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Reproductive biology of *Sepietta oweniana* (Pfeffer, 1908) (Sepiolidae: Cephalopoda) in the Aegean Sea*

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SUMMARY: It is stated that *S. oweniana*, one of the well-known taxa of the family Sepiolidae, has a wide distribution throughout the Aegean Sea. In this study 805 specimens were collected, and the gonad stages of both sexes and the seasonal gonado-somatic index value were examined. It was observed that the spawning period of *S. oweniana* covers the whole year with two maxima in April-May and October-November. No discernible difference in length frequencies of males and females was observed. The reproductive biology parameters of the specimens were compared with those observed in other seas.

Key words: *S. oweniana*, reproductive biology, Aegean Sea.

INTRODUCTION

Sepietta oweniana is known to have one of the shortest lifespans among cephalopods. It is found in the Aegean Sea as well as in other areas of the Mediterranean (Katağan and Kocataş 1990). *S. oweniana* has little or no commercial value (Mangold and Boletzky 1987), and is preyed upon by various demersal fishes and chordates (Bergstrom and Summers 1983) in both littoral and deepsea zones at depths between 80-600 meters. Bergstrom and Summers (1983) report that *Galeus melastomus* and some members of family Gadidae prey upon *Sepietta* spp. Examination of the stomach contents of commercially important fish species such as *Merluccius* sp., *Serranus* spp., *Pagellus* spp., *Trigla* spp., *Upeneus* sp., and *Sparus* spp. revealed *Sepietta* as a primary prey species (unpublished observations). *S. oweniana,* therefore, has a direct relation to fisheries as an important source of food.

The reproductive cycles and behaviors of cephalopods have been analysed (Arkhipkin, 1992). Furthermore, reproductive biology (Durward *et al*., 1979; Worms, 1980; Boyle and Knobloch, 1982, 1983, 1984; Mangold, 1987, 1989; Moriyasu, 1988; Gabel-Deickert, 1995) and fisheries biology (Guerra and Rocha, 1994; Gonzales *et al*., 1994) of commercially important cephalopod species have been studied in recent years. Very little is known, however, about the biology of *S. oweniana* (Mangold-Wirz, 1963; Bergstrom and Summers, 1983; Relini and Massi, 1988). Vertical distribution of this species was investigated by Villanueva (1992, 1995), Wurtz *et al*. (1995), Sartor and Belcari (1995) and Jereb *et al* (1997). This study investigates the reproductive behavior of *S. oweniana* and compares the population of the Northeastern Atlantic and western Mediterranean to that of the Aegean.

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MATERIALS AND METHODS

Samples were collected within the scope of the Demersal Stock Assessment Project on board R/V K. Piri Reis. A total of 805 individuals (505 males and 300 females) were studied. Sampling was done between 26-500 m depth. Seasonal samples were collected in summer 1991, winter 1991/1992, spring 1992 and autumn 1992 using a 20 mm mesh polypropylene trawl and was preserved in 4% formalin solution. After sex determination, dorsal mantle lengths (DML) were measured to the nearest 1 mm. Body weights (BW) were recorded to the nearest 0.1 g. Ovaries (OV) and nidimental glands (NI) were weighed to the nearest 0.01 g. The numbers of oocytes (ON) and spermatophores (SPn) were counted and measured to the nearest 0.01 mm and standard deviation calculated.

Maturity was determined according to Mangold-Wirz (1963). Reproductive stages of female and male specimens were assigned to 5 and 3 categories, respectively. Additionally, Gonadosomatic Indices (GSI) of both sexes were measured for each sampling period (GSI=(GW/BW)x100). In order to determine the relationship between the weights of reproductive organs and various somatic parameters, several power regression analyses were conducted.

RESULTS

Maturity stage

Maturity stages were recorded in both sexes. Mantle lengths of females ranged from 14 to 36 mm. First sexual maturity in females was observed at 22 mm, with 50% of the total population maturing at 28 mm. The distribution of gonadal stages according to size were: stage 1, 14-26 mm; stage 2, 18-32 mm; stage 3, 22-33 mm; stage 4, 23-31mm and stage 5, 22-36 mm. In males, first sexual maturity was observed at 21 mm as 24 mm in 50% of population while the total mantle length of males varied between 18 to 35 mm. Sexually immature males ranged from 20 to 28 mm, maturing 18 to 32 mm and mature males were observed between 21 to 35 mm (Table 1).

Gonadosomatic index

The data from GSI measurements provide a good indication of the reproductive cycle of this species in the Aegean Sea. The results indicate that *S. oweniana* shows two reproductive periods within a year. The first, the large peak occurs in April-May with an average GSI of 6.1. The second peak is in November and has a weaker GSI value of 4.6. Figure 1

TABLE 1. – Percentage of *S. oweniana* males and females in each maturity stage for each 1 mm size class (ML: Mantle length; ST: Stage).

Size class (ML) mm	Males				Females					
	N	Immature	Maturing	Mature	N	ST-1	ST-2	ST-3	ST-4	ST-5
14					2	100				
15					1	100				
16					3	100				
17					1	100				
18	3		100		4	75.00	25.00			
19	2		100		3	100				
20	7	42.85	57.15		8	71.43	28.57			
21	15	21.42	57.16	21.42	6	50.00	50.00			
22	27	14.81	48.16	37.03	17	47.05	17.67	23.52		11.76
23	27	11.11	48.14	40.75	17	29.41	29.41	29.41	11.77	
24	55	1.81	43.65	54.54	22	9.09	31.84	31.81	13.63	13.63
25	46	8.69	13.05	78.26	20		35.00	30.00	20.00	15.00
26	68	1.48	25.00	73.52	25	4.00		36.00	32.00	28.00
27	73	8.21	20.54	71.25	35		14.30	22.85	20.00	42.85
28	68	7.35	16.17	76.48	29		6.89	3.44	37.93	51.74
29	39		20.51	79.49	28			21.42	21.42	76.56
30	22		13.63	86.37	24		12.50	16.66	20.84	50.00
31	21		4.76	95.24	23		4.34		17.39	78.27
32	16		25.00	75.00	9		11.11			88.89
33	10			100	10			11.11		88.89
34	4			100	4					100
35	2			100	6					100
36					3					100
Total	505				300					

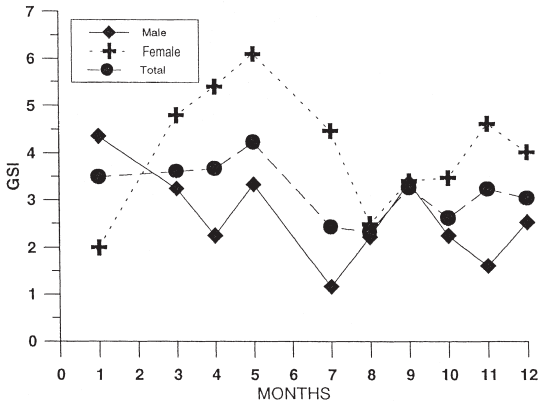

FIG. 1. – Monthly variation of the Gonado-Somatic Index for female and male *S. oweniana* from the Aegean Sea.

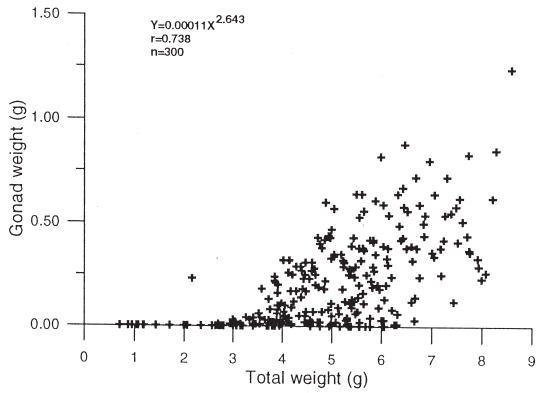

FIG. 3. – Relation between female gonad weight (in grams) and total weight (in grams)

shows the annual variation of average GSI values for females. Males, on the other hand, had homogeneous GSI values throughout the year. On an individual basis, however, extreme GSI values of 20%, 10%, 14% and 9%, were obtained for spring, summer, autumn and winter, respectively. The maximum values for males, on the other hand, were 21%, 7%, 17% and 5% for spring, summer, autumn and winter, respectively. The seasonal variations in GSI values between sexes coincide.

Gonad development

The development of the gonads was studied in females by weighing the gonads and nidamental glands. The power regression analysis (Fig. 2) indicates a correlation (r=0.861) between the gonad and nidamental gland weights (GW/NI). The power regression analysis between the body weight and the weight of gonads (TW/GW) gives a correlation value of r=0.738 (Fig. 3). In males, gonad development with respect to body weight showed a correlation of r=.0.488 (Fig. 4). Besides that, there was no statistically significant correlation between ML/SPn, TW/SPn, GW/SPn in males and ML/Egg Diameter, GW/Egg Diameter, ON/Egg Diameter in females.

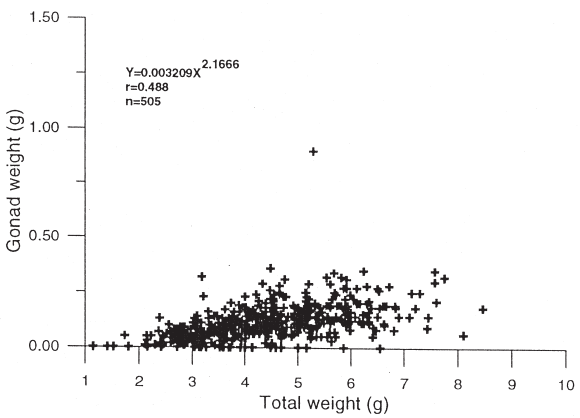

FIG. 4. – Relation between male gonad weight (in grams) and total weight (in grams)

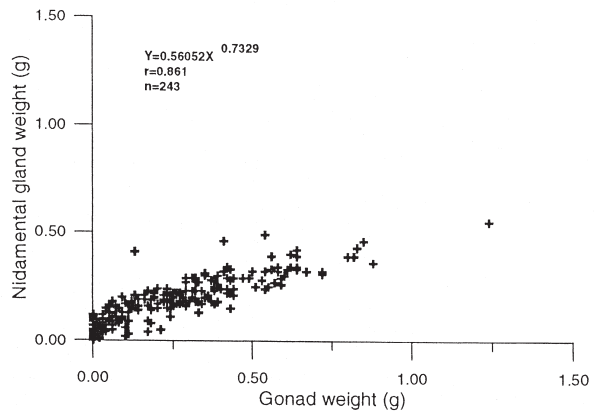

FIG. 2. – Relation between nidamental gland weight (in grams) and gonad weight (in grams)

Fecundity

Forty one males were randomly sampled to determine the size and numbers of spermatophores. The number of spermatophores was between 87-824 with a size of 3.95-9.50 mm. Average length of a spermatophore was 7.2±1.02 mm and their average number was 320±154.

A total of 37 females was randomly sampled for oocyte size determination. The mean diameter (long axis) of the oocytes extracted from 37 females was 2.3±0.40mm and range 1.4 and 3.4 mm. The total number of oocytes varied from 58 to 236 with a mean of 120±65.8 per individual female.

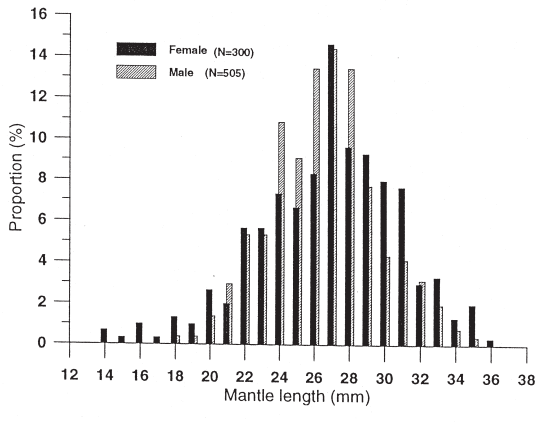

FIG. 5. – Length-frequencies of male and female *S. oweniana* in the Aegean Sea

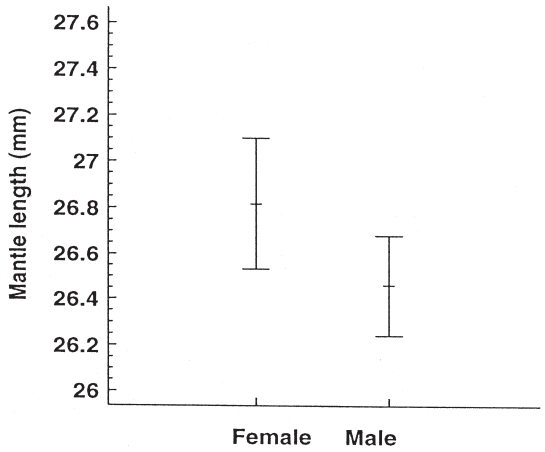

FIG. 6. – Statistical comparison of length distribution of males and females of *S. oweniana*

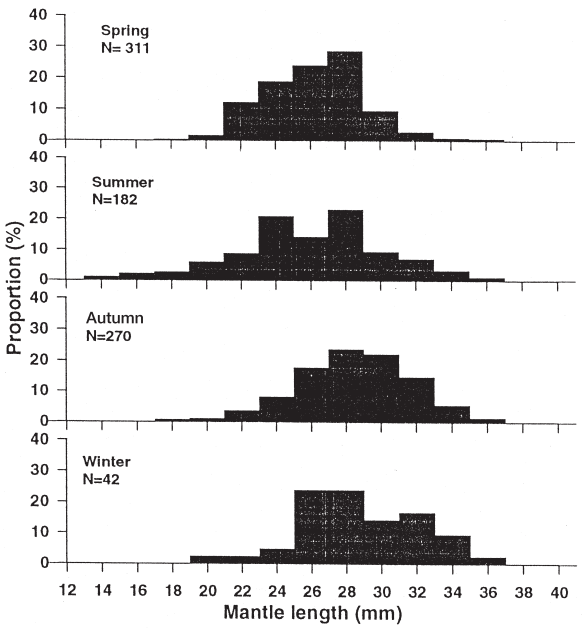

FIG. 7. – Seasonal distribution of *Sepietta oweniana* in the Aegean Sea.

Length-frequency relationship

The frequency distribution indicated that 27 mm length class had the highest number of individuals of both sexes (Fig. 5). The females were slightly but insignificantly ($p>0.05$) more numerous than the males (Fig. 6).

It has been observed that the small sized individuals were found in all seasons but they were smaller sized and were found more frequently during summer (Fig. 7). The mean length of individuals were 25.86±2.85, 25.50±4.12, 27.94±3.37 and 28.02± 3.34 for spring, summer, autumn and winter respectively.

DISCUSSION AND CONCLUSION

The results of this study conform to the sexual maturity analysis reported by Mangold-Wirz (1963). However, the mantle length at first sexual maturity differs from that reported by Bergstrom and Summers (1983). In this study, sexual maturity was reached at 24 mm mantle length in male individuals. Mangold-Wirz (1963) had reported that in males sexual maturity was reached 20 mm in the western Mediterranean. Bergstrom and Summers (1983) indicate that sexual maturity was reached at 23mm. In this study, the ML at which the females reach sexual maturity at 28 mm (Table 1). In the western Mediterranean, Mangold-Wirz (1963) reported 30 mm ML while 33 mm ML was observed by Bergstrom and Summers (1983). It appears that this species reaches sexual maturity at smaller sizes in the eastern Mediterranean.

Gonadosomatic indices observed in this study were similar to those observed in both western Mediterranean and the North Eastern Atlantic (Mangold-Wirz 1963; Bergstrom and Summers, 1983) and followed a bimodal pattern. The first peak occurred between March and July while the latter was observed in November. However, at all samplings some mature individuals were recorded (Fig. 1). Boletzky (1975) reported similar results for Sepiolidae in that the populations contained sexually mature individuals at all times. GSI values varied between 2 and 6% throughout the year with extremes at 21%. Boyle (1984) reported comparable extreme values for *Eledone cirrhosa*. The mean spermatophore number was 320±154 per individual male with minimum 110 (22 mm ML) and maximum 824 (30 mm ML). The spermatophore count

did not correlate with body weight, gonad weight, and mantle length. Mean oocyte diameter was 2.3 mm which conforms with the results of Mangold-Wirz (1963). Similar to males, there was no correlation between the oocyte diameter and ML, GW and the number of oocytes.

The mean mantle lengths in females and males were 26.79±4.01 mm and 26.46±2.91 mm, respectively. In both sexes the highest frequencies were observed at 26.5 mm (Fig 6). There were no significant differences in mantle length between sexes ($P>0.05$). The seasonal length-frequency analyses revealed that the smallest sized individuals were possibly hatched during spring (Fig 7). These results supported the first and highest peak of GSI data gathered during spring. Reproduction continues throughout the year as show by the small sized individuals found in all seasons.

Mangold-Wirz (1963) and Bergstrom and Summers (1983) indicate that the mantle lengths of males and females differ in the western Mediterranean and Northeast Atlantic. Boyle *et al.*(1988) reported a regional difference between populations in the northern Atlantic. Following the data given by Boyle *et al.* (1988), it appears in this study that the size decreases eastwardly in Mediterranean populations.

Bathymetric distribution of *S. oweniana* according to Mangold-Wirz (1963) varies from 70-700 m depths in the Catalan Sea and 8-200 m depths in other areas. Bergstrom and Summers (1983) reported that vertical distribution was between 60-300 m, while Villanueva (1992) reported it as a maximum of 974 m in the western Mediterranean and Ruby and Knudsen (1972) as a minimum of 22 m in the eastern Mediterranean and Jereb *et al* (1997) as a minimum of 27 m and maximum 708 m in the Strait of Sicily. In this study, only 90-500 m samplings revealed *S. oweniana*.

In conclusion, the results of this study indicate that *S. oweniana* has different sex specific size distributions while showing similar reproductive behavior in the Mediterranean. In the Northeastern Atlantic, *S. oweniana* shows a different size distribution and reproductive structure, possibly due to the conditions of light, temperature and food.

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