

Research Article

Age, Growth and Reproduction of the Tub Gurnard, *Chelidonichthys lucerna* (Linnaeus, 1758) from the Egyptian Mediterranean waters off, Alexandria

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Abstract: The biology of the tub gurnard, *Chelidonichthys lucerna* (Linnaeus, 1758), has been studied based on data collected between August (2009) and July (2010) from the Egyptian Mediterranean water in front of Alexandria. A total of 873 specimens ranged between 10.6 and 28.2 cm TL and from 10.2 to 232.5 g total weight, were sampled. The age, growth, length-weight relationship, sex ratio, length and age at first sexual maturity and reproduction period were estimated. Total lengths of males ranged from 12.6 to 23.2 cm and of females from 11.8 to 28.2 cm. The maximum age observed was 4 and 5 years for males and females respectively. Length-weight relationships for males and females were estimated as $W = 0.0043 * L^{3.2644}$ and $W = 0.0042 * L^{3.2651}$, respectively indicating an allometric growth. The von Bertalanffy growth equations were $L_t = 29.77(1 - e^{-0.274(t+1.36)})$ and $L_t = 32.36(1 - e^{-0.255(t+1.09)})$ for males and females respectively. The growth performance index value (Φ_L) was computed as 2.39 for males and 2.44 for females. Length at first sexual maturity was 15 cm (1.21 years) in males and 15.2 cm (1.40 years) in females. The male: female ratio was 1:1.67. The Gonado-Somatic Index (GSI) values indicated that the spawning season starts from November to February with a peak in January for both sexes.

Keywords: Alexandria, *Chelidonichthys lucerna*, gurnard, growth, reproduction,

INTRODUCTION

The tub gurnard, *Chelidonichthys lucerna* (Linnaeus, 1758) is a demersal marine fish that is distributed in the Mediterranean Sea, Black Sea and the Atlantic Ocean from Norway to Senegal (Tortonese, 1975). *Chelidonichthys lucerna* is one of the three major gurnard species landed in the area of Alexandria; the other two are *Chelidonichthys lastoviza* and *Lepidotrigla cavillone*. *C. lucerna* lives mostly on sand or gravel bottoms at depths ranging from 20 to 300 m, often forming shoals (Ben Othmen, 1973). The tub gurnard exhibits a particular pattern of migratory movement within its overall depth range during the year; it shows a pronounced concentration in the shallow depths in spring and summer and then moves progressively to deeper waters in winter (Ismen and Ismen, 2004).

The biological characteristics of tub gurnard was investigated in Mediterranean French coast (Priol, 1932) and (Baron, 1985); Catalan Sea (Mouneimne, 1971); Greece waters (Papaconstantinou, 1984) and (Tsimenides *et al.*, 1992); northeastern Mediterranean Sea (Bingel *et al.*, 1993), (Ismen and Ismen, 2004) and (Cicek *et al.*, 2008); Ionian Sea (Matarrese *et al.*, 1994); Egyptian Mediterranean water off Alexandria (Faltas,

1996) and (Faltas and Abdallah, 1997); Spanish coasts (Morte *et al.*, 1997); Sea of Marmara (Eryilmaz and Meric, 2005); Izmir Bay (Uckun and Togulga, 2007, 2005); Gulf of Gabes, Tunisia (Boudaya *et al.*, 2008); Libyan coast (Ahmed, 2012).

The present study is proposed to provide information about age, growth, length-weight relationship and reproduction of *C. lucerna* in the Egyptian Mediterranean waters off Alexandria. Such information should be considered as a prerequisite for an effective fisheries management of the stock of this species in the area of study.

MATERIAL AND METHODS

A total of 873 specimens of Tub gurnard, *Chelidonichthys lucerna* were collected monthly from Alexandria landing centers from August (2009) to (July) 2010. After sample collection, fish were brought to the laboratory and the Total Length (TL) and the Total Weight (TW) were measured to the nearest 1.0 mm and 0.1 g, respectively. The gutted weight was used to avoid any bias resulted from weights of gonads and stomachs. Weight of gonads was recorded to the nearest 0.01 g. The sex and maturity stages of each fish were detected.

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Table 1: Back calculated length with age of *C. lucerna* from the Egyptian Mediterranean water off Alexandria

Age (Year)	Males				Females			
	No.	Observed length (cm)	Calculated length (cm)	%of increment	No.	Observed length (cm)	Calculated length (cm)	% of increment
I	89	14.90	14.13	61.67	142	15.03	13.33	52.25
II	123	18.98	17.87	16.32	213	19.30	17.60	16.70
III	79	21.11	20.78	12.69	89	22.42	20.97	13.24
IV	11	23.26	22.91	9.320	38	25.12	23.60	10.27
V	-	-	-	-	16	26.60	25.52	7.540

Sagittalolith was removed, cleaned and stored dry in small laboratory envelopes for later age determination. Age was read from the whole otoliths immersed in glycerin and xylol and viewed with a binocular microscope under reflected light against a black background. Opaque and transparent rings were counted and one opaque zone together with one transparent zone has been considered as annual growth.

The growth parameters of the von Bertalanffy growth model (L_{∞} and K) were computed by Ford (1933)-Walford (1964) and Gulalnd (1969). While t_0 was estimated by the equation: $t_0 = t + (1/K) * (L_n(L_{\infty} - L_t)/L)$. Growth was expressed in terms of the von Bertalanffy equation: $L_t = L_{\infty} * (1 - e^{-k(t-t_0)})$ and $W_t = W_{\infty} * (1 - e^{-k(t-t_0)})^b$ where L_t and W_t are the fish length and weight at age t ; L_{∞} and W_{∞} represent the asymptotic length and weight, k is a relative growth coefficient and t_0 the theoretical age when the fish length is zero.

The allometric growth equation, $W = a * L^b$ was used to describe the length-weight relationship (Ricker, 1975), where W is the total weight (g) and L is the total length (cm) and a and b are constants whose values were estimated by least square method.

Maturity stages of *C. lucerna* were classified according to Nikolsky (1963) into six maturity stages [I and II: immature stage, stage III: mature, stages IV and V: mature/ripe and running and VI: spent]. The length at first sexual maturity was obtained as the length of which 50% of all individuals are sexually mature (Pitt, 1970). Gonado-somatic index values $GSI = (Gonad\ weight / Gutted\ weight) * 100$. Sex ratio was determined as the percentage of Males to Females (M: F). According to Moreau *et al.* (1986), the following equations were adopted to estimate the growth performance of *C. lucerna*. $\Phi L = \log k + 2 \log L_{\infty}$ (for length) and $\Phi W = \log K + 2/3 \log W_{\infty}$ (for weight).

RESULTS

Length composition: Of the 873 specimens measured, 302 were male (34.59%) and 498 were female (57.04%). The total length of males ranged from 12.6 to 23.3 cm, while it was higher for females and ranged from 11.8 to 28.2 cm (Fig. 1).

Growth in length: The maximum life span of *C. lucerna* was four years for males and five years for females, age group II was the most frequent group in the catch, constituting 40.73% for males and 42.57% for females. Growth in length and the average back

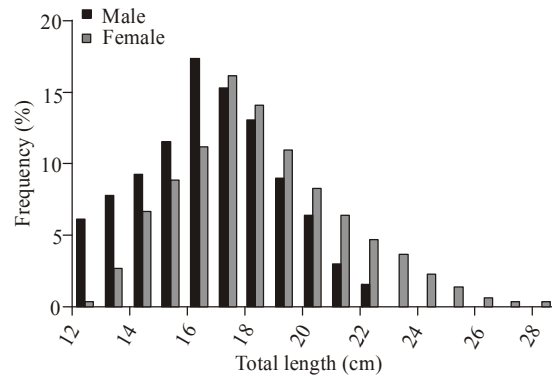


Fig. 1: Length frequency distribution of *C. lucerna* from the Egyptian Mediterranean water off Alexandria

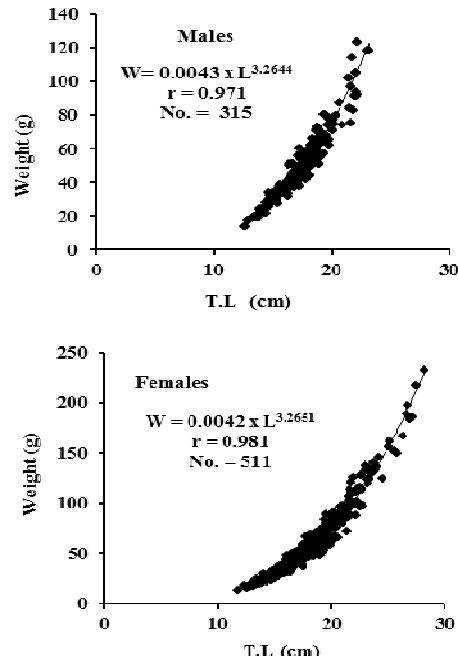


Fig. 2: Length-weight relationship of *C. lucerna* from the Egyptian Mediterranean water off Alexandria

calculated lengths by age groups were identified for *C. lucerna* as 14.13, 17.87, 20.78 and 22.91 cm for 1st, 2nd, 3rd and 4th year for males and 13.33, 17.60, 20.97, 23.60 and 25.52 cm for 1st, 2nd, 3rd, 4th and 5th year for females, respecting the growth of *C. lucerna* had a high rate during the first year of life, then the annual growth rate rapidly drop (Table 1).

Table 2: Back calculated weights with age of *C. lucerna* from the Egyptian Mediterranean water off Alexandria

Age (Year)	Males				Females			
	No.	Observed weight (g)	Calculated weight (g)	% of increment	No.	Observed weight(g)	Calculated weight (g)	% of increment
I	89	29.050	24.460	20.67	142	29.230	20.200	12.26
II	123	64.020	52.570	23.75	213	66.180	49.040	17.50
III	79	90.600	85.990	28.24	89	107.95	86.850	22.95
IV	11	124.35	118.34	27.34	38	156.48	127.65	24.76
V	-	-	-	-	16	188.64	164.76	22.52

Table 3: Parameters of the vonBertalanffy growth equation and Φ values of *C. lucerna*

Sex	No.	L_{∞}	K	t_0	W_{∞}	ΦL	ΦW
Males	302	29.77	0.274	-1.36	278.22	2.39	1.07
Females	498	32.36	0.255	-1.09	357.77	2.44	1.13

Length-weight relationship: The total length of males ranged between 12.6 and 23.3 cm in size and from 13.6 and 123.3 g in weight, while females ranged from 11.8 to 28.2cm in length and from 12.6 to 232.5 g in weight. The most abundantly captured specimens ranged from 16.0 to 19.0 cm and from 15.0-19 cm for males and females respectively. Positive allometric growth was observed for both males and females (Fig. 2). The relationships obtained were, $W = 0.0043 * L^{3.2644}$ for males and $W = 0.0042 * L^{3.2651}$ for females.

Growth in weight: The calculated weights by age groups were 24.46, 52.57, 85.99 and 118.38g for the 1st, 2nd, 3rd and 4th year of life for males. While back calculated weights for females were 20.20, 49.04, 86.85, 127.65 and 164.76 g for 1st, 2nd, 3rd, 4th and 5th year of fish life. The growth rate in weight was much slower during the first year of life and then the annual growth increment in weight increased reaching its maximum at the end of the third and fourth year of life for males and females respectively (Table 2).

Growth parameters and growth performance: The estimated vonBertalanffy growth parameters for *C. lucerna* were; $L_{\infty} = 29.77$ cm, $W_{\infty} = 278.22$ g, $K = 0.274/y$ and $t_0 = -1.36y$ for males and $L_{\infty} = 32.36$ cm, $W_{\infty} = 357.77$ g, $K = 0.255/y$ and $t_0 = -1.09y$ for females. The growth performance (ΦL) for length was found to be 2.39 and 2.44 for males and females respectively. On the other hand, the growth performance for weight (ΦW) was found to be 1.07 and 1.13 for males and females, respectively (Table 3).

Gonado-somatic index: Figure 3 shows the monthly variation of the Gonado-somatic index values, the lower values were recorded in July (0.61 and 0.70 for males and females, respectively). Meanwhile the higher values which obvious the spawning season found to be from November to February with a peak in January (3.19 and 8.10 for male and female respectively), generally, the average values of gonado-somatic index of females are much greater than those of males.

Length and age at first maturity: In all individual, fish less than 13cm length are immature. Larger fishes

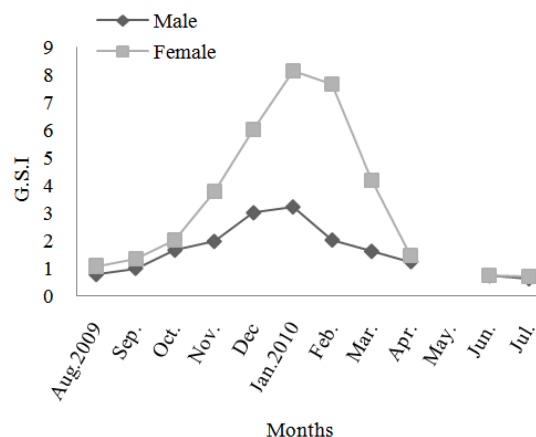


Fig. 3: Monthly variation of gonado-somatic index (GSI) of *C. lucerna* from Egyptian Mediterranean water off Alexandria

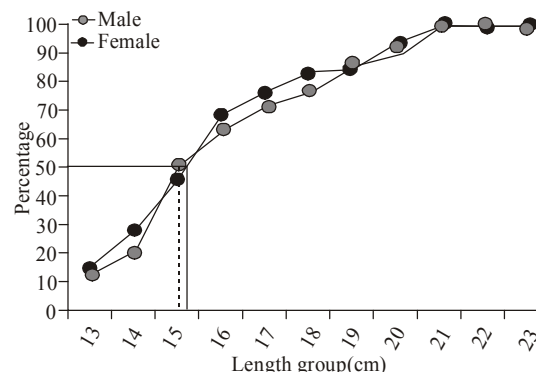


Fig. 4: Percentage of mature according to fish length of *C. lucerna* from Egyptian Mediterranean water off Alexandria

show an increasing in the frequency of mature specimens, while fish longer than 20 cm are fully mature. Length at 50% of maturity for males and females found to be at the total length of 15 and 15.2 cm, respectively. This length corresponds to 1.21, 1.40 years for males and females respectively (Fig. 4).

Sex ratio: The fluctuation in the sex ratio was examined in the different months of the year and the

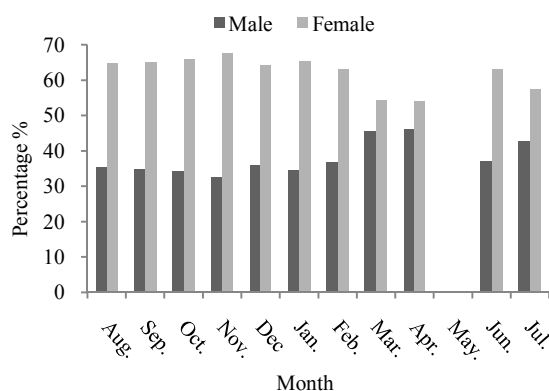


Fig. 5: Monthly variation of *C. lucerna* from the Egyptian Mediterranean water, off Alexandria

data available are given in (Fig.5), it is concluded that, females were higher in occurrence than males throughout the whole period of investigation, representing with 62.53% of the total fish with sex ratio (M/F = 1:1.67). The chi-square value was (50.63; $p < 0.05$).

DISCUSSION

Females of *C. lucerna* of the Egyptian Mediterranean waters off Alexandria reach greater lengths than males. This difference is the most common pattern found in other locations (Table 4). Papaconstantinou (1984) declared that, females up to 77 cm, while males were no longer than 35 cm TL. The length at age and vonBertalanffy parameter estimates showed that *C. lucerna* is a relatively fast-growing and moderately long-living species, like other triglid species (Boudaya *et al.*, 2008).

The oldest fish recorded in the present study was 4 years old for males and 5 years for female. The study material shows that, females seem to have a slower growth rate and larger maximum length and age than males; the males of *C. lucerna* were attaining approximately 62% of its maximum adult size during the first year of life compared with 52% for the females. After completion of the first year, the annual growth rate drops rapidly in both sexes. A similar result

Table 4: Maximum length of *C. lucerna* from different locations

Location	Max.L (males)	Max.L (females)	Max.L (combined)	Authors
Black Sea	60	70.0		Banaruscu (1964)
Morocco	36	61.0		Collignon (1968)
Catalan Sea	20	25.0		Mouneimne (1971)
Adriatic Sea	60	70.0		Soljan (1975)
Thermaiakos Gulf	34	76.7		Papaconstantinou (1984)*
Douarnenez Bay			70.0	Baron (1985)
Yumotalik Bay			26.9	Alton <i>et al.</i> , (1997)
Tuscany Coast			70.0	Serena <i>et al.</i> (1998)
Iskenderun Bay	21.2	30.3		Ismen and Ismen (2004)
Sea of Marmara	36.5	41.5		Eryilmaz and Meric (2005)
Izmir bay	29.9	34.4		Uckun and Togulga (2007)*
Gulf of Gabes	26.0	36.0		Boudaya <i>et al.</i> (2008)
Egyptian mediterranean	23.3	28.2		Present study

Table 5: Average length (cm) at different age groups of *C. lucerna* in different locations

Authors	Locations	Sex	Age groups										
			0	I	II	III	IV	V	VI	VII	VIII	IX	X
Papaconstantinou, 1984*	Thermaiakos	F	14.57	18.19	22.60	26.39	31.70	35.66	38.40	43.27	-	-	61.10
	Gulf (Greece)	M	15.24	18.26	21.84	26.05	30.33	-	-	-	-	-	-
Baron, 1985	Douarnenez Bay (France)	F	-	23.00	35.00	44.00	50.00	55.00	-	-	-	-	-
		M	-	21.00	31.00	37.00	41.50	44.00	-	-	-	-	-
Faltas and Abdallah, 1997	Egyptian Mediterranean	F+M	-	11.79	18.84	24.33	28.23	-	-	-	-	-	-
Serena <i>et al.</i> , 1998	Tuscany (Italy)	-	11.7	21.30	35.70	45.50	-	-	-	-	-	-	-
Ismen and Ismen, 2004	Iskenderun Bay (Medit.)	F	-	13.40	19.70	24.80	30.30	-	-	-	-	-	-
		M	-	13.20	19.10	24.00	-	-	-	-	-	-	-
		F+M	-	13.20	19.60	24.60	30.30	-	-	-	-	-	-
Uckun, 2005 *	Edremit Bay (Agean Sea)	F	14.17	18.07	22.49	26.48	30.13	32.55	-	-	-	-	-
		M	12.70	18.82	22.06	25.04	-	-	-	-	-	-	-
		F+M	14.02	18.54	22.27	26.20	30.13	32.55	-	-	-	-	-
Eryilmaz and Meric, 2005	Sea of Marmara	F	-	15.20	17.31	24.97	31.93	39.93	41.50	-	-	-	-
		M	-	14.27	17.48	22.80	33.50	-	-	-	-	-	-
		F+M	-	-	-	-	-	-	-	-	-	-	-
Uckun and Togulga, 2007*	Izmir Bay (Agean Sea)	F	13.70	18.15	23.62	27.50	31.27	34.40	-	-	-	-	-
		M	14.15	17.93	22.80	25.92	-	-	-	-	-	-	-
		F+M	13.83	18.07	23.34	27.33	31.27	34.40	-	-	-	-	-
This study	Egyptian Mediterranean	F	-	13.33	17.60	20.97	23.60	25.52	-	-	-	-	-
		M	-	14.13	17.87	20.78	22.91	-	-	-	-	-	-

*FL: Forked Length

Table 6: Summary of growth parameters of *C. lucerna* according to different localities

Authors	Localities	Sex	L_{∞}	K	to	Φ
Baron, 1985	Douarnenez Bay (France)	F	66.80	0.320	-0.460	3.155
		M	48.40	0.460	-0.410	3.032
Altun <i>et al.</i> , 1997	Turkish water	F+M	40.90	0.140	-2.260	2.540
Faltas and Abdallah, 1997	Egyptian Mediterranean	F+M	40.30	0.287	-	2.668
Serena <i>et al.</i> , 1998	Tuscany (Italy)	F+M	65.90	0.390	-	3.229
Ismen and Ismen, 2004	Iskenderun Bay (Medit.)	F	45.60	0.223	-0.602	2.583
		M	36.00	0.309	-0.478	2.469
Uckun, 2005 *	Edremit Bay(Aegean Sea)	F+M	45.00	0.221	-0.581	2.566
		F	47.45	0.170	-1.826	2.666
		M	59.22	0.084	-3.574	2.603
Eryilmaz and Meric, 2005	Sea of Marmara	F+M	58.95	0.106	-2.545	2.651
Uckun and Togulga, 2007 *	Izmir Bay(Aegean Sea)	F+M	61.30	0.170	-0.040	2.810
		F	49.09	0.186	-1.484	2.651
		M	31.44	0.447	-0.886	2.645
		F+M	52.12	0.163	-1.608	2.646
Boudaya <i>et al.</i> , 2008	Gulf of Gabes (Tunisia)	F+M	52.12	0.163	-1.608	2.646
This study	Egyptian Mediterranean	F	46.16	0.050	-3.030	2.040
		M	40.26	0.060	-1.320	2.000
		F	32.36	0.255	-1.360	2.440
		M	29.77	0.274	-1.090	2.390

*FL: Forked length

Table 7: Length-weight relationships equation constants ($W = aL^b$) of *C. lucerna* from different locations

Authors	Localities	Sex	a	b	r
Papaconstantinou, 1984	Thermaikos Gulf (Greece)	F	0.000006	3.1100	0.997
		M	0.000005	3.1470	0.992
Serena <i>et al.</i> , 1998	Egyptian Mediterranean	F+M	0.013900	2.8590	0.997
Abdallah, 2002	Iskenderun Bay (Medit.)	F+M	0.029000	2.6300	0.973
Ismen and Ismen, 2004	Edremit Bay (Aegean Sea)	F	0.009500	2.9900	0.980
		M	0.008900	3.0100	0.990
Uckun, 2005 *	Sea of Marmara	F	0.005800	3.1810	0.992
		M	0.003400	3.3580	0.971
		F+M	0.005400	3.2060	0.989
Eryilmaz and Meric, 2005	South coast of Portugal	F+M	0.009200	3.0190	0.989
Olim and Borges, 2006	Izmir Bay (Aegean Sea)	F	0.021000	2.7200	0.990
		F+M	0.011000	2.9300	0.990
Uckun and Togulga 2007 *	Gulf of Gabes (Tunisia)	F	0.005100	3.2450	0.988
		M	0.005300	3.2370	0.982
		F+M	0.005200	3.2400	0.987
Boudaya <i>et al.</i> , 2008	Egyptian Mediterranean	F	0.015500	2.8200	0.950
		M	0.007300	3.0300	0.850
This study		F	0.004200	3.2651	0.981
		M	0.004300	3.2644	0.971

*FL: Forked Length

was reported by Papaconstantinou (1984) for *C. lucerna* and for the other triglid species (Staples, 1972; Elder, 1976; Hecht, 1977; Papaconstantinou, 1981, 1982, 1983; Baron, 1985; Booth, 1997; Wood-McPhail, 1997). Despite differences in ageing methodology, the overview of growth patterns in triglids reveals that most species reach at least 50% of their maximum size before sexual maturation and then show a decrease in growth (McEachran and Davis, 1970; Elder, 1976; Hecht, 1977; Papaconstantinou, 1982, 1983, 1984; Booth, 1997).

According to the studies carried out in different areas, it was determined that *C. lucerna* is mostly distributed between the age groups I-V. Resembling the present study, the majority of these populations are formed by these age groups. Papaconstantinou (1984) and Tsimenides *et al.* (1992) stated that the larger fish migrate to greater depths and this is more evident among females, mainly because of their greater length and life-span. Mean length values per age group are given in (Table 5).

The asymptotic length value (L_{∞}) is related to size of the largest individual in the area. The differences in growth rates between areas were probably related to different bio-ecological conditions, age determinations method and sampling depths and also fishing mortality. A comparison of growth performance values for males (2.39) and female (2.44) show that *C. lucerna* of the Egyptian Mediterranean waters off Alexandria had a slow growth performance compared with other studies except the study of Boudaya *et al.* (2008). He showed that, the growth performance for males and females of *C. lucerna* was 2.00 and 2.04, respectively. Growth performance and growth parameters values were compared with those observed by other studies in Table 6.

The length-weight relationship equation parameters for males and females from different studies are given in Table 7.

The overall sex ratio is in favor of females and no males were found in a size class higher than 23 cm TL.

The number of females was more than the number of males in all age groups, the predominance of females has also been observed in other studies. Considering that this findings may be related to the migration of older fish to deeper regions. According to Frogli (1976); Papaconstantinou (1984); Baron (1985); Serangeli *et al.* (1985) and Colloca *et al.* (1994), a clear relationship between size and depth has been observed. Juveniles of *C. lucerna* are distributed in shallow waters, where food is abundant (Colloca, 1999). Furthermore, the depth migration of juveniles during growth is very common in fishes (Helfman, 1978), particularly in sea-robin species (Lewis and Yerger, 1976; Richards *et al.*, 1979). However, variation in size of the sexes can be explained by differences in growth and mortality (Turner *et al.*, 1983; Kartas and Quignard, 1984).

Concerning reproduction, the gonado-somatic index values were computed in the present study, the reproduction of this species took place from November to February with peak in January for both sexes. Serena *et al.*, (1998) reported that there is a clear shift of timing for the reproductive processes of *C. lucerna* between the Mediterranean and North Atlantic waters. These differences in spawning season may reflect different temperature regimes among these areas (Kashiwagi *et al.*, 1987).

Generally, triglid males mature at a younger age and smaller size than females (Papaconstantinou, 1984; Baron, 1985 and Wood-McPhail, 1997). *C. lucerna* was maturing in males and females at 15.0 cm (1.21y) and 15.2 cm (1.40y), respectively. Papaconstantinou (1984) reported that maturity in males begins on completion of the third year while in females the fourth. Altun *et al.* (1997) stated that gurnards in Yumurtalik Bay achieve sexual maturity from the first year. Ismen and Ismen (2004) indicated that *C. lucerna* males mature at about 18 cm and females about 20 cm, when they are about 2 years old. Eryilmaz and Meric (2005) reported that males and females matured in their third year of life when they have a total length of 18.5 and 19.0 cm, respectively. This can be attributed to the average size of maturation being directly related to the population density and ecological conditions, particularly temperature that stimulates sexual maturation (Nikolsky, 1963; Kashiwagi *et al.*, 1987).

In conclusion, control of fishing activity is achieved by enforcement of the current system and cover restrictions on species, fish sizes, mesh sizes, locations, breeding seasons, etc. The length frequency distribution of *C. lucerna* from the Egyptian Mediterranean waters off Alexandria suggests that this area is an important nursery ground for the species and, so such, should receive special consideration in any program for management of the fisheries in this zone. Also, the available data suggest that, *C. lucerna* smaller than 15cm must not be caught and fishing should be restricted between November and February.

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