VIE ET MILIEU - LIFE AND ENVIRONMENT, 2022, 72 (1-2): 1-8. https://doi.org/10.57890/VIEMILIEU/2022.72.1/2:1-8

SCALIMETRY AND REPRODUCTION OF THE COMBER *SERRANUS CABRILLA* (LINNAEUS, 1758) (TELEOSTEI, SERRANIDAE) FROM THE GULF OF ANNABA (ALGERIA, MEDITERRANEAN)

M. RACHEDI[*]*, F. DERBAL*

Department of Marine sciences, Marine Bioressources Laboratory, Badji Mokhtar University, Annaba, Algeria
** Corresponding author: rachedi.mounira@yahoo.fr*

AGE
GROWTH
BREEDING
SERRANUS CABRILLA
GULF OF ANNABA
MEDITERRANEAN

ABSTRACT. – This study addresses for the first time the biology of the comber, *Serranus cabrilla* (Linnaeus, 1758), from the eastern Algerian coast. From October 2015 to September 2016, 1063 specimens were collected each month in the Gulf of Annaba. The total length of the whole population ranged from 11.3 to 23.7 cm, and the population aged between 1 and 6 years old. The growth parameters obtained by von Bertalanffy model were: $L_\infty = 24.03$ cm, $k = 0.22$ year^{-1} and $t_0 = -1.67$ year for males, $L_\infty = 24.7$ cm, $k = 0.21$ year^{-1} and $t_0 = -1.65$ year for females and $L_\infty = 24.91$ cm, $k = 0.20$ year^{-1} and $t_0 = -1.81$ year for all individuals, with a growth performance (ϕ') equal to 2.10 for both sexes and 2.09 for all specimens. The relationship between total length and body mass of fish for males, females, immatures and all individuals were $EW = 0.013\ TL^{3.01}$, $EW = 0.008\ TL^{3.05}$, $EW = 0.015\ TL^{2.82}$ and $EW = 0.01\ TL^{2.998}$, respectively. The sex-ratio was estimated at 0.49:1 in favor of females and the breeding season extended from March to July. Males and females reached their first sexual maturity at 16.08 and 16.37 cm TL, respectively.

INTRODUCTION

The family Serranidae includes predators of high commercial interest as fish food (Froese & Pauly 2000). The genus *Serranus* is composed of 29 valid species (Froese & Pauly 2000), of which 15 species have been inventoried in the Mediterranean Sea (Quignard & Tomasini 2000).

The comber *Serranus cabrilla* (Linnaeus, 1758) is a demersal fish inhabiting rocky areas, *Posidonia* beds, and sandy and muddy bottoms until at least 500 m depth and up (Louisy 2005), with a maximum total length in the Mediterranean Sea of 40 cm (Bauchot 1987). This species preferentially feeds on benthic preys, especially Crustacea and Teleost (Rachedi *et al*. 2018). The comber is a solitary and territorial species. It spawns in spring to early summer in the North-West of Mediterranean water (Sabatés 1990). The simultaneous hermaphroditism of this species was reported by numerous authors (Bouain 1981, García-Díaz *et al*. 1997, Ilhan *et al*. 2010, Birim *et al*. 2016). This species is moderately commercially exploited in the study area, according to fishers. It is fished locally in an artisanal way (gillnets and longlines). *Serranus cabrilla* occurs in the Mediterranean, Western Black Sea, and the Atlantic Ocean (from the British Isles to the Cape of Good Hope, including the Azores, Madeira, and the Canary Islands) (Fischer *et al*. 1987).

Despite this wide distribution, some aspects of the biology of *S. cabrilla* were studied for the first time on the Algerian coasts and compared with other areas of the Mediterranean Sea and the Atlantic Ocean. Information on age, growth, mortality, and reproduction of *S. cabrilla* is limited in the Atlantic (García-Díaz *et al*. 1997, Gordo *et al*. 2016), but more information is available from the Mediterranean for age, growth, and mortality (Bouain 1983, Tserpes & Tsimenides 2001, Torku-Koç *et al*. 2004, Ilhan *et al*. 2010), and reproduction (Bauchot 1987, Sabatés 1990, Torku-Koç *et al*. 2004, Ilhan *et al*. 2010, Birim *et al*. 2016), but still limited on the northern coast of Africa. The only available data is related to the length at first maturity and the reproduction period (Bouain 1981) and the linear growth in Tunisia (Bouain 1983), along with two studies related to growth, mortality, and exploitation on the Algerian coasts (Rachedi & Dahel 2019, Ailane *et al*. 2021).

According to Campana (2001), the age information is fundamental since it forms the basis for calculating growth and mortality rates and productivity estimates, making it essential for fishery management (Casselman 1987, Tsikliras *et al*. 2013). Selection of the morphological structure that would be the most suitable for determining the fish age is one of the main problems facing age and growth estimates. In teleosts, the scalimetric method (scale-reading) is still the most usable for age estimation (Beamish & McFarlane 1983, Casselman 1987). Despite its abundance, no study concerning the reproduction of *S. cabrilla* on the Algerian coasts exists to date. Thus, this study provides additional information on the age, growth, and reproductive biology of this species sampled in this area.

MATERIALS AND METHODS

A total of 1063 *S. cabrilla* were collected monthly from October 2015 to September 2016 along the eastern Algerian coasts (36°54'N; 7°46'E) by long lines via fishmongers from the city of Annaba. The sample obtained was measured to the nearest 0.1 cm total length (*TL*), and the nearest 0.01 g total weighed (*TW*) with an electronic balance (model: Kern EMB 600-2, weighing range: 600 g ± 0.01 g). The eviscerated weight (*EW*; to the nearest lower 0.01 g), gonad weight (*GW*; to the nearest lower 0.001 g), and liver weight (*LW*; to the nearest lower 0.001 g) were also recorded. The maturity stage was identified by macroscopic observation of gonads according to the five-point scale of West (1990).

Age was determined by scale-reading. Scales were removed from the area below the pectoral fin, assuming that this location is protected from any physical attacks, leading to the loss of scales. Broussonet (1786) reported that the shed scales are immediately replaced by regenerating ones to cover the exposed area. According to Ayoma (1957), McCart (1967), and Fouda (1979), in all species, the number of regenerated scales increases with age. It is most abundant in the areas surrounding the caudal peduncle, suggesting that this part of the body is often injured. These scales and all unreadable scales were not considered. The recovered scales were washed and stored dry in individually labeled plastic vials. They were placed between two glass slides and photographed with a digital camera coupled with a binocular microscope. The measurements and quantification of the calcified structures were established by the TNPC software v. 5 (Fablet & Ogor 2005). A marginal increment analysis validated annual growth increment formation (Beamish & Mc Farlane 1983). We calculated the monthly mean marginal increment using the follow equation:

$$MI = (R - R_n) / (R_n - R_{n1})$$

where, R is the distance from the focus to the margin, R_n and R_{n1} distance from the focus to the last growth increment and the penultimate growth increment, respectively.

Monthly values of MI were compared using a one-way ANOVA test, followed by a multiple sample comparison of means (Dagnélie 1975). The relationship between the size of the fish and the total scale radius was calculated. The significance of the correlation coefficient (r) was estimated by Student's t-test. The age-length relationship was back-calculated using Lee's (1920) method. Lengths at different ages were compared with the back-calculation results by Student's t-test. Mean length at age data were used to estimate the growth parameters of von Bertalanffy (1938):

$$L_t = L_\infty (1 - e^{-k(t - t0)})$$

where, L_t is the *TL* at time t, L_∞ is the ultimate length an average fish could achieve, *k* is the growth constant that determines how fast the fish approaches L_∞ and t_o is the hypothetical age at $L_t = 0$.

The exponential regression equation of Ricker (1973) giving length-weight relation was applied:

$$EW = aTL^b$$

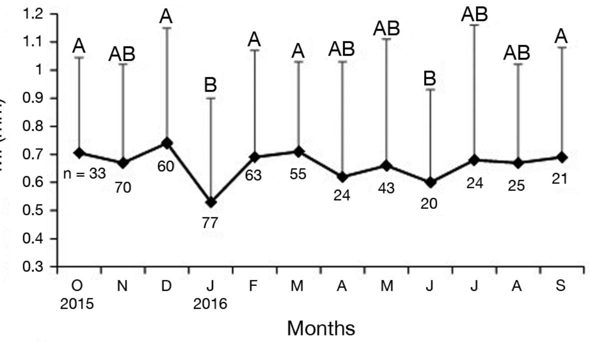

Fig. 1. – Monthly evolution of marginal increment (*MI*) of *Serranus cabrilla* from the north-eastern Algeria. The different letters indicate significant differences between sampling months.

where, *EW* is the eviscerated weight (g), *TL* is the total length (cm), and *a* and *b* are constants. The difference in the length-weight relation between sexes was tested by ANCOVA and the hypothesis of isometric growth by the t-test.

The growth performance index (ϕ') (Pauly & Munro 1984) is expressed as follows:

$$\phi' = \log(k) + 2\log(L_\infty)$$

The growth performance index (ϕ') was calculated to compare results obtained in this study with results published from other geographic areas. The sex-ratio of the comber was calculated and compared using the Chi-square test (χ^2). The spawning period was determined by analyzing the monthly relative frequency of maturity stages (based on macroscopic classification) and the mean gonadosomatic index, which was determined as follows:

$$GSI = (GW/EW) \times 100$$

Monthly analysis of hepatosomatic index (*HSI*) and condition factor (*K*) were also calculated:

$$HSI = (LW/EW) \times 100$$

$$K = (EW/TL^b) \times 100$$

where, *b* is the slope of the length-weight relationship.

Monthly values of *GSI*, *HSI*, and *K* were compared using a one-way ANOVA test, completed by a multiple sample comparison of means (Dagnélie 1975). Length at first maturity was estimated by the length at which 50 % of the fish had become mature (Lt_{50}) using a sigmoid model with Microcal Origin Software (version 6.0). The interval of sexual maturity is defined as the interval of size corresponding to the pubescent transformation (Loubens 1980). Sexual inversion length was estimated by aggregating the length-frequency distribution where mature individuals overlap, then calculating the median of the distribution (Shapiro 1984). The sex proportions by length class intervals (2 cm) were determined monthly.

RESULTS

Age and growth

Only 514 scales of the sample were successfully red and used to determine the fish age. The equation expressing the linear relationship between total length (*TL*) and

Table I. – Age-length key of *Serranus cabrilla* from the north-eastern Algeria, from scale readings. *TL*: total length; *N*: number of fish sampled; *SD*: standard deviation; *M*: mean; *EW*: eviscerated weight.

Total length interval (cm)		Age (years)						
		1^+	2^+	3^+	4^+	5^+	6^+	N
[12-13[		11	4					15
[13-14[		9	19	5				33
[14-15[			33	29	1			63
[15-16[			16	67	6			89
[16-17[			7	58	20			85
[17-18[			1	40	40	5		86
[18-19[				9	56	3		68
[19-20[					27	17		44
[20-21[				2	7	6	2	17
[21-22[					2	7	1	10
[22-23[						2	1	3
[23-24[							1	1
N		20	80	210	159	40	5	514
N%		3.89	15.56	40.85	30.93	7.78	0.97	100
TL	M	12.83	14.54	16.13	18.08	19.81	21.5	16.69
	SD	0.52	1.05	1.19	1.2	1.2	1.4	2.1
EW	M	18.96	26.24	36.26	53.39	67.01	92.88	44.61
	SD	2.72	6.12	11.24	13.77	12.33	21.37	19.81

Table II. – Total length at the appearance of each growth ring in the scales of *Serranus cabrilla* from the north-eastern Algeria. *N*: number of fish sampled; *M*: mean of the length; *SD*: standard deviation. *TL*1 to *TL*6: back-calculated sizes-at-age.

Age		*TL*1	*TL*2	*TL*3	*TL*4	*TL*5	*TL*6
	N	20					
I	*M*	11.95					
	SD	1.34					
	N	80	80				
II	*M*	11.21	13.49				
	SD	13.2	1.07				
	N	210	210	210			
III	*M*	10.3	13.23	15.8			
	SD	1.37	1.19	1.57			
	N	159	159	159	159		
IV	*M*	10.35	13.25	15.26	16.8		
	SD	1.31	1.36	1.39	1.46		
	N	40	40	40	40	40	
V	*M*	10.32	13.25	15.47	17.11	18.51	
	SD	1.52	1.5	1.56	1.64	1.67	
	N	5	5	5	5	5	5
VI	*M*	10.21	13.83	16.08	17.39	18.6	18.97
	SD	1.08	2.25	3.05	2.92	2.85	2.86
	N	514	494	414	204	45	5
Total	*M*	10.52	13.28	15.19	16.86	18.46	18.97
	SD	1.42	1.27	1.52	1.53	1.8	2.86

Table III. – Parameters (L_∞, K, and t_0) of the von Bertalanffy growth curve and growth performance (ϕ') for males, females and all individuals of *S. cabrilla* in the north-eastern Algeria. L_∞ = asymptotic length, K = growth coefficient, t_0 = hypothetical age, ϕ' = growth performance index.

Sex	L_∞ [cm]	K [years^{-1}]	t_0 [years^{-1}]	ϕ'
Male	24.03	0.22	–1.67	2.10
Female	24.7	0.21	–1.65	2.10
All	24.91	0.21	–1.81	2.09

the scale radius (R) is $TL = 63.22\ R + 25.49$ mm ($r = 0.62$; $p \leq 0.001$). A one-way ANOVA applied for comparing successive monthly mean values of the marginal increment (*MI*) showed a significant difference ($F = 11.61$, $p \leq 0.001$) between December and January (Fig. 1). Thus, the rings were considered to be annual increments. The highest values of marginal increment were recorded in December, followed by a minimum in January, when the ring appeared.

The age of the sampled fish ranged from 1 to 6 years, with the predominance of age classes 3 and 4 years in catches (71.78 % of individuals) (Table I). Back-calculated lengths obtained by Lee's equation are given in Table II and used to estimate the von Bertalanffy growth parameters. Male and female ages also ranged from 1 to 6 years. The estimated von Bertalanffy growth parameters for both sexes and all individuals are given in Table III, and were as follows: $L_\infty = 24.91$ cm, $k = 0.20$ year^{-1}, $t_o = -1.81$ year for males, $L_\infty = 24.91$ cm, $k = 0.20$ year^{-1}, $t_o = -1.81$ year for females and $L_\infty = 24.91$ cm, $k = 0.20$ year^{-1}, $t_o = -1.81$ year for all individuals (Table III). The growth performance index (ϕ') was: 2.10 for both sexes and 2.09 for all individuals combined (Table III).

Length-weight relationships

The length-weight relations were calculated as: $EW = 0.013\ TL^{3.01}$ for males, $EW = 0.008\ TL^{3.05}$ for females, $EW = 0.015\ TL^{2.82}$ for immatures and $EW = 0.01\ TL^{2.998}$ for all individuals (Fig. 2). According to Student's *t*-test, we observed isometric growth for this species in the study area, whether for both sexes, immatures, and all individuals (Fig. 2). The ANCOVA test showed no significant difference between the sexes' slopes of the length-weight relations ($F = 1.856$, $p > 0.05$).

Reproduction

Among the 1063 specimens of *S. cabrilla* examined for their reproductive state, 292 (27.47 %) were males ($12.5 \leq TL \leq 23.7$ cm, $19.97 \leq EW \leq 128.91$ g), 599 (56.35 %) were females ($13.3 \leq TL \leq 23.3$ cm, $20.55 \leq EW \leq 140.2$ g) and 172 (16.18 %) were immatures individuals ($11.3 \leq TL \leq 18.6$ cm, $13.45 \leq EW \leq 52.43$ g). The sex-ratio was estimated at 0.49:1, and the χ^2 test revealed a very high significant difference between sexes

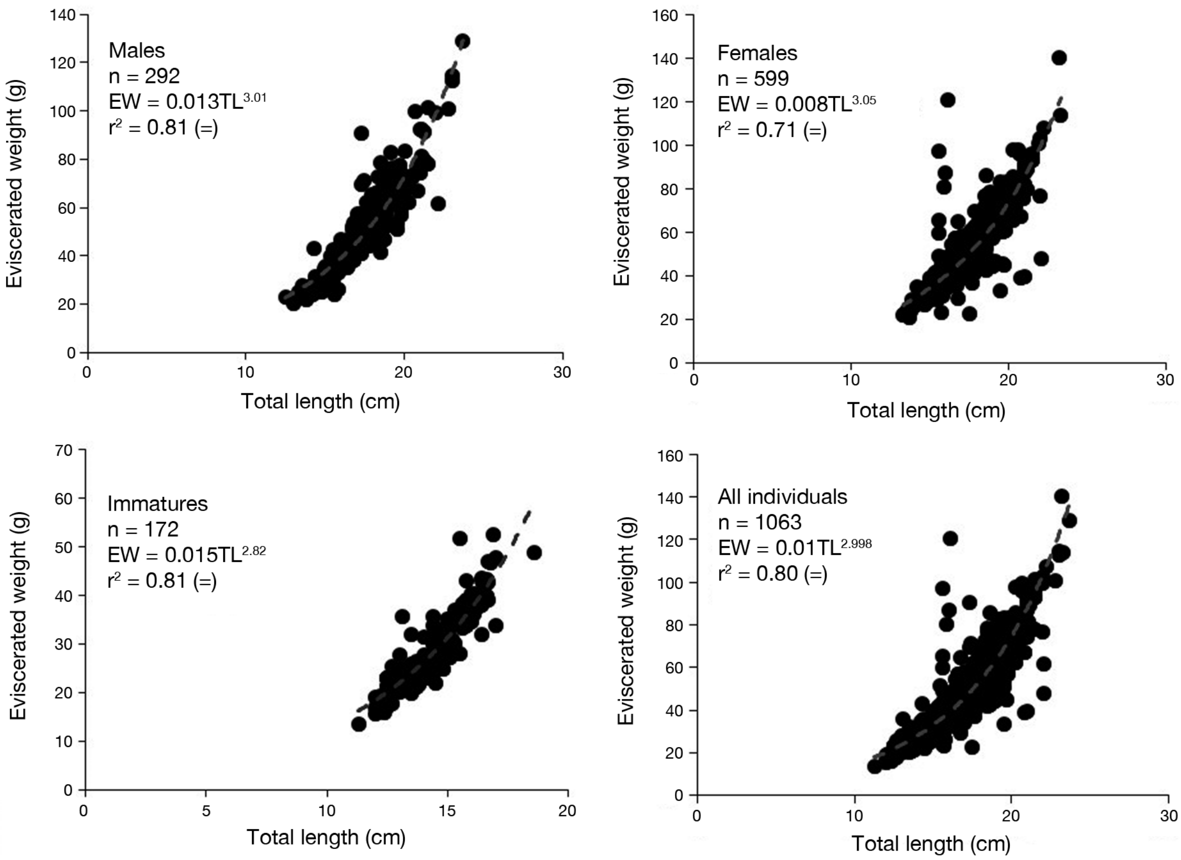

Fig. 2. – Length-weight relationship of males, females, immatures and all individuals of *Serranus cabrilla* from the north-eastern Algeria.

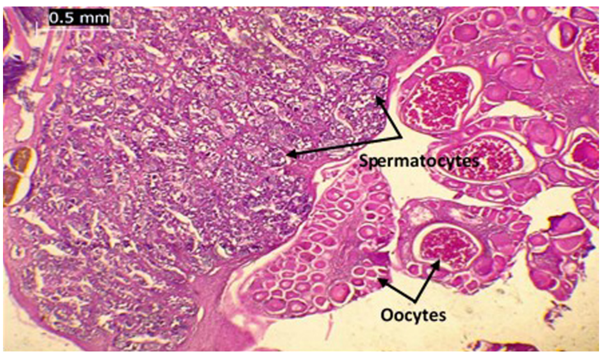

Fig. 3. – Transverse section of gonad of *Serranus cabrilla* sampled in the north-eastern Algeria.

in favor of females ($\chi^2 = 105.78$, df = 1, $p < 0.001$). Histological sections were made on the gonads of *S. cabrilla* (Fig. 3), where male and female gametes were observed on the same gonad or section, thus confirming the synchronous hermaphroditism of this species. Simultaneous hermaphroditism is defined as an adult individual with both male and female sexual organs simultaneously. It can be regarded as both sexes present in the same individual.

Gametogenesis begins in March, and developing gonads (stage II) were recorded for males and females until June. Ripe (stage III) and spawning (stage IV) stages appeared in April and became dominant in May for male and female gonads. After spawning, male and female gonads were in the sexual resting stage (stage V), which extended from August to February (Fig. 4). Fig. 5 indicates the mean monthly *GSI* value. The highest *GSI* value occurred between March and July, with a maximum in May (males: 3.98 %, females: 3.88 %) and a minimum in January (males: 0.21 %, females: 0.30 %). A one-way ANOVA applied to mean values of *GSI* indicated their significant heterogeneity (males: $F = 74.88$, females: $F = 117.63$, $p < 0.001$). These data suggested that the reproduction season extended between March and July. The Newman-Keuls test was applied to compare means two to two and showed that the average values obtained in April, May, and June differed from each other and were significantly higher than those of the remaining months for both sexes.

In the case of *HSI*, the difference was also significant for the two sexes (males: $F = 10.33$, females: $F = 17.39$, $p < 0.001$). Means obtained in April and May differed from the other months for both males and females. The *HSI* increased gradually from February to April, when it reached its maximum value for males (1.31 %) and in May for females (1.27 %). Then it decreased gradually to a minimum value in January (males: 0.33 %, females:

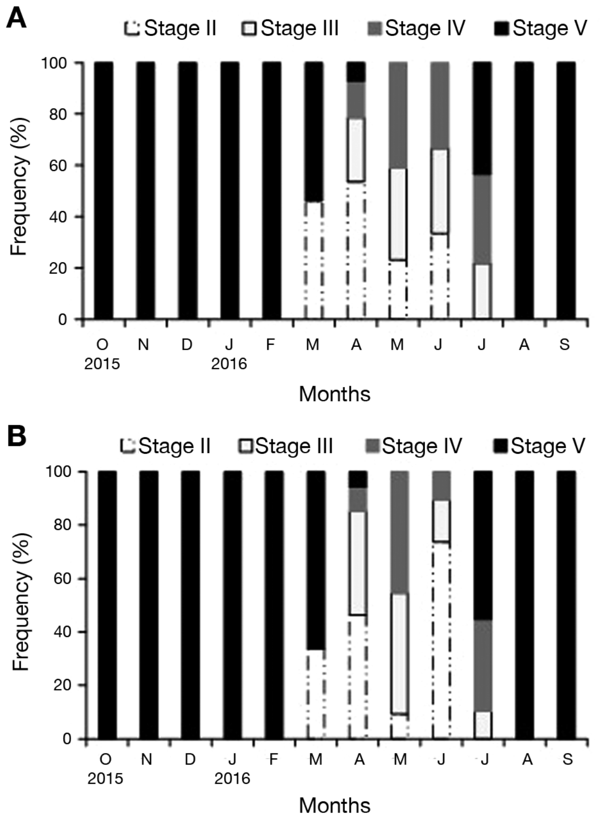

Fig. 4. – Monthly evolution of the maturity stages of *Serranus cabrilla* for males (**A**) and females (**B**) from the north-eastern Algeria.

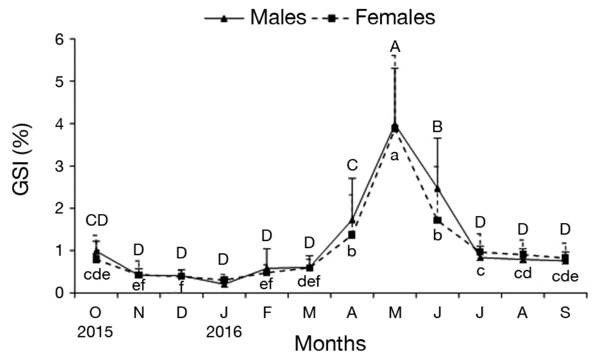

Fig. 5. – Monthly variations of gonado-somatic index (*GSI*) of *Serranus cabrilla* for males and females from the north-eastern Algeria. The different letters indicate significant differences between sampling months. Vertical bars represent standard deviation.

0.41 %). The highest value of *HSI* preceded that of the *GSI* in males by one month, whereas they coincided in females (Fig. 6).

A one-way ANOVA applied to mean values of *K* indicated their significant heterogeneity for males ($F = 74.88$, $p < 0.001$) and no significant difference for females ($F = 1.43$, $p > 0.05$). The condition coefficient (*K*) oscillated between 0.81 and 1.02 for both sexes, with a minimum in autumn: in October for males (0.81 %) and in December for females (0.91 %), while maximum values were observed in winter: males in February ($K = 1.02$ %) and females in March ($K = 1$ %) (Fig. 7).

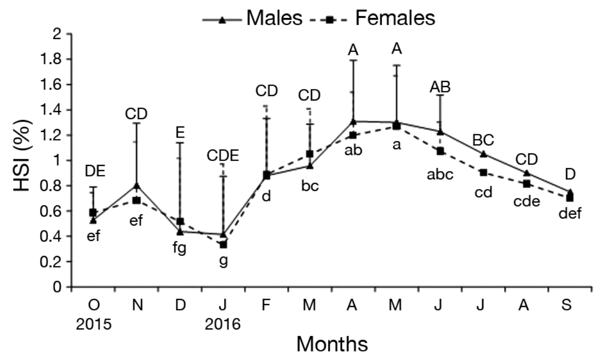

Fig. 6. – Monthly variations of hepato-somatic index (*HSI*) of *Serranus cabrilla* for males and females from the north-eastern Algeria. The different letters indicate significant differences between sampling months. Vertical bars represent standard deviation.

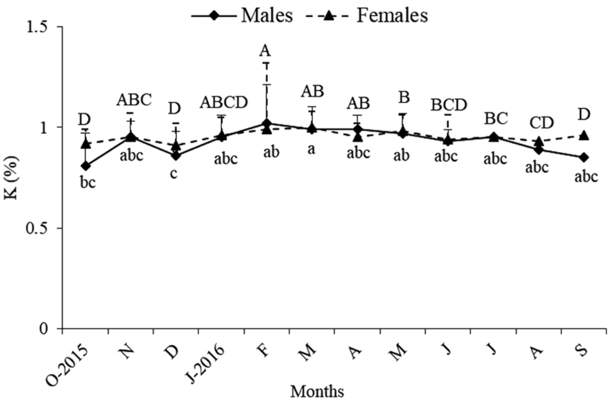

Fig. 7. – Monthly variations of the condition factor (*K*) of *Serranus cabrilla* for males and females from the north-eastern Algeria. The different letters indicate significant differences between sampling months. Vertical bars represent standard deviation.

Size at first maturity

Fig. 8 displays the percentage of mature individuals as a function of length class. The size at which 50 % of individuals were mature was estimated at 16.079 and 16.37 for males and females, respectively, with no significant difference between the two sexes (*t*-test = 1.02, $p > 0.05$).

DISCUSSION AND CONCLUSIONS

Age data are required in managing fishery resources to determine the composition by the age of catches and the growth rates of individuals (Ricker 1973). The maximum total length of *Serranus cabrilla* reported by Bauchot (1987) in the Mediterranean waters is 40 cm. In our

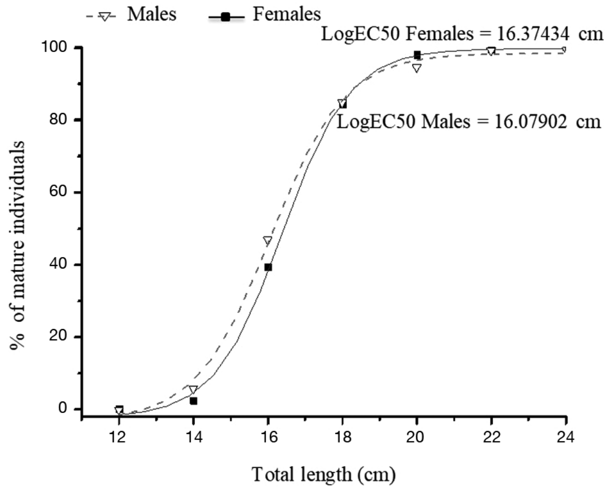

Fig. 8. – Proportion of mature individuals by total length of *Serranus cabrilla* for males and females from the north-eastern Algeria.

sampling site, it is less than 24 cm, whereas the maximum lengths reported in different localities of the Mediterranean differ from one region to another: 19.7 cm (Tserpes & Tsimenides 2001), 22.1 cm FL (Torku-Koç *et al.* 2004), 22.5 cm (Ilhan *et al.* 2010) and 26.2 cm (Ailane *et al.* 2021). In the Atlantic waters, especially along the Portuguese coast, the maximum recorded lengths are 30.2 cm (Gonçalves *et al.* 1997) and 26.5 cm (Gordo *et al.* 2016) (Table IV). Scale marginal increment values suggested that only one growth ring was formed in December and appeared in January, which is considered the period of annulus formation for *S. cabrilla* in the study area. This month constituted the period in which the temperature in the Gulf of Annaba was the lowest (close to 15° C, Boumaza 2014).

This study estimated six age classes, similar to the Aegean Sea (Turkey) results obtained by Ilhan *et al.* (2010). The reported maximum ages (Table IV) varied from 4 years (Torku-Koç *et al.* 2004) to 9 years (Bouain 1983) in the Mediterranean Sea and 11 years (Gordo *et al.* 2016) in the Atlantic. The differences in length and age estimation may be due to different environmental conditions, sampling methods, and ecological factors (food availability, competition, etc.). Overfishing may also be a major reason why smaller fish were always found in certain areas. In addition, the method of reading the sclerochronological structures (scales or otoliths) may be at the origin of errors in the reading of the growth rings, highlighting the importance of standardization methodology.

Table IV presents the von Bertalanffy growth parameters obtained in this study and other areas. The asymptotic length (L_∞) calculated in the present work is lower than those observed in other Mediterranean and Atlantic areas. Length differences may be attributed to variations in temperature and feeding habits. The growth coefficient, $k = 0.20$ years$^{-1,}$ indicated slow attainment of the maximum size but was higher than the value recorded in Tunisia by Bouain (1983) ($k = 0.1$). The lowest growth performance is observed on the North African coasts with values between 2.01 (Bouain 1983), and 2.09 (present study), only Ailane *et al.* (2021) found a value equal to 2.64 in the same area but using the indirect method (ELEFAN I). The growth performance index values are slightly higher in the Atlantic (Gordo *et al.* 2016) and in other areas of the Mediterranean (Tserpes & Tsimenides 2001, Torku-Koç *et al.* 2004, Ilhan *et al.* 2010) (Table IV).

Isometric growth between size and weight was observed as $b = 2.998$ for all specimens of *S. cabrilla* estimated on the eastern coast of Algeria. Similar results on total population were reported on the Turkish coasts by Akalin *et al.* (2015) ($b = 3.092$) in Çandarli Bay, by Oztekin *et al.* (2016) ($b = 2.90$) for the Aegean Sea, and Gordo *et al.* (2016) ($b = 3.054$) for Portuguese coasts. However, different values were presented on the Turkish coast with negative allometry by Torku-Koç *et al.* (2004) ($b = 2.67$), Kapiris & Klaoudatos (2011) ($b = 2.71$)

Table IV. – Von Bertalanffy growth and growth performance indexes (ϕ') of *Serranus cabrilla* in different localities (O: Otoliths; S: Scales). [a] Fork length, [b] Standard length.

Locality	Method	Sex	Age	L_∞	k	t_o	ϕ'	Length range (*TL*)	Author's
Tunisia	S	♂ + ♀ + I	1-9	31.85[b]	0.10	–1.48	2.01	-	Bouain 1983
Portugal, Atlantic	–	–	–	–	–	–	–	12-30.2	Gonçalves *et al.* 1997
Crete, Greece	O	♂ + ♀ + I	0-5	22.39	0.38	–0.53	2.28	6.3-19.7	Tserpes & Tsimenides 2001
Aegean Sea, Turkey	O	♂ + ♀ + I	1-4	33.55[a]	0.24	–0.11	2.432	8.6-22.3[a]	Torçu-Koc *et al.* 2004
Aegean Sea, Turkey	O	♂ + ♀ + I	0-6	23.88	0.30	–1.58	2.23	7.4-22.5	Ilhan *et al.* 2010
Portuguese, Atlantic	O	♂ + ♀ + I	1-11	25.26	0.21	–1.72	2.13	12.4-26.5	Gordo *et al.* 2016
Central coasts, Algeria	ELEFAN I	♂ + ♀ + I	-	32.8	0.41	–0.39	2.64	9.3-26.2	Ailane *et al.* 2021
Gulf of Annaba, eastern coasts of Algeria	S	♂	1-6	24.03	0.22		2.10	12.5-23.7	Present study
	S	♀	1-6	24.7	0.21		2.10	13.3-23.3	
	S	♂ + ♀ + I	1-6	24.91	0.21	–1.81	2.09	11.3-23.7	

in the Aegean Sea, and Altin *et al*. (2015) (b = 2.908) in the Gulf of Antalya. Only two cases of positive allometry were recorded for this species by Sangun *et al*. (2007) (b = 3.22) and Ozvarol (2014) (b = 3.048) in the Mediterranean. The growth type between length and weight for males and females in the present study area was isometric (b = 3.01 and b = 3.05, respectively), while Kapiris & Klaoudatos (2011) recorded negative allometry for the first (b = 2.39) and positive one for the second (b = 3.09) in the Aegean Sea. Allometric variations are probably attributed to differences in sampling methods, ontogenetic stages, and sample size in the different studies. On the other hand, interannual changes in the nutritional condition of the organisms may be partly the cause of this variation (Zorica *et al*. 2006).

The breeding period of *S. cabrilla* on the eastern coast of Algeria concords with the results of other studies: spring to early summer in Algeria and North-West of the Mediterranean Sea (Sabatés 1990), April to June in Tunisia (Bouain 1981), April to July in the Mediterranean and the Black Sea (Bauchot 1987), February to July in the Atlantic (García-Díaz *et al*. 1997) and March to June on Turkish coasts (Torku-Koç *et al*. 2004, Ilhan *et al*. 2010, Birim *et al*. 2016). García-Díaz *et al*. (1997) noted that, as latitude decreases, the length of the breeding season increases for *S. cabrilla*, clearly reflecting environmental conditions. The highest value of GSI was recorded in May in the study area, just as Bouain (1981) for Tunisian coasts and García-Díaz *et al*. (1997) in the Atlantic. The first maximal HSI value precedes GSI, which indicates an energetic transfer of reserves to the gonads. The condition factor (K) displays maxima just before the breeding period (February for males, March for females), while the minima are recorded after spawning (October for males, December for females).

The same results were observed by Bouain (1981) for *S. cabrilla* on the Tunisian coasts, where the coefficient "K" has two maxima, one before the breeding period (in December) and the other after that period in September. Indeed, fishes that decrease their food intake during gonadic maturation use their endogenous reserves in muscle, adipose tissue, and liver (Martin *et al*. 1993). The length at first maturity of comber was estimated at 16.08 and 16.37 for males and females, respectively, in the east of Algeria, which agreed perfectly with Bouain's (1981) results on the southern Tunisian coasts with a value equal to 16 cm. In the Canary Islands, sexual maturity occurred earlier with a value equal to 15.4 and 15.2 cm SL with macroscopic and histological methods, respectively (García-Díaz *et al*. 1997). Around the Turkish coasts, this value was reported as 15 cm SL by Torku-Koç *et al*. (2004), 13.2 cm TL by Ilhan *et al*. (2010), and 12.9 cm FL by Birim *et al*. (2016). The synchronous hermaphroditism of *S. cabrilla* was reported by numerous authors (Bouain 1981, García-Díaz *et al*. 1997, Ilhan *et al*. 2010, Birim *et al*. 2016) and supported in this study by histological sections.

The few biological studies on comber *S. cabrilla* on southern Mediterranean coasts, and especially their absence on Algerian coasts, allowed us to study the age, growth, and reproduction of this species, as these parameters have crucial importance for stock assessment and would be needed for better management of the natural stocks of *Serranus* in the southern Mediterranean.

REFERENCES

Ailane F, Kasser A, Hemida F 2021. Growth and mortality of *Serranus cabrilla* (Linnaeus, 1758) (Actinopterygii: Perciformes: Serranidae) from Bou Ismail Bay, off Algeria, southwestern Mediterranean. *Indian J Fish* 68(2): 1-7.

Akalin S, lhan D, Özaydin O 2015. Length-weight relatıonshıps for 30 demersal fısh species from Çandarli Bay (North Aegean Sea, Turkey). *Croat J Fish* 73: 73-76.

Altin A, Ayyildiz H, Kale S, Alver C 2015. Length-weight relationships of forty-nine fish species from shallow waters of Gökçeada Island, northern Aegean Sea. *Turk J Zool* 39: 971-975.

Ayoma T 1957. On the regeneration of the teleost scale with special reference to the yellow sea bream, *Taius tumifrons*. *Bull Jpn Sci Fish* 23: 679-684.

Bauchot ML 1987. Poissons osseux. *In* Fischer W, Bauchot ML, Schneider M (Eds), Fiches FAO d'Identification pour les Besoins de la Pêche (Rev 1). Méditerranée et mer Noire. Zone de pêche 37. Vol 2. CCE & FAO, Rome: 891-1421.

Beamish RJ, Mc Farlane GA 1983. Validation of age determination estimates: The forgotten requirement. *In* Prince ED, Pulos LM (Eds), Proceedings of the international workshop on Age Determination of Oceanic Pelagic Fishes: Tunas, Billfishes, and Sharks. NOAA Technical Report NMFS 8. 15-18 February 1982, Miami, FL, USA: 29-33.

Birim BD, Cihangir B, Tirasin EM 2016. The Reproduction Properties of *Serranus cabrilla* (L., 1758) and *Serranus hepatus* (L., 1758) from Izmir. *NESciences* 1(3): 25.

Bouain A 1981. Les serrans (Teleostei, Serranidae) des côtes sud de la Tunisie : taille de première maturité, période de reproduction. *Cybium* 5(4): 65-75.

Bouain A 1983. La croissance linéaire des serrans des côtes sud-est de la Tunisie. Rapp P IV Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée 28(5): 87-91.

Boumaza FZ 2014. Évaluation de l'état de santé des eaux du golfe d'Annaba à travers un mollusque gastéropode *Patella caerulea* (L. 1758) : paramètres écologiques et biochimiques. Thèse de doctorat (LMD) en Biologie animale environnementale, option : Physico-toxicologie, Université Badji Mokhtar, Annaba, Algérie.

Broussonet M 1786. Observations sur la régénération de quelques parties du corps des poissons. *Hist Acad R Sci* 684-688.

Campana SE 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *J Fish Biol* 59(2): 197-242.

Casselman JM 1987. Determination of age and growth *In* Weatherley AH, Gill HS (Eds), The Biology of Fish Growth. Academic Press, London, UK.

Dagnélie P 1975. Théorie et méthodes statistiques, Applications agronomiques. Vol 2 Les méthodes de l'inférence statistique. 2e edit. Presses agronomiques de Gembloux, Gembloux, Belgique: 463 p.

Fablet R, Ogor A 2005. TNPC: Digitised for calcified structures, Ifremer-France, Code Lutin, Jean Couteau, Noesis SA, France.

Fischer W, Schneider M, Bauchot ML 1987. Fiches FAO d'identification des espèces pour les besoins de la pêche. Méditerranée et Mer Noire. Zone de pêche 37, Rév 1, Vol 2: 762-1529.

Fouda MM 1979. Studies on scale regeneration in the common goby, *Pomatoschistus microps* (Pisces). *J Zool Lond* 189: 503-509.

Froese R, Pauly D 2000. FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines: 344 p.

García-Díaz MM, Tuset VM, González JA, Socorro J 1997. Sex and reproductive aspects in *Serranus cabrilla* (Osteichthyes: Serranidae): macroscopic and histological approaches. *Mar Biol* 127(3): 379-386.

Gonçalves JMS, Bentes L, Lino PG, Riberio J, Canario AVM, Erzini K 1997. Weight-length relationships for selected five fish species of the small-scale demersal fisheries of the South-West coast of Portugal. *Fish Res* 30: 253-256.

Gordo SL, Neves A, Vieira AR, Paiva RB, Sequeira V 2016. Age, growth and mortality of the comber *Serranus cabrilla* (Linnaeus, 1758) in the eastern Atlantic. *Mar Biol Res* 112(6): 656-662.

Ilhan D, Akalin S, Tosunoglu Z, Özaydin O 2010. Growth caracteristics and reproduction of comber, *Serranus cabrilla* (Actinopterygii, Perciformes, Serranidae), in the Aegean Sea (Turkey). *Acta Ichthyol Piscat* 40(1): 55-60.

Kapiris K, Klaoudatos D 2011. Length-weight relationships for 21 fish species caught in the Argolikos Gulf (central Aegean Sea, eastern Mediterranean). *Turk J Zool* 35(5): 717-723.

Lee RM 1920. A review of the methods of age and growth determination in fish by means of scales. *Fish Investig* 4(2): 1-32.

Loubens G 1980. Biologie de quelques espèces de Poissons du lagon néo-calédonien. III. Croissance. *Cah Indo-Pac* 2: 101-153.

Louisy P 2005. Guide d'identification des Poissons marins. Europe de l'ouest et Méditerranée. Ulmer: 430 p.

Martin NB, Houlihan DF, Talbot C, Palmer RM 1993. Protein metabolism during sexual maturation in female Atlantic salmon (*Salmo salar* L.). *Fish Physiol Biochem* 12: 131-141.

McCart P 1967. Scale regeneration in the bluespot goby, *Coryphopterus nicholsi*. *J Fish Res Bd Can* 24: 433-434.

Oztekin A, Özekinci U, Daban IB 2016. Length-weight relationships of 26 fish species caught by longline from the Gallipoli peninsula, Turkey (northern Aegean Sea). *Cah Biol Mar* 57: 335-342.

Ozvarol Y 2014. Length-weight relationships of 14 fish species from the Gulf of Antalya (northeastern Mediterranean Sea, Turkey). *Turk J Zool* 38: 342-346.

Pauly D, Munro JL 1984. Once more on the comparison of growth in fish and invertebrates. *ICLARM Fishbyte* 2(1): 21.

Quignard JP, Tomasini JA 2000. Mediterranean Fish Biodiversity. *Biol Mar Medit* 7(3): 1-66.

Rachedi M, Dahel AT 2019. Population Dynamic Parameters of the Comber *Serranus cabrilla* (Teleostei, Serranidae) in Western Mediterranean (Eastern Coast of Algeria). *Egypt J Aquat Biol Fish* 23(5): 31-42.

Rachedi M, Derbal F, Kara MH 2018. Feeding habits of the comber *Serranus cabrilla* (Linnaeus, 1758) Teleostei, Serranidae) from the Gulf of Annaba (Eastern coast of Algeria). *Cah Biol Mar* 59 : 149-158.

Ricker WE 1973. Linear regression in fishery research. *J Fish Res Bd Can* 30: 409-434.

Sabatés WE 1990. Distribution pattern of larval fish population in the Northwerstern Mediterranean. *Deep-Sea Res* 37: 1085-1098.

Sangun L, Akamca E, Akar M 2007. Weight-Length Relationships for 39 Fish Species from the North-Eastern Mediterranean Coast of Turkey. *Turk J Fish Aquat Sci* 7: 37-40.

Shapiro DY 1984. Sex reversal and Sociodemographic process in coral reef fishes. *In* Botts GW, Wootton RJ (Eds), Fish Reproduction: Strategies and Tactics. Academic Press, London: 103-118.

Torku-Koç H., Türker-Cakir D., Dulčić J 2004. Age, growth and mortality of the comber, *Serranus cabrilla* (Serranidae) in the Edremit Bay (NW Aegean Sea, Turkey). *Cybium* 28(1): 19-25.

Tserpes G, Tsimenides N 2001. Age, growth and mortality of *Serranus cabrilla* (Linnaeus 1758) on the Cretan shelf. *Fish Res* 51: 27-34.

Tsikliras AC, Stergiou KI, Froese R 2013. Editorial note on reproductive biology of fishes. *Acta Ichthyol Piscat* 43(1): 1-5.

Von Bertalanffy L 1938. A quantitative theory of organic growth (inquiries on growth laws II). *Hum Biol* 10(2): 181-213.

West G 1990. Methods of assessing ovarian development in fishes: a review. *Aust J Mar Freshw Res* 41: 199-222.

Zorica B, Sinovcic G, Pallaoro A, Cikes Kec V 2006. Reproductive biology and length-weight relationship of painted comber, *Serranus scriba* (Linnaeus, 1758), in the Trogir Bay area (middle-eastern Adriatic). *J Appl Ichthyol* 22: 260-263.

Received on December, 24 2021
Accepted on June 28, 2022
Associate editor: T Changeux