SCIENTIA MARINA

Distribution and abundance of *Eledone cirrhosa* (Lamarck, 1798) and *E. moschata* (Lamarck, 1798) (Cephalopoda: Octopoda) in the Mediterranean Sea*

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SUMMARY: Information on distribution, abundance and size composition of the two octopods *Eledone cirrhosa* and *E. moschata* was obtained from the MEDITS trawl surveys, carried out in a wide area of the Mediterranean basin from 1994 to 1999. Both species showed a wide geographic distribution, as they were collected in all the major areas investigated. *E. cirrhosa* showed a wide depth distribution, down to the 800 m isobath, while *E. moschata* was mostly restricted to within 200 m. Further analysis on spatio-temporal basis with a Generalised Linear Model, evidenced that differences among major areas, depth strata and their interaction were always significant. In the case of *E. cirrhosa,* differences among years and year-major area interaction were also significant. Two cohorts can be singled out in the size frequency distributions of *E. cirrhosa*, whereas only one mode can be clearly distinguished in most of the length distributions of *E. moschata*.

Key words: cephalopods, distribution, abundance estimations, trawl surveys, Mediterranean Sea, *Eledone cirrhosa*, *Eledone moschata*.

INTRODUCTION

The two octopods of the genus *Eledone,* the horned octopus *Eledone cirrhosa* (Lamarck, 1798) and the musky octopus *Eledone moschata* (Lamarck, 1798) are soft bottom species found throughout the Mediterranean. *E. cirrhosa* is quite common also in the northeastern Atlantic, where the northern limit is located around 66-67º N and the southern limit,

still uncertain, is at the level of the Moroccan coasts (Guerra, 1992). In the Mediterranean Sea, the species displays a wide bathymetric distribution, generally down to the 700 m bathymetric line, with higher occurrence within the first 300 m (Belcari and Sartor, 1999).

The musky octopus *E. moschata* is, on the other hand, a typical Mediterranean species, limited in the Atlantic Ocean to the southern coasts of Portugal and the Gulf of Cadiz (Guerra, 1992). In the Mediterranean, it is mainly distributed from 15 to

200 m depth, with greatest abundance down to 100 m, although in some areas it is found at greater depths (Belcari and Sbrana, 1999).

The two species represent a commercially important resource in the Mediterranean basin, and are fished mainly with bottom trawl nets. Catches made by means of other gear, such as traps and set-nets are of less importance. *E. cirrhosa* is undoubtedly one of the most important commercial species among cephalopods. For this reason, it has currently been the object of a number of studies, related mainly to its biology (see Belcari and Sartor, 1999, for a review). The existing literature on the biology of *E. moschata* is, on the contrary, quite limited, although the species is economically important due to its abundance along the eastern and southern coasts of the Mediterranean Sea and in the Adriatic. The only studies on this species have been performed on a small geographic scale, especially in the Gulf of Lions (Mangold-Wirz, 1963; Moriyasu, 1981; Mangold, 1983). Some information regarding the populations of the Adriatic, the southern Aegean and the Thracian seas have also been reported (Manfrin-Piccinetti and Rizzoli, 1984; Lefkaditou *et al.*, 1998; Belcari and Sbrana, 1999; Lefkaditou *et al.*, 2001).

The two species are generally pooled together or with *Octopus vulgaris* in the commercial landings and in the Mediterranean fishery statistics (Sánchez and Martín, 1993; Belcari *et al.*, 1998; Lefkaditou *et al.,* 2000). This makes it impossible to assess catch levels per species as an index of stock biomass. To date there is still a lack of basic information for correct management of these resources.

The present paper aims at contributing to the knowledge of distribution, abundance and demographic structure of the two *Eledone* species, collected by means of experimental trawl surveys carried out with a common methodology in a wide area of the Mediterranean basin.

MATERIALS AND METHODS

Sampling

Six annual bottom trawl surveys that were mainly aimed at obtaining estimates of abundance indices for a series of target species were carried out from late spring to mid summer in the Mediterranean Sea from 1994 to 1999 (Bertrand *et al.*, 2000, 2002). The surveys covered 40 sub-areas belonging to 15 major

TABLE 1. – List of the major areas covered by the surveys. *Area 114 was not included in the analysis since only one-year data were available. A map can be found in Bertrand *et al.* (2000, 2002).

Area Code	Area name
111	Alborán Sea
112	Alicante region
113	Catalan Sea
114*	Morocco
121	Gulf of Lion
131	Corsican Sea
132	Ligurian, N and Central Tyrrhenian Sea
133	Sardinian Sea
134	S Tyrrhenian Sea and Sicilian Channel
211	N and Central Adriatic Sea
221	S Adriatic and W Ionian Sea
222	E Ionian Sea
223	Argosaronikos region
224	N Aegean Sea
225	S Aegean Sea

areas (Table 1) (see Bertrand *et al.*, 2002); the Mediterranean coasts of Morocco were included in the project since 1999. A total of approximately 1000 hauls was made during each survey in the depth range 10-800 m, by means of a standard trawl net GOC 73 having a cod-end mesh opening of 20 mm. Selection of sampling stations was based on a depth-stratified sampling scheme, taking into account the surface area of each stratum; five depth zones were considered: 10-50, 50-100, 100-200, 200-500 and 500-800 m. Specimens were counted, weighed, measured (mantle length, ML, to the next lower 0.5 cm), sexed and assigned to a maturity stage by macroscopic analysis of the gonads. The same sampling protocol was used in all cases (see Bertrand *et al*, 2000, 2002, for details). Mantle length measurements of *E. moschata* were not available for the cruises 1994-1996, due to its late inclusion in the list of target species.

Data analysis

Catch data (number and weight of octopuses collected) were analysed by means of specifically developed software (Souplet, 1996), taking into account the surface of each sub-area and depth stratum, in order to obtain estimates of abundance indices expressed in terms of both number of specimens and kg per km^2. The abundance estimations of the two species were calculated as a mean value per year of sampling, geographic sector and bathymetric stratum. In addition, the summary statistics were estimated by sub-area and major depth stratum (shelf: 10-200; slope: 200-800 m). The above estimates indicated that the abundance of *E. moschata*

was negligible in waters deeper than 200 m. For this reason further analysis for this species was confined to depth strata down to 200 m.

In order to examine the effects of year and major areas on the abundance and identify overall trends, the detailed relative abundance indices, i.e. catch per unit effort (CPUE) by sub-area and depth stratum, were standardised using General Linear Model (GLM) techniques (Gulland, 1956; Kimura, 1981; Hilborn and Walters, 1992). CPUE indices were expressed in g/km^2 and the general model used was of the form:

$$\ln(CPUE_{ijk} + 1) = \mu + A_i + Y_j + D_k + \text{interaction} + \varepsilon_{ijk}$$

where: μ: overall mean
    A_i: effect of major area i
    Y_j: effect of year j
    D_k: effect of depth stratum k
    interaction: any possible combination of interaction between two effects
    ε: error term assumed to be distributed normally

The constant 1 was added to all CPUE rates to account for the zero observations. The coefficient of determination (r^2) was considered to express the goodness of fit of the model with the data. All statistical inferences were based on the 95% confidence level.

The demographic structure of the two species was studied by computing the size frequency distributions for every major area; all the years were pooled, since the cruises were always performed at the same period of the year. Length frequency distributions in major areas were compared by means of the Kolmogorov-Smirnov test. Variations in the size distribution patterns of *E. cirrhosa* between shelf and slope were also examined.

RESULTS

Abundance indices

From the examination of the all sectors investigated, it appears that *E. cirrhosa* was present in the whole western basin; in the central basin the species was fairly sparse, increasing again in the eastern Mediterranean, in the Argosaronikos and northern Aegean Sea (Tables 2 and 3). The species showed a wide depth distribution, the largest catches occurred generally from 50 to 500 m.

E. moschata was sparse or absent in some geographic sectors, such as the northern Ligurian Sea, north-eastern Corsica, Ionian Sea and Morocco, although in the latter case only data pertaining to the 1999 survey were available (Tables 4 and 5). In contrast, in other sub-areas, catches were comparable to the maximum amounts reached by the closely related species *E. cirrhosa*, and vastly exceeded these amounts in the northern Adriatic Sea off the Slovenian coasts in 1995, reaching the values of 2,396 individuals per km^2 and 336.1 kg per km^2. The species was mostly restricted to within 100 m; below 200 m catches were scarce, and only occasional at further depths.

From the analysis carried out for the major areas, the computed r^2 indicated that the adopted GLM models explained a large proportion of the variance for both species (Table 6). The Analysis of Variance (ANOVA) for the applied GLM model, indicated that differences among major areas, depth strata and their interaction were always statistically significant. In the case of *E. cirrhosa,* differences among years and the year-major area interaction were also significant. Overall, yearly fluctuations do not seem to be important and this is particularly true for *E. moschata* (Fig. 1).
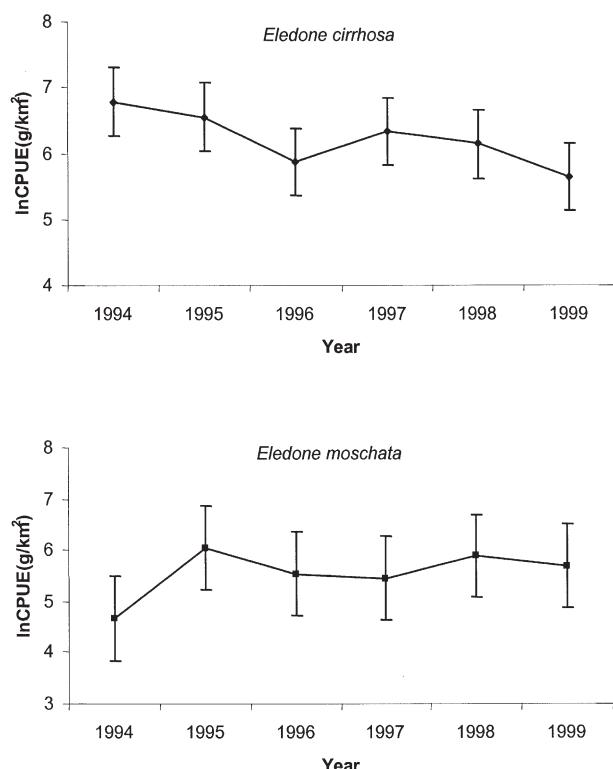

FIG. 1. – Standardised CPUE estimates (marginal means) for *Eledone cirrhosa* and *Eledone moschata* by year. Vertical lines indicate the 95% confidence intervals of the corresponding estimates.

TABLE 2. – *Eledone cirrhosa*: mean abundance (in number of individuals/km^2) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994 - 1999). Not sampled strata are indicated by *. Values higher than 300 individuals/km^2 are presented in bold.

Sector code	Sector	1994 Depth (m)					1995 Depth (m)					1996 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	13	44	73	13	1	0	15	228	14	0	0	166	54	36	2
112a	Alicante	0	51	50	64	0	0	9	96	46	0	0	5	56	55	0
113a	Catalan Sea	6	220	**475**	63	0	8	184	**336**	33	0	0	75	241	100	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	8	141	**583**	46	2	**1097**	**665**	283	129	2	40	263	63	83	14
121b	E Gulf of Lions	18	149	265	54	4	70	**445**	298	197	14	5	119	287	52	0
131a	NE Corsica	*	41	78	32	5	*	180	133	59	14	*	43	59	114	24
131b	SE Corsica	*	22	33	18	0	*	**627**	**531**	10	0	*	126	0	57	26
132a	N Ligurian Sea	0	**359**	**797**	48	5	165	158	135	108	2	0	16	80	107	7
132b	E Ligurian Sea	3	**371**	**311**	102	0	0	**313**	255	129	0	0	183	208	182	10
132c	N Tyrrhenian	0	85	273	90	1	0	62	**308**	99	7	0	120	211	111	8
132d	C Tyrrhenian	4	123	**347**	94	20	13	181	122	99	44	15	176	103	146	43
133a	SE Sardinia	19	27	12	49	0	0	99	249	49	0	40	67	86	183	0
133b	NE Sardinia	48	152	226	68	17	35	132	**367**	96	103	32	133	**504**	214	45
133c	N Sardinia	7	211	41	99	0	0	11	**498**	53	10	0	8	143	62	30
133d	NW Sardinia	0	167	288	59	12	*	129	49	52	0	12	128	**337**	83	4
133e	W Sardinia	5	*	283	59	0	9	90	**314**	106	35	0	88	183	56	0
133f	SW Sardinia	0	110	250	**376**	10	132	59	252	249	8	0	39	**338**	**357**	11
133g	S Sardinia	0	**450**	67	94	0	0	*	161	31	2	0	69	110	25	4
134a	SE Tyrrhenian	6	64	67	45	5	0	143	108	32	2	0	67	95	33	4
134b	SW Tyrrhenian	0	44	51	16	5	0	68	78	30	1	0	84	69	6	0
134c	Sicilian Chan.	6	50	35	50	0	6	11	30	19	0	0	3	58	19	0
211a	N Adriatic Sea	3	0	*	*	*	5	0	*	*	*	0	3	*	*	*
211b	Central Adriatic	0	120	288	158	0	2	65	109	36	0	3	50	83	51	0
211c	N Adriatic-Slov	*	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	0	9	65	62	*
221a	E Sicily	0	0	7	0	0	0	0	0	0	0	0	10	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	12	0	0	0	0	0	65	12	0	0
221c	N Ionian Sea	0	15	0	0	0	0	28	162	0	0	0	48	82	5	0
221d	N Ionian Sea	*	0	12	4	0	0	0	25	0	0	0	0	7	4	0
221e	SW Adriatic	0	45	159	11	0	*	0	49	2	0	*	36	44	0	0
221f	SW Adriatic	13	157	**318**	0	0	0	7	37	0	0	0	14	52	0	0
221g	SW Adriatic	0	0	**322**	*	0	0	7	15	*	0	0	0	34	*	0
221h	SW Adriatic	0	49	256	83	0	0	0	100	7	0	0	4	27	13	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	0	15	177	85	2
222a	E Ionian Sea	0	63	30	44	0	18	12	8	48	0	0	62	46	88	0
223a	Argosaronikos	0	**851**	**418**	129	0	0	**300**	254	89	0	0	39	113	11	0
224a	N Aegean Sea	112	**305**	**395**	86	4	20	**393**	102	60	3	7	108	138	23	0
225a	S Aegean Sea	0	113	**395**	**322**	1	0	8	79	52	0	0	0	0	33	0

Sector code	Sector	1997 Depth (m)					1998 Depth (m)					1999 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	15	67	112	68	0	21	258	112	45	0	0	61	25	18	0
112a	Alicante	9	12	61	74	0	0	40	164	87	4	0	3	20	10	0
113a	Catalan Sea	0	143	275	52	0	0	116	**345**	-1	0	0	45	103	33	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	172	149	1	2
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	138	0	45	1	0
121a	W Gulf of Lions	65	191	199	72	15	5	175	110	110	10	263	**796**	**706**	24	103
121b	E Gulf of Lions	23	201	92	81	0	0	75	183	134	0	32	**504**	**482**	12	*
131a	NE Corsica	*	0	*	51	9	*	0	28	15	4	*	13	161	13	0
131b	SE Corsica	*	72	7	43	*	*	18	52	31	0	*	121	28	60	0
132a	N Ligurian Sea	10	217	**406**	87	8	0	184	**493**	55	1	11	143	145	72	0
132b	E Ligurian Sea	0	64	**349**	171	12	3	107	165	156	2	3	239	237	78	2
132c	N Tyrrhenian	0	36	146	141	2	88	30	178	94	23	0	30	81	38	3
132d	C Tyrrhenian	0	60	94	61	16	0	29	84	73	18	0	39	79	63	4
133a	SE Sardinia	9	22	**649**	270	20	10	116	138	30	4	37	45	126	41	0
133b	NE Sardinia	7	164	**726**	**308**	34	65	197	260	77	3	27	**323**	210	184	2
133c	N Sardinia	0	31	**780**	70	10	0	17	**312**	99	0	8	122	**585**	73	10
133d	NW Sardinia	0	110	171	38	0	0	61	105	22	0	0	290	182	30	3
133e	W Sardinia	14	0	**441**	47	0	0	68	245	6	6	26	94	283	24	0
133f	SW Sardinia	0	47	**336**	296	7	67	140	**376**	**561**	7	75	**477**	**383**	254	6
133g	S Sardinia	0	113	**670**	182	23	78	**738**	191	56	26	34	250	221	20	2
134a	SE Tyrrhenian	0	133	76	32	0	0	19	179	24	2	0	0	117	13	0
134b	SW Tyrrhenian	0	11	28	13	0	0	6	35	21	0	37	0	16	0	0
134c	Sicilian Chan.	6	5	29	26	0	0	5	38	35	0	0	3	98	27	0

TABLE 2 (Cont.). – *Eledone cirrhosa*: mean abundance (in number of individuals/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994 - 1999). Not sampled strata are indicated by *. Values higher than 300 individuals/km² are presented in bold.

Sector code	Sector	1997 Depth (m)					1998 Depth (m)					1999 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
211a	N Adriatic Sea	0	9	*	*	*	4	4	*	*	*	0	4	*	*	*
211b	Central Adriatic	0	26	52	66	0	0	29	57	64	*	2	54	92	0	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	16	50	83	*	10	0	57	50	*	0	*	*	*	*
221a	E Sicily	16	31	0	14	0	7	34	38	0	0	0	22	44	4	0
221b	NW Ionian Sea	48	87	75	61	0	23	118	32	51	0	0	22	22	42	0
221c	N Ionian Sea	0	167	132	3	0	0	36	42	5	0	0	7	193	3	0
221d	N Ionian Sea	0	0	27	5	0	0	0	79	15	0	0	0	0	7	0
221e	SW Adriatic	*	15	56	2	0	*	15	104	2	0	*	0	25	2	0
221f	SW Adriatic	0	7	48	0	0	0	15	65	0	0	0	15	68	0	0
221g	SW Adriatic	0	15	43	*	0	0	0	166	*	0	0	15	22	*	0
221h	SW Adriatic	0	4	62	26	0	0	0	161	24	0	3	15	25	49	0
221i	SE Adriatic	0	33	129	51	0	0	4	126	82	0	0	2	9	12	0
222a	E Ionian Sea	0	27	0	6	0	7	2	0	28	0	81	43	0	40	0
223a	Argosaronikos	0	**440**	83	43	3	0	117	104	18	0	0	**306**	149	29	13
224a	N Aegean Sea	112	252	187	138	0	49	152	107	67	0	0	44	111	78	0
225a	S Aegean Sea	0	22	16	56	2	0	0	8	15	0	0	0	5	7	0

TABLE 3. – *Eledone cirrhosa*: mean biomass (in kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Not sampled strata are indicated by *. Values higher than 30 kg/km² are presented in bold.

Sector code	Sector	1994 Depth (m)					1995 Depth (m)					1996 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	0.4	7.2	20.2	4.7	0.0	0	8.2	**69.5**	4.5	0	0	13.6	13.4	8.8	0.01
112a	Alicante	0	1.1	5.6	28.6	0	0	5.2	**36.1**	13.2	0	0	3.5	20.1	14.7	0
113a	Catalan Sea	0.3	19.1	**44.9**	22.3	0	0.4	**32.7**	**49.1**	14.2	0	0	18.4	**52.0**	**31.2**	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	1.7	**34.0**	**88.5**	15.7	0.4	**85.7**	**54.4**	20.1	**44.6**	0.9	3.3	20.6	9.3	20.1	3.5
121b	E Gulf of Lions	2.4	**45.1**	**51.6**	13.6	0.7	6.2	**33.0**	**39.7**	**46.3**	2.3	0.3	16.2	27.5	12.2	0
131a	NE Corsica	*	6.7	7.7	4.7	0.6	*	15.8	17.1	11.6	3.2	*	6.0	6.2	22.2	4.5
131b	SE Corsica	*	4.3	4.0	2.7	0	*	14.5	8.2	2.4	0	*	**37.0**	0	9.7	6.1
132a	N Ligurian Sea	0	**49.5**	**107.1**	10.3	1	16.5	11.4	20.0	24.2	0.9	0	1.2	8.4	24.5	1.6
132b	E Ligurian Sea	0	**51.4**	**41.1**	11.5	0	0	**37.8**	**31.0**	18.6	0	0	18.9	28.2	**34.9**	4.0
132c	N Tyrrhenian	0	21.8	**37.4**	11.3	0.2	0	12.2	**61.5**	20.0	1.7	0	**30.7**	25.9	11.8	2.1
132d	C Tyrrhenian	0.1	26.5	**47.6**	18.7	5.4	0.1	11.6	13.8	24.3	11.3	0.2	10.5	8.2	26.7	8.7
133a	SE Sardinia	3.5	6.1	0.1	0.7	0	0	2.7	3.1	3.1	0	8.0	7.8	1.0	6.0	0
133b	NE Sardinia	2.6	29.4	24.6	11.4	4.3	7.7	15.2	25.2	15.5	19.8	5.4	22.4	**37.0**	25.36	9.7
133c	N Sardinia	3.3	**49.8**	4.3	15.5	0	0	3.4	18.0	12.1	1.0	0	2.3	7.2	9.2	11.2
133d	NW Sardinia	0	26.9	21.57	8.2	2.4	*	12.9	2.2	9.4	0	2.4	3.9	11.4	14.7	0.9
133e	W Sardinia	1.4	*	24.3	6.8	0	2.6	17.9	26.3	23.3	4.0	0	5.1	5.3	9.1	0
133f	SW Sardinia	0	11.9	9.5	24.2	2.4	**37.2**	13.5	20.4	28.2	1.5	0	5.5	15.2	21.1	1.6
133g	S Sardinia	0	**96.4**	21.45	4.8	0	0	*	13.0	8.5	0.3	0	18.3	9.6	3.1	0.8
134a	SE Tyrrhenian	0.6	7.4	10.8	6.4	1.4	0	2.2	4.4	4.1	0.4	0	4.0	13.6	4.4	0.8
134b	SW Tyrrhenian	0	11.1	9.3	3.4	0.8	0	7.6	12.3	4.1	0.4	0	20.5	8.8	1.2	0
134c	Sicilian Chan.	0.9	13.6	10.9	12.3	0	0.6	2.1	4.4	2.6	0	0	0.9	10.3	3.0	0
211a	N Adriatic Sea	0.2	0	*	*	*	1.2	0	*	*	*	0	0.5	*	*	*
211b	Central Adriatic	0	24.8	**57.2**	**31.1**	0	0.4	12.0	25.5	11.8	0	0.0	15.0	24.2	10.6	0
211c	N Adriatic-Slov	*	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	0	3.1	16.5	17.8	*
221a	E Sicily	0	0	0.9	0	0	0	0	0	0	0	0	0.0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0.4	0	0	0	0	0	6.2	2.3	0	0
221c	N Ionian Sea	0	4.8	0	0	0	0	0.2	0.9	0	0	0	0.3	0.4	1.4	0
221d	N Ionian Sea	*	0	7.1	1.8	0	0	0	10.0	0	0	0	0	6.1	0.4	0
221e	SW Adriatic	0	15.2	**40.5**	5.4	0	*	0	21.0	1.3	0	*	11.1	15.3	0	0
221f	SW Adriatic	3.5	**32.4**	**71.5**	0	0	0	0.1	9.2	0	0	0	0.2	16.1	0	0
221g	SW Adriatic	0	0	**72.9**	*	0	0	0.1	2.7	*	0	0	0	1.3	*	0
221h	SW Adriatic	0	15.56	**54.4**	**31.4**	0	0	0	27.1	3.5	0	0	0.0	3.3	2.8	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	0	6.2	**39.3**	23.6	0.3
222a	E Ionian Sea	0	10.0	4.1	6.0	0	9.7	0.1	1.2	1.6	0	0	11.6	3.0	16.7	0
223a	Argosaronikos	0	**129.6**	**70.5**	21.9	0	0	**74.9**	**51.5**	15.6	0	0	6.8	13.0	1.6	0
224a	N Aegean Sea	16.1	**35.9**	**52.2**	16.0	0.4	7.0	**66.6**	12.0	6.6	0.3	1.3	21.6	16.6	2.9	0
225a	S Aegean Sea	0	22.3	**71.8**	37.0	0.1	0	1.1	10.7	6.2	0	0	0	0	3.6	0

TABLE 3 (Cont.). – *Eledone cirrhosa*: mean biomass (in kg/km^2) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Not sampled strata are indicated by *. Values higher than 30 kg/km^2 are presented in bold.

		1997 Depth (m)					1998 Depth (m)					1999 Depth (m)				
Sector code	Sector	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	1.1	13.3	19.8	14.1	0	5.4	**79.1**	13.1	7.8	0	0	20.6	5.1	2.5	0
112a	Alicante	0.1	2.3	21.5	22.5	0	0	17.0	**41.9**	25.2	1.3	0	1.5	6.1	2.5	0
113a	Catalan Sea	0	27.8	**48.4**	18.2	0	0	**32.8**	71.9	*	0	0	17.6	20.4	16.0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	27.3	**50.7**	0.1	0.5
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	24.1	0	8.4	0.5	0
121a	W Gulf of Lions	6.1	26.3	**30.1**	16.8	4.9	0.3	25.3	**30.1**	**37.6**	3.6	18.8	**84.0**	**60.7**	8.1	**50.1**
121b	E Gulf of Lions	0.6	28.9	13.0	24.6	0	0	12.3	**37.1**	**39.6**	0	2.5	**86.2**	**71.3**	3.5	*
131a	NE Corsica	*	0	*	7.9	1.8	*	0	3.1	2.1	1.0	*	1.6	24.6	2.6	0
131b	SE Corsica	*	9.9	1.0	6.6	*	*	2.6	8.0	4.1	0	*	25.7	7.0	9.6	0
132a	N Ligurian Sea	0.6	11.0	22.0	14.7	2.3	0	9.2	**47.4**	11.3	0.2	0.2	5.2	23.0	14.1	0
132b	E Ligurian Sea	0	8.6	27.1	29.5	2.6	1.1	20.3	25.0	24.1	0.3	1.1	**48.6**	**43.4**	13.5	0.2
132c	N Tyrrhenian	0	10.7	27.6	24.9	0.5	**31.2**	7.6	**31.0**	22.4	6.4	0	8.9	21.2	7.7	0.9
132d	C Tyrrhenian	0	2.4	6.7	11.1	4.2	0	8.6	15.8	16.1	4.4	0	2.7	10.4	19.7	1.3
133a	SE Sardinia	1.5	6.0	**31.9**	11.3	3.5	1.5	**31.3**	24.7	1.8	0.4	10.7	14.6	20.8	1.7	0
133b	NE Sardinia	1.3	24.6	**38.5**	**38.6**	7.7	17.24	**41.7**	25.4	10.8	0.8	9.3	**65.0**	**34.2**	**43.8**	0.6
133c	N Sardinia	0	8.6	20.5	15.0	4.1	0	6.1	18.2	14.3	0	0.1	**33.0**	14.1	19.7	2.1
133d	NW Sardinia	0	17.3	12.3	5.4	0	0	14.9	11.1	3.0	0	0	**43.5**	12.4	2.3	0.3
133e	W Sardinia	3.6	0	9.4	3.7	0	0	12.2	21.9	0.3	0.9	4.5	10.9	9.7	3.8	0
133f	SW Sardinia	0	6.3	15.6	13.9	1.2	16.8	27.7	**30.8**	**47.5**	1.4	13.5	**47.1**	**32.8**	28.1	0.8
133g	S Sardinia	0	10.2	18.6	9.3	0.4	20.7	**115.4**	**30.3**	8.7	5.2	9.0	**54.8**	14.5	2.9	1.0
134a	SE Tyrrhenian	0	3.6	6.6	4.0	0.1	0	5.9	27.8	3.1	0.4	0	0	13	1.3	0
134b	SW Tyrrhenian	0	2.2	3.0	2.4	0	0	0.8	6.6	2.0	0	10.8	0	1.5	0	0
134c	Sicilian Chan.	0.6	1.3	3.8	4.7	0	0	1.8	7.0	6.5	0	0	0.4	12.9	3.6	0
211a	N Adriatic Sea	0	3.7	*	*	*	0.3	1.3	*	*	*	0	0.4	*	*	*
211b	Central Adriatic	0	6.3	10.5	15.1	0	0	6.2	11.2	12.7	*	0.1	1.7	4.4	0	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	3.8	12.0	18.7	*	0.6	0	13.3	7.6	*	0	*	*	*	*
221a	E Sicily	7.4	4.1	0	4.1	0	2.9	12.8	6.7	0	0	0	6.6	11.8	0.7	0
221b	NW Ionian Sea	16.2	21.9	11.7	15.0	0	5.2	20.2	3.9	8.2	0	0	2.3	3.6	4.2	0
221c	N Ionian Sea	0	28.7	6.8	0.5	0	0	11.6	1.7	0.9	0	0	2.6	0.7	0.4	0
221d	N Ionian Sea	0	0	10.5	2.0	0	0	0	21.4	4.1	0	0	0	0	1.1	0
221e	SW Adriatic	*	7.9	9.6	1.6	0	*	7.4	29.8	1.2	0	*	0	3.8	0.9	0
221f	SW Adriatic	0	4.0	17.2	0	0	0	7.8	18.2	0	0	0	0.2	2.2	0	0
221g	SW Adriatic	0	0.2	12.6	*	0	0	0	**38.7**	*	0	0	0.3	0.2	*	0
221h	SW Adriatic	0	0.1	4.9	10.0	0	0	0	29.5	5.9	0	0.0	0.2	2.4	12.4	0
221i	SE Adriatic	0	5.1	23.1	9.8	0	0	1.6	16.3	13.8	0	0	0.1	1.6	2.2	0
222a	E Ionian Sea	0	0.6	0	0.0	0	0.0	0.8	0	3.5	0	7.1	7	0	1.7	0
223a	Argosaronikos	0	**100.0**	11.3	4.8	0.6	0	27.1	12.6	1.6	0	0	104.3	11.5	2.7	1.7
224a	N Aegean Sea	**50.2**	**59.5**	25.5	27.9	0	12.6	**33.8**	9.0	10.3	0	0	8.6	16.3	15.3	0
225a	S Aegean Sea	0	6.0	3.6	7.7	0.1	0	0	1.6	2.2	0	0	0	0.7	0.7	0

TABLE 4. – *Eledone moschata*: mean abundance (in number of individuals/km^2) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Not sampled strata are indicated by *. Values higher than 200 individuals/km^2 are presented in bold.

		1994 Depth (m)					1995 Depth (m)					1996 Depth (m)				
Sector code	Sector	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
111a	Alboràn Sea	0	54	0	0	0	117	49	0	2	0	34	44	0	5	0
112a	Alicante	0	0	6	0	0	0	36	7	0	0	0	7	4	0	0
113a	Catalan Sea	0	21	0	0	0	4	10	2	0	0	7	12	6	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	183	56	0	7	0	**308**	12	0	0	0	**266**	18	0	0	3
121b	E Gulf of Lions	138	17	2	0	0	**306**	35	8	0	0	168	7	7	0	0
131a	NE Corsica	*	41	0	0	0	*	65	0	0	8	*	28	20	0	0
131b	SE Corsica	*	0	0	0	0	*	**563**	0	0	0	*	53	0	6	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132b	E Ligurian Sea	5	24	1	0	0	2	49	0	0	0	27	45	0	0	0
132c	N Tyrrhenian	0	46	0	0	0	31	7	0	0	0	0	0	0	0	0
132d	C Tyrrhenian	19	18	2	0	0	6	3	0	0	0	11	0	0	0	0
133a	SE Sardinia	102	**314**	**214**	0	0	110	**228**	0	0	0	24	67	0	0	0
133b	NE Sardinia	0	44	0	0	0	12	11	0	0	0	71	48	0	0	0
133c	N Sardinia	**200**	**275**	0	0	0	**231**	**294**	0	0	0	175	99	0	0	0
133d	NW Sardinia	13	65	0	0	0	*	21	0	0	0	0	0	0	0	0
133e	W Sardinia	41	*	0	0	0	26	67	0	0	0	7	13	0	0	0

TABLE 4 (Cont.). – *Eledone moschata*: mean abundance (in number of individuals/km^2) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Not sampled strata are indicated by *. Values higher than 200 individuals/km^2 are presented in bold.

Sector code	Sector	1994 Depth (m)					1995 Depth (m)					1996 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
133f	SW Sardinia	41	130	0	0	0	120	76	5	2	0	50	19	0	0	0
133g	S Sardinia	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0
134a	SE Tyrrhenian	18	34	4	0	0	23	4	0	0	0	12	7	0	0	0
134b	SW Tyrrhenian	33	19	10	0	0	28	16	17	0	0	0	6	17	6	0
134c	Sicilian Chan.	18	158	0	0	0	67	188	3	0	0	52	188	6	0	0
211a	N Adriatic Sea	69	7	*	*	*	**355**	49	*	*	*	171	21	*	*	*
211b	Central Adriatic	15	0	0	0	0	29	0	0	0	0	3	5	0	0	0
211c	N Adriatic-Slov	*	*	*	*	*	**2396**	*	*	*	*	**1448**	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	**566**	**231**	13	16	*
221a	E Sicily	0	22	7	0	0	89	0	0	0	0	73	0	0	0	0
221b	NW Ionian Sea	8	0	0	0	0	0	0	0	0	0	11	22	0	0	0
221c	N Ionian Sea	8	0	0	5	0	17	0	0	0	0	0	7	0	0	0
221d	N Ionian Sea	*	0	0	0	0	84	0	6	0	0	0	19	0	0	0
221e	SW Adriatic	0	64	0	0	0	*	0	0	0	0	*	29	0	0	0
221f	SW Adriatic	54	7	0	0	0	75	7	0	0	0	21	7	0	0	0
221g	SW Adriatic	37	98	0	*	0	22	7	0	-1	0	0	0	0	*	0
221h	SW Adriatic	79	39	0	0	0	39	7	0	0	0	15	0	0	0	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	95	28	0	0	0
222a	E Ionian Sea	17	72	0	0	0	18	6	16	0	0	0	28	0	0	0
223a	Argosaronikos	0	0	13	86	0	143	17	11	0	0	0	141	8	0	0
224a	N Aegean Sea	25	2	0	0	0	5	10	0	0	0	**331**	25	0	1	1
225a	S Aegean Sea	**222**	86	48	0	0	137	36	106	0	0	113	**387**	75	0	0

Sector code	Sector	1997 Depth (m)					1998 Depth (m)					1999 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	15	25	5	5	0	21	7	4	3	0	11	3	4	1	0
112a	Alicante	0	4	23	0	0	0	6	0	0	0	0	3	18	0	0
113a	Catalan Sea	0	10	0	0	0	8	13	0	-1	0	0	5	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0	1	0
121a	W Gulf of Lions	**205**	21	0	0	0	**213**	24	0	0	0	**392**	22	7	0	0
121b	E Gulf of Lions	**241**	8	4	0	0	**301**	8	41	0	0	191	0	0	0	*
131a	NE Corsica	*	0	*	0	0	*	0	0	0	0	*	0	0	0	0
131b	SE Corsica	*	72	0	0	*	*	0	0	0	0	*	8	0	0	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132b	E Ligurian Sea	18	57	2	0	0	3	22	0	0	0	13	50	0	0	0
132c	N Tyrrhenian	0	13	2	0	0	0	3	0	0	0	0	12	4	0	0
132d	C Tyrrhenian	14	4	3	0	0	14	0	0	0	0	4	0	1	0	0
133a	SE Sardinia	87	54	0	0	0	72	81	0	0	0	66	68	0	0	0
133b	NE Sardinia	**347**	106	0	0	0	98	82	0	0	0	89	39	0	0	0
133c	N Sardinia	181	**228**	0	0	0	115	9	7	0	0	0	7	0	0	0
133d	NW Sardinia	152	8	0	0	0	0	92	0	0	0	0	9	0	0	0
133e	W Sardinia	36	104	0	0	0	30	14	0	0	0	0	0	0	0	0
133f	SW Sardinia	**230**	170	0	0	0	108	85	0	0	0	97	52	0	0	0
133g	S Sardinia	146	0	0	0	0	35	0	0	0	0	17	12	0	0	0
134a	SE Tyrrhenian	11	19	2	0	0	17	15	2	0	0	11	0	0	0	0
134b	SW Tyrrhenian	6	44	42	1	0	35	34	10	0	0	11	11	44	11	0
134c	Sicilian Chan.	84	**211**	4	0	0	23	104	6	0	0	51	174	10	0	0
211a	N Adriatic Sea	**375**	28	*	*	*	41	5	*	*	*	**361**	114	*	*	*
211b	Central Adriatic	0	0	0	0	0	0	25	0	4	*	0	32	1	0	*
211c	N Adriatic-Slov	**1463**	*	*	*	*	**853**	*	*	*	*	**725**	*	*	*	*
211d	NE Adri Croatia	**446**	120	7	0	*	**213**	66	7	0	*	0	*	*	*	*
221a	E Sicily	31	10	0	14	0	74	22	0	0	0	15	33	0	0	0
221b	NW Ionian Sea	12	0	0	0	0	23	11	0	0	0	23	11	0	0	0
221c	N Ionian Sea	0	0	0	0	0	7	0	0	0	0	0	7	11	0	0
221d	N Ionian Sea	22	0	0	0	0	0	0	0	0	0	0	23	0	2	0
221e	SW Adriatic	*	37	0	0	0	*	0	0	0	0	*	7	3	0	0
221f	SW Adriatic	24	15	0	0	0	32	8	0	0	0	30	0	8	0	0
221g	SW Adriatic	12	8	0	*	0	22	8	0	*	0	0	15	7	*	0
221h	SW Adriatic	13	4	0	0	0	63	11	0	0	0	39	54	9	20	0
221i	SE Adriatic	130	16	0	0	0	166	53	6	0	0	**642**	35	7	4	0
222a	E Ionian Sea	0	0	0	0	0	7	75	4	0	0	10	5	0	0	0
223a	Argosaronikos	**242**	147	6	0	0	191	19	0	0	0	189	177	3	0	0
224a	N Aegean Sea	189	7	0	0	0	**242**	22	5	0	0	**214**	66	13	1	0
225a	S Aegean Sea	160	**357**	32	1	0	**615**	**401**	81	1	0	**230**	**582**	58	0	0

TABLE 5. – *Eledone moschata*: mean biomass (in kg/km^2) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994 - 1999). Not sampled strata are indicated by *. Values higher than 20 kg/km^2 are presented in bold.

Sector code	Sector	1994 Depth (m) 10-50	50-100	100-200	200-500	500-800	1995 Depth (m) 10-50	50-100	100-200	200-500	500-800	1996 Depth (m) 10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	0	9.5	0	0	0	18.69	7.1	0	0.3	0	7.2	13.1	0	0.5	0
112a	Alicante	0	0	1.6	0	0	0	3.4	0.9	0	0	0	0.5	0.6	0	0
113a	Catalan Sea	0	4.7	0	0	0	1.2	1.6	0.2	0	0	0.6	1.1	0.5	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	16.1	11	0	1.6	0	**36.9**	2.1	0	0	0	**28.9**	1.9	0	0	0.4
121b	E Gulf of Lions	18.2	3.0	0.3	0	0	**44.8**	6.3	1.4	0	0	**21.8**	1.0	1.2	0	0
131a	NE Corsica	*	19.0	0	0	0	*	13.7	0	0	2.2	*	9.8	6.4	0	0
131b	SE Corsica	*	0	0	0	0	*	5.8	0	0	0	*	16.9	0	1.1	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132b	E Ligurian Sea	1.0	10.6	0.5	0	0	0.1	3.1	0	0	0	1.1	3.4	0	0	0
132c	N Tyrrhenian	0	17.8	0	0	0	6.1	0.9	0	0	0	0	0	0	0	0
132d	C Tyrrhenian	4.7	4.5	0.3	0	0	2.8	0.2	0	0	0	1.4	0	0	0	0
133a	SE Sardinia	6.9	**34.1**	16.1	0	0	14.0	**23.9**	0	0	0	3.2	6.7	0	0	0
133b	NE Sardinia	0	10.3	0	0	0	1.8	1.6	0	0	0	16.6	6.2	0	0	0
133c	N Sardinia	11.1	12.0	0	0	0	17.5	**28.3**	0	0	0	**22.1**	17.1	0	0	0
133d	NW Sardinia	1.9	4.4	0	0	0	*	1.3	0	0	0	0	0	0	0	0
133e	W Sardinia	6.2	*	0	0	0	3.5	4.5	0	0	0	0.3	1.0	0	0	0
133f	SW Sardinia	13.3	10.6	0	0	0	9.6	4.0	0.2	0.1	0	5.0	1.3	0	0	0
133g	S Sardinia	0	0	0	0	0	0	*	0	0	0	0	0	0	0	0
134a	SE Tyrrhenian	1.8	8.2	0.2	0	0	3.7	0.5	0	0	0	2.6	0.7	0	0	0
134b	SW Tyrrhenian	5.8	3.8	2.2	0	0	7.5	0.6	5.6	0	0	0	1.4	2	0.6	0
134c	Sicilian Chan.	3.3	**22.6**	0	0	0	6.7	19.1	0.0	0	0	4.3	**22.6**	0.5	0	0
211a	N Adriatic Sea	7.7	0.8	*	*	*	**49.1**	5.1	*	*	*	**21.7**	0.5	*	*	*
211b	Central Adriatic	1.9	0	0	0	0	5.2	0	0	0	0	0.5	0.1	0	0	0
211c	N Adriatic-Slov	*	*	*	*	*	**336.1**	*	*	*	*	**163.7**	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	**38.5**	11.2	0.6	0.7	*
221a	E Sicily	0	7.7	0.7	0	0	13.9	0	0	0	0	**22.7**	0	0	0	0
221b	NW Ionian Sea	5.5	0	0	0	0	0	0	0	0	0	8.7	12.8	0	0	0
221c	N Ionian Sea	0.4	0	0	1.3	0	4.3	0	0	0	0	0	2.8	0	0	0
221d	N Ionian Sea	*	0	0	0	0	9.9	0	2.0	0	0	0	3.8	0	0	0
221e	SW Adriatic	0	7.5	0	0	0	*	0	0	0	0	*	4.8	0	0	0
221f	SW Adriatic	7.6	1.9	0	0	0	14.3	1.2	0	0	0	2.3	1.7	0	0	0
221g	SW Adriatic	5.3	16.9	0	*	0	4.7	1.7	0	*	0	0	0	0	*	0
221h	SW Adriatic	13.3	7.0	0	0	0	7.8	1.2	0	0	0	2.8	0	0	0	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	12.1	7.0	0	0	0
222a	E Ionian Sea	0.7	19.6	0	0	0	2.1	0.9	1.3	0	0	0	4.8	0	0	0
223a	Argosaronikos	0	0	3.3	18.1	0	**29.7**	2.0	1.3	0	0	0	**26.0**	0.9	0	0
224a	N Aegean Sea	3.0	0.1	0	0	0	1.3	0.7	0	0	0	**81.5**	8.7	0	0.3	0
225a	S Aegean Sea	**21.3**	15.7	8.7	0	0	17.4	3.6	8.2	0	0	**28.7**	**35.3**	8.6	0	0

Sector code	Sector	1997 Depth (m) 10-50	50-100	100-200	200-500	500-800	1998 Depth (m) 10-50	50-100	100-200	200-500	500-800	1999 Depth (m) 10-50	50-100	100-200	200-500	500-800
111a	Alborán Sea	2.0	2.8	0.4	0.7	0	3.3	2.4	0.7	0.4	0	1.5	0.8	1.9	0.3	0
112a	Alicante	0	0.2	0.9	0	0	0	0.6	0	0	0	0	0.1	5.1	0	0
113a	Catalan Sea	0	2.0	0	0	0	1.1	1.2	0	*	0	0	0.4	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	0	0	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0	0.1	0
121a	W Gulf of Lions	**25.0**	2.5	0	0	0	**30.7**	4.6	0	0	0	**37.3**	1.9	1.0	0	0
121b	E Gulf of Lions	**20.2**	1.9	0.4	0	0	**55.9**	1.4	8.6	0	0	**24.5**	0	0	0	*
131a	NE Corsica	*	0	*	0	0	*	0	0	0	0	*	0	0	0	0
131b	SE Corsica	*	16.8	0	0	*	*	0	0	0	0	*	2.9	0	0	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
132b	E Ligurian Sea	0.3	3.4	0.2	0	0	0.2	1	0	0	0	1.7	6.1	0	0	0
132c	N Tyrrhenian	0	5.9	1.5	0	0	0	0.2	0	0	0	0	1.7	0.4	0	0
132d	C Tyrrhenian	3.2	0.2	0.9	0	0	2.5	0	0	0	0	0.4	0	0.6	0	0
133a	SE Sardinia	7.4	4.0	0	0	0	6.6	**28.4**	0	0	0	9.9	**32.6**	0	0	0
133b	NE Sardinia	**37.7**	11.1	0	0	0	**20.8**	19.9	0	0	0	8.6	13.5	0	0	0
133c	N Sardinia	16.21	27.9	0	0	0	19.8	3.4	1.1	0	0	0	2.5	0	0	0
133d	NW Sardinia	**23.5**	0.8	0	0	0	0	8.8	0	0	0	0	0.4	0	0	0
133e	W Sardinia	5.7	11.9	0	0	0	4.4	2.7	0	0	0	0	0	0	0	0
133f	SW Sardinia	**22.4**	11.46	0	0	0	10.8	6.7	0	0	0	7.5	2.6	0	0	0
133g	S Sardinia	12.7	0	0	0	0	6.0	0	0	0	0	6.0	10.7	0	0	0
134a	SE Tyrrhenian	1.5	1.6	0.7	0	0	3.4	4.0	0.5	0	0	2.6	0	0	0	0
134b	SW Tyrrhenian	0.4	10.9	5.1	0.4	0	15.2	8.7	3.0	0	0	3.7	1.6	2.6	1.9	0
134c	Sicilian Chan.	10.8	**21.3**	0.1	0	0	1.5	12.6	0.6	0	0	5.2	**20.0**	1.1	0	0

TABLE 5 (Cont.). – *Eledone moschata*: mean biomass (in kg/km^2) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Not sampled strata are indicated by *. Values higher than 20 kg/km^2 are presented in bold.

Sector code	Sector	1997 Depth (m)					1998 Depth (m)					1999 Depth (m)				
		10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800	10-50	50-100	100-200	200-500	500-800
211a	N Adriatic Sea	**47.5**	1.7	*	*	*	5.9	0.2	*	*	*	**59.9**	8.8	*	*	*
211b	Central Adriatic	0	0	0	0	0	0	2.9	0	1.5	*	0	2.7	0.0	0	*
211c	N Adriatic-Slov	**190.7**	*	*	*	*	**121.5**	*	*	*	*	**141.8**	*	*	*	*
211d	NE Adri Croatia	**49.4**	9.8	0.6	0	*	19.5	4.3	1.5	0	*	0	*	*	*	*
221a	E Sicily	8.7	5.7	0	4.1	0	**31.8**	11.1	0	0	0	3.8	18.7	0	0	0
221b	NW Ionian Sea	0.16	0	0	0	0	8.2	4.3	0	0	0	5.3	4.7	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0.1	0	0	0	0	0	3.8	5.2	0	0
221d	N Ionian Sea	2.2	0	0	0	0	0	0	0	0	0	0	3.5	0	1.0	0
221e	SW Adriatic	*	7.9	0	0	0	*	0	0	0	0	*	0.2	0.6	0	0
221f	SW Adriatic	5.2	3.9	0	0	0	4.2	1.0	0	0	0	5.9	0	1.7	0	0
221g	SW Adriatic	3.4	1.8	0	*	0	3.8	1.1	0	*	0	0	2.9	4.1	*	0
221h	SW Adriatic	3.4	1.0	0	0	0	10.81	1.4	0	0	0	7.6	9.3	2.0	4.0	0
221i	SE Adriatic	10.8	2.6	0	0	0	**29.0**	10.5	0.68	0	0	**45.7**	4.7	0.9	0.1	0
222a	E Ionian Sea	0	0	0	0	0	2.1	6.3	1.7	0	0	1.0	0.1	0	0	0
223a	Argosaronikos	**82.5**	**76.1**	0.8	0	0	**88.1**	5.5	0	0	0	**75.9**	**26.6**	1.6	0	0
224a	N Aegean Sea	**26.4**	1.0	0	0	0	**49.9**	1.9	0.1	0	0	**37.9**	3.3	1.3	0.1	0
225a	S Aegean Sea	14.4	**23.2**	2.1	0.1	0	**33.9**	**28.4**	11.3	0.0	0	**34.9**	**35.3**	6.0	0	0

TABLE 6. – ANOVA for the General Linear Models fitted to the Catch per Unit Effort (g/km^2) indices.

Eledone cirrhosa (r^2 = 0.66)

Source of variation	Type III Sum of Squares	Df	Mean Square	F	Signif. level
Intercept	22859.73	1	22859.72	3265.97	0
Year	90.28	5	18.05	2.58	0.02
Major area	2805.9	13	215.84	30.83	0
Depth	5204.98	4	1301.25	185.91	0
Year * major area	675.47	65	10.39	1.48	0.01
Year * depth	145.07	20	7.25	1.04	0.41
Major area * depth	1173.86	51	23.02	3.29	0
Error	6145.44	878	6.99		
Corrected Total	18376.33	1036			

Eledone moschata (r^2 = 0.51)

Source of variation	Type III Sum of Squares	Df	Mean Square	F	Signif. level
Intercept	11231.88	1	11231.88	1052.22	0
Year	72.93	5	14.59	1.37	0.23
Major area	1222.38	13	94.03	8.81	0
Depth	923.46	2	461.73	43.26	0
Year * major area	795.39	65	12.24	1.15	0.21
Year * depth	149.21	10	14.92	1.4	0.18
Major area * depth	900.14	25	36.01	3.37	0
Error	5422.62	508	10.67		
Corrected Total	11077.9	628			

The spatial distribution of both species followed a rather complex pattern and there were noticeable fluctuations among areas, particularly for *E. moschata* (Fig. 2). In some areas, such as the northern Tyrrhenian seas, the northern Adriatic and the southern Aegean, there appeared to be an inverse relationship regarding the abundance of the two *Eledone* species. In other areas, both species showed high abundance, as in the Gulf of Lions. *E. cirrhosa* was more abundant in the western Mediterranean and its highest index was computed for the Gulf of Lions. In this area a high abundance of *E. moschata* was also observed. Both species were found in relatively lower abundance in the southern Adriatic and Ionian seas. The highest abundance of *E. moschata* was observed in the southern Aegean Sea.

The standardised abundance indices by depth stratum shown in Figure 3, confirm the narrower depth distribution of *E. moschata*. The highest indices were computed for depths up to 100 m. In contrast, *E. cirrhosa* was found at all depths but it was more abundant in the 50-500 m depth strata.
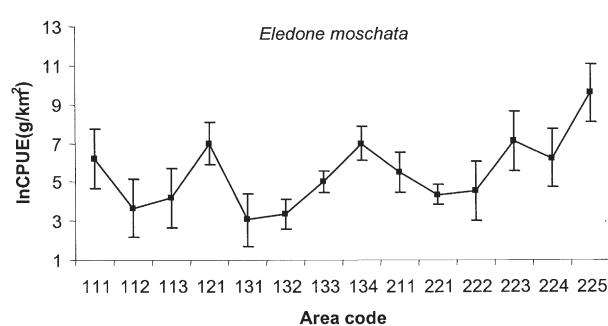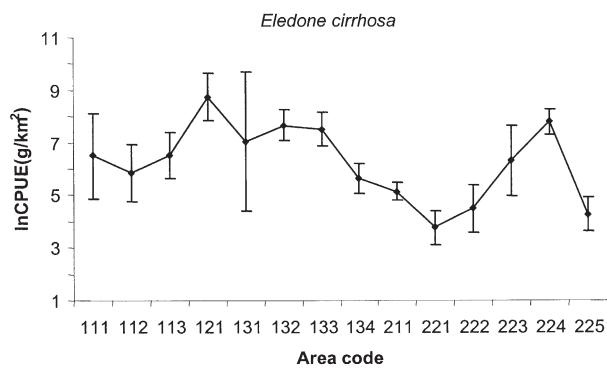
FIG. 2. – Standardised CPUE estimates (marginal means) for *Eledone cirrhosa* and *Eledone moschata* by area. Vertical lines indicate the 95% confidence intervals of the corresponding estimates. Area codes correspond to the area names mentioned in Table 1.
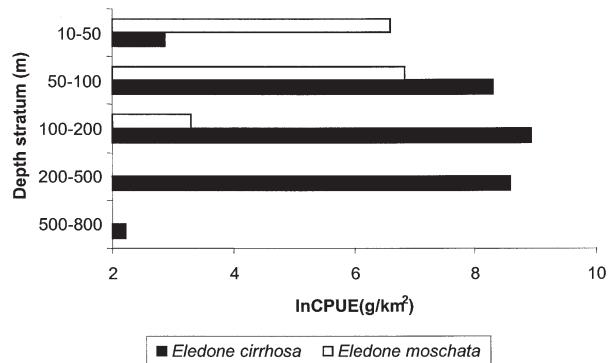

FIG. 3. – Standardised CPUE estimates (marginal means) for *Eledone cirrhosa* and *Eledone moschata* by depth stratum.

Size structure

The distribution of the annual length frequencies by sub-area was far from normal in most of the cases.

Two cohorts were generally present in *E. cirrhosa* catches (Figs. 4 and 5). Small individuals (ML: 1-5 cm) were present in the entire study area except from the southern Aegean Sea, where recruitment was sparsely observed during the sampling season. Recruits with modal lengths from 2 to 4 cm constituted the dominant mode in the Gulf of Lions,
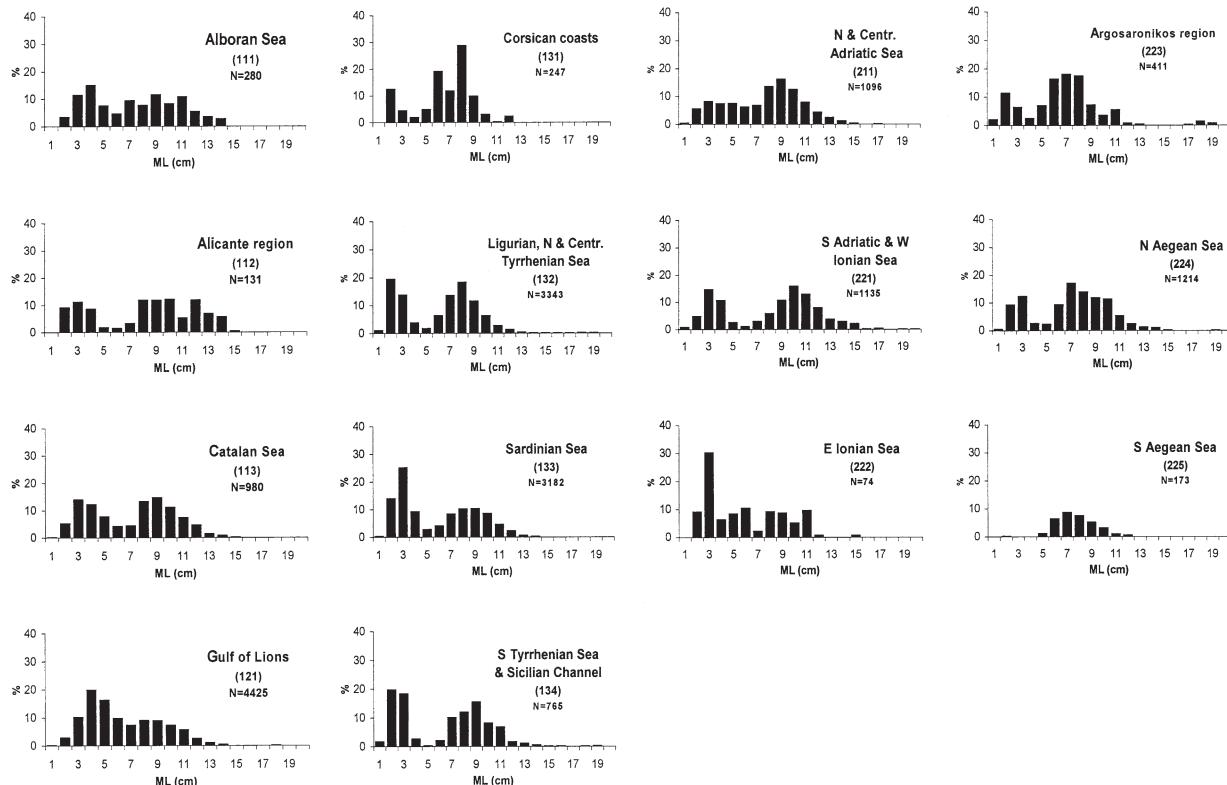
FIG. 4. – Demographic structure of *Eledone cirrhosa* on the continental shelf: results from MEDITS 1994-1999 trawl surveys.
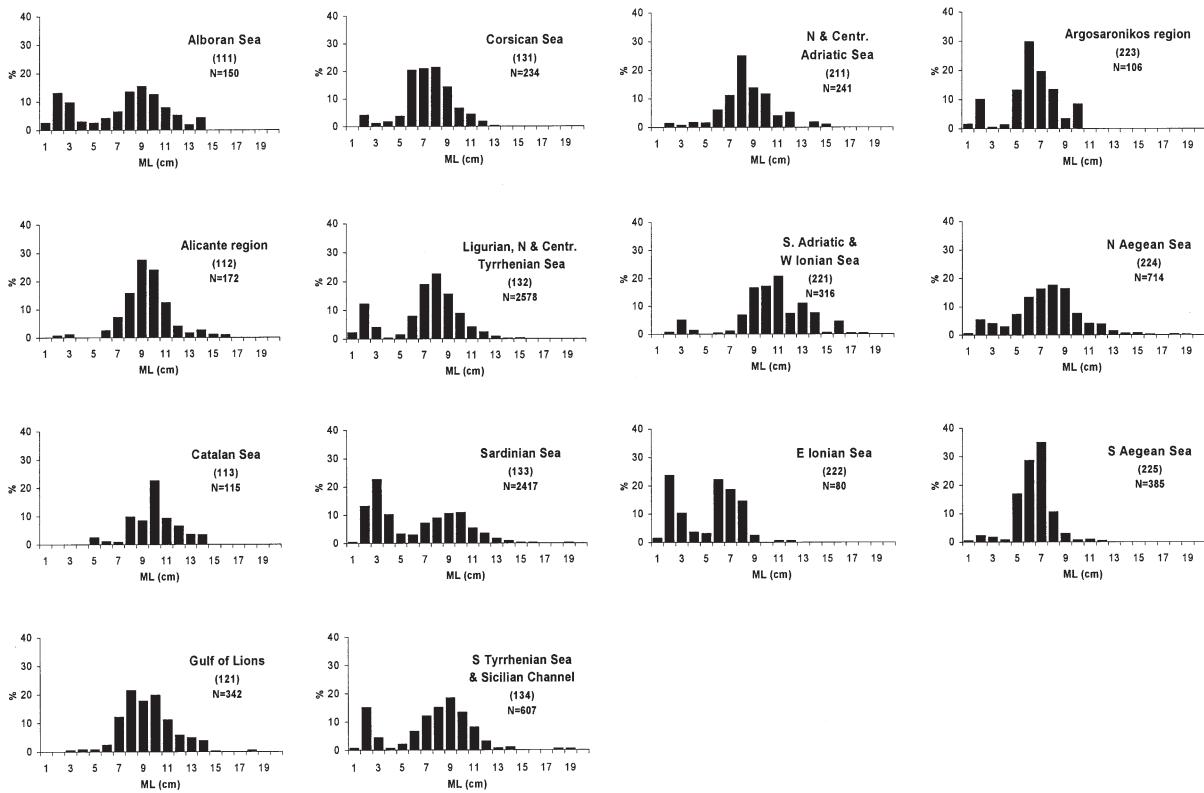
FIG. 5. – Demographic structure of *Eledone cirrhosa* on the continental slope: results from MEDITS 1994-1999 trawl surveys.

southern Tyrrhenian Sea, Sardinian and Sicilian waters. Greater individuals with modal lengths from 6 to 9 cm ML dominated in the Aegean, Adriatic, western Ionian, Ligurian and northern Tyrrhenian seas, the Corsican coasts, and the Alicante and Argosaronikos regions. Comparison of length compositions on shelf and slope showed significant variations ($P < 0.05$) between the two depth strata in all areas. Recruits (1-5 cm ML) were mainly distributed on the shelf, especially in areas with a wide continental shelf, such as the Gulf of Lions, the Catalan Sea and the Adriatic Sea.

One mode can be clearly distinguished in most of the length distributions of *E. moschata* (Fig. 6).
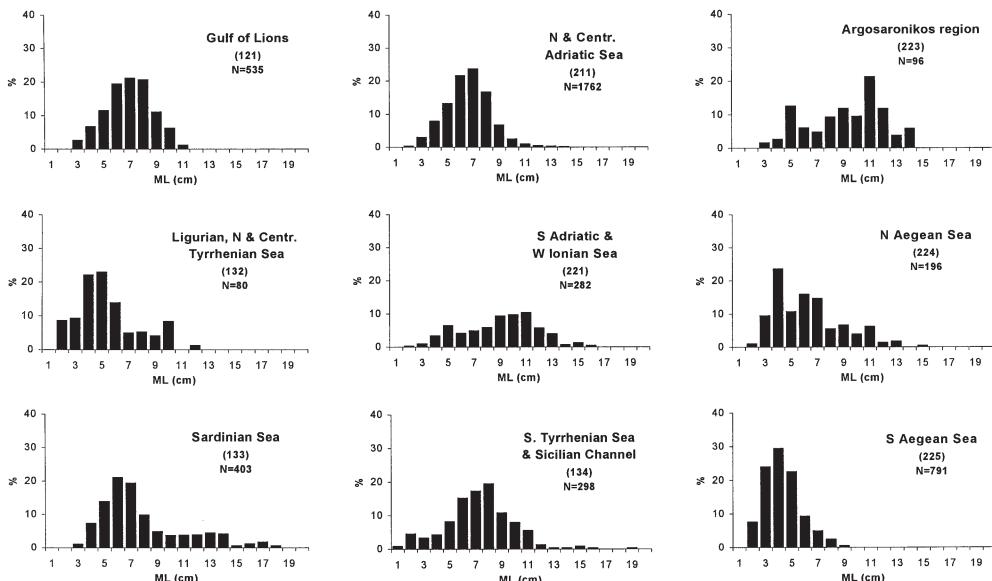
FIG. 6. – Demographic structure of *Eledone moschata*: results from MEDITS 1997-1999 trawl surveys.

Catches obtained in the Gulf of Lions, northern Adriatic Sea and southern Aegean Sea, showed a relatively restricted size range. In other macro-areas, size range proved to be wider (ML:1-19 cm) and it was more difficult to single out only one predominant size. The modal mantle length varied considerably between the areas, presenting the lowest values (3-5 cm) in Aegean, Ligurian and northern Tyrrhenian seas.

The length structures of the populations of both eledonids during the MEDITS sampling season were found significantly different between the major areas (P< 0.05).

DISCUSSION

The MEDITS project allowed data to be collected on the two octopuses *E. cirrhosa* and *E. moschata* in a wide area of the Mediterranean, providing useful information on distribution, demographic structure and abundance from areas not yet widely investigated. Comparisons between the different areas were allowed by the common methodology used in the surveys. The two species showed a wide geographical distribution, as they were collected in all the major areas investigated although notable differences were evidenced among the 40 geographic sectors. The pattern of spatial distribution confirmed data already reported in the literature, *E. cirrhosa* being present in a wide bathymetric range, up to the 800 m isobath, with recruits concentrating mainly on the shelf, and *E. moschata* mostly restricted to within 200 m, but sometimes found at greater depths, as in the Aegean Sea (Boyle, 1983; Mangold, 1983; Würtz *et al.*, 1992; Belcari and Sartor, 1993; D' Onghia *et al.*, 1995; Sánchez *et al.*, 1998).

The highest densities of *E. cirrhosa* were found in the Gulf of Lions, in the Ligurian and northern Tyrrhenian seas and in the northern Aegean Sea. The latter finding is of interest since the presence of *E. cirrhosa* has only recently been reported in this area (Tursi *et al*., 1995): until just a few years ago it was considered uncertain because of the small number of studies conducted there (Mangold and Boletzky, 1987). Biomass estimates available for the western coasts of Italy (Würtz *et al*., 1992) corroborate the present finding that the main biomass of the species in Italian waters is concentrated in the eastern Ligurian and northern Tyrrhenian seas.

The present study highlights a decreasing trend of the overall annual abundance of *E. cirrhosa*, while *E.*

moschata abundance seems much more stable. Considering that the official landed catch statistics generally pool the two species together or with *Octopus vulgaris* (Worms, 1979; Sánchez and Martín, 1993; Belcari *et al.*, 1998; Quetglas *et al.*, 1998), comparisons with previous data are possible only in the few areas investigated by means of experimental surveys or observations on commercial landings. In the northern Tyrrhenian Sea, a decreasing trend in experimental catches of *E. cirrhosa* was noticed (Biagi *et al.*, 1998), while from the evaluation of landings in the Ligurian Sea, Relini *et al.* (1998) reported an increase in catches per unit effort.

Despite the economic importance of *E. moschata,* especially on the southern and eastern coasts of the Mediterranean and in the Adriatic Sea (Mangold, 1983), few fishery surveys and analysis of landings are available. Investigations reporting a slight decrease of annual catches date back to several years ago (Gamulin-Brida, 1963; Moriyasu, 1981).

The present results confirm the discontinuous pattern in the catches presented by both octopods. Apart from environmental conditions that may markedly affect the stocks, annual fluctuations in abundance should be related to the peculiarities of species dynamics and to fishing strategies, that take advantage of these characteristics.

Because of the short life span, rapid population turnover and reproductive period, which displays seasonal sexual maturity and post-reproductive mortality (Mangold-Wirz, 1963; Boyle, 1983), marked differences in the demographic structure of the population sampled in different seasons or different areas can be detected. Size frequency distributions of *E. cirrhosa* from MEDITS surveys, clearly show two components in almost all areas, even if with different amplitude, corresponding to the two cohorts of trawl net recruits and adults, respectively. The exception of the southern Aegean Sea is not easily interpretable: the lack of recruits could be due to the scarcity of catches or to the postponement of the reproductive period. In the Mediterranean, sexual maturity occurs generally earlier in the western basin (spring-summer) than in the eastern basin (summer-autumn) (Belcari *et al.,* 1990; Sánchez and Martín, 1993; Lefkaditou and Papacostantinou, 1995; Tursi *et al.*, 1995; Agnesi *et al.*, 1998).

The reproductive period of *E. moschata* investigated by Mangold-Wirz (1963) in the Banyuls population (Gulf of Lions) seems to extend from winter until spring, with the disappearance of large size individuals from the catch in April-May (Mangold-

Wirz, 1963). Experimental research cruises conducted in the Adriatic in May (Manfrin-Piccinetti and Rizzoli, 1984) still show the contemporary presence of two age classes: young individuals and adults. MEDITS samplings, carried out from May onwards, highlight the presence of one age class in most of the investigated areas. However, the prolonged spawning season and long brooding period could explain the wide size range detected in some areas, and support the existence of cohorts with different growth rates depending on the hatching period, as hypothesised by Mangold (1983), who proposed a model of alternating short-long cycles which would be very flexible according to environmental conditions.

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