeniformes) de la Baie de Douarnenez. Cybium, 1985; 9: 127-144.
10. Altun, A.: The Growth Performance of *Solea vulgaris* and *Trigla lucerna* in Yumurtalık Bay (Adana). MSc Thesis University of Çukurova, Adana, Turkey (in Turkish), 1994; 40p.
11. Faltas, S. N.: Food and Feeding Habits of Gurnards; *Trigla lucerna* L.1758 and *T. lastovisa* B.1768 in the Egyptian Mediterranean Waters. Bull. Natl. Inst. Oceanogr. Fish., Egypt, 1996; 22: 167-179.
12. Collignon, J.C.: Les Trigles des Eaux Marocaines (Iére note), Generalités: L'espece *Trigla lucerna* . Bul. Inst. Peches Marit. Maroc, 1968; 16: 3-13.
13. Rizzi, E., Bello, G.: Triglidae (Osteichthyes) of the Lower Adriatic Sea. Nova-Thalassia, 1986; 8: 665-666.
14. Akşıray, F.: Türkiye Deniz Balıkları ve Tayin Anahtarı. İst. Üniv. Rektörlüğü Yayınları. İstanbul, 1987; No. 349.
15. Jardas, I.: Distribution of the Adriatic Fishes of Triglidae Family as Affected by Ecological Factors. FAO Fisheries Report, 1987; No.394. 147-151.
16. Tsimenides, N., Mechias, A., Kallianiotis, A.: Distribution Patterns of Triglids (Pisces, Triglidae) on the Cretan Shelf (Greece), and Their Interspecific Association. Fish. Res., 1992; 15: 83-103.
17. Matarrese, A., Onghia, G.D., Sion, L., Panza, M.: Distribution of Triglids in the Ionian Sea. Biol. Mar. Mediterr., 1994; 1: 331-332.
18. Quero, J.C., Cendrero, O.: Effect of Fishing on the Ichthological Biodiversity of the Basin d'Arcachon and the Surrounding Continental Shelf. Cybium, 1996; 20: 323-356.
19. Başusta, N.: Pelagic and Demersal Fish Species in İskenderun Bay. PhD Thesis University of Çukurova, Adana, Turkey (in Turkish), 1997; 202 p.
20. Sparre, P., Ursin, E., Venema, S.C.: Introduction to Tropical Fish Stock Assessment. Part 1- Manual, FAO Fish Tech. Pap., 1989; No. 306, 337 p.
21. Beverton, R.J.H., Holt, S.J.: On the Dynamics of Exploited Fish Populations. UK. Min. Agric. Fish., Fish Invest., 1957; 19, 53p.
22. Holden, M.J., Raitt, D.F.S.: Manual of Fisheries Science. Part 2-Methods of Resource Investigation and Their Application. FAO Fish. Tech. R., 1974; 115, 214p.
23. Bagenal, T.B.: Fecundity. In T.B. Bagenal (Editor): Methods for Assessment of Fish Production in Fresh Waters. IBP Handbook. No. 3, Blackwell Scientific Publications, London, 1978; 166-178p.
24. İşmen, A.: Fecundity of Whiting, *Merlangius merlangus euxinus* (L.) on the Turkish Black Sea Coast. Fish. Res., 1995; 22: 309-318.
25. Papaconstantinou, C., Politou, C. Y., Caragitsou, E., Stergiou, K. I., Mytilineou, C., Vassilopoulou, V., Fourtouni, A, Karkani, M., Kavadas, S., Petrakis, G., Siapatis, A., Chatzinikolaou, M., Giagnisi, M.: Investigations on the Abundance and Distribıution of Demersal Stock of Primary Importance in the Thermaikos Gulf and the Thracian Sea (Hellas). National Centre for Marine Research, Athens, Hellas, Technical Report, North Aegean Sea Series 4, 1994; 356p.
26. Bini, G.: Atlante dei Pesci delle Coste Italiane. Mondo Sommerso Edn., Milano, 1969; Vol. VII, 200p.
27. Tortonese, E.: Osteichthyes. Part II. In: Fauna d'Italia. Vol. XI, Ed. Calderini, Bologna, Italy, 1975; 636p.