

Reproduction of *Octopus vulgaris* Cuvier, 1797 in Gabes Gulf (Tunisia, Eastern Mediterranean Sea)

Reproduction d'*Octopus vulgaris* Cuvier, 1797 dans le golfe de Gabès (Tunisie, Méditerranée orientale)

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Résumé

Zghidi W., S. Ezzeddine-Najai, F. Charfi-Cheikhrouha, A. El Abed, 2004 – [Reproduction d'*Octopus vulgaris* Cuvier, 1797 dans le golfe de Gabès (Tunisie, Méditerranée orientale)]. *Mar. Life*, 14 (1-2) : 31-36.

Cette étude concerne les aspects de la reproduction d'*Octopus vulgaris* dans le golfe de Gabès (Méditerranée orientale). Durant la période d'octobre 1996 à septembre 1998, des échantillons d'*Octopus vulgaris* ont été collectés dans cette région. La période de ponte a été estimée à partir du calcul des indices de reproduction (GSI, HI, OGI et PI). La sex-ratio et la taille de la première maturité ont été déterminées. Les résultats ont été comparés avec ceux trouvés sur l'espèce de l'Atlantique Est et de la Méditerranée occidentale.

MOTS CLÉS :

Reproduction, *Octopus vulgaris*, golfe de Gabès.

Abstract

Zghidi W., S. Ezzeddine-Najai, F. Charfi-Cheikhrouha, A. El Abed, 2004 – Reproduction of *Octopus vulgaris* Cuvier, 1797 in Gabes Gulf (Tunisia, Eastern Mediterranean Sea). *Mar. Life*, 14 (1-2) : 31-36.

This study deals with reproductive aspects of *Octopus vulgaris* in Gabes Gulf (Central Mediterranean Sea). In the period from October 1996 to September 1998, samples of *Octopus vulgaris* were collected from this area. Spawning season was estimated using reproductive indices (GSI, HI, OGI and PI). Sex ratio and size at first maturity were determined. Results were compared with information on this species in Eastern Atlantic waters and Western Mediterranean waters.

KEY-WORDS :

Reproduction, *Octopus vulgaris*, Gabes Gulf.

Introduction

Octopus vulgaris is a common cephalopod species in Mediterranean waters. It has been the subject of continuing scientific interest over the last three decades especially in the Western Mediterranean and Eastern Atlantic waters.

In Tunisia and particularly in the Gabes Gulf, *Octopus vulgaris* is the most important cephalopod commercially exploited, representing about 48% of the national cephalopod catch and yielding up to 6000 tons by year.

In spite of its economic importance, few data are available on the species' biology in this area. In fact, Heldt (1948) described spawning in an aquarium and Ezzeddine-Najai (1992) studied recruitment using size frequency data.

In the present paper, we set out to study the reproductive activity of *Octopus vulgaris* in the Gabes Gulf. Our goal is to determine the season of spawning, and to estimate the size at the first maturity.

Material and methods

Several monthly samplings were carried out from October 1996 to September 1998, resulting in 4 152 specimens (1998 males, 2 154 females). Samples were collected from trawl and coastal landings in several sites of the Gabes Gulf (**figure 1**). In this region, 96% of *Octopus vulgaris* landings occur from coastal gears, which are pots, hollow stones, nets and traps. In order to deal with the conservation and management of this resource, Tunisian legislation prohibits *Octopus* fishing from 15 May to 15 October a year. This legislation puts the possibility to extend the prohibition of *Octopus* fishing until 15 November or to advance him to 1st April and this by decision of the authority concerned and considering the bio-climatic particularities of every fishing ground.

To define the spawning period, four reproductive indices were examined:

– Gonado-somatic index: $GSI = (Wg * 100) / We$; Wg: gonad weight, We: eviscerated body weight

– Hayashi index (Hayashi, 1970) modified for *Octopus* according to Guerra (1975): $HI = Wov / (Wgo + Wov)$ for females, Wov: oviductal weight; Wgo: gonad weight and $HI = Wag / (Wtes + Wag)$ for males, Wag: accessory gland weight; Wtes: testis weight

– Penis index: $PI = (Lp * 100) / Lm$, Lp: penis length; Lm: mantle length

– Oviductal gland index: $OGI = (Dovg * 100) / Lm$, Dovg: oviductal gland diameter; Lm: mantle length.

Maturity stages were determined on the basis of the macroscopic gonad aspect using Dia (1988) criteria. Individuals are sexed and separated in immature, maturing and mature. The criteria used are as follows:

Males:

Immature (M1): small testis, spermatophoric sac empty, Maturing (M2): size of testis more important, spermatophoric organ containing no complete spermatophores, Mature (M3): voluminous testis, spermatophoric sac with fully developed spermatophores,

Females:

Immature (M1): small ovary, ovary and oviductal glands colorless, invisible oocytes.

Maturing (M2): increase in size of ovary and oviductal glands, visible oocytes but not individualized, restricted brown strip at oviductal glands,

Mature (M3): voluminous yellow ovary, broad brown strip at oviductal glands, individualized oocytes.

Size at first maturity was determined for males and females separately and estimated by a logistic function of the size attained by 50% of the specimens maturing or fully mature.

Sex ratio was determined and samples were examined for deviation from numerical equality of the sexes. The t test was applied ($P < 0.05$).

Results

Reproductive index

In both sexes, reproductive activity occurred almost at the same period of the year. Mature males were present throughout most of the year, but they displayed maximum activity from February to June (**figures 2, 3 and 4**).

The most important peak of the female activity was recorded in May when the highest value of GSI and OGI and the lowest value of HI were recorded. Female maximum activity was noted in May – June (July) (**figures 2, 3 and 4**). A second peak of GSI, less important, is recorded in September.

Frequency of maturity stages

The monthly variation of maturity stages for both sexes is illustrated in **figure 5**.

Immature females were caught throughout the study period. Their minimal proportions were noted in the

Figure 1
 Gabes Gulf / golfe de Gabès.

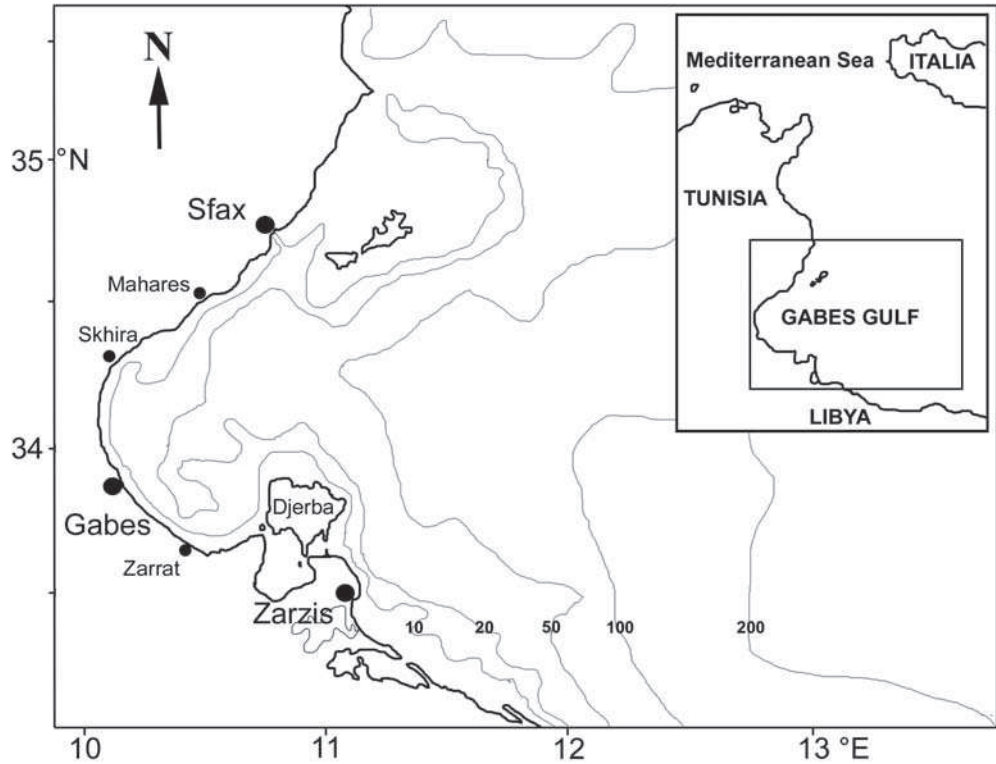


Figure 2
 Evolution of gonado-somatic index (GSI) of *Octopus vulgaris* of the Gabes Gulf. / Évolution de l'indice gonado-somatique (GSI) d'*Octopus vulgaris* du golfe de Gabès.

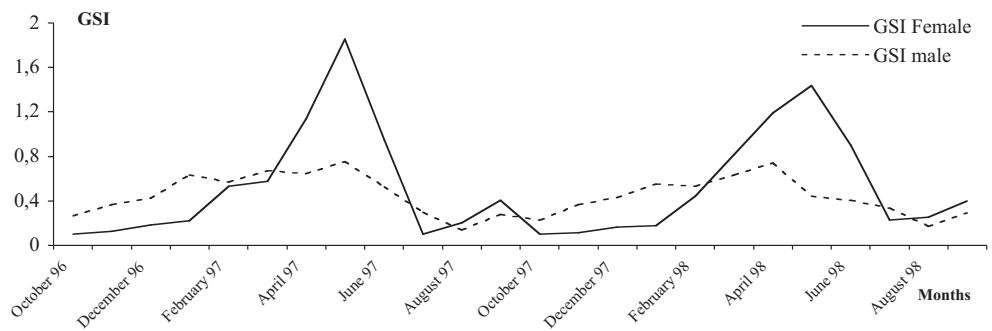


Figure 3
 Evolution of Hayashi index (HI) of *Octopus vulgaris* of the Gabes Gulf. / Évolution de l'indice de Hayashi (HI) d'*Octopus vulgaris* du golfe de Gabès.

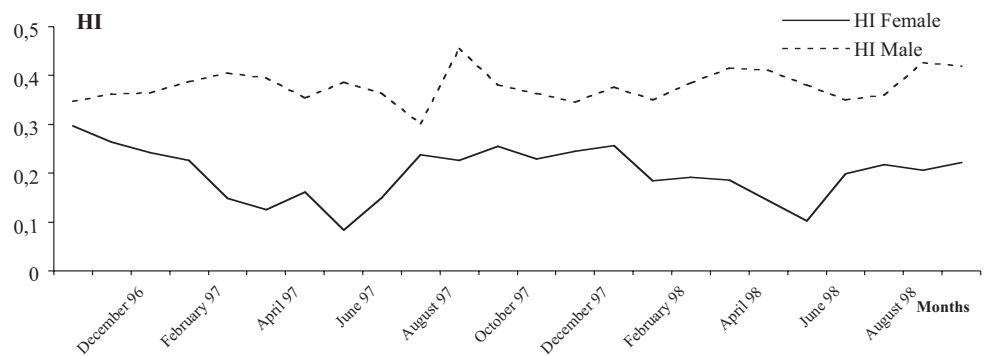
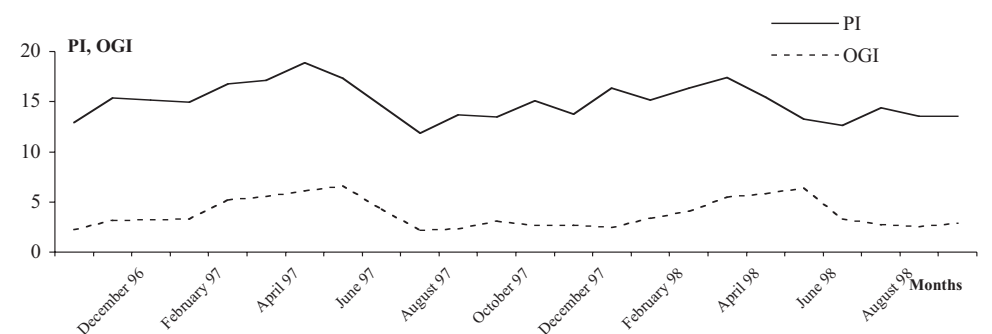


Figure 4
 Evolution of penis index (PI) and oviductal gland index (OGI) of *Octopus vulgaris* of the Gabes Gulf. / Évolution de l'indice de pénis (PI) et de l'indice de la glande de l'oviducte (OGI) d'*Octopus vulgaris* du golfe de Gabès.



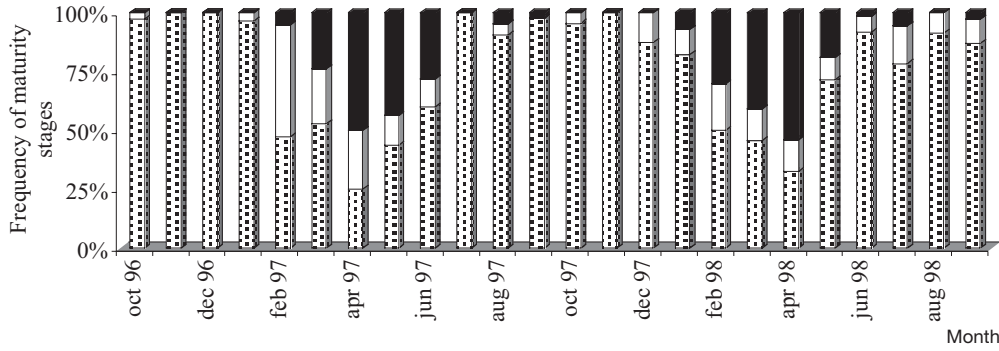
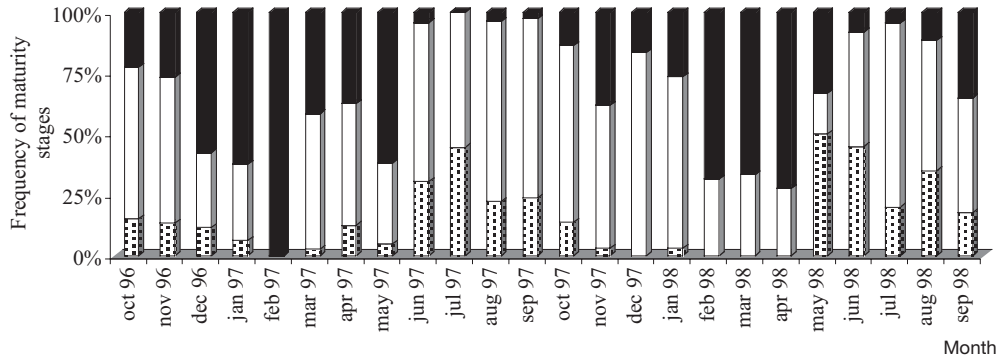


Figure 5
Frequency of sexual maturity stages of *Octopus vulgaris* in the Gabès Gulf. A: Females; B: Males. / *Fréquence des stades de maturité sexuelle d'Octopus vulgaris du golfe de Gabès. A: Femelles ; B: Mâles.*

A : Females



B : Males

Month	Number of females	Number of males	Total number	Sex ratio	p<0.05
October 1996	69	66	135	51.11	-
November 1996	330	237	567	58.20	+
December 1996	220	192	412	53.40	-
January 1997	206	163	369	55.83	+
February 1997	74	77	151	49.01	-
March 1997	38	36	74	51.35	-
April 1997	12	8	20	60.00	-
May 1997	23	21	44	52.27	-
June 1997	158	142	300	52.67	-
July 1997	8	9	17	47.06	-
August 1997	15	24	39	38.46	-
September 1997	41	39	80	51.25	-
October 1997	36	60	96	37.50	+
November 1997	242	260	502	48.21	-
December 1997	177	162	339	52.21	-
January 1998	74	89	163	45.40	-
February 1998	28	35	63	44.44	-
March 1998	35	17	52	67.31	+
April 1998	37	29	66	56.06	-
May 1998	39	18	57	68.42	+
June 1998	55	37	92	59.78	-
July 1998	37	46	83	44.58	-
August 1998	40	47	87	45.98	-
September 1998	160	184	344	46.51	-
Total	2154	1998	4152	51.88	+

Table I
Frequency of sexual maturity stages of *Octopus vulgaris* in the Gabès Gulf. A: Females; B: Males. / *Fréquence des stades de maturité sexuelle d'Octopus vulgaris du golfe de Gabès. A: Femelles ; B: Mâles.*

Length-class (mm)	Number of females	Number of males	Total number	Sex ratio
80	46	35	81	56.79
100	110	87	197	55.84
120	154	120	274	56.20
140	98	97	195	50.26
160	81	72	153	52.94
180	44	47	91	48.35
200	24	28	52	46.15
220	12	14	26	46.15
240	3	4	7	42.86

Table II
Sex ratio evolution in terms of size range in *Octopus vulgaris*. / *L'évolution de la sex-ratio d'Octopus vulgaris en fonction de la taille.*

spring culminating a minimum in April. As of June, they became more and more numerous to reach maximum proportion in November and December.

Maturing females appeared in December (January) and were more numerous during the period of February-September especially February-May.

Mature females appeared in February. The sample of April contains the most elevated proportion of mature female octopuses. In July, August and September, the mature individual capture became rare. Samples caught in October, November and December contain no mature female.

Males

Immature males were essentially numerous in May-June-July. While, maturing males are practically major for the best part of samples. Mature males are present during nearly all year round. However, they are more abundant in February, March and April.

Size at attainment of maturity

Size at attainment of maturity was determined for both sexes. Males attained sexual maturity at a smaller size than females: 101.2 mm in mantle length for males and 140.3 mm for females.

Sex ratio

In the whole sampling throughout the two years, the sex ratio was significantly female biased. The monthly values of sex ratio are indicated in **table I**. Females were significantly more abundant in November 1996, January 1997, March 1998 and May 1998 ($P < 0.05$). Males predominated significantly only in October 1997. The sex ratio analyzed in terms of size range (**table II**) showed a male predominance from 180 mm mantle length.

Discussion and conclusion

Spawning period

The presence of mature females is the best index to determine the duration of the reproductive activity. The data indicate that mature females of *O. vulgaris* of the Gulf of Gabes were found from February to September but their sexual activity occurred mainly in May-July. The reduced number of mature females (3 individuals) in August and September suggests the presence of an autumnal spawning period in unexploited sectors.

It appears clearly that this long reproductive activity was similar, though slightly shorter, to other Mediter-

anean populations of *Octopus vulgaris* which started in early Spring and ended in early fall (Mangold, 1963, 1983; Guerra, 1975).

However, *Octopus vulgaris* from the North-Western African coast exhibited a different reproductive activity pattern. The reproductive activity showed two spawning periods, one in May to July and the other in September to October (Hatanaka, 1979; Dia, 1988).

Frequency of maturity stages

Mature females are abundant in the Spring (March-April-May). After the achievement of their full sexual maturity, females leave fishing grounds and look for cavities or anfractuosités to lay and brood eggs until hatching. During egg laying and brooding, females don't feed and they end up dying (Mangold, 1983). Of this fact, mature individuals become more and more rare in Summer and practically non-existent during the period October-December.

As females, mature males become few in Summer and disappear in October-December. The mature individual death, males or female, happen necessarily following spawn. It seems to be bound to the physiology of the species and particularly to the optic gland that, according to Tait (1986), determine reproduction as well that the senility.

Size at attainment of maturity

In the Gabes Gulf, males became sexually mature when smaller in size than mature females. The precociousness of the male sexual maturity is recorded in Western Mediterranean (Mangold, 1963) and Atlantic populations (Dia, 1988). However, male maturity in the Gabes Gulf occurred at smaller size than in the Atlantic populations (118 mm in Spring spawning and 122 mm in fall spawning) and at greater size than Western Mediterranean ones (80-90 mm).

Females of the Gabes Gulf attained sexual maturity at greater size than Western Mediterranean (Mangold, 1963) and Atlantic populations (Dia, 1988) which reached maturity respectively at 130 mm and 118 and 135 mm in mantle length.

In Octopods, size at maturity seems to be most dependent on temperature, nutritional history and light intensity (Van Heukelem, 1976, 1979; Mangold, 1983). Warmer temperature conditions and bright light seem to decelerate sexual maturation whereas reduction in food intake has an accelerating effect (Mangold, 1983; Mangold *et al.*, 1975).

Sex ratio

Females were predominant especially at smaller sizes. At the mature stage, females' proportion has a tendency to decrease. Reduction of mature female numbers seems to be related to refuge behaviour when females retire to spawn. Male predominance recorded in October was probably due to higher mortality rates of females after laying eggs.

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