

Growth and spawning period of *Sepia officinalis*, (Lineaus, 1758) in the Algiers region (centre of Algeria)

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Abstract

A total of 1,364 specimens of *Sepia officinalis* (Lineaus, 1758), including 643 females and 532 males were measured from February 2010 to January 2011 catching by the commercial trawling fisheries of Algiers region. The sex, dorsal mantle, wet body mass, nidamental gland weight and female gonadal weight were recorded. The mean length of the dorsal mantle for females was 11.68 ± 0.03 cm and for males 12.04 ± 0.04 cm. The difference between the two averages was not significant. The Powell-Wetherall method for determining the asymptotic dorsal length of the mantle (DML_{∞}) was applied (26.93 cm for both sexes combined) and the growth coefficient K, of 0.38 yr^{-1} , was established using the ELEFAN method. A seasonal analysis of this coefficient shows a slowdown in growth in autumn and winter. The value of t_0 determined by the Pauly method is 0.704 y^{-1} . Relative growth shows a negative allometry of 2.55 for both sexes and a constant of proportionality is about 0.391. The study of the overall sex ratio showed a slight predominance of females with a ratio of 1:1.2. In autumn and winter, the females predominate with 67.3% and 52.5%, respectively. Considering the gonad and the nidamento-somatic index, *S. officinalis* in the Algiers region seems to breed between March and July.

Keywords: *Sepia officinalis*, Sex-ratio, Gonadosomatic index, Length-weight relationship, Algiers.

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Introduction

Sepia officinalis, commonly known as the cuttlefish is a common cephalopod mollusc and is abundant in the Mediterranean. It is a nekton-benthic species occurring predominantly on sandy and muddy bottoms from the coastline (2-3 m depth) to a depth of approximately 200 m, with the greatest abundance in the upper 100 m (Guerra, 2006).

In Algeria, it is caught by fishing trawlers and small-scales fisheries (trammel netting). Their catches reached 55.9 tonnes in 2010 in the centre of Algeria (between Cherchell and Dellys).

In comparison with other cephalopods, *S. officinalis* is one of the most studied due to the high frequency of catches, its seasonal concentration in coastal waters and its relative ease of breeding (Richard, 1971). Few studies on the growth of cuttlefish, in the Mediterranean sea, have been undertaken, but among the extant studies are those of Inejih (1990) in Mauritania, Ezzeddine-Najai and El Abed (2001) in Tunisia and Jardas *et al.* (2001, 2004) in the Adriatic. The aim of this study, focusing for the first time on the region of Algiers, is to provide new information on *S. officinalis* concerning the length frequency distribution, sex-ratio and length-weight relationship, together with an overview of the spawning season because it is important to understand their life cycle and their population dynamics. Such information

is essential for assessment and management.

Materials and methods

The study is based on data collected from regular samples obtained from the commercial trawling fisheries of the three major fishing ports in the region of Algiers (Algiers, Bou Haroun and Cherchell) (Fig. 1). From February 2010 to January 2011, 1,364 specimens were collected including 643 females and 532 males. The sex, dorsal mantle length (DML) to the nearest 0.1 cm, wet body mass (WT) to the nearest 1g, nidamental gland weight and gonadal weight for females were recorded. A comparison of the mean size of the two sexes was made using the test of the reduced gap ε (Schwartz, 1983) as follows:

$$\varepsilon = \frac{|m_1 - m_2|}{\sqrt{[(\theta^2_1/N_1) + (\theta^2_2/N_2)]}}$$

where :

m_1 : denotes mean, θ^2_1 : the variance and N_1 : sample size 1.

m_2 : denotes mean, θ^2_2 : the variance and N_2 : sample size 2.

For the study of linear growth, the analysis of size structure was used. This method allowed us to estimate asymptotic dorsal mantle length (DML_∞) and the growth coefficient (K).

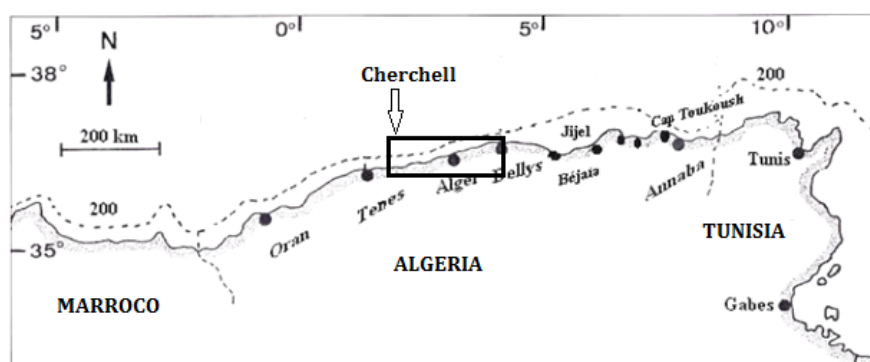


Figure 1: The study area.

These parameters were determined using the Electronic Length Frequency Analysis (ELEFAN) approach, which combines the Petersen method and modal progression analysis with the minimum subjective items. Knowing L_{∞} and K , the parameter t_0 is obtained from the empirical equation suggested by Pauly (1980) in the form:

$$\log_{10}(-t_0) = -0.3922 - 0.2752 \log_{10} L_{\infty} - 1.038 \log_{10} K$$

The relative growth of *S. officinalis* establishes the coefficients a and b according to the equation:

$$W_{\infty} = a L_{\infty}^b$$

The sex ratio in turn is calculated by the number of females on the number of males.

The spawning period for females is determined by the gonado-somatic index (GSI) and nidamento-somatic index (RNS) according to the following formulae:

$$\text{GSI} = (\text{gonad weight} / \text{total weight}) * 100$$

$$\text{RNS} = (\text{nidamental gland weight} / \text{total weight}) * 100$$

Results

The sample sizes of *S. officinalis* for both sexes range from 5 cm to 25 cm in dorsal mantle length. The females range in size from 5.3 cm to 25 cm, and the males from 6 cm to 24.5 cm. Females predominate in catches for most size ranges, whereas males predominate in the sizes: 10-11cm, 16 cm, 19 cm, 18-19 cm, and 22 cm (Fig. 2).

These measurements give a mean size of 11.68 ± 0.03 cm for females and 12.04 ± 0.04 cm for males. The mean size of the both sexes combined is 11.84 ± 0.02 cm.

The calculated value of the reduced gap (ξ) is 0.87 lower than the value given in the Gaussian table for a 5% of level of confidence (1.96) indicating a non-significant difference between the two mean sizes. For this reason only the estimated DML_{∞} of both sexes was considered. This was achieved by employing a length frequency distribution following the Powell-Wetherall method (FISAT II) which gives a value of 26.93 cm.

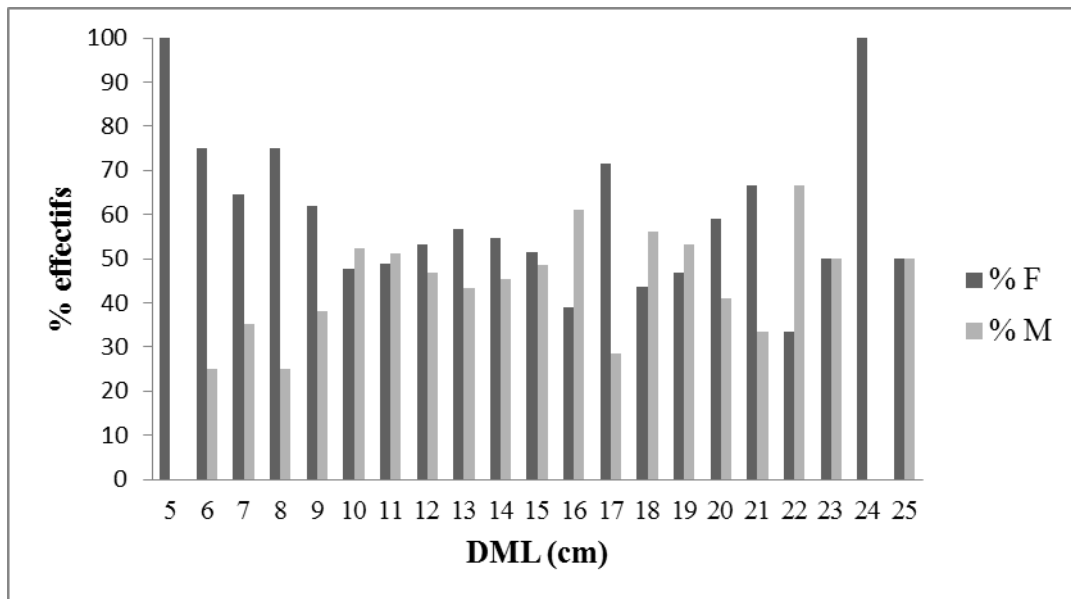


Figure 2: Length frequency distribution of *Sepia officinalis*.

Using the same software FISAT II, the ELEFAN program was used to obtain the value of annual K yielding a value of 0.38 an^{-1} for both sexes.

The equation of growth when t_0 is $0.704/\text{y}$ is:

$$L_t = 26.93 (1 - e^{-0.38(t-0.704)})$$

Bearing in mind that growth varies with the season according to Medhioub (1986), an estimation of seasonal K is given in Table 1.

The relationship between the total weight (W_t) and dorsal mantle length (DML) shows slope values b less than 3 indicating a minor growth allometry for *S. officinalis* (Fig. 3). The annual value of this parameter is 2.557 for both sexes.

The equations of growth are for both sexes combined as follows:

$$W_\infty = 0.391 L_\infty^{2.557}$$

throughout the study period, females dominate slightly at 54.7%, giving a sex ratio of 1:1.2.

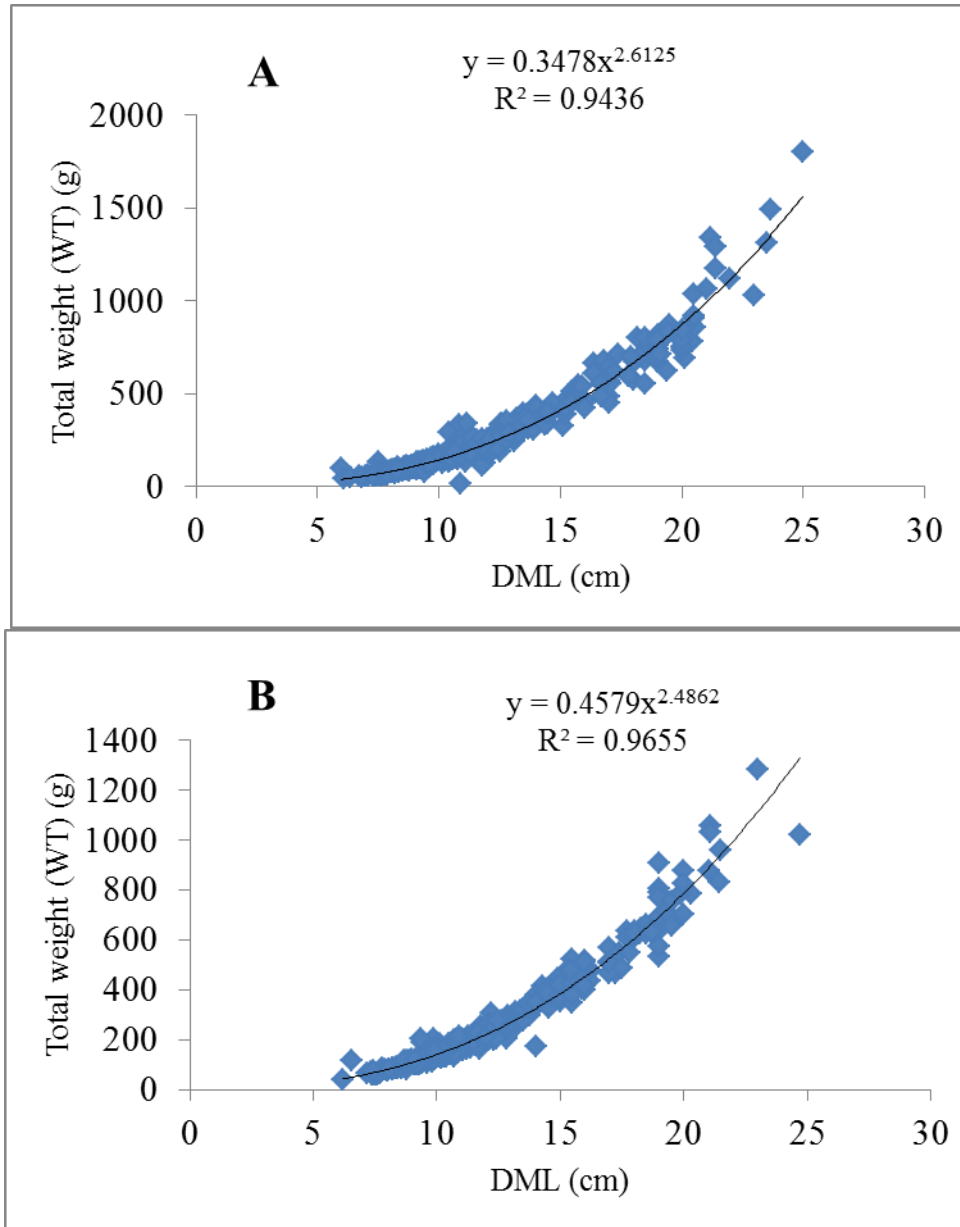
From the study of the seasonal sex ratio we can note that females predominate in autumn (especially in October) with a percentage of 67.3% and in winter with 52.5%. However, in summer and spring males are more abundant.

To define the spawning period of *S. officinalis* in the Algiers region, the nidamento-somatic and gonado-somatic indices are estimated as shown in Figs. 4 and 5, respectively.

The values of the nidamento-somatic ratio are between a minimum of 0.14 in October and a maximum of 5.79 in June. Two peaks can be observed in Fig. 4 in March (4.76) and June.

Table 1: Evolution of seasonal values of K for *Sepia officinalis* off Algiers.

Season	K/(year)
Winter	0.310
Spring	0.740
Summer	0.520
Autumn	0.270



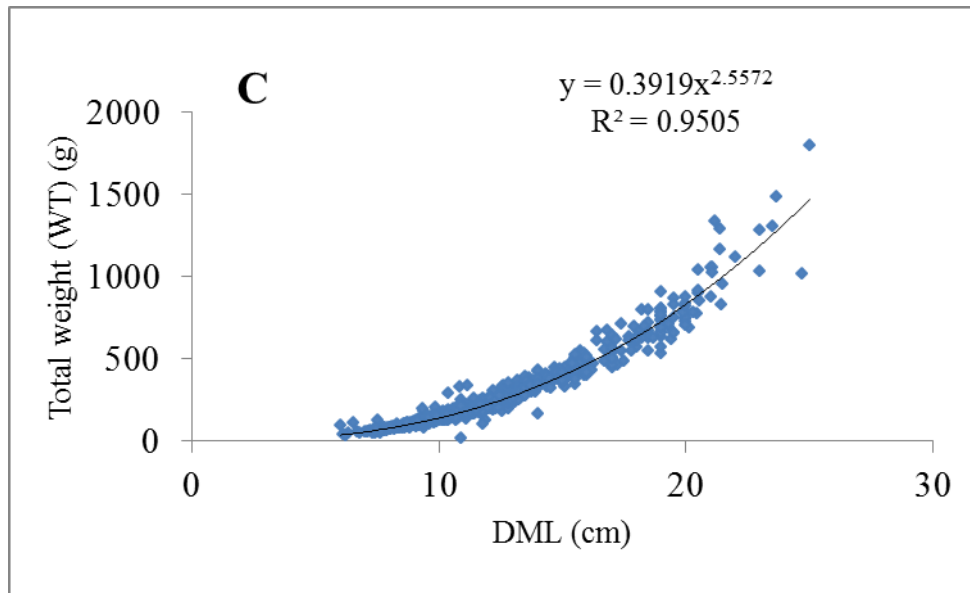


Figure 3: Relative growth *Sepia officinalis* : females (A), males (B) and combined (C).

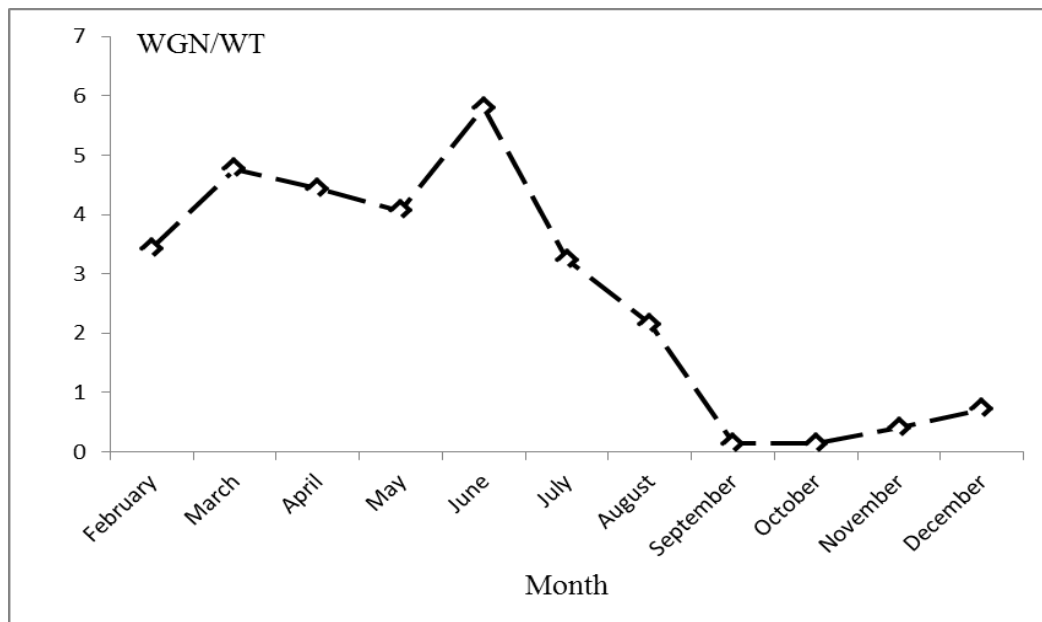


Figure 4: Monthly evolution of the gonado-somatic index of *Sepia officinalis*. (WGN: weight of gonad; WT: total weight).

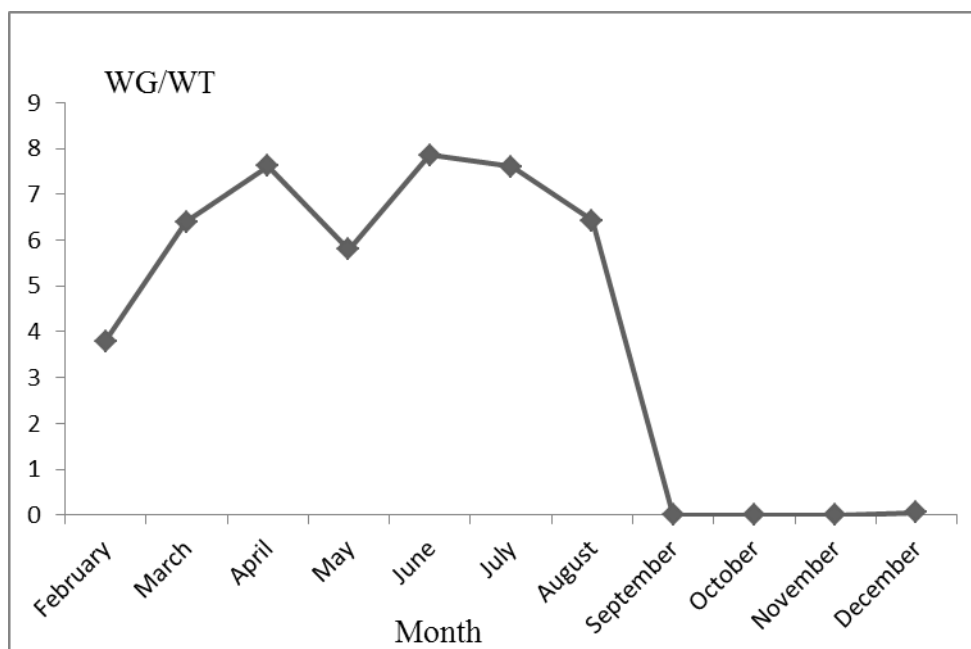


Figure 5: Monthly evolution of the gonado-somatic index of *Sepia officinalis* (WG: gonad weight; WT: total weight)

The gonado-somatic index, shows a long period of reproduction for *S. officinalis* in the Algiers region from March to July mainly in June. Between September and December, gonad weight is negligible.

Discussion

Growth studies are rare in natural conditions. Apart from the study conducted by Ezzeddine-Najai, 1997, Ezzeddine-Najai and El Abed, 2001 in Tunisia and that by Manfrin Piccinetti and Giovanardi (1984) in the Adriatic, we found no other studies carried out in the Mediterranean, and thus we include results obtained in other regions in the discussion.

Several points identified in the article merit discussion. The average size of females (11.68 cm) is lower than that of males (12.04 cm) confirming the

finding of Inejih (1990) who noted that males reach larger sizes than females, albeit without there being a significant difference between the two sexes. Indeed, Le Goff and Daguzan (1991) find that there are no differences between the sizes for females and males over a year, whereas the difference is significant between the years.

The average size of all the samples was 11.89 ± 0.02 cm, smaller than that found by Jardas *et al.* (2004) in the north Adriatic (13.9 ± 1.83 cm), but very close to that obtained by Jardas *et al.* (2001) in the east of the Adriatic (11.7 ± 2.86 cm). The sex ratio obtained in the Algiers region is in favour of females, in contrast to the results of Jardas *et al.* (2001).

Dunn (1999) obtained a very similar value of K for *S. officinalis* to ours for males (0.4 an^{-1} vs. 0.38 an^{-1} in this

study), but a much lower value for females (0.24 an^{-1}). Ezzedine-Najai (1997) obtained a K value of 0.429 an^{-1} in the Gulf of Tunisia.

The different seasonal values of K are consistent with the observations made by Richard (1971), Jeon (1982), Boletzky (1983) and Medhioub (1986). These authors report that the growth of *S. officinalis* is variable and depends on the water temperature, sexual maturation, food availability and decreased filling of the stomach during the breeding season.

Growth will be faster in the spring and summer compared to the winter, confirming the findings of Richard (1971) and also Challier *et al* (2005) who reported more rapid growth from June to August.

Moreover, this change in growth is probably due to the fact that the cuttlefish is a visual predator and water turbidity prevents significant capture of prey in winter (Hanlon and Messenger, 1996).

The parameters of the relationship between size and weight of *S. officinalis* in the Algiers region are comparable to those obtained by other authors (Table 2). The results obtained by Dunn (1999) in the English Channel and Jardas *et al.* (2004) in the Northern Adriatic, give values very close to ours : $b = 2.56$ and $b = 2.55$, respectively.

Table 2: Parameters of the relationship between height and weight for *Sepia officinalis* off Algiers and in other regions according to different authors.

Author	Sex	a	b	n	Region
Bakhayokho (1983)	F	0.26	2.74		Senegal coast
	M	0.24	2.74		
Mattacola <i>et al.</i> (1984)	F	0.501	2.7	89	English Channel
	M	0.631	2.65	122	
	Comb.	0.562	2.67	211	
Manfrin Piccinetti & Giovanardi (1984) Inejih (1990)	Comb.	0.22	2.77		Adriatic Sea Mauritania coast
	F	0.438	2.53	262	
	M	0.458	2.51	326	
Dorel <i>et al</i> (1998)	Comb.	0.26	2.7		Gulf of Biscay
Dunn (1999)	F	0.8	2.64	519	English Channel
	M	0.9	2.58	512	
	Comb.	1.1	2.56	1031	
Jardas <i>et al.</i> (2001)	F	0.232	2.73	286	East Adriatic Sea
	M	0.244	2.69	457	
	Comb.	0.237	2.72	743	
Jardas <i>et al.</i> (2004)	Comb.	0.343	2.55		North Adriatic Sea
Royer <i>et al.</i> (2006)	Comb.	0.27	2.26		English Channel
This study	F	0.35	2.61	597	Algiers coast
	M	0.46	2.49	461	
	Comb.	0.39	2.55	1058	

The monitoring of the evolution of the gonado-somatic index during the year 2010 shows a minimum value from September to December, whereas nidamento-somatic index increases from September and peaks in June. The study by Manfrin Piccinetti and Giovanardi (1984) shows evidence of a spawning period which extends all year with a peak in spring and summer. Their results indicate spawning extending from February to September with a peak from April to June. In Adriatic waters, the peak of breeding is found to be in June-July off the coast of Portugal (Jorge and Sobral, 2004). Gauvrit (1997) found that cuttlefish in the Bay of Biscay reproduce mainly between mid-March and the end of June.

This study represents the first description of the growth and the changes in female reproductive glands in the Algerian water. The results allow us to observe that they do not differ to those obtained in other regions. This is in line with Mangold-Wirz (1963) who noted that the behaviour of Mediterranean cuttlefish does not differ from that of Atlantic cuttlefish.

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