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Sepiolinae (Mollusca: Cephalopoda) from the Strait of Sicily*

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SUMMARY. – Nine species belonging to three genera of the subfamily Sepiolinae (Leach, 1817) were collected in the Strait of Sicily by two series of bottom trawl surveys carried out during the years 1985-87 and 1992: *Sepiola rondeletii, Sepiola intermedia, Sepiola ligulata, Sepiola robusta, Sepiola affinis, Sepietta oweniana, Sepietta neglecta, Sepietta obscura* and *Rondeletiola minor*. For each species, abundance, distribution, sex ratio and maturity condition were analysed. *S. oweniana* was the most abundant species, followed by *R. minor,* while the single record of *S. ligulata* indicates that the species is rare in the area. The bathymetric distributions observed generally agree with what is known for the species from the literature, but present data support the extension of the bathymetric range inhabited by *S. robusta* (down to 498 m). Mature specimens represented 81.8% of the examined sample, and no substantial differences in the percentages of mature individuals with season was noticeable; this supports the existence of an extended reproductive period in the Sepiolines.

Key words: Cephalopoda, Sepiolinae, Mediterranean Sea, Strait of Sicily, distribution, abundance, maturity.

INTRODUCTION

The subfamily Sepiolinae (Mollusca: Cephalopoda), along with the Heteroteuthinae and the Rossinae, belongs to the family Sepiolidae (named "bobtail squid"), one of the lesser known groups among Mediterranean cephalopods (Volpi *et al*., 1995), at least as far as distribution, biology and reproductive features at sea are concerned. Even though all sepiolids are eventually marketed, they seldom represent a target group for the fishery. This, along with the small size of many of them and the rather indistinct morphology that makes the identification of many species rather difficult especially at juvenile stages (Lu *et al*., 1992), makes them very good candidates for being overlooked (Mangold and Boletzky, 1988). On the other side, the small adult size and the general life habits make sepiolids particularly useful for experimental work (Boletzky, 1983), and detailed studies on some aspects of their biology were made by rearing specimens in the laboratory (Boletzky and Boletzky, 1970; Boletzky *et al.,* 1971; Boletzky, 1975; Bergstrom and Summers, 1983; Boletzky, 1983; Gabel-Deickert, 1995).

The subfamily Sepiolinae includes 5 genera, only 3 of which, *Sepietta*, *Sepiola* and *Rondeletiola* are represented in the Mediterranean Sea (Bello, 1986).

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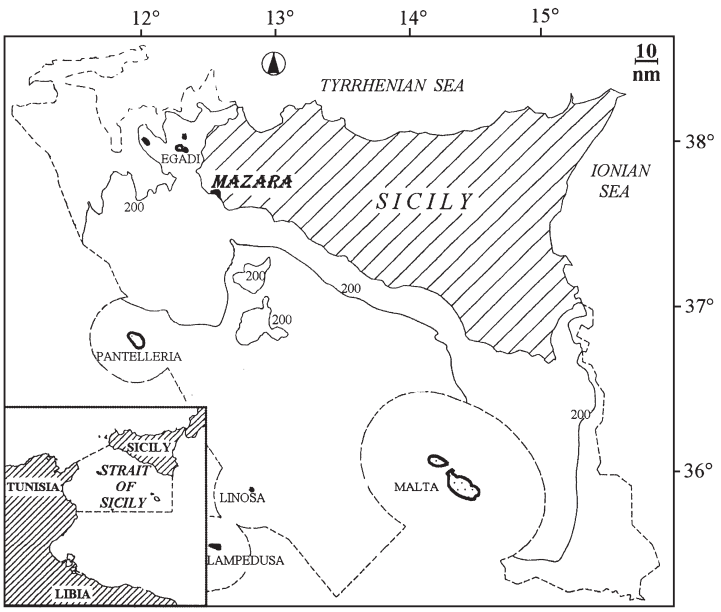

FIG. 1. – Illustration of the studied area (dashed line) during the research programme T.R.A.W.L. Within the small square on the left, the area officially defined as the Strait of Sicily by Cassio (1993) is shown.

Referred to as benthic, epibenthic and nectobenthic animals as information on their life style increased (Naef, 1923; Mangold Wirz, 1963; Bergstrom and Summers, 1983; Boletzky, 1983; Mangold and Boletzky, 1987; Mangold and Bidder, 1989; Guerra, 1992), these sepiolids are fully adapted to bottom life, but at the same time they are good swimmers, able to capture fast-moving prey far from the bottom, and some species were found to carry out considerable excursions in the water column (Boletzky, 1983; Bello and Biagi, 1995).

In the Strait of Sicily all sepiolids, better known as "cappuccetto", are commercialised, and captures can be quite consistent in some of the southern Sicilian landing places (Andreoli *et al.,* 1995), where a target fishery for these squid does exist. Nevertheless information on this group within the area was rather limited till the last decade (Arena, 1985; Jereb and Ragonese, 1990; Ragonese and Jereb, 1990). A first systematic list of the cephalopod species of the Strait of Sicily was recently prepared, including sepiolids (Jereb and Ragonese, 1994). Then, a more detailed study on the Sepiolidae was undertaken, and some preliminary results on males sepiolids were given (Jereb and Di Stefano, 1995; Jereb *et al.*, in press).

Here all information available on the distribution, abundance and maturity condition of Sepiolines from the Strait of Sicily is presented.

MATERIAL AND METHODS

Data come mainly from 8 trawl surveys carried out with seasonal periodicity, from May-June 1985 to February-March 1987, within the research project T.R.A.W.L. (Levi, 1991). Some additional material was provided by another survey (Spring 1992) framed in the same project. Within this programme a wide portion of the area officially defined as the Strait of Sicily (Cassio, 1993), was investigated (namely from 35°10' to 38°35' N and from 11°05' to 15°55' E; Fig. 1). Hauls (1 hour each) took place during day-time, exploring a depth range between 1 and 800 m. Five bathymetric strata were identified: 1-50, 51-200, 201-400, 401-600 and 601-800 m, and hauls were allocated proportionally to the horizontal extent of each strata, following a randomly stratified sampling method. The number of hauls varied around a medium value of 60 for each survey during the first cycle (1985-1987), and a medium value of 100 during the second cycle (1990-1992). Due to the bottoms morphology of the area, the highest percentage of hauls (about 40%) was allocated in the second stratum, while only about 10% of hauls was allocated in the first one, 15% in the third and fifth one respectively, and about 20% in the forth one. A commercial trawler (32 m length, 197 tons gross tonnage, 1112 Hp engine) and the typical local commercial bottom trawl (18 mm mesh side cod-end) were used.

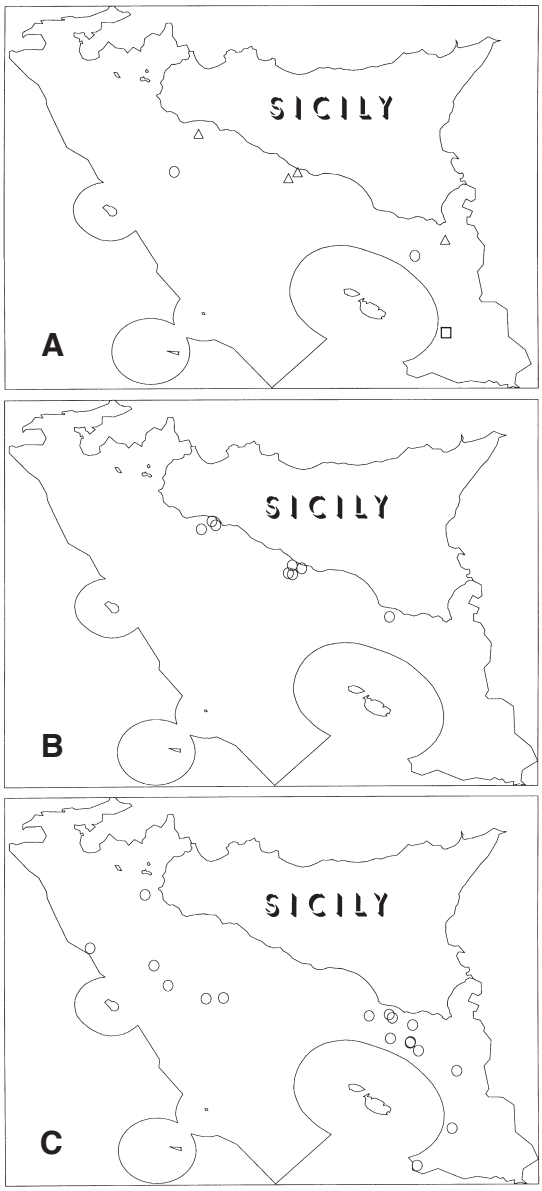

FIG. 2. – Distribution of Sepiolines captured within the studied area. **A**) ▪ *Sepiola rondeletii*; ○ *Sepiola ligulata* ; Δ *Sepiola affinis*. **B**) *Sepiola intermedia*. **C**) *Sepiola robusta*.

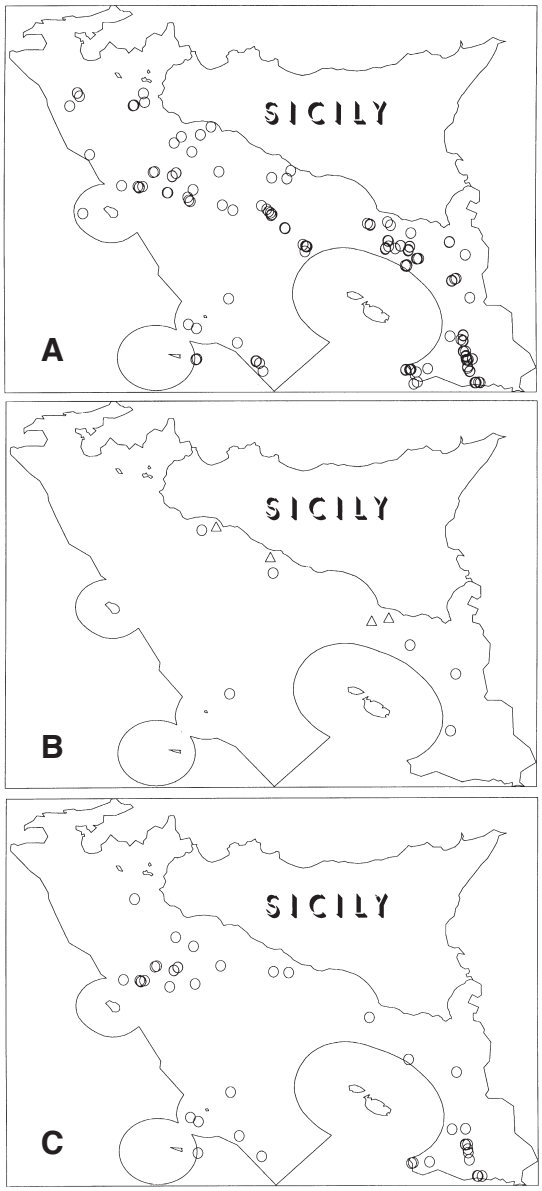

FIG. 3. – Distribution of Sepiolines captured within the studied area. **A**) *Sepietta oweniana*. **B**) ▪ *Sepietta neglecta*; Δ *Sepietta obscura*. **C**) *Rondeletiola minor*.

Specimens were fixed in formalin (8%) then preserved in alcohol (75%).

Systematic identification was made according to the suggestions of Naef (1923) i.e. mainly by the observation of the hectocotylus for males (the left modified dorsal arm in Sepiolinae) and the bursa copulatrix for females. Naef's collection at the Stazione Zoologica of Naples was examined to compare the main anatomical characteristics mentioned above, and additional information from subsequent works was also taken into consideration (Roper *et al*., 1984; Nesis, 1987; Bello, 1995).

Dorsal mantle length (ML; mm, 0.1) was measured according to Roper and Voss (1983), using callipers.

Two maturity stages were assigned (i.e. immature/maturing and mature), based on the storage of spermatophores in males and on the egg size and appearance in females, according to the suggestions by Mangold Wirz (1963).

All measurements were taken on preserved material and specimens not well preserved were not considered for measures.

TABLE 1. – List and depth distribution of the Sepiolines captured in the Strait of Sicily. Enlarged areas indicate the main concentration of the species. N_o = number of specimens.

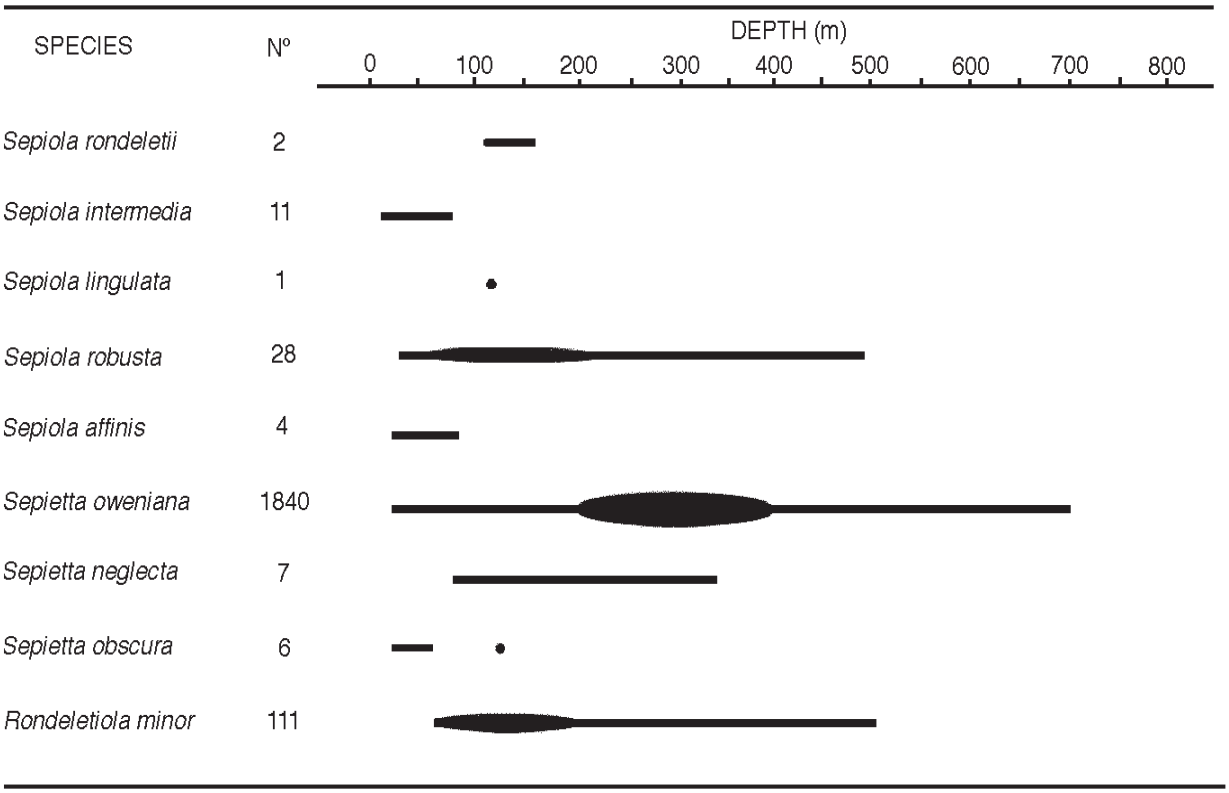

TABLE 2. – Sepiolines from the Strait of Sicily. For each species and sex, the number of specimens (N_o), the number of hauls in wich they were caught (H), depth range (m) and mantle length range (ML; mm, 0.1) are reported.

Species	Sex	N_o	H	Depth	ML
Sepiola rondeletii	M	-	-	-	-
	F	2	2	126-166	19.3-21.2
Sepiola intermedia	M	8	6	22-73	16.3-20.8
	F	3	3	40-86	16.2-19.5
Sepiola ligulata	M	1	1	113	13.2
	F	-	-	-	-
Sepiola robusta	M	19	12	88-498	14.3-23.5
	F	9	7	55-216	16.0-26.2
Sepiola affinis	M	-	-	-	-
	F	4	4	22-86	14.4-18.2
Sepietta oweniana	M	1078	139	70-486	14.0-34.0
	F	762	131	27-708	14.5-36.8
Sepietta neglecta	M	4	3	86-338	16.9-19.2
	F	3	3	113-217	17.0-18.5
Sepietta obscura	M	1	1	128	15.2
	F	5	3	23-55	16.4-20.4
Rondeletiola minor	M	63	30	122-401	11.4-20.0
	F	48	26	73-496	12.7-20.5

TABLE 3. – Sepiolines from the Strait of Sicily. For each species, sex and season, the number of mature specimens (M), their percentage (%) on the total number (N_o) and the relative mantle length range (ML; mm, 0.1) are reported.

Season	S e	Spring				Summer				Autum				Winter			
Species	x	N_o	M	%	ML	N_o	M	%	ML	N_o	M	%	ML	N_o	M	%	ML
Sepiola rondeletii	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	-	-	-	-	-	-	-	2	2	100	19.3-21.2
Sepiola intermedia	M	4	3	75	16.6-18.4	1	1	100	16.3	2	2	100	17.5-20.8	1	1	100	19.4
	F	-	-	-	-	1	1	100	16.2	1	1	100	19.5	-	-	-	-
Sepiola ligulata	M	1	1	100	13.2	-	-	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sepiola robusta	M	8	8	100	14.3-20.7	2	2	100	21.8-22.7	8	8	100	15.5-23.5	1	1	100	19.6
	F	2	2	100	21.5-25.0	3	3	100	21.5-25.5	2	2	100	24.0-26.2	2	0	0	0
Sepiola affinis	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	F	2	0	0	0	-	-	-	-	2	2	100	14.8-18.2	-	-	-	-
Sepietta oweniana	M	408	398	97.5	14.0-28.5	154	149	96.7	17.8-32.0	212	208	98.1	17.0-34.0	239	237	99.2	15.3-29.3
	F	281	134	47.7	19.5-36.8	109	69	63.3	20.0-32.5	191	110	57.6	20.5-35.0	180	126	70	18.5-34.5
Sepietta neglecta	M	3	2	67	17.9-18.1	-	-	-	-	1	1	100	19.2	-	-	-	-
	F	2	2	100	17.0-18.5	-	-	-	-	-	-	-	-	1	1	100	17.6
Sepietta obscura	M	-	-	-	-	-	-	-	-	-	-	-	-	1	1	100	15.2
	F	-	-	-	-	3	3	100	16.4-20.4	-	-	-	-	2	2	100	19.0-20.0
Rondeletiola minor	M	36	34	94.4	11.4-17.5	6	6	100	16.3-20.0	8	8	100	15.6-19.0	13	13	100	13.9-19.4
	F	21	20	95.2	12.7-20.2	6	5	83.3	15.2-20.5	2	2	100	17.5-18.0	19	19	100	14.5-20.3

RESULTS

On the whole, 2010 individuals (1174 males and 836 females) belonging to 9 Sepiolinae species were collected (Table 1); their spatial distribution is shown in Figs. 2-3.

Genus *Sepiola* Leach, 1817

Five species (out of seven reported for the Mediterranean Sea) were identified.

Sepiola rondeletii Leach, 1817

Only two mature females measuring 19.3 and 21.2 were collected, at depths of 166 and 126 m respectively (Table 2). They were caught during winter, along with *Sepietta oweniana* and *Rondeletiola minor*, in the areas North East of Pantelleria and Malta (Fig. 2A).

Sepiola intermedia Naef, 1912

Eleven specimens were collected, 8 males and 3 females, with sizes ranging from 16.2 mm (mature female) to 20.8 mm (mature male) (Tables 2-3). They were caught along the southern coast of Sicily, at depths ranging between 22 and 86 m (Fig. 2B; Tables 1-2).

Sepiola ligulata Naef, 1912

A single mature male was collected off the south-eastern coasts of Malta (Fig. 2A), at a depth of 113 m, along with specimens of *S. robusta*. It measured 13.2 mm (Table 2).

Sepiola robusta Naef, 1912

This species was the most abundant of the genus, with 28 individuals caught (19 males and 9 females) in several parts of the investigated area (Fig. 2C), between 55 and 498

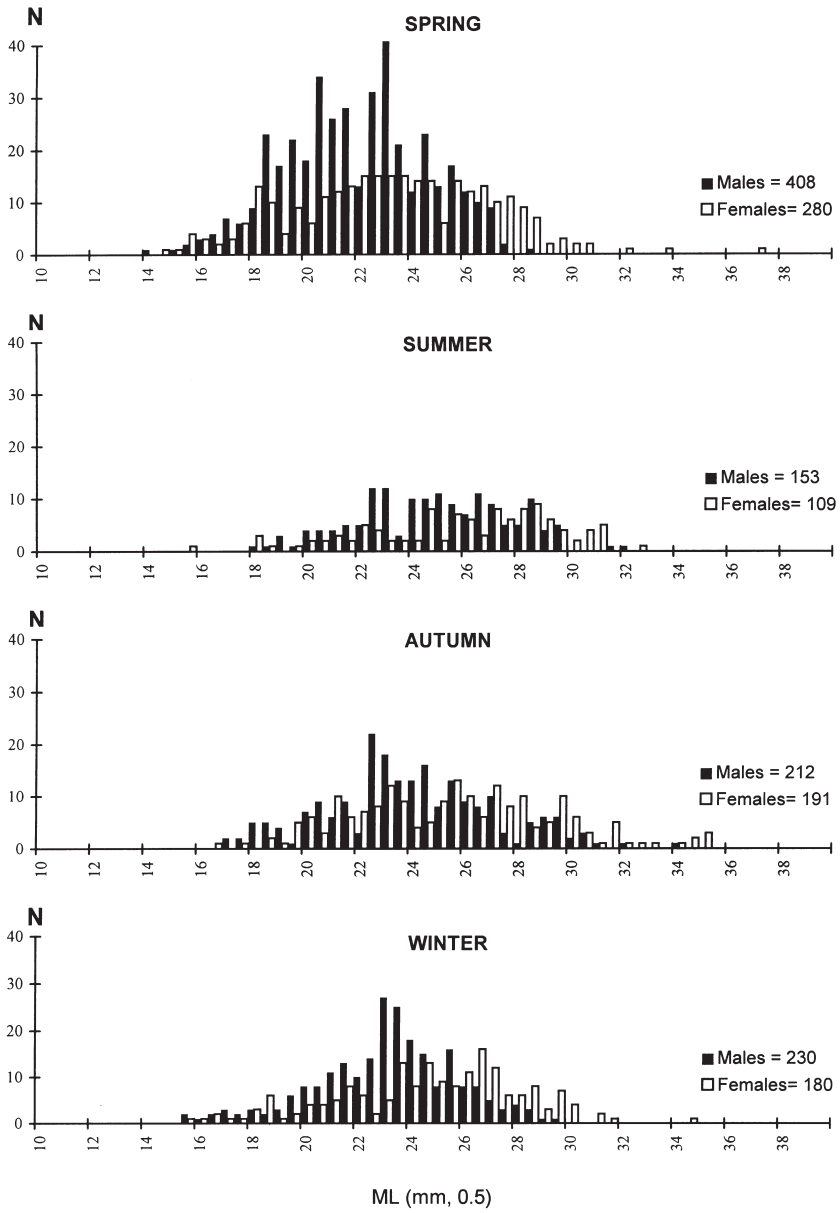

FIG. 4. – *Sepietta oweniana*. Length frequency distributions for season.

m depth (Table 1-2), together with *Sepietta oweniana, Sepiola intermedia, Rossia macrosoma* and *Rondeletiola minor*. Females (most of which were mature) were larger than males, all of which were mature (Table 3). Maximum mantle length was 26.2 mm in females, 23.5 mm in males.

Sepiola affinis Naef, 1912

Only four females were captured along the southern coasts of Sicily (Fig. 2A), two immature in spring and two mature in autumn (Table 3), at depths ranging between 22 and 86 m (Table 2). Mantle length ranged between 14.8 and 18.2 mm.

Genus *Sepietta* Naef, 1912

All the three species included in this genus are present in the Strait of Sicily.

Sepietta oweniana (Orbigny, 1840)

A total of 1840 specimens (1078 males and 762 females) were captured all over the area (Fig. 3A) at

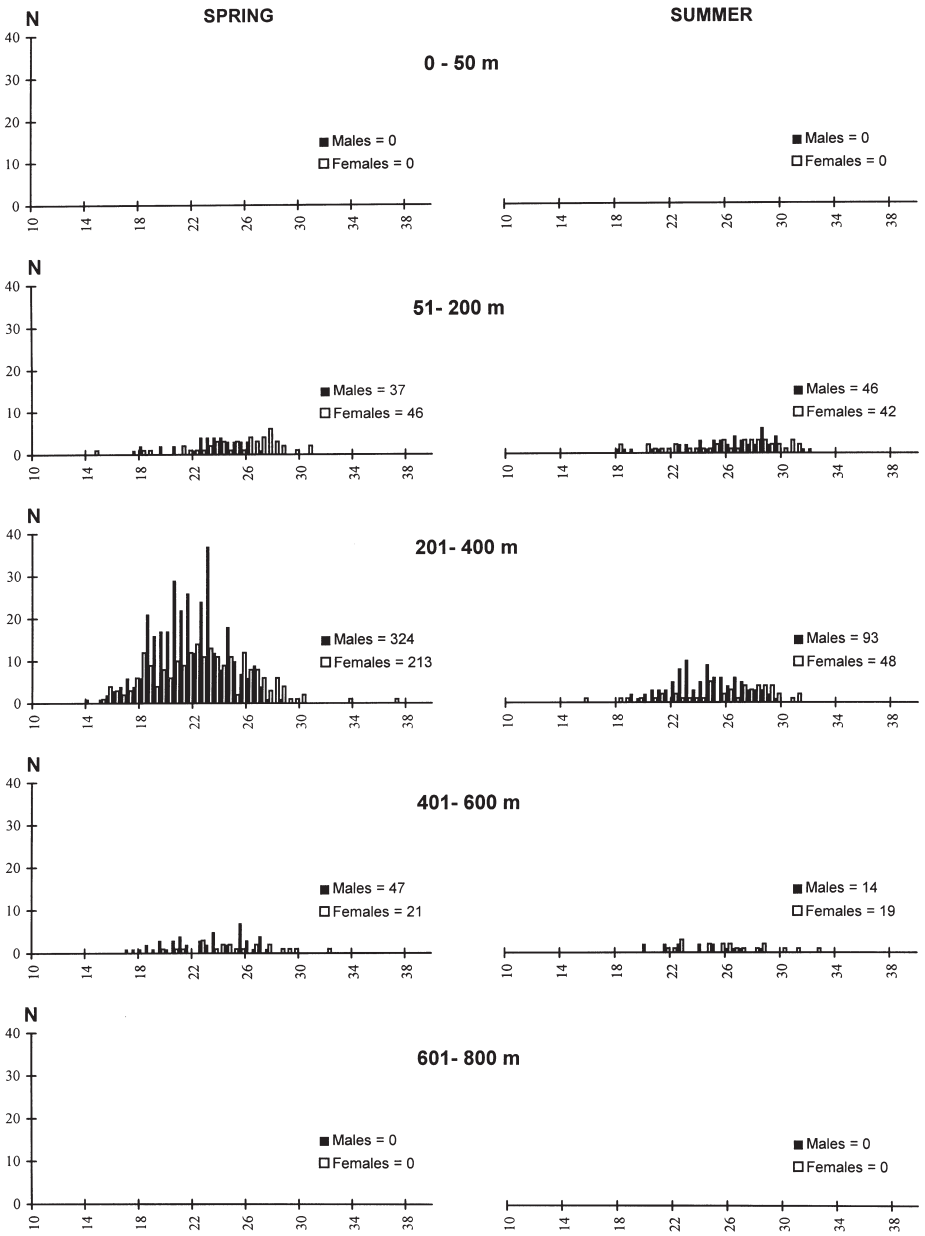

FIG. 5. – *Sepietta oweniana*. Length frequency distributions for season and depth: spring and summer samples.

depths ranging between 27 and 708 m, even though the major concentration occurred on bottoms between 200 and 400 m depth all over the year (Table 1; Figs. 5-6). No substantial difference in the bathymetric distribution between sexes was noticeable (Fig. 5-6): however no male was ever captured in shallow waters (less than 50 m depth), nor deeper than 500 m (Table 2). Most males were mature (97.9 % of the total) and no difference in the percentage of mature animals with season was noticeable (Table 3). Mature females represented 57.7 % of the examined specimens, with the maximum number of mature individuals being recorded in winter, the minimum in spring (Table 3). An analysis of maturity condition in relation to depth, showed a constant situation for males, with mature individuals uniformly captured within all the investigated depth ranges**,** all over the year (Figs. 7, B-C). A variation of the percentage of mature females with depth was noticeable during each season and along the year (Figs. 7, A-C) but no trend was identifiable. *S. oweniana* occurred mostly along with *Rondeleti-*

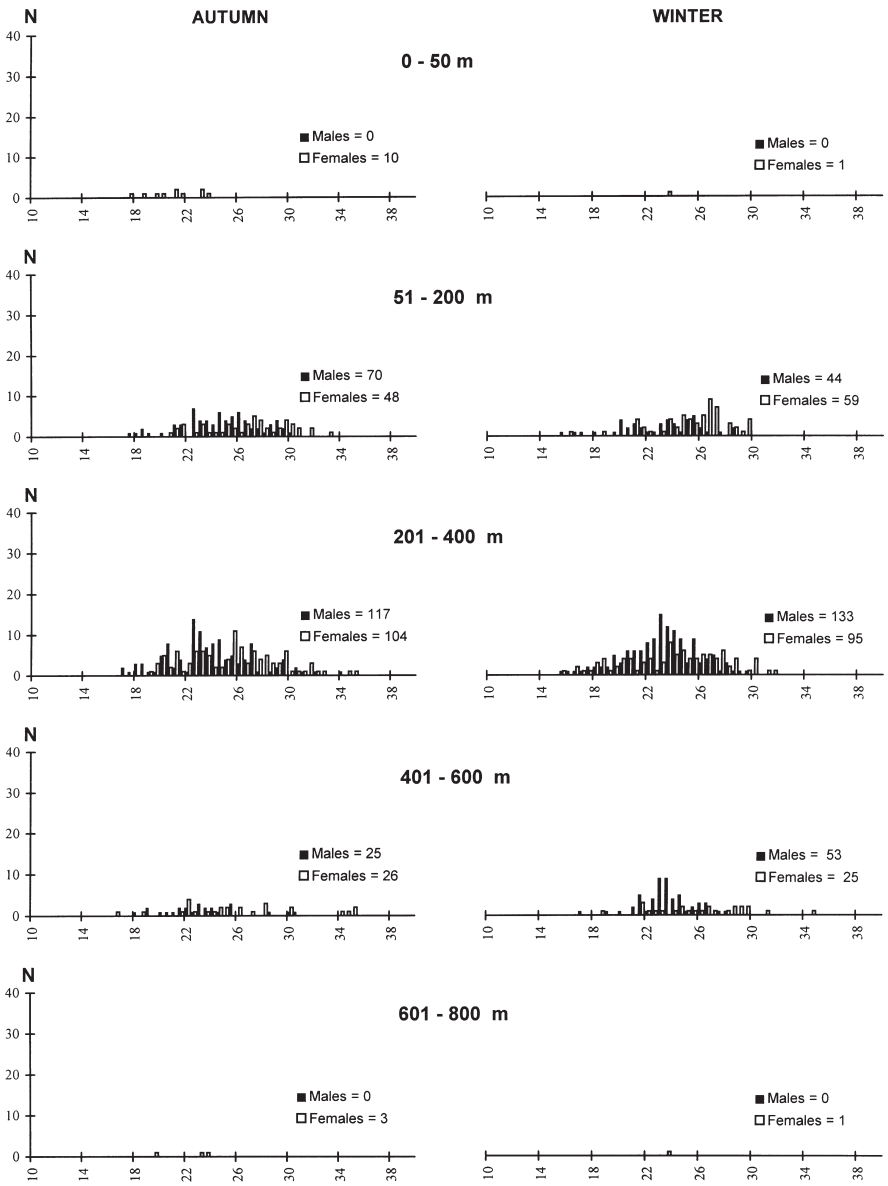

FIG. 6. – *Sepietta oweniana*. Length frequency distributions for season and depth: autumn and winter samples.

ola minor, *Rossia macrosoma* and *Neorossia caroli*, and was the most abundant sepiolid captured.

Among the examined specimens, the minimum recorded size was 14 mm for a mature male, the maximum was 36.8 mm, for a mature female (Table 2-3). Small as well as large animals were present all over the year (Fig. 4).

Sepietta neglecta Naef, 1916

Only 7 specimens (4 males and 3 females, all mature except one male) were collected between 86 and 338 m depth, off the East coast of Malta and South Western Sicily and in the area North East of Linosa Island (Fig. 3B). Size ranged from 16.9 and 19.2 mm (for an immature and mature male respectively; Tables 2-3).

Sepietta obscura Naef, 1916

This species was represented by 6 mature individuals, 5 females captured in coastal waters and only one male captured at 128 m depth in the South Eastern part of the area (Fig. 3B). Size ranged between 15.2 (male) and 20.4 mm (female) (Table 2).

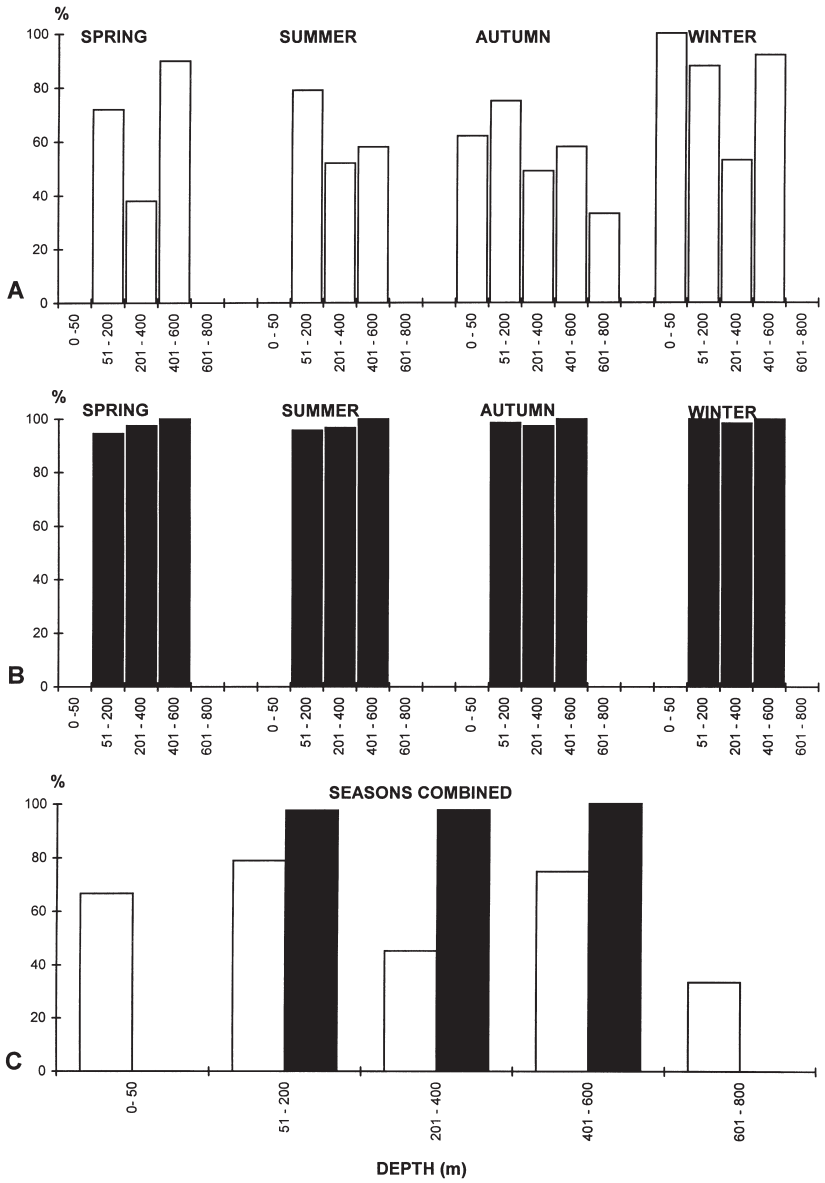

FIG. 7. – *Sepietta oweniana*. Distribution of mature specimens (%) with depth during each season (**A**; **B**) and for seasons combined (**C**). o Females; nMales.

Genus *Rondeletiola* Naef, 1921

Rondeletiola minor (Naef, 1921)

A total of 111 individuals were captured, 48 females and 63 males, between 73 and 496 m depth (Table 1), all over the area (Fig. 3C), mostly together with *Sepietta oweniana,* but also with *Rossia macrosoma* and *Sepiola robusta*. All the examined specimens were mature and mantle length ranged between 11.4 and 20.5 mm (Tables 2-3).

DISCUSSION

Among the Sepiolinae reported from the Mediterranean Sea (Bello, 1995), only *Sepiola steentrupiana* Levy, 1912 and *Sepiola aurantiaca* Jatta, 1896 were not found in the Strait of Sicily.

S. steenstrupiana is known from only few records (Gulf of Salerno and near Naples: Naef, 1923; Adriatic Sea: Rudolph, 1932; Haifa Bay: Knudsen, 1981; Balearic Islands, Guerra, pers. com.), and it was found in none of the most recent

studies of the Mediterranean sepiolids (see Boletzky, 1995, for a review). Therefore it is probably a rare species in the Mediterranean Sea, even though its absence in the Strait of Sicily would need confirmation by a targeted study in very shallow waters. The species in fact was reported only at infralittoral levels (5-20 m, maximum depth 47 m), in waters which therefore represent a small fraction of the investigated area in the present study.

As for *S. aurantiaca*, this is considered the rarest species of the family in the Mediterranean Sea (Orsi-Relini and Bertuletti, 1989; Bello, 1995) and known records are even fewer, being limited to those by Naef (1923) also from Naples. Following Naef's indications (the author himself states that only "few preserved specimens" were available to his examination) *S. aurantiaca* would live in deep waters (between 200 and 400 m) but it is not clear on which ground he based his statement. Considering the very peculiar hectocotylization which would allow an easy identification of males, it seems difficult to believe that it could have been overlooked in all subsequent studies. The absence of *S. aurantiaca* in the examined material from the Strait of Sicily, where bottoms between 200 and 400 m depth represent a consistent fraction of the investigated area, again indicates the actual rarity of this species.

As for the other Sepiolines species, even though it is by means of bottom trawl fishery that most of the information on Mediterranean Sepiolids distribution and abundance was collected, for sake of caution it has to be remembered that a bottom trawl gear is probably not the most adequate fishing tool to obtain reliable samples of at least some species, which can be more pelagic than previously supposed (Bello and Biagi, 1995). The lack of an opening-closing system in a trawl gear can also obviously bias the definition of depth range distribution. Taking into account these considerations, present results are compared with those available in the literature.

On the whole, the bathymetric distribution of the identified species and their numerical consistence in the catches showed good correspondence with what is already reported for other Mediterranean areas. Only a few records referring to *Sepiola robusta* can be considered rather atypical, as discussed below.

Sepietta oweniana was the most abundant sepiolid captured, as reported for other areas of the Mediterranean Sea (Lumare, 1970**:** Tyrrhenian Sea; Bello, 1983-84, Guescini and Manfrin, 1986: Adriatic Sea; Orsi Relini and Bertuletti, 1989, Sartor and Belcari, 1995, Volpi *et al.*, 1995**,** Wurtz *et al.*, 1995: Tyrrhenian Sea; Villanueva, 1995**:** Northwestern Mediterranean), followed by *Rondeletiola minor,* the two species together representing 97.1% of the Sepiolinae collected.

The typical association already reported for these two species (Naef, 1923; Lumare, 1974; Bello, 1983-84; Mannini and Volpi, 1989; Belcari *et al.*, 1989; Orsi Relini and Bertuletti, 1989; Villanueva, 1995), was noticed also in the Strait of Sicily, where *S. oweniana* and *R. minor* were captured mostly together, especially on bottoms between 200 and 400 m depth.

Both *S. oweniana* males and females were present throughout the year and all over the area, but males outnumbered females, whereas females showed a slightly wider bathymetric distribution, even though the maximum concentration for both sexes occurred between 200 and 400 m depth. The major numerical consistence was observed in winter and spring, with a slight decrease in summer, on the contrary of what was reported for the Ligurian and the Tyrrhenian Sea (Orsi Relini and Bertuletti, 1989; Sartor and Belcari 1995; Wurtz *et al.,* 1995). There was no evidence of migration at different depths in relation to seasons based on length frequency distributions, nor was there any evidence of size-related or maturity-related depth preference. However, it has to be pointed out that the noticed *aggregation-forming-behaviour* of these sepiolids (Naef, 1923; Bergstrom and Summers, 1983; Belcari *et al.*, 1989) requires great caution in considering density values (Villanueva, 1995), at least unless extended sampling periods all over the year and different sampling techniques are used.

In *Rondeletiola minor* also males slightly outnumbered females; the latter showed a wider bathymetric distribution, even though concentrating between 51 and 200 m depth. This species, often reported as rare in some areas of its distribution range (Mangold and Boletzky, 1987; Guerra, 1992), was recently shown to be well represented in several areas of the Western Mediterranean (Belcari *et al.*, 1989; Orsi Relini and Bertuletti, 1989; Villanueva, 1995; Sartor and Belcari, 1995; Volpi *et al.*, 1995**;** Wurtz *et al.*, 1995) and so it has to be considered also in the Strait of Sicily, where it was captured both in the Eastern and Western zone, on bottoms between 51 and 400 m depth. A fair concentration of females occurred also in the waters north of Lampedusa Island, where only few males were captured, however.

As for *Sepietta neglecta*, *Sepietta obscura*, and *Sepiola intermedia* the bathymetric distribution observed in the Strait of Sicily agrees with what was reported for other Italian and Mediterranean areas, these species being considerably eurytopic (Guerra, 1982; Bello and Motolese, 1983; Bertuletti and Orsi Relini 1986; Guescini and Manfrin, 1986; Belcari *et al*., 1989; Orsi Relini and Bertuletti, 1989; Sartor and Belcari, 1995, Villanueva, 1995; Wurtz *et al*., 1995). Their scarcity in the captures however, though probably indicative of an actual low frequency in the area, could also indicate a certain preference for shallow waters (Lumare 1970; Guescini and Manfrin, 1986; Volpi *et al*., 1995) which constitute a small fraction of the investigated area.

The known preference of *Sepiola rondeletii* and *Sepiola affinis* for shallow waters (Naef, 1923; Mangold Wirz, 1963; Lumare 1970; Bello, 1983-84; Guerra, 1992) could be also the cause of the poor representation of these species in the present material. As for *S. rondeletii*, however, present depth records (126 - 166 m) confirm that a dispersal greater than previously thought has to be taken into consideration for this species, and indeed not only for young, immature individuals (Guerra 1982; Orsi Relini and Bertuletti, 1989; Wurtz *et al*., 1995).

The single record of *Sepiola ligulata,* on the other side, is more likely indicative of true rarity of this sepiolid in the Strait of Sicily, considering the wide bathymetric range usually inhabited by the species (Naef, 1923; Wirz, 1958; Lumare, 1970; Sanchez and Morales, 1986; Belcari *et al.,* 1989; Sartor and Belcari, 1995; Volpi *et al*., 1995**;** Wurtz *et al.,* 1995) which is reported as seldom abundant, though not rare.

As for *Sepiola robusta*, the bathymetric distribution range observed for males in the Strait of Sicily (maximum depth recorded being 498 m) is definitely wider than that generally reported for the species (Belcari *et al*., 1989; Orsi Relini and Bertuletti, 1989; Guerra, 1992; Sartor and Belcari, 1995; Volpi *et al*., 1995). However, considering another rather atypical record recently mentioned for the lower Tyrrhenian Sea (Wurtz *et al*., 1995), it seems likely that the depth distribution of this species should be extended.

Mature specimens represented 81.8% of the examined sample, and no substantial differences in the percentage of mature individuals related to seasons were noticeable at a first qualitative analysis, both in males and in females. This indicates the existence of a reproductive period extended throughout the year, which is likely to be a characteristic of most Sepiolines, as already indicated by other observations (Mangold Wirz, 1963; Boletzky, 1975; Boletzky, 1983). The fact that sexual maturation in these small-sized, short-lived animals seems independent of environmental "markers" (Boletzky, 1983) would support these results.

The observed minimum sizes for mature animals is generally in agreement with reports in the literature (Boletzky, 1983; Orsi Relini and Bertuletti, 1989; Volpi *et al.,* 1995), except perhaps for *S. oweniana*, the present sizes being the smallest so far reported for mature specimens. However, Orsi Relini and Bertuletti (1989) also reported quite small mature *S. oweniana* females (15 mm; ML) and males (16 mm; ML).

In any case these values have obviously only indicative value, first because they refer to preserved material, secondly because they do not provide any information on the population size at maturity. However, considering that smaller sizes at maturity were already observed for *S. oweniana* from the western Mediterranean compared to those of the Atlantic population (Bergstrom and Summers, 1983), they are interesting biological features, which could indicate the existence of a decreasing maturation size gradient also in the Mediterranean, from the North Western to the South Eastern areas.

Present results give a first global picture of the Sepiolines of the Strait of Sicily, a necessary step given the lack of earlier information on this group in the area.

Considering that a targeted fishery for Sepiolines does exist in some of the Sicilian landing places, a fact which has practical effects on management decisions (i.e. mesh size regulations), a target study in shallow waters would now be desirable, and a target monitoring of the landings. This would allow us to verify and complete the present results and hypotheses.

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