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SOME ASPECTS OF THE BIOLOGY OF *SEPIA ELEGANS* (CEPHALOPODA, SEPIOIDEA) FROM THE RIA DE VIGO, NW SPAIN

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CEPHALOPODA
SEPIIDAE
SEPIA ELEGANS
BIOLOGIE
ESPAGNE NORD-OUEST

RÉSUMÉ — *Sepia elegans* se répartit de préférence dans les zones vaseuses des bassins central et externe de la ria de Vigo. Elle ne pénètre pas dans la partie interne de la ria qui subit d'importantes fluctuations de salinité et de température. Son abondance reste la même pendant toute l'année sauf en été où elle est nettement plus faible. Les animaux mesurent 3,3 mm à l'éclosion, les plus grands mâles 61 mm et les femelles 67 mm. Les relations taille-poids indiquent une croissance allométrique. Les mâles sont plus précoces que les femelles. On trouve des mâles et des femelles matures selon les mêmes proportions durant toute l'année. La ponte semble se produire toute l'année. Avant l'éclosion les œufs mesurent 4,6 mm de diamètre. Le nombre d'œufs par femelle mature à une taille de 40-65 mm varie entre 42 et 59. Les mâles sont plus abondants que les femelles, dans l'échantillon total, au printemps et en automne.

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ABSTRACT — *Sepia elegans* is distributed preferentially in muddy zones of the central and outer basins of the ria de Vigo. It does not enter the internal part of the ria, where important fluctuations in salinity and temperature exist. Abundance is similar throughout the year except in summer when it is significantly lower. The hatchling has a mantle length (ML) of 3.3 mm. The biggest males observed measured 61 mm ML, the females 67 mm. The mantle length-weight relationships indicate the existence of growth allometries. Males are more precocious than females. A high proportion of mature males and females are found the whole year round. The spawning period seems to cover all the year. Before hatch the eggs measure 4.6 mm in diameter. The number of eggs per mature female of 40-67 mm ML range from 42 to 59. Males were more abundant than females in spring and autumn in the total sample.

INTRODUCTION

Sepia elegans Blainville, 1827 has a geographical distribution which extends in the Eastern Atlantic from 15° to 50°N, and throughout the Mediterranean Sea (Mangold-Wirz, 1963; Roper *et al.*, 1984). It is a species with a depth range from 2 to 430 m (Guerra, 1985).

Although *S. elegans* is quite abundant in different Atlantic and Mediterranean zones, its biology has not yet been thoroughly studied. The only known report on this aspect is that published by Mangold-Wirz (1963) for the Western Mediterranean. The aim of this work is to provide some data on the biology of this species in the ria de Vigo, and to compare them with those found in the Mediterranean (Mangold-Wirz, 1963).

STUDIED AREA, MATERIAL AND METHODS

The ria de Vigo is a drowned tectonic valley of about 170 km² of surface. The maximum depth is about 50 m. The water circulation is estuarine. Seasonal upwellings of water from the Atlantic Ocean produce very high rates of productivity. The inner part of the ria undergoes heavy fluctuations in

salinity and temperature (Anadon *et al.*, 1961: Fraga and Margalef, 1979).

The ria was divided into 8 zones according to the following criteria : 1) hydrographic, mainly salinity and temperature variations; 2) nature of the bottom; 3) bottom profile, and 4) depth. These zones are as follows (Fig. 1) :

— Zone A. The San Simon inlet, with important salinity and temperature fluctuations, absent elsewhere. Depth range 2-22 m. Here the bottom is muddy and heavily covered by algae. *Zostera marina*, and the sponge *Ficulina fiscus*.

— Zone B. The central part of the ria, which comprises the central basin and the adjoining coastline zones. Depth range 2-45 m. The bottom is mainly muddy with plenty of shell fragments, rocky in some zones close to the banks. Algae are generally very abundant.

— Zone C. The external basin of the ria, with a depth ranging from 30 to 45 m. The bottom is of sludge type without algae.

— Zone D. The coastal zone between Punta Molino and Monteferro, whose bottom is made up of rock and shell sand covered by algae. Its depth ranges from 0 to 30 m.

— Zone E. The coastal area stretching from Borneira to Cape Home. Its depth ranges from 0 to 23 m. With a bottom similar to that of the foregoing zone.

— Zone F. The northern mouth of the rai, whose bottom is rocky without algae. Depth range 0-45 m.

— Zone G. The Cies islands area where the bottom is made up of rock and shells and in the middle, muddy in the deepest zone (30 m) and sandy near the coast. Algae being quite abundant.

— Zone H. The southern mouth of the ria, whose bottom is rock and shell sand, with abundant algae in some places. Depth range 0-50 m.

In order to study the composition and structure of the bottom communities of the ria de Vigo, a total of 539 bottom trawls of 15 minutes of duration were made from April 1982 to February 1987. The gear used was mainly a small bottom trawl of the type called « baca » with 30 mm cod-end mesh size, the weight of each trawl board of the gear was 15 kg. A stratified random sampling was carried out. Details on the sampling methodology, the characteristic of the gear used, hauls and the methods employed on board ship to process the catches has been described by Alonso-Allende and Guerra (1984); Guerra (1984), and Guerra *et al.* (1986).

A total of 717 specimens of *Sepia elegans*, 388 males and 329 females, provide the data. The mantle length (ML), total body weight (WT), sex and maturation stage were determined in all specimens. The maturation was determined according the scale shown in Table I, established in keeping with the indications of Mangold-Wirz (1963), and according to our own observations.

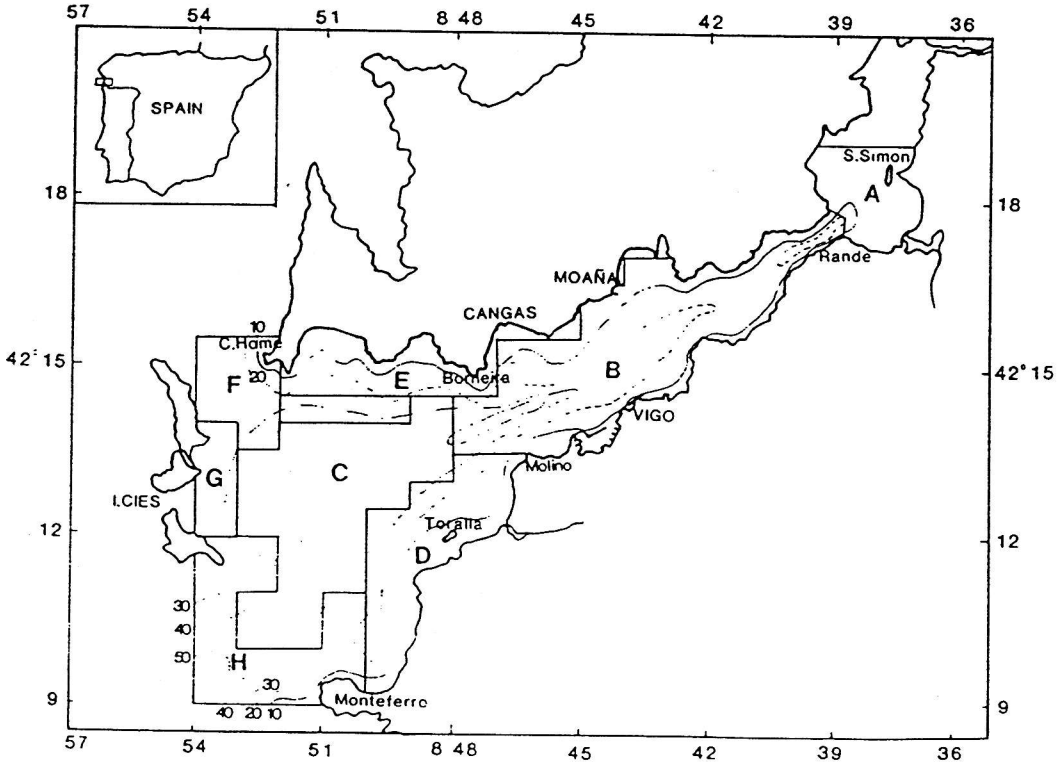

Fig. 1. — Map of the ria de Vigo showing the zones into which it was divided. The isobars are in meters.

Table I. — Scale of sexual maturation of *Sepia elegans*.

STAGE	MALES
1	Gonads hardly visibles
2	Spermatophoric sac hardly visible. Testis small.
3	Spermatophoric sac medium-size. Testis visible. With spermatozoids in vas deferens. No spermatophores.
4	Spermatophoric sac and testis large. With spermatophores in the spermatophoric sac.
5	Post-reproductive.

STAGE	FEMALES
1	Ovary very small. The glands are unnoticeable. Very small eggs up to 1.0 mm.
2	Ovary medium-sized. The glands can be seen. Small eggs 1.1-2 mm.
3	Ovary large. The glands are visible but small. Medium-sized eggs: 2.1-3.0 mm.
4	Ovary large. Large nidamental glands. Accessory glands red. Large-sized eggs: 3.1-4.5 mm.
5	Post-spawning.

Seasons were defined as follow :

I Winter = January-March
II Spring = April-June
IIISummer = July-September
IVAutumn = October-December

During sampling three spawns of *S. elegans* were caught, one consisting of 25 eggs laid on a red sea-whip on 27 April 1982 in zone B at 25 m depth, another of 20 eggs in the same zone and also fixed on a red sea-whip on 10 July 1985 between 16 and 26 m depth, and a third one on 31 July 1986 between 16 and 20 m depth in zone C with 23 eggs fixed on an alcionid. The eggs, which do not form clusters, were carried out to the laboratory and placed into a tank with a sea water closed system. All them containing embryos in different stages of development. Ten freshly laid eggs just before hatching were measured. The 36 newly hatched *S. elegans* obtained were preserved into 70 % ethyl alcohol, and measured and weighted to the nearest mg in a H80 Mettler balance, after the excess of alcohol was drained.

RESULTS

Relative abundance and distribution

Table IIA shows the relative abundance of *S. elegans* in each zone, and its presence in the total of trawls carried out in each zone 43 trawls including two zones and 23 failured ones were not considered. For the comparison of the zones use was made of the presence-absence records. The Chi square obtained between the number of trawls in which the

Table II. — A, relative abundance and presence of *Sepia elegans* in each zone in which the ria de Vigo was divided; B, significance levels obtained by comparing the zones among themselves by means of a Chi square test.

A

Zone	Depth	Type of subtrate	Number of specimens	Number of trawls	Presence in trawls	Presence in trawl. Number of trawl.
A	2-22	Mud-algae	6	54	0	0
B	2-45	Mud-she.., rock,algae	396	27	11	0.51
C	30-45	Mud	85	41	3	0.43
D	0-30	Rock,she.., sand,algae	54	31	11	0.31
E	0-25	Rock,she.., sand,algae	44	44	11	0.14
F	0-45	Rock,she.., sand	1	11		0
G	0-30	Rodck,she.., sand,mud,algae	11	17	5	0.31
H	0-50	Rock,she.., sand,algae	13	29	5	0.17

B

ZONE	A	C	D	E	F	G	H
A	xxx	xxx	---	xxx	---	---	---
B		n.s.	x	xx	n.s.	xx	
C			n.s.	x	---	n.s.	xx
D				n.s.	---	---	n.s.
E					---	---	n.s.
F						---	---
G							---

xxx. p<0.001; xx. p<0.01; x. p<0.05; n.s.not significant; ---comparision not possible.

Table III. — A, relative seasonal abundance of *Sepia elegans* by number; B, mantle length-weight relationship ($WT = aML^b$) in *Sepia elegans* of the ria de Vigo.

A

SEASON	Number of Trawls	Specimens number	No.specimens / No.Trawls
I	122	210	1.69
II	148	243	1.64
III	58	52	0.89
IV	94	181	1.96

B

SEASON	SEX	No.specimens	a	b	r
Winter	♂	105	0.0015	2.3311	0.9725
	♀	114	0.0016	2.3418	0.9128
Spring	♂	141	0.0024	2.1858	0.9631
	♀	107	0.0041	2.0715	0.9529
Summer	♂	34	0.0021	2.4091	0.9539
	♀	38	0.0021	2.2607	0.9539
Autum	♂	101	0.0017	2.3029	0.9648
	♀	74	0.0011	2.4521	0.9621
Total	♂	384	0.0016	2.3119	0.9657
	♀	329	0.0020	2.2731	0.9542

species appears versus the number wherein it does not appear was 84.06, the significance level being $p < 0.001$, thus indicating that the frequency of appearance is not similar in all the zones.

Table IIB provides the significance level obtained by comparing the zones among themselves by means of a Chi square. The null hypothesis being that the zones compared are the same as regard presence. These results show the existence of a high and similar appearance frequency area of *S. elegans*, comprising zones B, C and G, a intermediate zone D, zones E and H with similar low appearance frequency, and zones A and F where the species does not appear.

Table IIIA provides the variation in seasonal relative abundance in number of *S. elegans*. Effective trawls (516) only were taken into account, and those made in zones A and F were deduced. From these data the conclusion is that the abundance was not significantly homogeneous $p < 0,05$, throughout all the seasons, which is due to the low abundance in summer.

Size frequencies and growth

Figure 2 provides the length (ML) frequency distributions of all the specimens examined, per

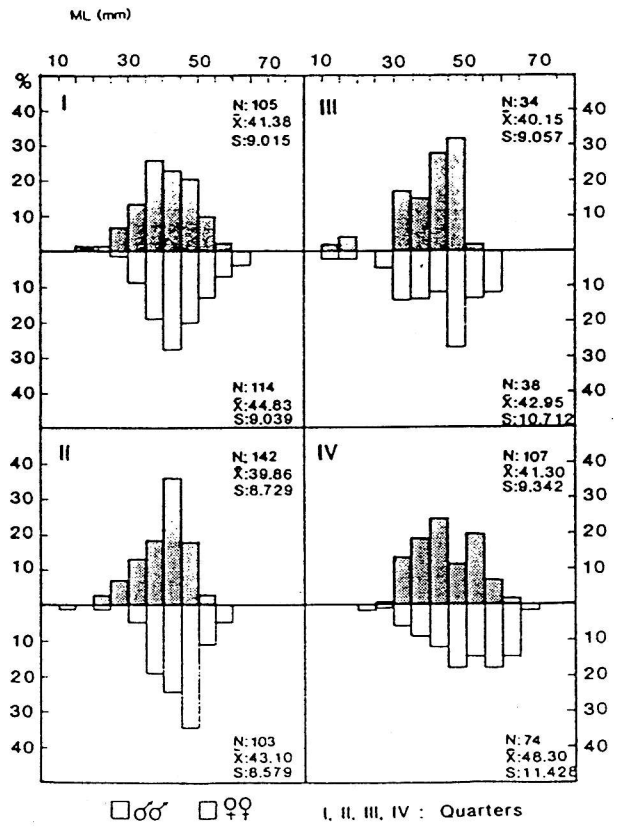

Fig. 2. — Percentages of males and females of *Sepia elegans* from the ria de Vigo in each maturation stage for each season of the year.

sexes and seasons. The mean and standard deviation of each distribution is shown. The largest male observed was 61 mm ML, and the largest females measured 67 mm ML. There is a trend for increase in ML from the winter to the autumn, but it is very difficult to follow growth from movement of modes through time. Bhattacharya's (1967) method for separating mixtures of normal distribution was employed, but the modes were not clear enough.

Mantle length-weight relationship

Table IIIB displays the values of the parameters of the exponential equation $WT = a\ ML^b$, where WT is given in g and ML in mm. The values of the correlation coefficient (r) are aslo shown. The data are provided for each sex separatly taking into account the total sample and the seasons. It is seen that the values for b are under 3, indicating that the body growth is allometric.

Proportion of sexes

Table IV provides the results of the Chi square test applied to the proportion of sexes observed in each season of the year and in the total. These results indicate that males were significantly ($p < 0.05$) more abundant than females in spring, autumn and in the total sample.

Table IV. — Sex ratios comparison of *Sepia elegans* by means of a Chi square test.

SEASON	No. of males	No. of females	p
Winter	105	114	n.s
Spring	142	103	x
Summer	34	38	n.s
Autumn	107	74	x
Total	388	329	x

x: p<0.05 n.s: not significant

Sexual maturation, spawning period and place (Table V, Fig. 3)

Table V and figure 3 show that 1) the males are more precocious than females; there are mature males of 25 mm ML while the first mature females measure 30 mm; 2) sexual maturity may be attained at different sizes; 3) there are immature and mature males and females throughout the year, and 4) no main maturation period can be recognized.

The eggs number counted in 30 females in stage 4 of 40-67 mm ML (8.8-22.8 g), ranges from 42 to 59. There was not a significant relationship between the eggs number and the female size.

Table V. — Percentage of specimens of *Sepia elegans* in each maturation stage according to ML.

	MALE MATURATION STAGES%					FEMALES MATURATION STAGES%				
Size class	1	2	3	4	N.	1	2	3	4	N.
						100				
		33.3				100				
	60.0	20.0	20.0			100				
	20.0	45.0	25.0	10.0	20	75.0	25.0			
	1.4	25.0	26.4	47.2	53	16.0	48.0	32.0	4.0	25
		11.5	15.3	73.2	78	5.6	19.2	55.8	19.2	52
		10.1	23.8	66.1	109		11.6	26.1	62.5	69
		2.6	9.7	87.5	72		4.8	31.7	63.5	63
			5.5	95.5	36		2.2	25.9	73.9	46
				100	19			7.4	92.6	27
				100	1				100	16
									100	1

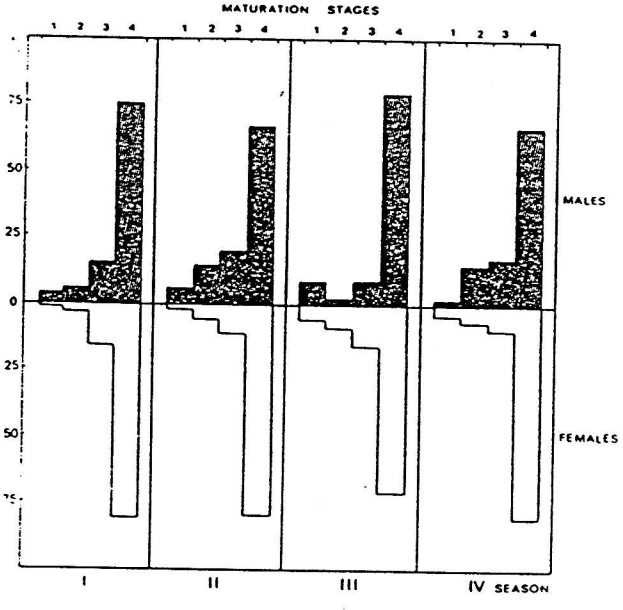

Fig. 3. — Length (ML) frequency distributions of *Sepia elegans* by sexes and seasons of the year.

Spawns have been caught in zones B and C of the ria between 16 and 25 m depth on April and July. The eggs does not form clusters, they were fixed to red sea-whip and alcionids. The eggs caught on 27 April 1982 start to hatch one month after, the end of the hatching was on 18 June. The temperature of the water ranges from 20 to 22°C.

Eggs and newly hatched size

Freshly laid eggs are smooth, soft and gelatinous. The color of the external envelop before hatching is brown. The greatest diameter (N = 10) was 4.6 mm (s = 0.46), and the minimal diameter was 4.2 mm (s = 0.20).

The mean and standard deviation of ML, total length and WT of the 36 hatching *Sepia elegans* measured were 3.3 mm and 0.42; 5.5 mm and 0.53; 11.5 mg and 4.8 respectively.

DISCUSSION

Sepia elegans from the ria de Vigo attains smaller ML compared to those observed on the Galicean continental shelf. Pérez-Gandaras (1980) points out that there the females reach 80 mm ML and the males 65 mm. The largest male caught in the ria measured 61 mm ML, this size coinciding with that observed by Mangold-Wirz (1963) in the Catalonian sea, but there the largest females (76 mm) were bigger than those from the ria de Vigo (67 mm ML).

The absence of animals less than 10 mm ML in our samples is due to the selectivity of the cod-end employed (30 mm mesh size).

The absence of *S. elegans* in the San Simon inlet, and presence in the internal part of the zone B, is taken to reflect the non adaptation of this species to the fluctuating or low salinities, or to temperature variations. Anadon *et al.* (1961) indicate that in an hydrographic station site in S.Simon the salinity ranges from 35.5 to 20 ‰, and the temperature from 22 to 11°C, while in the station site near Moaña (Zone B, fig. 1) they were 35.5-33 ‰ and 16-11°C taking into account the whole year. And Prego (per. comm.) indicates that in a station site in Rande (Zone B) the salinity ranges from 35.4 to 31 ‰ in 1986 and the temperature from 17.9 to 12.5°C, these values being 35.6-34.4 ‰ and 15.6-12.2°C in a station near Vigo port (Zone B). However, controled experiments are necessary to provide a complete evidence of this. On the contrary, a related species, *Sepia officinalis*, not only does occupy zone A, but also has its main spawning area there (Alonso-Allende and Guerra, 1984; Guerra, 1985). *S. elegans* is distributed preferentially in muddy zones of the zones B and C of the ria de Vigo. Its high frequency of appeareance in zone G was always in the deepest zone where mud is abundant. A similar preference for muddy bottoms was observed by Mangold-Wirz (1963) in June and July in the Catalonian sea, when *S. elegans* population is located in coastal waters. This preference can not be due to a bias in the sampling, because sandy and shell sand bottoms were well sampled.

The seasonal distribution of *S. elegans* in the ria de Vigo seems to be different from that observed by Mangold-Wirz (1963) in the continental shelf of the Western Mediterranean. This author indicates that the abundance of *S. elegans* increases during summer, and decreases during autumn and winter in coastal waters, while in the ria the abundance is similar throughout the year, except the decrease observed in Summer.

The Bhattacharya's method employed for separing mixtures of normal distribution did not give enough clear results, probably due to a constant recruitment of the species and to changes in growth rates with temperature like have been observed in *Sepia officinalis* (Richard, 1971). Nevertheless, the trend of the modes indicates a growth rate of 2 mm ML per month from the middle of February to the middle of November. Mangold-Wirz (1963) has obtained growth rates of 1.5 mm DML from May to September in specimens of the same sizes than the ria de Vigo ones. However, Mangold-Wirz (1963) has observed the growth rate is faster during the initial period of the life cycle. There are specimens of 35-50 mm ML throughout the year but the proportions vary through seasons: females are always larger than males by an average of 5 mm. Mangold-Wirz (1963) indicates that females growth faster than males, and the something similar may to occur in the ria de Vigo.

The sexual maturation, fecundity and spawning of *S. elegans* in the ria de Vigo coincide essentially with that observed by Mangold-Wirz (1963). Perhaps the only difference is that in this zone of the Atlantic, a principal spawning period can not be recognized, and the spawns seems to take place the whole year, according with the sexual maturation data, while a main period exists in the Mediterranean, from March to October, where the spawning occurs.

Mangold-Wirz (1963) indicated that *S. elegans* hatchling measured about 4 mm of ML. This value is in agreement with our observations, differences probably due to a bring back of the mantle caused by the alcohol.

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