Distribution and some aspects of the biology of Scaeurgus unicirrhus (Cephalopoda: Octopodidae) in the southern Tyrrhenian Sea (central Mediterranean)

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DISTRIBUTION AND SOME ASPECTS OF THE BIOLOGY OF *SCAEURGUS UNICIRRHUS* (CEPHALOPODA: OCTOPODIDAE) IN THE SOUTHERN TYRRHENIAN SEA (CENTRAL MEDITERRANEAN)

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CEPHALOPODA
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BIOLOGY
TYRRHENIAN SEA

ABSTRACT. – Distribution, abundance and some aspects of the biology of *Scaeurgus unicirrhus* are reported in the Southern Tyrrhenian Sea (Central Mediterranean), by integrating data from 14 bottom trawl surveys (1994-2007). The catches of *S. unicirrhus* showed a wide bathymetric distribution (32-608 m), although the bulk of the catches was observed in the 100-150 m depth range. The spatial distribution highlighted that the species was captured in higher abundance in the western part of Sicily and in the easternmost part of the studied area. Catch data (number and weight) were analyzed, taking into account the surface of each sub-area and depth stratum, in order to obtain estimates of Biomass Index (BI = kg/km^2) and Density Index (DI = N/km^2). The temporal evolution of the overall (all strata combined) survey mean DI (N/km^2) showed a significant trend ($r_s = 0.670$); while BI (kg/km^2) showed a not significant trend ($r_s = 0.165$). Mean length of immature and mature specimens were not different between sexes ($p > 0.05$). The potential fecundity of maturing and mature females ranged from 263 to 4295 eggs. The relative fecundity was 44.55 egg/g. The number of spermatophores ranged from 12 (50 mm ML) to 29 (45 mm ML).

INTRODUCTION

Scaeurgus unicirrhus (Delle Chiaje, 1841) is one of the ten octopodids living in the Mediterranean Sea (Bello 2003). It was described for the first time by d'Orbigny (1840) who gave the name of *Octopus unicirrhus*. Then Tiberi (1880) and Jatta (1896) referred to it as *S. unicirrhus*. Outside the Mediterranean it was described for the first time by Berry (1913), who recorded it in Hawaiian waters and used the name of *Scaeurgus patagiatus*. Sasaki (1920) and Robson (1921) recorded *S. patagiatus* in Japanese waters and in Indian Ocean respectively. Then Robson (1929) merged the two species (*S. patagiatus* and *S. unicirrhus*) into a single one giving the name of *Scaeurgus unicirrhus* because he considered that name to have priority. Voss (1951) confirmed Robson's decision. Later, Boletzky (1984) reviewed the validity of a separate Hawaiian form, which was considered to have a distinctive spawning and brooding behavior, but it maintained the same specific name.

The unihorn octopus *S. unicirrhus* is distributed over tropical and temperate zones of the Atlantic Ocean, from Georgia, in the United States (Kraeuter & Thomas 1975), to Brazil (Haimovici 1985) and Florida (Cairns 1976), and from the coast of North Africa (Lloris *et al*. 1978) to the Namibian coast (Sanchez & Alvarez 1988).

This species is present throughout the Mediterranean Sea (Salman *et al*. 1997, Guerra 1992, Belcari 1999) and lives both on continental shelf and slope, on sandy, coralline, or muddy bottoms, at a depth of 50-500 metres but mostly deeper than 100 m.

About its distribution in the Italian waters, Belcari (1999) reported that it is quite rare or a seldom found species more frequently caught in the Sicilian Channel. In this area *S. unicirrhus* is commercialized either alone or mixed with other more valuable octopus species (*Octopus vulgaris, Eledone cirrhosa* and *Eledone moschata*) (Irepa 2008).

Little is known about the biology and ecology of *S. unicirrhus* in the study area but, recently, information on the life cycle of this specie was reported by Bello (2007).

The spawning period extends from May to August (Boletzky 1984). Fecundity of this species is poorly understood. In the present paper distribution, abundance and some aspects of the biology of the octopod *S. unicirrhus*, collected over 14 years by bottom trawl surveys in the Southern Tyrrhenian Sea (Central Mediterranean), are analyzed.

MATERIALS AND METHODS

Study area and sampling design: Samples were collected within the framework MEDIterranean trawl surveys (Bertrand *et al*. 2002), in which annual bottom trawl surveys mainly aimed to obtain estimates of abundance indices for a series of target species. The surveys were carried out from late spring to mid summer (1994 - 2007) by the operative unit of Italy 134b-IT3. The study area, located in FAO sub-area GSA10, extends from Cape Suvero (Calabria) to Cape S.Vito (Sicily). The hauls were distributed by applying a stratified scheme with random drawing inside each stratum. The stratification variable adopted was the depth, with the following bathymetric limits: stratum A (10-50 m), B (50-100 m), C (100-200 m), D (200-500 m) and E (500-800 m). Each haul was selected randomly in small subareas, defined to obtain a compromise between the constraints of statistics based on random sampling and those of geostatistics (Green 1979, Hilborn & Walters 1992). An experimental sampling gear (GOC 73) was designed specially for the Medits Project (Fiorentini *et al*. 1999). To increase the catch of demersal species, it has a vertical opening (2.5 m) slightly superior to the usual gear used in the Mediterranean. Daytime (30 minutes before dawn and after dusk) hauls lasting 0.5-1 h were performed.

Sample processing: Haul catch, once on the deck, was sorted for *S. unicirrhus* and overall abundance in weight and number recorded on board. A subsample (186 specimens) collected during 2001, 2002, 2003 surveys was measured (ML, 0.5 cm). Individual weight (TW: 0.01 g) and gonad weight (GW: 0.01 g) were also recorded on board. The following three-stage maturity scale (adapted from Mangold-Wirz 1963) was used: **I** immature, **II** maturing, **III** mature. **I** immature (ovary semi-transparent, stringy and lacking granular structure. Oviduct meander not visible; spermatophoric organ semi-transparent with vas deferens not visible, absence of spermatophores); **II** maturing (ovary occupies the whole posterior half of mantle cavity, containing oocytes of all sizes tightly packed and probably a few ripe eggs in its proximal part. Oviduct fully developed but empty). The Vas deferens white, meandering, enlarged. Needham's sac (SS) with structureless whitish particles inside. The testis tight, crispy, with visible structures. Few spermatophores, barely developed and not functional; **III** mature (ovary containing high percentage of large reticulated eggs and some large ripe ova with smooth surface). Testis as before. Well developed spermatophores packed in Needham's sac.

Data analysis:

Abundance and spatial distribution: Mean Biomass Index (BI = kg/km^2) and Density Index (DI = N/km^2) were estimated for overall area (all strata combined), according to the swept-area principle (Gunderson 1993). Frequency of occurrence (f) was also computed as percentage of positive hauls (presence of at least 1 specimen). The temporal correlation in biomass and density indices was evaluated by computing the Spearman non parametric rank coefficient (r_s) . The density index by haul, calculated as mean values of pooled years normalized to the highest value obtained in each survey, were interpolated and mapped using ArcMap 9.2 for the whole population. Inverse Distance Weighting (IDW) is a deterministic technique that calculates the parameter value at an unmeasured point using a distance-weighted average of the data points. It uses samples located within the designated neighborhood surrounding the unmeasured point to estimate the value. The weight assigned to a particular value decreases as distance from the prediction location increases; thus sample data closest to the unmeasured point contribute more to the calculated average. This technique works well for sparse or irregularly spaced data.

Size, maturity and fecundity: Mean mantle length and mean weight were determined for all maturity stages in both sexes. The length-weight relationships were elaborated according to the equation: $TW = a*ML^b$. Unsexed specimens were distributed in males and females according to the sex ratio. Weight and length data were logtransformed, and linearized relationships fitted by least square regression were used to calculate coefficients "a" (intercept) and "b"(allometry) (Sparre & Venema 1996). The allometry ($b \neq 3$) was tested by the Student's test. The analysis of covariance (ANCOVA) was used to compare the slope of females and males. Student's test was used to test the differences of length and weight between sexes and maturity stages.

Sexual development was determined by analysing the gonadosomatic index (GSI, the percentage of gonad weight to total weight) throughout the different maturity stages in males and females.

The Kruskal-Wallis test was used to compare GSI between sexes of the same maturity stage in both sexes.

The potential fecundity (PF) of maturing (22) and mature (18) females was estimated by counting the number of oocytes in a known mass of ovary and extrapolating to whole ovary mass (Laptikhovsky 1999). A total of 25 oocytes, of maturing (22) and mature (18) females, were measured along their major axis to the nearest 0.001 mm to estimate the mean oocyte length. The relative fecundity was estimated as the ratio between the potential fecundity (PF) and the total weight (TW). The relationship between fecundity (F) and total weight (TW) and mantle length (ML) was established. The relationships were elaborat-

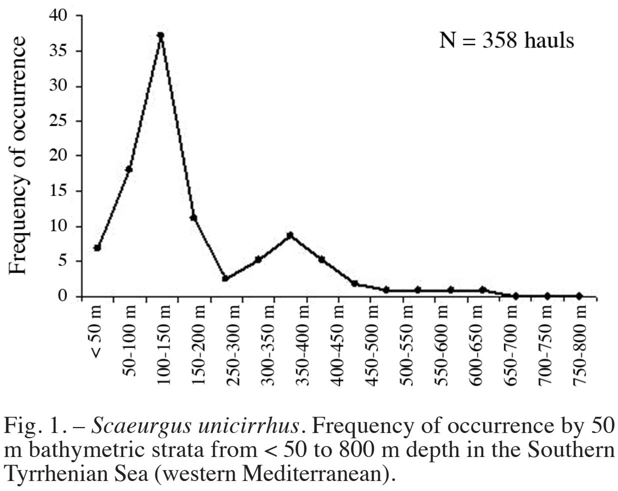

Fig. 1. – *Scaeurgus unicirrhus*. Frequency of occurrence by 50 m bathymetric strata from < 50 to 800 m depth in the Southern Tyrrhenian Sea (western Mediterranean).

ed according to the equation: y = a+bx, where y and x are the fecundity and total weigth/mantle length respectively, while a is the intercept and b is the slope; a and b are estimated by the least squares method (Sparre & Venema 1996). The potential fecundity of males was calculated by counting the number of spermatophores present in Needham's sac of 40 individuals of stage III. Mean spermatophore length (nearest 0.001 mm) was estimated measuring 12 fully developed spermatophores from Needham's sac of each individual.

RESULTS

Abundance and spatial distribution

To determine the bathymetric distribution of the species a total of 578 individuals of *Scaeurgus unicirrhus* from 32 to 608 m along the Southern Tyrrhenian Sea were captured. The octopus was more abundant from 100 to 150 m depth, where the frequency of occurrence was 40 %. Out of 250-650 m depth, the occurrence was markedly lower (<10 %) and no individual was taken in the hauls carried out deeper than 650 m (Fig. 1).

The temporal evolution, from 1994 to 2007, of the overall (all strata combined) survey mean DI (N/km^2) showed a significant increasing trend (r_s= 0.670; $p < 0.05$); while BI (kg/km^2) showed a not significant trend (r_s = 0.165; $p > 0.05$) (Fig. 2).

Overall inverse distance weighted (IDW) (Isaaks & Srivastava 1989) of *S. unicirrhus* in terms of mean density index (N/km^2) is shown in Fig. 3.

The spatial distribution of *S. unicirrhus* highlighted that the species was captured in higher abundance in the western part of Sicily (inside and immediately outside the Gulf of Castellammare, Gulf of Termini Imerese and Sant'Agata di Militello, along Sicilian coasts), and in the easternmost part of the studied area (Gulf of S. Eufemia, Calabria).

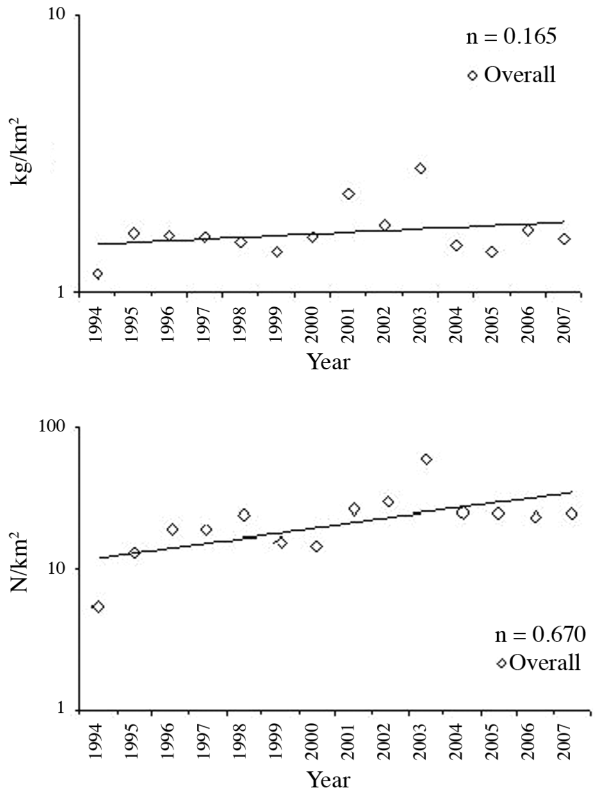

Fig. 2. – *S. unicirrhus*. Temporal trend (from 1994 to 2007) of the overall (all strata combined) mean biomass and density indices, with the relative Spearman coefficient (r_s) values.

Size, maturity and fecundity

Mean ML and TW for both sexes and for all maturity stages are reported in Table I. ML ranged from 30 to 70 mm both for females and males, while the unsexed ranged from 20 to 40 mm of mantle length. Mean length of immature and mature specimens were not different between sexes ($p > 0.05$), otherwise maturing females were larger than males at the same maturity stage ($p < 0.001$). Mean weight of immature specimens was not different between sexes. Maturing and mature females were heavier than males at the same maturity stage

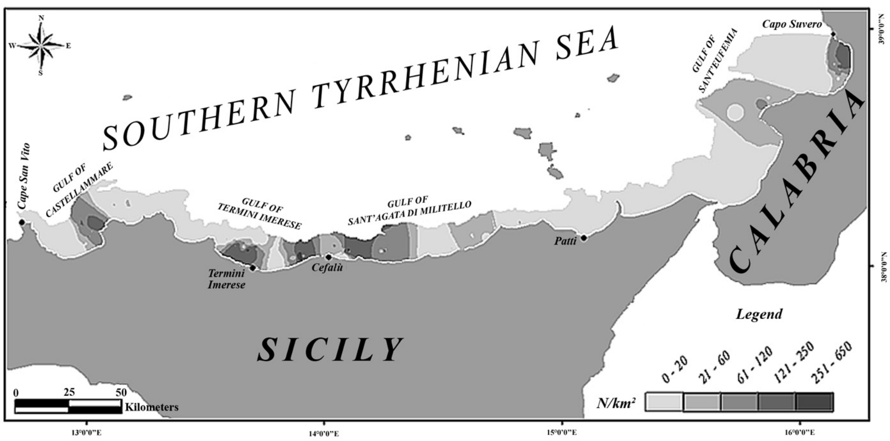

Fig. 3. – Overall inverse distance weighted (IDW) of *S. unicirrhus* in terms of mean density index (N/km^2).

Table I. – *Scaeurgus unicirrhus*. Mean size (ML, mantle length) weight (TW, total weight) and number of individuals (N) by sex throughout the different maturity stages (in specimens from the western Mediterranean Sea). Values are means (± standard deviation) and total ranges (in parentheses).

	Males			Females		
	ML (mm)	TW (g)	N	ML (mm)	TW (g)	N
Immature	41.25 ± 5.5	18.29 ± 6.7	20	41.47 ± 7.2	17.06 ± 6.9	17
	(30-50)	(9.97-38.17)		(30-50)	(7.03-34.81)	
Maturing	43.07 ± 6.9	22.56 ± 5.4	26	50.45 ± 5.5	31.04 ± 13.09	22
	(30-55)	(15.3-31.87)		(40-65)	(12.7-53.79)	
Mature	53.47 ± 7.5	31.10 ± 14.7	46	56.94 ± 9.2	41.56 ± 20.1	18
	(45-70)	(13.46-63.08)		(45-70)	(20.4-78.0)	

Table II. – Relationships between potential fecundity (PF) *versus* mantle length (ML) and total weight (TW). (a) intercept; (b) allometry coefficient; (R) coefficient of determination.

Type of Regression PF Vs.	R	a	b	F (1.34)	s
Mantle length	0.85	-10.52	4.46	93.6	p < 0.001
Total weight	0.92	-6.13	2.45	182.9	

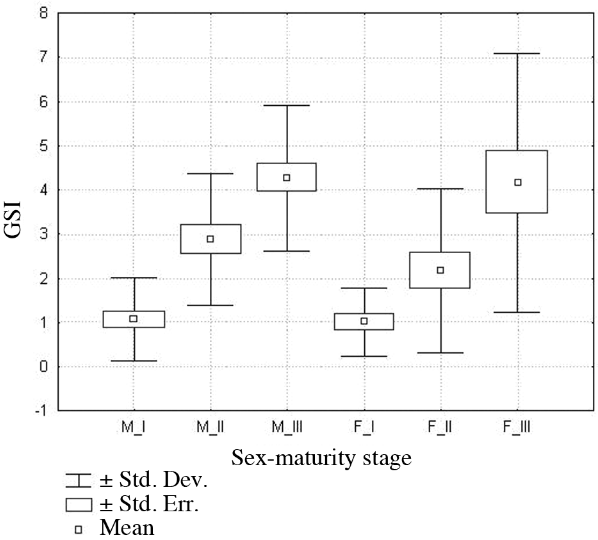

Fig. 4. – Box plot of gonado somatic index (GSI) in relation to the different maturity stages in males and females of *S. unicirrhus*.

($p < 0.01$ and $p < 0.05$ respectively).

The length-weight relationship was allometric negative ($p < 0.05$). Because ANCOVA results did not show significant differences when the slopes were compared between sexes ($p > 0.05$) only the weight-length relation for the whole population is reported ($TW = 0.004*ML^{2,8}$; $R^2 = 0.887$).

Regarding the distribution at different stages of maturity, the percentage of immature males and females was 22 % and 30 % respectively, maturing males and females was 28 % and 39 % and mature males and females was 50 % and 31 %, respectively

Trend of GSI in relation with maturity stages is shown in Fig. 4. The index increases gradually from stage I to stage III with a similar trend in both sexes. For maturity stage I, II and III no significant differences between males and females were found ($p > 0.05$).

Table II shows the relationships between total (PF) and (TW) and (ML). The relative fecundity was 44.55 egg/g.

Oocytes number ranged between 263 (40 mm ML) to 2450 (55 mm ML) in maturing females and between 912 (45 mm ML) to 4295 (60 mm ML) in mature females (Fig. 5). Oocytes of maturing females (22) presented a length along their major axis comprised between 1.2 (40 mm ML) and 1.7 mm (65 mm ML) with a mean size of 1.54 ± 0.67. Oocytes of mature females (18) presented a length along their major axis comprised between 1.5 (45 mm ML) and 2.6 mm (70 mm ML) with a mean size of 1.96 ± 0.25 (Table III).

The number of spermatophores ranged from 12 (50 mm ML) to 29 (45 mm ML). The spermatophores length ranged from 45.012 to 65.036 mm in males with 45 and 70 mm ML respectively (Table III).

DISCUSSION

In the studied area the species was caught in all depth strata up to 608 m depth showing, the bulk of the catch in the restricted range of 100-150 m of depth; above 50 m and beyond 500 m the presence of unihorn octopus was occasional. In the Catalan Sea it was reported between 100 and 350 m depth and from 60 to 450 m depth (Mangold-Wirz 1963). In Italian seas from 6-50 m to 800 m depth, with greater abundance between 100 and 350 m on

Table III. – Mantle length range, spermatophore number and length in males (stage III) and oocyte number and length in females (stage II and III) of *S. unicirrhus* in the Southern Tyrrhenian Sea.

	Males (Stage III)		Females (Stage II)		Females (Stage III)	
	Range	Medium ± SD	Range	Medium ± SD	Range	Medium ± SD
Mantle length	45-70 mm	53.59 ± 8.48	40-65 mm	50.87 ± 5.64	45-70 mm	56.63 ± 9.64
Spermatophore length	45-65 mm	50.72 ± 5.38				
Spermatophore number	12-29	19,69 ± 4,84				
Oocyte length			1.2-1.7 mm	1.54 ± 0.67	1.5-2.6 mm	1.96 ± 0.25
Oocyte number			263-2450	878.09 ± 574.68	912-4295	3302 ± 892.89

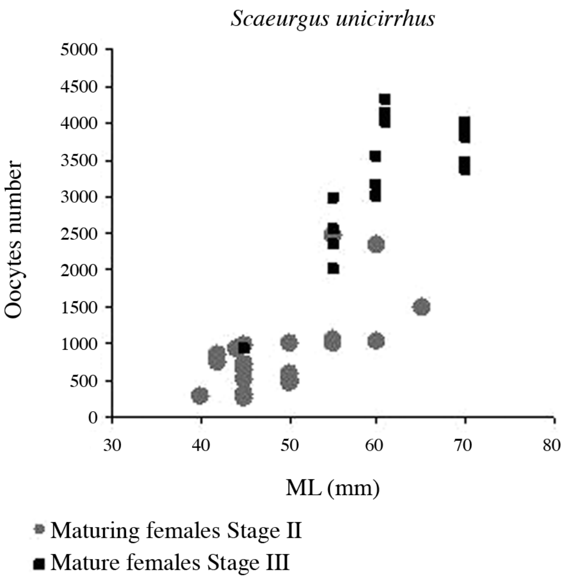

Fig. 5. – Potential fecundity in *S. unicirrhus* females in stage II (maturing) and III (mature)

sundy, muddy bottoms and on madreporian formations as white coral (Belcari 1999).

Hydrobiological characteristics of Cefalù basin and Eolian Archipelago were studied in the 0-200 m layer. Thermocline vertical structure showed the presence of three different water masses: Tyrrhenian Surface Water (TSW); Modified Atlantic Water (MAW) and Tyrrhenian Intermediate Water (TIW) (Azzaro *et al.* 2003).

The highest abundance of *S. unicirrhus* in the Gulf of S. Eufemia (Calabria) and in the Sicilian gulfs of Termini Imerese, S.Agata Militello and Castellammare del Golfo is probably correlated with the physico-chemical characteristics of the waters and with food availability.

These gulfs presented similar hydrological features. In particular, the Gulf of S. Eufemia (Azzaro *et al.* 2006) is influenced between 70 m and 200 m depth by the TIW (Tyrrhenian Intermediate Water), with temperature and salinity values close to 13.5 °C and 38.6 ‰, respectively. Below 50 m of depth the temperature decreases: in the southern part of the gulf the lowest values of temperature, that characterize the most salted waters, can be recorded. In the Gulf of Termini Imerese and in the Gulf of Sant Agata di Militello thermocline zone, between 10 and 50 m, is mainly influenced by the presence of MAW (Modified Atlantic Water) which are characterized by temperature variyng from 26 °C to 15 °C and by salinity from 38.2 to 37.8 ‰. MAW water flowing eastward change their original features, increasing the salinity to 37.9 ‰ because of mixing with the TIW (Azzaro *et al.* 2003).

In accordance with some authors (Ragonese *et al.* 1992, Boletzky 1984, Bello 2004), our results also show that the unihorn octopus seems to prefer relatively cold (13-14 °C) and salty (S > 38 ‰) waters, definitely below the upper limit of the thermocline.

The food of the octopus *Scaeurgus unicirrhus* is based on benthic organisms, mainly Caridea crustaceans and also polychaetes; adult specimens can also feed on bony fishes (Aluigi & Spedicato 1994).

In the studied area, the zones in which the highest yield of unihorn octopus were recorded are characterized (Potoschi & Spano 1998) by the circalittoral soft bottoms biocenoses "Terrigenous Mud" (defined with the symbol "VTC" by Peres & Picard 1964.) and the transition with "Muddy detritic bottoms" (DE, Peres & Picard 1964). The most abundant macro benthic species observed in these bottoms were *Goneplax rhomboides* and other decapod crustaceans (Potoschi & Spano 1998).

Our results showed a maximum size for adult specimens in accordance to what is known from literature. Jereb *et al.* (1992) observed a maximum size of 75 mm and 80 mm ML for males and females, respectively. Bello (2007) recorded a medium size of 30.89 mm ML for juveniles while the ML of mature specimens ranged from 60 to 82 mm in males and from 66 to 79 mm in females. Sánchez & Alvarez (1988) reported one adult male of 72 mm ML and Salman *et al.* (1998) reported one male of 69 mm ML. The largest specimen of *S .unicirrhus* in the Mediterranean was 120 mm ML (Mangold & Boletzky 1987, Jereb & Ragonese 1990).

The size of the smallest mature male and female in the present study (45 mm ML) was lower than the size reported in the Catalan Sea (50 mm ML) (Mangold-Wirz 1963).

Generally growth of cephalopods is affected by reproduction in different way in males and females (females heavier than males). In this study comparing the slope between sexes no significant differences were evident.

Bello (2007) reported for *S. unicirrhus* a similar general allometric coefficient (equal to 2.938) without significant differences between males and females.

Among the Mediterranean juvenile cephalopods, in which the proportions of the body and in some cases the entire morphology are very different from those of adults and that lead for some time living in a different environment than the adult stage, has been coined the term "paralarva" (Boletzky 1974, Young & Harman 1988, Sweeney *et al*. 1992). The definition of "larva" in fact, involves an indirect development, with the regular passage through a metamorphosis, which is not present in Cephalopods. Species that have an ontogenetic migration, thus linked to different stages of development, can be distinguished according to Nesis (1996): deposition at the surface, paralarvae spread in the water column, and young adults living at the surface; deposition on the surface, and young adults descending deep; deposition depth, paralarvae rise to the surface and then the young adults descending deep; deposition depth, paralarvae dispersed in the water column and then down again for young specimens and adults.

Among the various paralarvae of octopus, those of *S. unicirrhus* go through a prolonged planktonic stage, and this phenomenon gives them the opportunity to find a more convenient backdrop to the desired depth (Mangold-Wirz 1963). Some deep-sea octopus produce few but large eggs (Voss 1988). Benthic species, as *Eledone cirrhosa* and *Pteroctopus tetracirrhus* have a great number of eggs, but the size is larger, 7.0-7.5 mm for *E. cirrhosa* and 8.0 mm for *P. tetracirrhus*.

Few informations are present about the fecundity of this species. In the Catalan Sea males are ready for reproduction from 50 mm (ML). The length of spermatophores varies from 48 to 51 mm (males 48-56 mm ML); mature females have streaked eggs of 2-2.5 mm of diameter (Mangold-Wirz 1963). Fully mature females were rarely caught with smooth eggs. Females can lay up to about 1000 eggs (Mangold 1989); mature eggs were 2.5 mm long and about 1 mm wide and the (SpLl) index was 91-100 mm (Mangold 1998) in thirty-five specimens from the Mediterranean Sea. Ragonese *et al*. (1992) observed females in advanced maturity stage with large but still striated eggs of about 2-2.5 mm length in the ovary, found some smooth eggs only in six specimens, indicating a fully mature condition (Mangold-Wirtz 1963), and observed that the percentage of females in the catches decreased linearly with the increasing size of the specimens. This suggests a decreasing vulnerability of mature females to be captured.

The number of spermatophores observed in our study (12-29) is higher than the (SpLl) index reported by Mangold-Wirtz (1963) and lower than that reported (91-100 mm) by Mangold (1989).

Our results about female fecundity, as regard the egg size, are in agreement with what was observed by Mangold-Wirz (1963), but the egg number was higher.

Generally, species belonging to the Octopodidae show GSI values in mature specimens less than 8 % in males and varying between 10 and 40 % in females (Mangold 1983). Our results for males are in agreement with these values; while in mature females the GSI values were lower than 8 % (quite similar to the males).

The results reported in this paper, although not exhaustive for the life cycle comprehension, should contribute to improve the poor available knowledges on *S. unicirrhus* reproduction in the Mediterranean.

REFERENCES

Aluigi MG, Spedicato MT 1994. Alimentazione di *Scaeurgus unicirrhus* (Orbigny, 1840) (Cephalopoda, Octopoda). *Biol Mar Medit* 1(1): 287-288.

Azzaro F, Decembrini F, Raffa F, Greco S 2003. Caratteristiche idrobiologiche dello strato eufotico nel Tirreno Sud Orientale: primavera 2001. *Biol Mar Medit* 10(2): 631-635.

Azzaro F, Raffa F, Marini A, Rinelli P 2006. Caratteristiche idrobiologiche del Golfo di S.Eufemia (Tirreno Sud Orientale): Estate 2006. *Biol Mar Medit* 13(2): 228-229.

Belcari P 1999. *Scaeurgus unicirrhus In* G Relini, JA Bertrand & A Zamboni (eds.). Synthesis of the knowledge on bottom fishery resources in Central Mediterranean (Italy and Corsica). *Biol Mar Medit* 6(suppl 1): 771-773.

Bello G 2003. The biogeography of Mediterranean cephalopods. *Biogeographia* 24: 209-226.

Bello G 2004. First record of paralarvae of *Scaeurgus unicirrhus* (Cephalopoda: Octopodidae). *J Plankton Res* 26(12): 1555-1558.

Bello G 2007. Notes on the life cycle of *Scaeurgus unicirrhus* (Cephalopoda: Octopodidae). *Iberus* 25(1): 21-26.

Berry SS 1913. Some new Hawaiian cephalopods. *Proc US Nat Mus* 45: 563-566.

Bertrand JA, Gil De Sola L, Papaconstantinou C, Relini G, Souplet A 2002. The general specifications of the Medits surveys. *Sci Mar* 66(suppl 2): 9-17.

Boletzky SV 1974. The "larvae" of Cephalopoda: a review. *Thalass Jugosl* 10: 45-76.

Boletzky SV 1984. The embryonic development of the Octopus *Scaeurgus unicirrhus* (Mollusca, Cephalopoda). Additional data and discussion. *Vie Milieu* 34(2-3): 87-93.

Cairns SD 1976. Cephalopods collected in the Straits of Florida by the R/V *Gerda*. *Bull Mar Sci* 26(2): 233-272.

D'Orbigny A 1840. Des céphalopodes acétabulifères vivants et fossiles. *In* Ferussac A & A d'Orbigny eds, Histoire Naturelle Générale et Particulière. JB Baillière, Paris, 605 p.

Fiorentini L, Dremière PY, Leonori I, Sala A, Palumbo V 1999. Efficiency of the bottom trawl used for the Mediterranean international trawl survey (MEDITS). *Aquat Living Resour* 12(3): 187-205.

Green RH 1979. Sampling design and statistical methods for biologists. John Wiley & Sons, New York.

Guerra A 1992. Mollusca Cephalopoda. *In* Ramos MA *et al*. ed, Fauna Iberica, Vol 1, Museo Nacional de Ciencias Naturales CSIC, Madrid, 327 p.

Gunderson DR 1993. Surveys of fisheries resources. John Wiley & Sons, New York, 248 p.

Haimovici M 1985. Class Cephalopoda Cuvier, 1797. *In* Rios EC ed, Seashells of Brazil, Rio Grande RS Fundação Universidade do Rio Grande: 283-288.

Hilborn R, Walters CJ 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics Uncertainly. Chapman & Hall, London.

Irepa 2008. Osservatorio economico sulle strutture produttive della pesca marittima in Italia 2006. Irepa. Franco Angeli, 288 p.

Isaaks EH, Srivastava RM 1989. An Introduction to Applied Geostatistics. Oxford University Press, New York, 561 p.

Jatta G 1896. I cefalopodi viventi nel Golfo di Napoli (Sistematica). *Fauna Flora del Golfo di Napoli* 23, 268 p.

Jereb P, Ragonese S 1990. Sui cefalopodi di scarso o nullo interesse commerciale nel Canale di Sicilia. *Oebalia* 16(2): 689-692.

Jereb P, Ragonese S, Di Stefano L 1992. Occurrence of the unihorn octopus *Scaeurgus unicirrhus* in the Sicilian Channel. III: Description of features. *Rapp Comm Int Mer Médit* 33: 296-297.

Kraeuter JN, Thomas RF 1975. Cephalopod mollusks from the waters off Georgia. *Bull Mar Sci* 25(2): 301-303.

Laptikhovsky VV 1999. Fecundity and spawning in squid of families Enoploteuthidae and Ancistrocheiridae (Cephalopoda: Oegopsida). *Sci Mar* 63(1): 1-7.

Lloris D, Rucabado J, Fustè X, Alluè C, Bas C 1978. Area de afloramiento de NW de Africa. Campañas "Atlor III" y "Atlor V" (1974) Cabo Bojador a Cabo Blanco. Pescas de arrastre de fondo. *Datos Informativos Inst Investnes Pesq* 4, 247 p.

Mangold K 1983. *Octopus vulgaris*. *In* Boyle PR ed, Cephalopod life cycles, Vol 1. Academic, London: 335-364.

Mangold K 1989. Reproduction, croissance et durée de vie. *In* Grassé PP ed, Traité de Zoologie. Céphalopodes 5(4), Masson, Paris: 493-552.

Mangold K 1998. The Octopodinae from the Eastern Atlantic Ocean and the Mediterranean Sea. *In* Voss NA, Vecchione M, Toll RB & Sweeney MJ, Systematics and Biogeography of Cephalopods Vol II. *Smiths Contr Zool* 586: 521-528.

Mangold K, Boletzky SV 1987. Céphalopodes. *In* Fischer W, Bauchot ML, Schneider M eds, Fiches FAO d'identification des espèces pour les besoins de la pêche, Révision 1. Méditerranée et Mer Noire. Zone de pêche 37. Vol I Végétaux et Invertébrés 1: 634-714.

Mangold-Wirz K 1963. Biologie des Céphalopodes benthiques et nectoniques de la Mer Catalane. *Vie Milieu* 13(suppl), 285 p.

Nesis KN 1996. Mating, spawning, and death in oceanic cephalopods: a review. *Ruthenica* 6(1): 23-64.

Pérès JM, Picard J 1964. Nouveau manuel de bionomie benthique de la mer Méditerranée. *Recl Trav Stn Mar Endoume* 31(47): 5-137.

Potoschi A, Spanò N 1998. Crostacei decapodi dei fondi mobili strascicabili del basso Tirreno. *Biol Mar Medit* 5(2): 201-210.

Ragonese S, Jereb P, Di Stefano L 1992. Occurrence of the unihorn octopus *Scaeurgus unicirrhus* in the Sicilian Channel: II Bathymetric distribution. *Rapp Comm Int Mer Médit* 33: 306-307.

Robson GC 1921. On the Cephaolopoda obtained by the Percy Sladen Trust Expedition to the Indian Ocean in 1905. *Trans Zool Linn Soc Lon* 17(4): 429-442.

Robson GC 1929. A monograph of the Cephalopoda. I. Octopodinae. London, British Museum (Natural History), 236 p.

Salman A, Katağan T, Benli HA 1997. Bottom trawl teuthofauna of the Aegean Sea. *Arch Fis Mar Res* 45(2): 183-196.

Salman A, Katağan T, Benli HA 1998. On the Cephalopod fauna of northern Cyprus. *Isr J Zool* 44: 47-51.

Sanchez P, Alvarez JA 1988. *Scaeurgus unicirrhus* (Orbigny, 1840) (Cephalopoda, Octopodidae): first record from the south-east Atlantic. *S Afr J Mar Sci* 7: 69-74.

Sasaki M 1920. Report on cephalopods collected during 1906 by the US Bur Fish Steamer "Albatros" in the Northwestern Pacific. *Proc US Nat Mus* 57(2310): 163-203.

Sparre P, Venema SC 1996. Introduction à l'évaluation des stocks de poissons tropicaux. *FAO Doc Tech Pêche* 306: 38-44.

Sweeney MJ, Roper CFE, Mangold K, Clarke MR, Boletzky S 1992. "Larval" and juvenile cephalopods: A manual for their identification. *Smith Contri Zool* Washington, 209.

Tiberi N 1880. Cefalopodi viventi nel Mediterraneo. *Bull Malacol* 6: 5.

Von Boletzky S 1984. The embryonic development of the octopus *Scaeurgus unicirrhus* (Mollusca: Cephalopoda). Additional data and discussion. *Vie Milieu* 34(2/3): 87-93.

Voss GL 1951. A first record of the cephalopod *Scaeurgus unicirrhus*, from the Western Atlantic. *Bull Mar Sci Gulf Caribb* 1(1): 64-71.

Voss GL 1988. The biogeography of the deep-sea Octopoda. *Malacol* 29: 295-307.

Young RE, Harman RF 1988. "Larva", "Paralarva" and "Subadult" in Cephalopod Terminology. *Malacologia* 29(1): 201-207.

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