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MEDITERRANEAN MARINE DEMERSAL RESOURCES: THE MEDITS INTERNATIONAL TRAWL SURVEY (1994-1999).
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Distribution and abundance of *Citharus linguatula*, *Lepidorhombus boscii*, and *Solea vulgaris* (Osteichthyes: Pleuronectiformes) in the Mediterranean Sea*

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SUMMARY: Information on distribution, relative abundance and size composition of the pleuronectiform species *Citharus linguatula*, *Lepidorhombus boscii* and *Solea vulgaris* was obtained during the "MEDITS" trawl surveys, carried out in a wide area of the Mediterranean Sea from 1994 to 1999. The three species showed a wide geographic distribution, as they were collected in all the macro-areas investigated, but with some differences in degree of presence among the 40 geographic sectors. Variations in abundance indices, analysed on a spatio-temporal basis with a Generalised Linear Model, were mostly related to the depth stratum and the macro-area. *C. linguatula* and *S. vulgaris* were especially found from 10 to 100 m depth, while *L. boscii* was most abundant on bottoms ranging from 100 to 500 m depth. The three species showed the highest abundance indices (kg/km^2) in the Gulf of Lions, in the Greek Seas and along the Sardinian coasts. Especially for *L. boscii* and *C. linguatula*, the demographic structure showed that the sampled populations were mainly constituted by juveniles. The lowest biomass and abundance indices were obtained for *S. vulgaris,* whose catch was mainly composed of adult fish.

Key words: Pleuronectiformes, distribution, abundance estimations, trawl surveys, Mediterranean Sea, *Citharus linguatula*, *Lepidorhombus boscii*, *Solea vulgaris*

INTRODUCTION

Pleuronectiformes constitutes a very distinctive taxon: adults of the species belonging to this group show a marked asymmetry of the body, a unique phenomenon among all Vertebrates. The body is highly compressed ("flatfish"), somewhat rounded on the eyed side and flat on the blind side. The specimens live and swim on the eyeless side. The upper side is pigmented and frequently highly mimetic, whereas the lower side is usually non-pigmented. Flatfish are typical marine benthic species, which live on soft, sandy or muddy bottoms. Most species are littoral or sublittoral, although deep-water species are also present.

A total of 538 extant species of Pleuronectiformes are reported in the world, belonging to 117 genera and six families (Nelson, 1984). According

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to Fischer *et al.* (1987), 34 species belonging to six Families (Bothidae, Citharidae, Cynoglossidae, Pleuronectidae, Scophtalmidae and Soleidae) are reported for the Mediterranean basin. Many Pleuronectiformes species are valued as food sources and are intensely exploited in the world. Fishing activity involving flatfish is mainly carried out with towed gears (i.e. otter and beam trawls), although passive gears (i.e. set nets) are also commonly employed to catch these species. In the Mediterranean basin, flatfish provide an important contribution to commercial landings. Common sole, *Solea vulgaris* Quensel 1806 (common synonym *Solea solea* Linnaeus 1758), is undoubtedly the most important species of this group in the area, especially concerning its commercial value. According to FAO statistics (Stamatopoulos, 1993), annual landings of *S. vulgaris* in the Mediterranean increased from about 4,500 tons in 1972 to about 10,000 tons in 1992. Mediterranean trawl landings include Spotted Flounder *Citharus linguatula* (Linnaeus, 1758) and Four-spotted Megrim *Lepidorhombus boscii* (Risso, 1810), which are regularly present at domestic markets and represent important by-catches (Relini *et al*., 1999).

On account of their ecological, morphological and behavioural peculiarities, Pleuronectiformes are currently the object of many studies. However, to date, there is still a lack of basic information for correct management of these resources, especially in the Mediterranean area. The "MEDITS" research project has made it possible for the first time to collect a large dataset in a wide area of the Mediterranean Sea by means of experimental trawl surveys (Bertrand *et al.*, 2000, 2002), thereby improving knowledge on demersal species on a large geographical scale.

The aim of this paper is to provide information on relative abundance and demographic structure of *C. linguatula*, *L. boscii* and *S. vulgaris*, which are important not only for their commercial value but also because of their abundance in trawl catches in the Mediterranean Sea. In this area, available information on *S. vulgaris* mostly derives from studies on ecology and biology, but only on a small geographical scale (Pagotto *et al*., 1979; Ramos, 1982a, 1982b, 1983, 1985; Cau and Deiana, 1983; Piccinetti and Giovanardi, 1984; Froglia and Giannetti, 1985, 1986; Vianet and Quignard, 1986; Pagotto and Piccinetti, 1988; Paci *et al*., 1989). The same is true for *L. boscii* (Bello and Rizzi, 1987; Mannini *et al*., 1990; Sabatés, 1991; Sartor *et al*., 1993; Ungaro and Marano, 1995; Sartor and De Ranieri, 1996; Ungaro and Martino, 1998) and for *C. linguatula* (Planas and Vives, 1956; Jardas, 1983, 1984; Sabatés, 1988; Redon *et al*., 1994; Vassilopoulou and Papaconstantinou, 1994; García-Rodríguez and Esteban, 2000).

MATERIAL AND METHODS

The "MEDITS" project (Bertrand *et al*., 2000, 2002) was carried out in a wide area of the Mediterranean Sea, concerning mainly European waters, from the Alborán Sea to the South Aegean Sea. In the period 1994-1999, six late spring - early summer experimental trawl surveys were carried out, performing a total of 6,336 hauls within the depth range 10-800 m. An experimental trawl net (GOC 73) with 10 mm cod-end mesh size (knot to knot) was employed for the sampling.

The study area was subdivided into 40 geographical sectors and five depth strata: A: 10-50 m, B: 50-100 m, C: 100-200 m, D: 200-500 m, E: 500-800 m. Selection of sampling stations was based on a depth-stratified sampling scheme, taking into account the surface area of each stratum. A detailed map of the sampled area and further details of the sampling design, methodology and sampling gear are described in Bertrand *et al.* (2000, 2002).

For each haul, the specimens caught of *C. linguatula*, *L. boscii* and *S. vulgaris* were counted and total weight of each species was recorded. Total length (TL, to the next lower 0.5 cm) was then recorded for each individual caught. Raw catch data (biomass and number of specimens collected) were converted to catch rates with a specifically developed software (Souplet, 1996) in order to compute abundance (number of specimens/km^2) and biomass indices (kg/km^2). Catch rates of the three species were analysed as mean value per year of sampling, geographic sector and bathymetric stratum.

Variation in biomass indices was investigated on a spatio-temporal basis. For this analysis, in order to obtain readable and effective information, the 40 geographical sectors were pooled in five geographic macro-areas, according to the "old" GFCM (General Fisheries Council for the Mediterranean) indications (Stamatopoulos, 1993; Relini *et al*., 1999): Morocco-Spain-France (ex GFCM 1.1 and 1.2), Sardinian-Tyrrhenian Sea (ex GFCM 1.3), Adriatic Sea (ex GFCM 2.1), Ionian Sea (ex GFCM 2.2), Aegean Sea (ex GFCM 3.1). Data concerning the two

Moroccan sectors were not included in this analysis, since sampling in these areas only started in 1999. The variation of the biomass indices with macro-area, depth stratum and year, was studied using Generalised Linear Models (GLMs) (McCullagh and Nelder, 1989; Chambers and Hastie, 1992). The analyses were performed by applying the routines contained in the S-Plus programming environment (Becker *et al*., 1988). Following the approach of Stéfansson (1996) a gamma distribution was used in the analysis since the frequency distribution of the biomass indices was skewed and the variance proportional to nearly the square of the mean. The following generalised linear model was used:

$$\text{Ln}(\text{Biomass Index}_{ijk}) = \\ = \mu + A_i + D_j + Y_k + \text{interaction} + \varepsilon_{ijk}$$

where:

Biomass Index_{ijk}: expected value of g/km^2 at the macro-area i, in the depth stratum j and in the year k;

μ: overall mean;

A_i: effect of macro-area i;

D_j: effect of depth stratum j

$Y_{k:}$: effect of year k;

interaction: any possible combination of interaction between two effects

ε: error term assumed to be distributed normally.

Standardisation was performed on biomass indices expressed in g/km^2. The constant 1 was added to the abundance values to account for zero values. Analysis of deviance to evaluate the significance of the main factors and interactions in the model was performed. All covariates are considered as fixed factors.

Subsequently, the demographic structure of the three species was studied considering the six years of sampling jointly, according to the five above mentioned macro-areas.

RESULTS

Citharus linguatula

The Spotted Flounder was frequently caught in the macro-areas 1.1-1.2 and 3.1 (with a percentage occurrence of 34% and 33%, respectively). In the other macro-areas, this species was collected in a percentage ranging from 10% to 18% of total hauls. It is worth noting that *C. linguatula* was never caught in some geographic sectors, such as north and south-east Sardinia, north Ionian Sea and south-west Adriatic Sea (Tables 1 and 2). This species was mainly found in the first three depth strata, its presence being occasionally noted down to 200 m. For this reason further analyses were confined to the first three depth strata.

Results from the analysis of deviance for the GLM model indicated that the differences in biomass indices observed among macro-areas as well as among depth strata and years were significant (Table 3). In addition, the variations explained by interactions between year and macro-area and between stratum and macro-area were also significant. The model accounted for 91% of the deviance, with most of the variation being due to differences between macro-areas.

Highest biomass indices were estimated in the Aegean Sea, followed by those of the Spain-France macro-area (Fig. 1; Table 4). The high values of this last macro-area were mostly due to the two sectors in the Gulf of Lions (Table 1). High biomass values, greater than 10 kg/km^2, were also observed along the Moroccan and Sardinian coasts in 1999 (Table 1). Biomass indices were found to be significantly ($p<0.0001$) higher in the depth range 50-100 m (Table 3; Fig. 1), despite the fact that in some sectors the highest values were obtained in the other two strata. This finding supported the significance ($p<0.001$) of the interaction between stratum and macro-area. The differences ($p<0.05$) among years in all macro-areas studied were due to the notably lower biomass value obtained in the first year of study (Fig.1 and Table 4). In general, the abundance indices expressed in number of individuals per km^2 provided a similar trend to that shown by the corresponding weight index (Table 2).

The size range of individuals caught during the six years of sampling was 4-34 cm TL, although most of the catch was comprised between 6 and 20 cm TL. Length frequency distributions obtained in each macro-area (Fig. 2) are characterised by two modes, the first corresponding to 7-9 cm TL and the second to 12-14 cm TL.

The catches obtained in the Sardinian-Tyrrhenian Sea macro-area showed the highest presence, albeit only occasional, of larger individuals (greater than 26 cm TL). Specimens caught in the Adriatic Sea were characterised by the smallest size range (from 5 to 24 cm TL).

Considering the entire "MEDITS" area, the number of specimens included in the first mode (lower

TABLE 1. – *Citharus linguatula*: Mean biomass (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 10 kg/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	Alborán Sea	1.3	0	0	0	0	2.4	7.0	0	0	0	0	0.4	0	0	0
112a	Alicante	1.5	5.1	0	0	0	0.5	**17.5**	3.2	0	0	0	0.8	0.3	0	0
113a	Catalan Sea	1.2	2.5	0.4	0	0	**21.4**	**14.9**	6.7	0	0	0	0.5	0.3	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	1.7	6.9	1.4	0	0	1.1	**16.1**	0	0	0	0.4	**12.6**	0	0	0
121b	E Gulf of Lions	0	**14.9**	**14.1**	0	0	1.9	**29.5**	**19.0**	0	0	0.1	**27.7**	**16.5**	0	0
131a	NE Corsica	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
131b	SE Corsica	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	1.8	0	0	0	1.1	0	0.5	0	0	0	0.1	0	0	0
132b	E Ligurian Sea	0	0.6	0.3	0	0	0	0.3	0.1	0	0	0	0.4	0.2	0	0
132c	N Tyrrhenian	0	0.7	0.3	0	0	0	0.7	0.2	0	0	0	0.3	0.1	0	0
132d	C Tyrrhenian	0.6	6.8	1.0	0.1	0	0.4	7.0	0.5	0	0	0.6	0.9	0.2	0.1	0
133a	SE Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133b	NE Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133c	N Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	3.9	0	0	0	*	1.1	2.6	0	0	0	9.3	3.6	0	0
133e	W Sardinia	0	0	0.2	0	0	0	1.8	0.6	0	0	0	4.0	0.2	0	0
133f	SW Sardinia	0	2.0	0.8	0	0	0.6	1.6	1.3	0	0	0	0.5	1.8	0.1	0
133g	S Sardinia	0	0	0	0	0	0	*	8.5	0	0	0	0	0.2	0	0
134a	SE Tyrrhenian	0	2.2	0.5	0	0	0.2	2.6	0.2	0	0	0	0.5	0.1	0	0
134b	SW Tyrrhenian	0	0	0.2	0	0	0	0.3	0	0	0	0	1.1	0	0	0
134c	Sicilian Chan.	0.2	0.1	0.9	0.1	0	0.1	4.2	1.2	0.1	0	0.1	5.0	1.7	0	0
211a	N Adriatic Sea	0	0.2	*	*	*	0.1	2.7	*	*	*	0.1	2.4	*	*	*
211b	Central Adriatic	0	0	0.1	0	0	0	0	0	0	0	0.1	1.1	0.2	0	0
211c	N Adriatic-Slov	*	0	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	0	*	*	*	*	*	*	*	*	4.5	**11.0**	1.0	0	*
221a	E Sicily	0	0	0.9	0	0	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221i	SE Adriatic	*	0	*	*	*	*	*	*	*	*	0.7	3.0	0.1	0	0
222a	E Ionian Sea	1.1	4.7	0	0	0	0	4.4	0	0	0	4.6	3.9	0.9	0	0
223a	Argosaronikos	2.2	**11.3**	1.4	0	0	1.9	**14.6**	8.6	0	0	5.6	**29.0**	1.1	0	0
224a	N Aegean Sea	2.0	4.7	1.3	0.1	0	2.3	5.4	2.3	0.1	0	**16.4**	9.8	4.7	0	0
225a	S Aegean Sea	0	7.0	3.0	0.1	0	0.5	3.6	6.2	0	0	0	**10.7**	7.0	0	0

		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	0	0.3	0	0	0	1.1	7.5	0	0	0	0	0	0.1	0	0
112a	Alicante	1.5	2.2	0.8	0.1	0	0.9	2.9	0.5	0	0	0.1	0.7	0.2	0	0
113a	Catalan Sea	0	1.3	0.6	0	0	0.5	2.3	1.5	*	0	0.4	0.2	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	0	**58.5**	7.9	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	5.2	0	3.5	0	0
121a	W Gulf of Lions	0.3	2.4	0	0	0	0.2	3.5	0	0	0	0.2	3.3	0.8	0	0
121b	E Gulf of Lions	0	8.3	2.5	0.1	0	0.1	5.3	8.1	0	0	0.2	5.6	**10.4**	0	*
131a	NE Corsica	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0
131b	SE Corsica	0	0	0	0	*	0	0	0.3	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	0.8	0.1	0	0	0	2.1	1.2	0	0	0.5	0.5	0	0	0
132b	E Ligurian Sea	0	0.6	0.1	0	0	0	0.5	0.1	0	0	0.1	0.8	0.2	0	0
132c	N Tyrrhenian	1.9	1.1	0.2	0	0	0.2	1.2	0.3	0	0	0	0.6	0.1	0	0
132d	C Tyrrhenian	1.4	1.7	0.3	0	0	0.3	1.6	0.6	0	0	0.3	0.7	0.3	0	0
133a	SE Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133b	NE Sardinia	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0
133c	N Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	**26.3**	6.0	0	0	0	4.7	4.4	0	0	0	**23.5**	5.5	0	0
133e	W Sardinia	1.1	0	0.2	0	0	0	2.7	1.2	0	0	0	**12.0**	**13.5**	0	0
133f	SW Sardinia	0	7.1	2.9	0	0	0.5	4.9	1.5	0	0	5.5	**11.4**	6.6	0.1	0.2
133g	S Sardinia	0	0	1.1	0	0	0.4	0	0.9	0	0	0	0	2.4	0	0
134a	SE Tyrrhenian	0.3	1.1	0.6	0	0	0	1.2	0.4	0	0	0	1.3	0.5	0	0
134b	SW Tyrrhenian	0	0	0.1	1.9	0	0	0	0	1.8	0	0	1.8	0	0.1	0.1

TABLE 1 (Cont.). – *Citharus linguatula*: Mean biomass (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 10 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
134c	Sicilian Chan.	0	4.6	2.5	0.2	0	0	4.1	1.0	0	0	0	3.3	2.1	0	0
211a	N Adriatic Sea	0.1	1.8	*	*	*	0.1	2.4	*	*	*	0.1	0.7	*	*	*
211b	Central Adriatic	0	1.2	0	0	0	0	0.2	0.1	0	*	0	0.2	0.1	0	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	2.1	5.7	0.3	0	*	1.2	3.5	0.1	0	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221i	SE Adriatic	2.7	2.0	0	0	0	0.4	1.2	0	0	0	4.2	1.0	0	0	0
222a	E Ionian Sea	4.5	1.3	0	0	0	2.9	3.4	0.3	0	0	5.1	3.1	0.4	0	0
223a	Argosaronikos	5.8	**20.9**	5.5	0	0	1.2	**27.1**	2.2	0	0	1.6	**27.9**	3.5	0	0
224a	N Aegean Sea	**27.4**	**10.6**	8.5	0	0	**30.9**	6.6	3.0	0	0	**51.3**	**11.2**	5.7	0.1	0
225a	S Aegean Sea	0	**12.7**	6.6	0.4	0	0	9.2	5.8	0.1	0	0.1	**10.0**	7.7	0.1	0

TABLE 2. – *Citharus linguatula*: 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 500 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	Alborán Sea	13	0	0	0	0	47	72	0	0	0	0	4	0	0	0
112a	Alicante	41	193	0	0	0	33	**639**	93	0	0	0	21	8	0	0
113a	Catalan Sea	34	78	4	0	0	**2299**	**761**	167	0	0	0	18	9	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	25	102	21	0	0	95	273	0	0	0	35	272	0	0	0
121b	E Gulf of Lions	0	376	414	0	0	**550**	**680**	500	0	0	16	**650**	419	0	0
131a	NE Corsica	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
131b	SE Corsica	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	9	0	0	0	22	0	6	0	0	0	8	0	0	0
132b	E Ligurian Sea	0	13	10	0	0	0	13	1	0	0	0	16	8	0	0
132c	N Tyrrhenian	0	40	4	0	0	0	48	4	0	0	0	9	2	0	0
132d	C Tyrrhenian	15	352	36	1	0	13	253	11	0	0	15	32	8	1	0
133a	SE Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133b	NE Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133c	N Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	93	0	0	0	*	43	65	0	0	0	443	149	0	0
133e	W Sardinia	0	0	4	0	0	0	45	11	0	0	0	341	6	0	0
133f	SW Sardinia	0	49	13	0	0	12	106	50	0	0	0	6	94	1	0
133g	S Sardinia	0	0	0	0	0	0	*	360	0	0	0	0	6	0	0
134a	SE Tyrrhenian	0	123	24	0	0	34	140	4	0	0	0	26	2	0	0
134b	SW Tyrrhenian	0	0	7	0	0	0	37	0	0	0	0	17	0	0	0
134c	Sicilian Chan.	12	6	107	6	0	6	207	47	1	0	6	234	94	0	0
211a	N Adriatic Sea	0	17	*	*	*	4	65	*	*	*	2	62	*	*	*
211b	Central Adriatic	0	0	1	0	0	0	0	0	0	0	3	47	8	0	0
211c	N Adriatic-Slov	*	0	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	0	*	*	*	*	*	*	*	*	130	**790**	34	0	*
221a	E Sicily	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221i	SE Adriatic	*	0	*	*	*	*	*	*	*	*	44	67	2	0	0
222a	E Ionian Sea	34	154	0	0	0	0	127	0	0	0	107	151	15	0	0
223a	Argosaronikos	56	415	91	0	0	164	**1096**	**778**	0	0	385	**1687**	68	0	0
224a	N Aegean Sea	41	193	68	1	0	132	391	150	1	0	432	**564**	244	0	0
225a	S Aegean Sea	0	219	183	1	0	27	134	300	0	0	0	421	395	0	0

TABLE 2 (Cont.). – *Citharus linguatula*: 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 500 individuals/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	0	4	0	0	0	11	306	0	0	0	0	0	4	0	0
112a	Alicante	110	49	8	2	0	11	161	8	0	0	6	25	3	0	0
113a	Catalan Sea	0	32	12	0	0	12	77	25	*	0	5	12	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	0	**4204**	**659**	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	105	0	72	0	0
121a	W Gulf of Lions	7	42	0	0	0	10	78	0	0	0	8	98	14	0	0
121b	E Gulf of Lions	0	190	50	3	0	4	135	196	0	0	11	186	259	0	*
131a	NE Corsica	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0
131b	SE Corsica	0	0	0	0	*	0	0	9	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	8	6	0	0	0	35	13	0	0	21	14	0	0	0
132b	E Ligurian Sea	0	29	5	0	0	0	16	3	0	0	3	12	4	0	0
132c	N Tyrrhenian	180	86	8	0	0	10	80	6	0	0	0	21	4	0	0
132d	C Tyrrhenian	85	88	10	0	0	14	78	14	0	0	32	24	7	0	0
133a	SE Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133b	NE Sardinia	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
133c	N Sardinia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	**824**	205	0	0	0	107	135	0	0	0	**1093**	212	0	0
133e	W Sardinia	93	0	4	0	0	0	81	45	0	0	0	**697**	**669**	0	0
133f	SW Sardinia	0	281	142	0	0	13	183	55	0	0	140	281	298	2	14
133g	S Sardinia	0	0	39	0	0	9	0	32	0	0	0	0	126	0	0
134a	SE Tyrrhenian	33	41	18	0	0	0	60	14	0	0	0	35	14	0	0
134b	SW Tyrrhenian	0	0	3	24	0	0	0	0	21	0	0	38	0	3	2
134c	Sicilian Chan.	0	181	95	3	0	0	159	49	0	0	0	122	79	0	0
211a	N Adriatic Sea	5	98	*	*	*	1	77	*	*	*	3	18	*	*	*
211b	Central Adriatic	0	36	0	0	0	0	11	1	0	*	0	10	5	0	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	67	288	7	0	*	34	151	2	0	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221i	SE Adriatic	72	47	0	0	0	17	35	0	0	0	170	26	0	0	0
222a	E Ionian Sea	60	27	0	0	0	75	82	8	0	0	191	124	37	0	0
223a	Argosaronikos	213	**1072**	255	0	0	70	**1544**	125	0	0	91	**1684**	216	0	0
224a	N Aegean Sea	**691**	**609**	425	0	0	**792**	400	135	0	0	**1219**	**875**	383	2	0
225a	S Aegean Sea	0	454	274	7	0	0	328	329	3	0	6	**587**	**510**	2	0

TABLE 3. – *Citharus linguatula*: analysis of deviance table for generalised linear models fitted to "MEDITS" biomass indices (g/km^2) obtained in the years 1994-1999.

Source of variation	Deviance	df	% explained	Residual deviance	Residual df	F	Probability of F
Null				213.8	89		
Main Effects							
Macroarea	118.9	4	55.6	69.4	78	77,341	0.00000
Stratum	19.8	2	9.3	188.4	82	25,721	<0.00001
Year	5.7	5	2.7	208.2	84	2,958	0.02301
Interactions							
Stratum : Macroarea	13.0	8	6.1	19.0	40	4,229	0.00096
Year : Macroarea	33.3	20	15.6	32.0	48	4,327	<0.00001
Year : Stratum	4.2	10	2.0	65.3	68	1,030	0.39300
Total explained			91.3	194.8	49		
Residual				19.0	40		

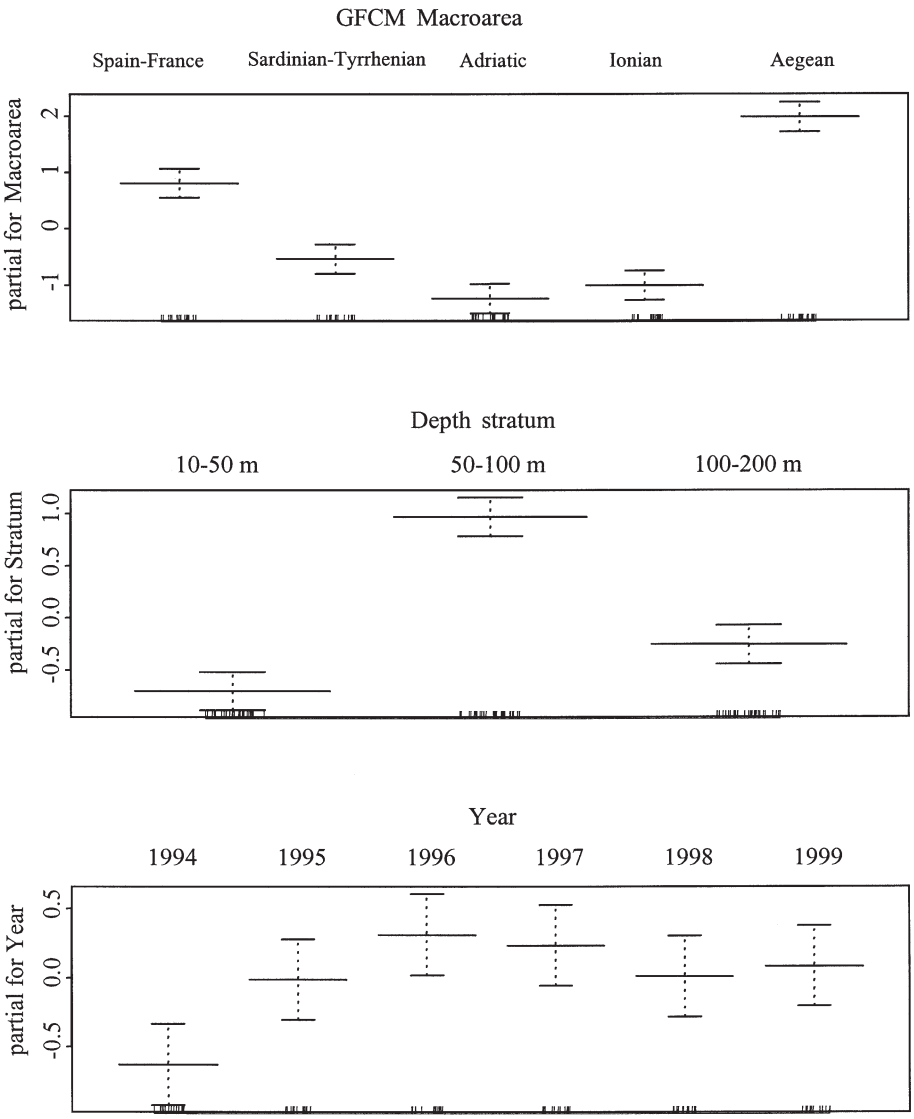

FIG. 1. – Results of the main effects of the model fitted to *Citharus linguatula* biomass indices, incorporating logarithmic link and gamma variance functions. Each plot represents the contribution of the corresponding variable to the fitted linear predictor: macro-area (above), depth stratum (centre) and year (below). The fitted values are adjusted to average zero; broken vertical bars indicate standard errors. The width of the solid bars at the base of the plots is proportional to the number of observations at each level of the factors.

TABLE 4. – *Citharus linguatula*: mean biomass indices, expressed in kg/km^2 (with standard error, in brackets), estimated from the MEDITS trawl surveys by macro-area, depth stratum and year.

MACROAREA	Spain-France	Sardinian-Tyrrhenian	Adriatic	Ionian	Aegean	
	3.651 (0.960)	0.947 (0.221)	0.821 (0.303)	0.451 (0.076)	8.622 (1.276)	
DEPTH STRATUM	10-50 m	50-100 m	100-200 m			
	2.107 (0.765)	4.829 (1.002)	1.760 (0.458)			
YEAR	1994	1995	1996	1997	1998	1999
	1.569 (0.598)	3.200 (1.196)	3.337 (1.170)	3.044 (1.143)	2.753 (1.088)	3.487 (1.474)

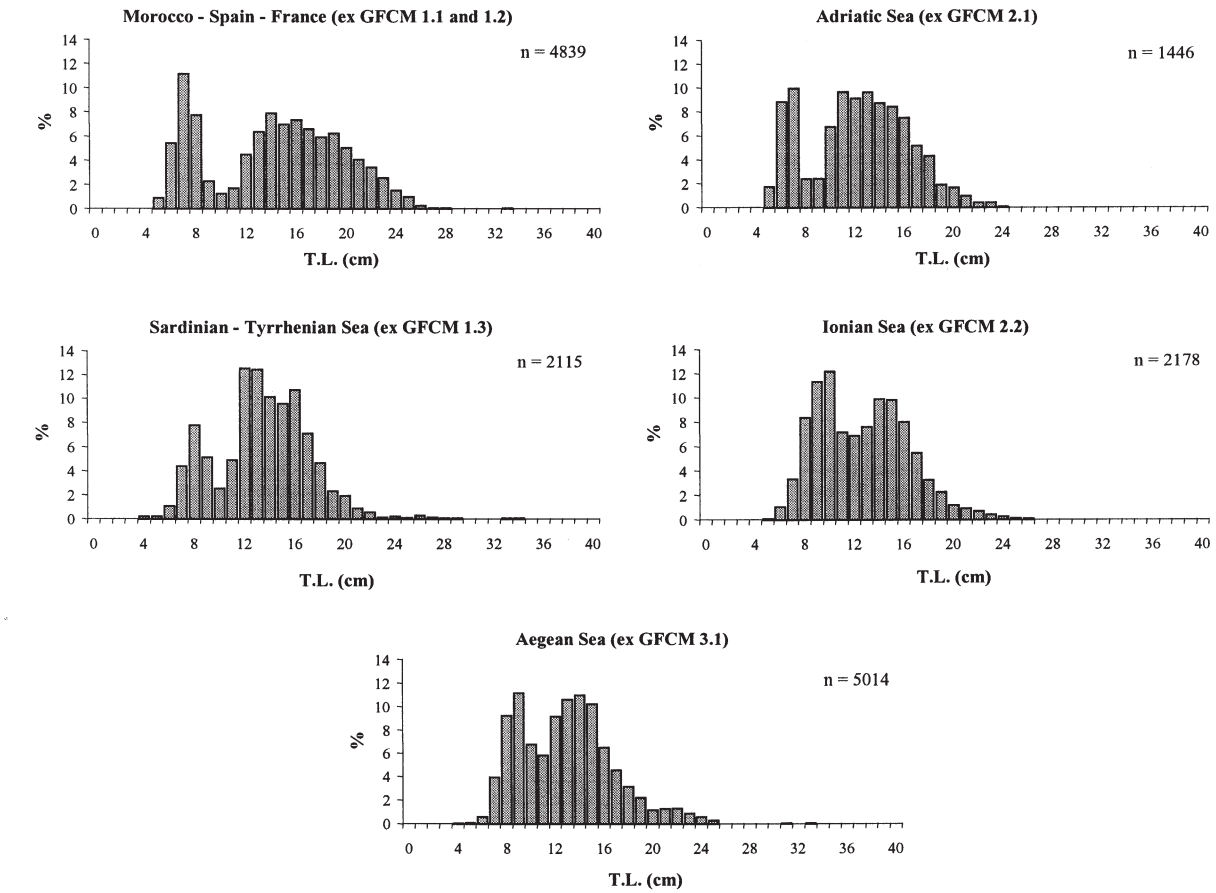

FIG. 2. – Overall length frequency distributions of *Citharus linguatula* in the GFCM macro-areas: results from "MEDITS" 1994-1999 trawl surveys.

than 10 cm TL) was about 25% of the total catch. In the different macro-areas this value ranged from 18.7% in the Sardinian-Tyrrhenian Sea to 27.3% in the Morocco-Spain-France area.

Lepidorhombus boscii

The Four-spotted Megrim was caught in all the macro-areas, more frequently in the western and eastern regions (percentage of occurrence: 31, 34 and 36% in Spain-France, Sardinian-Tyrrhenian and Aegean macro-areas, respectively) as compared to the Central regions (13% in the Adriatic macro-area and 19% in the Ionian macro-area). The species showed a wide depth distribution, being caught in all the depth strata. However, occurrence between 10 to 50 m was virtually restricted to the northern Aegean Sea (Tables 5 and 6), and this stratum was therefore not considered for GLM analysis.

The variation in biomass indices observed with varying macro-areas and depth was statistically significant (Table 7), while variation explained by the different years was non-significant ($p>0.6$). Moreover, differences in biomass indices were influenced by the interaction between stratum and macro-area. The model reduced null deviance from 318.8 to 45.9, which is similar to obtaining an r^2 of 0.86 in a normal regression. Results for the macro-areas showed that biomass indices were higher in Spain-France and Aegean GFCM regions, while in Adriatic and Ionian macro-areas significantly lower values were obtained (Fig. 3; Table 8). Also, the high values obtained in the Spain-France macro-area were due to those of the Gulf of Lions (Table 5). The depth factor accounted for most of the variation explained (37.6%). Biomass indices of *L. boscii* were significantly higher in strata C and D, for a depth from 100 to 500 m (Fig. 3; Tables 7 and 8).

Fairly similar results were obtained for indices expressed in number of individuals (Table 6). In this case, highest values were also obtained in the Gulf of Lions, but high abundance indices were also observed along the Sardinian coasts. This could be due to differences in the size composition of the catch in the macro-areas studied.

TABLE 5. – *Lepidorhombus boscii*: Mean biomass (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 10 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	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
112a	Alicante	0	0	0	0.5	0	0	0	0.1	1.3	0	0	0	0	0.8	0
113a	Catalan Sea	0	0	2.6	5.4	0.8	0	0	0.5	3.0	0.3	0	0	1.9	8.1	0.8
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	0	4.9	**10.6**	9.3	0	0	5.7	8.0	**19.1**	0.7	0	6.9	6.0	7.9	0.2
121b	E Gulf of Lions	0	2.5	**20.8**	5.5	1.1	0	1.0	**43.5**	8.2	1.9	0	1.5	**36.0**	8.1	0
131a	NE Corsica	*	0	0	4.0	1.1	*	0	0	8.3	1.1	0	0	0	5.1	0.8
131b	SE Corsica	*	0	0	1.6	1.9	*	0	0	1.1	0.1	0	0	0	2.8	2.2
132a	N Ligurian Sea	0	0	4.8	2.5	0.5	0	0.1	3.0	5.4	2.0	0	0	2.5	3.9	0.6
132b	E Ligurian Sea	0	0	3.3	1.4	2.6	0	0	3.4	3.0	1.1	0	0	3.2	2.4	4.0
132c	N Tyrrhenian	0	0	1.0	0.3	0.2	0	0	1.2	1.0	0.4	0	0.2	0.5	0.9	0.4
132d	C Tyrrhenian	0	0	0.4	0.4	0.1	0	0	1.0	2.2	1.3	0	0	0.4	1.7	0.4
133a	SE Sardinia	0	0	2.4	1.1	0.5	0	0	0	0.2	2.0	0	0	0	1.5	1.3
133b	NE Sardinia	0	0	0	1.6	0.2	0	0	1.1	6.4	8.3	0	0	0	4.0	2.0
133c	N Sardinia	0	0	**11.3**	2.8	4.3	0	0	7.4	7.5	**10.1**	0	0	6.4	1.7	9.7
133d	NW Sardinia	0	0	2.6	2.3	1.9	*	0	1.9	1.9	1.3	0	0	1.0	7.7	0.4
133e	W Sardinia	0	0	3.7	4.4	0	0	1.8	4.4	6.5	3.5	0	0	4.1	4.3	2.1
133f	SW Sardinia	0	0	0.5	4.5	1.1	0	0	1.1	2.7	1.3	0	0	1.4	4.1	8.7
133g	S Sardinia	0	0	0	1.5	0.2	0	*	0	0.3	5.4	0	0	1.2	0.6	2.2
134a	SE Tyrrhenian	0	0	0	0.7	0.3	0	0	0	0.2	0.5	0	0	0.1	0.5	0
134b	SW Tyrrhenian	0	0	0.8	0.9	1.0	0	0	1.0	0.8	0.3	0	0	0	0.1	0
134c	Sicilian Chan.	0	0	0	0.8	1.2	0	0	2.6	0.6	1.2	0	0	0	1.5	0.8
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0	0	*	*	*
211b	Central Adriatic	0	0	0.3	1.4	0	0	0.4	0.5	1.5	0	0	0.3	0.2	**13.0**	0.8
211c	N Adriatic-Slov	*	0	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	0	*	*	*	*	*	*	*	*	0	0.2	3.9	7.2	*
221a	E Sicily	0	0	0	0	0	0	0	1.2	4.6	0	0	0	0	0.6	0
221b	NW Ionian Sea	0	0	0	0.1	1.2	0	0	1.7	6.5	0.3	0	0	3.5	0.3	0.6
221c	N Ionian Sea	0	0	0	0.2	0	0	0	0	1.0	0	0	0	0	0.1	0.3
221d	N Ionian Sea	*	0	1.1	0.4	0.4	0	0	0	0.4	0	0	0.7	0.1	0.4	0
221e	SW Adriatic	0	0	2.9	2.4	1.7	*	0	3.9	2.9	0	0	0	1.1	2.0	0
221f	SW Adriatic	0	0	0	1.7	0	0	0	0	0	0	0	0	0	5.2	0
221g	SW Adriatic	0	0	0.8	*	0	0	0	2.2	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	1.3	1.2	0.6	0	0	2.5	2.8	0.9	0	0	1.6	**13.1**	0
221i	SE Adriatic	*	0	*	*	*	*	*	*	*	*	0	0	0.5	3.1	0.6
222a	E Ionian Sea	0	0	0	1.0	0	0	0	5.5	7.6	0	0	0	1.0	**17.5**	0
223a	Argosaronikos	0	0	0	**21.8**	0.3	0	0	3.1	**15.9**	0	0	0	0	**18.9**	0
224a	N Aegean Sea	0	0	4.0	**10.9**	1.3	0	0	0.5	5.1	0.3	0	0	7.5	8.6	0.9
225a	S Aegean Sea	0	0	0	7.8	0.4	0	0	1.3	**15.5**	1.6	0	1.5	0	9.6	2.0

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112a	Alicante	0	0	0	2.6	0	0	0	0	0.7	0	0	0	0.2	0.7	0
113a	Catalan Sea	0	0.1	2.0	8.4	2.2	0	0	3.4	*	0	0	0	1.8	4.3	0.2
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0	0.4	0
121a	W Gulf of Lions	0	3.2	1.4	**11.2**	4.5	0	2.4	7.6	**31.4**	1.7	0	4.2	8.8	**11.3**	3.2
121b	E Gulf of Lions	0	2.0	**17.3**	**20.0**	0	0	0.9	**12.8**	**17.0**	0	0	2.2	**27.8**	**13.8**	*
131a	NE Corsica	0	0	*	3.0	1.5	0	0	0	3.7	0.2	0	0	2.2	5.1	0
131b	SE Corsica	0	0	9.4	4.5	*	0	0	0	1.5	1.2	0	0	0	9.5	0.4
132a	N Ligurian Sea	0	0	1.5	3.0	0.9	0	0	2.0	4.9	0.4	0	0.1	1.1	3.3	0.4
132b	E Ligurian Sea	0	0	3.9	3.6	1.8	0	0.4	1.7	5.0	3.3	0	0	4.1	3.1	1.4
132c	N Tyrrhenian	0	0	1.6	1.4	0.7	0	0	1.1	2.1	0.4	0	0	1.1	1.4	0.1
132d	C Tyrrhenian	0	0	2.2	2.3	1.1	0	0.4	1.0	2.1	0.4	0	0	1.3	1.6	0
133a	SE Sardinia	0	0	0	3.8	5.7	0	0	0	0.7	1.2	0	0	0.6	3.0	0.2
133b	NE Sardinia	0	0	0.8	4.8	1.8	0	0	0	4.0	0.8	0	0	0	5.9	1.3
133c	N Sardinia	0	0	7.9	3.1	5.6	0	0	3.4	6.1	4.4	0	0	**10.6**	2.5	0.5
133d	NW Sardinia	0	0	2.6	**10.8**	0.8	0	0	0.7	2.6	0	0	0	3.0	3.4	1.2
133e	W Sardinia	0	0	1.9	4.9	6.5	0	0	3.1	3.4	4.0	0	1.6	7.1	5.3	**15.8**
133f	SW Sardinia	0	0	2.8	3.4	4.1	0	0	1.6	4.5	2.3	0	0	1.7	3.0	0.3
133g	S Sardinia	0	0	0	4.4	4.0	0	0	0	2.6	1.8	0	0	3.0	2.9	0.2
134a	SE Tyrrhenian	0	0	0	0.6	0.2	0	0	0	1.1	0.1	0	0	0	0.7	0.1
134b	SW Tyrrhenian	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0.8	0

TABLE 5 (Cont.). – *Lepidorhombus boscii*: Mean biomass (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 10 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
134c	Sicilian Chan.	0	0	0.3	0.6	0.7	0	0	0	1.2	0.7	0	0	0	0.8	0.8
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0	0	*	*	*
211b	Central Adriatic	0	0	0.2	**11.3**	0.3	0	0	0.2	7.0	*	0	0	0.4	9.2	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	0	4.6	**10.6**	*	0	0	3.0	9.1	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
221b	NW Ionian Sea	0	0	0	1.1	0.5	0	0.5	2.1	0.4	0	0	0	2.2	0.6	0
221c	N Ionian Sea	0	0	0	0.1	0	0	0	0	0.2	0	0	0	0	0.3	0
221d	N Ionian Sea	0	0	0	1.3	0	0	0	0	0.4	0	0	0	0	0	0
221e	SW Adriatic	0	0	0.7	0.2	0	0	0	2.8	0.6	0.4	0	0	3.6	4.5	0
221f	SW Adriatic	0	0	0	0.1	0	0	0	0	7.4	0	0	0	0	0.2	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0.8	*	0.5
221h	SW Adriatic	0	0	0	5.6	0.9	0	0	1.1	9.0	0	0	0	1.7	7.2	0
221i	SE Adriatic	0	0	0	2.7	0.5	0	0.1	0	2.0	0.4	0	0	0	0.9	3
222a	E Ionian Sea	0	0	0	**15.7**	0.6	0	0	1.1	2.0	0.3	0	0	0	2.3	7.3
223a	Argosaronikos	0	0	0	7.9	5.4	0	0	2.0	9.5	**10.3**	0	0	0.1	9.8	7.6
224a	N Aegean Sea	0	0.4	5.3	**12.2**	1.5	0.1	0	4.7	9.0	1.2	0	0	1.7	9.6	1.9
225a	S Aegean Sea	0	0	0	**11.9**	4.1	0	0	0.5	9.4	5.6	0	0	0	**10.2**	5.2

TABLE 6. – *Lepidorhombus boscii*: 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 250 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	Alborán Sea	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
112a	Alicante	0	0	0	29	0	0	0	2	24	0	0	0	0	11	0
113a	Catalan Sea	0	0	64	228	23	0	0	16	137	5	0	0	27	**303**	10
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	0	41	156	**396**	0	0	51	85	**798**	30	0	55	45	**415**	11
121b	E Gulf of Lions	0	28	238	79	11	0	8	**425**	155	59	0	17	**366**	130	0
131a	NE Corsica	*	0	0	80	24	*	0	0	167	39	0	0	0	112	35
131b	SE Corsica	*	0	0	89	57	*	0	0	35	6	0	0	0	103	130
132a	N Ligurian Sea	0	0	48	64	10	0	7	45	**361**	9	0	0	40	**298**	18
132b	E Ligurian Sea	0	0	41	106	52	0	0	62	100	26	0	0	41	153	119
132c	N Tyrrhenian	0	0	12	15	13	0	0	35	59	14	0	3	8	23	10
132d	C Tyrrhenian	0	0	3	28	4	0	0	9	105	75	0	0	5	42	9
133a	SE Sardinia	0	0	24	22	10	0	0	0	4	10	0	0	0	67	102
133b	NE Sardinia	0	0	0	20	6	0	0	21	83	44	0	0	0	102	50
133c	N Sardinia	0	0	144	93	129	0	0	116	**476**	**342**	0	0	96	56	**372**
133d	NW Sardinia	0	0	**407**	29	12	*	0	43	42	17	0	0	6	**340**	4
133e	W Sardinia	0	0	35	123	0	0	22	59	156	104	0	0	72	173	36
133f	SW Sardinia	0	0	18	73	31	0	0	14	80	22	0	0	23	106	101
133g	S Sardinia	0	0	0	9	3	0	*	0	3	64	0	0	19	**404**	88
134a	SE Tyrrhenian	0	0	0	19	2	0	0	0	6	7	0	0	2	8	0
134b	SW Tyrrhenian	0	0	10	3	24	0	0	7	13	1	0	0	0	1	0
134c	Sicilian Chan.	0	0	0	14	8	0	0	17	15	7	0	0	0	28	10
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0	0	*	*	*
211b	Central Adriatic	0	0	5	18	0	0	3	8	50	0	0	3	2	210	11
211c	N Adriatic-Slov	*	0	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	0	*	*	*	*	*	*	*	*	0	3	55	202	*
221a	E Sicily	0	0	0	0	0	0	0	14	12	0	0	0	0	4	0
221b	NW Ionian Sea	0	0	0	3	6	0	0	22	81	2	0	0	35	8	2
221c	N Ionian Sea	0	0	0	26	0	0	0	0	51	0	0	0	0	8	3
221d	N Ionian Sea	*	0	12	4	2	0	0	0	4	0	0	95	7	8	0
221e	SW Adriatic	0	0	20	34	14	*	0	23	32	0	0	0	8	21	0
221f	SW Adriatic	0	0	0	11	0	0	0	0	0	0	0	0	0	33	0
221g	SW Adriatic	0	0	4	*	0	0	0	8	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	11	29	3	0	0	26	25	5	0	0	12	155	0
221i	SE Adriatic	*	0	*	*	*	*	*	*	*	*	0	0	6	58	9
222a	E Ionian Sea	0	0	0	64	0	0	0	23	129	0	0	0	15	**261**	0
223a	Argosaronikos	0	0	0	**265**	7	0	0	32	188	0	0	0	0	160	0
224a	N Aegean Sea	0	0	86	**465**	40	0	0	12	147	3	0	0	76	198	3
225a	S Aegean Sea	0	0	0	115	7	0	0	13	169	10	0	24	0	178	25

TABLE 6. – *Lepidorhombus boscii*: 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 250 individuals/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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112a	Alicante	0	0	0	40	0	0	0	0	21	0	0	0	3	10	0
113a	Catalan Sea	0	2	29	**254**	23	0	0	82	*	0	0	0	26	84	3
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0	1	0
121a	W Gulf of Lions	0	29	54	**871**	136	0	20	**270**	**386**	77	0	31	130	233	96
121b	E Gulf of Lions	0	22	172	**354**	0	0	8	113	**358**	0	0	16	239	**295**	*
131a	NE Corsica	0	0	*	106	40	0	0	0	147	13	0	0	50	121	0
131b	SE Corsica	0	0	**367**	134	*	0	0	0	66	21	0	0	0	**563**	20
132a	N Ligurian Sea	0	0	24	225	38	0	0	39	213	8	0	7	21	149	10
132b	E Ligurian Sea	0	0	108	213	68	0	6	24	162	47	0	0	44	123	17
132c	N Tyrrhenian	0	0	21	69	9	0	0	17	78	9	0	0	19	40	2
132d	C Tyrrhenian	0	0	32	72	12	0	4	11	30	6	0	0	14	23	0
133a	SE Sardinia	0	0	0	111	155	0	0	0	15	16	0	0	10	38	4
133b	NE Sardinia	0	0	11	111	43	0	0	0	121	26	0	0	0	97	15
133c	N Sardinia	0	0	**274**	75	**335**	0	0	52	232	98	0	0	204	39	31
133d	NW Sardinia	0	0	28	**299**	15	0	0	12	54	0	0	0	34	61	3
133e	W Sardinia	0	0	40	90	112	0	0	49	29	34	0	10	108	43	93
133f	SW Sardinia	0	0	34	76	22	0	0	23	49	14	0	0	21	80	3
133g	S Sardinia	0	0	0	54	62	0	0	0	34	17	0	0	22	41	2
134a	SE Tyrrhenian	0	0	0	12	1	0	0	0	18	1	0	0	0	8	1
134b	SW Tyrrhenian	0	0	0	0	0	0	0	0	1	0	0	0	0	5	0
134c	Sicilian Chan.	0	0	2	19	6	0	0	0	25	7	0	0	0	11	6
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0	0	*	*	*
211b	Central Adriatic	0	0	13	**393**	5	0	0	1	226	*	0	0	5	121	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	0	63	**330**	*	0	0	56	231	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
221b	NW Ionian Sea	0	0	0	11	5	0	11	21	4	0	0	0	11	4	0
221c	N Ionian Sea	0	0	0	3	0	0	0	0	8	0	0	0	0	3	0
221d	N Ionian Sea	0	0	0	19	0	0	0	0	9	0	0	0	0	0	0
221e	SW Adriatic	0	0	6	11	0	0	0	11	7	3	0	0	11	32	0
221f	SW Adriatic	0	0	0	22	0	0	0	0	42	0	0	0	0	12	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	7	*	11
221h	SW Adriatic	0	0	0	64	5	0	0	6	120	0	0	0	25	70	0
221i	SE Adriatic	0	0	0	83	5	0	2	0	47	4	0	0	0	12	22
222a	E Ionian Sea	0	0	0	165	7	0	0	8	19	7	0	0	0	14	79
223a	Argosaronikos	0	0	0	144	45	0	0	9	**268**	110	0	0	3	184	118
224a	N Aegean Sea	0	4	81	228	13	4	0	45	207	17	0	0	26	197	18
225a	S Aegean Sea	0	0	0	151	101	0	0	6	**263**	52	0	0	0	176	68

TABLE 7. – *Lepidorhombus boscii*: analysis of deviance table for generalised linear models fitted to MEDITS biomass indices (g/km^2) obtained in the years 1994-1999.

Source of variation	Deviance	df	% explained	Residual deviance	Residual df	F	Probability of F
Null				318.8	119		
Main Effects							
Macroarea	68.4	4	21.5	128.2	107	23,583	0.00000
Stratum	119.8	3	37.6	196.6	111	55,051	0.00000
Year	2.4	5	0.8	316.4	114	0.661	0.65469
Interactions							
Stratum : Macroarea	62.4	12	19.6	46.4	60	7,167	<0.00001
Year : Macroarea	12.5	20	3.9	108.8	72	0.864	0.63010
Year : Stratum	6.9	15	2.2	121.3	92	0.631	0.83753
Total explained			85.6	272.9	59		
Residual				45.9	60		

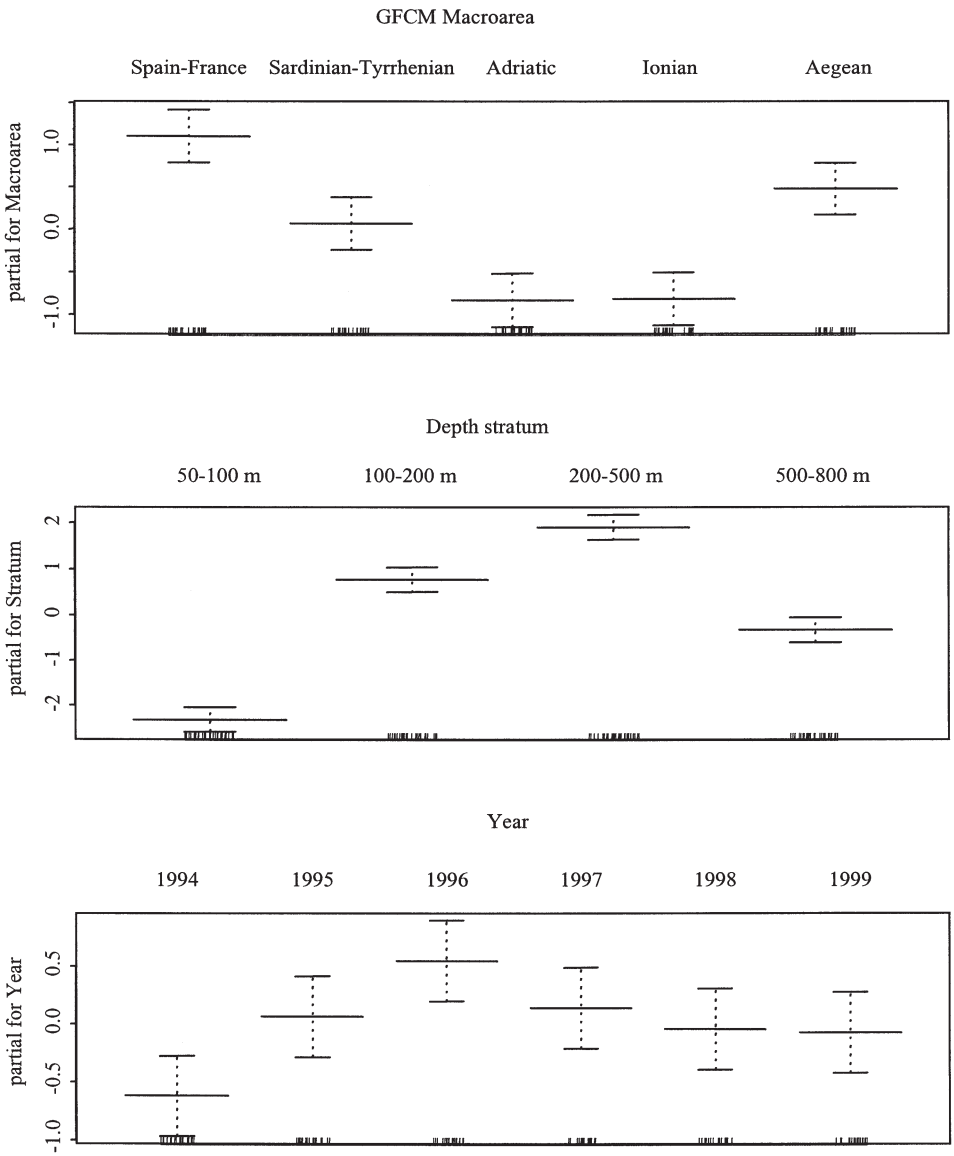

FIG. 3. – Results of main effects of the model fitted to *Lepidorhombus boscii* biomass indices, incorporating logarithmic link and gamma variance functions. Each plot represents the contribution of the corresponding variable to the fitted linear predictor: macro-area (above), depth stratum (centre) and year (below). The fitted values are adjusted to average zero; broken vertical bars indicate standard errors. The width of the solid bars at the base of the plots is proportional to the number of observations at each level of the factors.

TABLE 8. – *Lepidorhombus boscii*: mean biomass indices, expressed in kg/km^2 (with standard error, in brackets), estimated from the MEDITS trawl surveys by macro-area, depth stratum and year.

MACROAREA	Spain-France	Sardinian-Tyrrhenian	Adriatic	Ionian	Aegean	
	4.000 (0.738)	1.685 (0.240)	2.080 (0.719)	0.930 (0.237)	3.969 (0.947)	
DEPTH STRATUM	50 – 100 m	100 – 200 m	200 – 500 m	500 – 800 m		
	0.298 (0.094)	2.528 (0.479)	6.138 (0.732)	1.169 (0.261)		
YEAR	1994	1995	1996	1997	1998	1999
	1.855 (0.715)	2.401 (0.763)	2.846 (0.802)	2.825 (0.762)	2.681 (0.794)	2.588 (0.716)

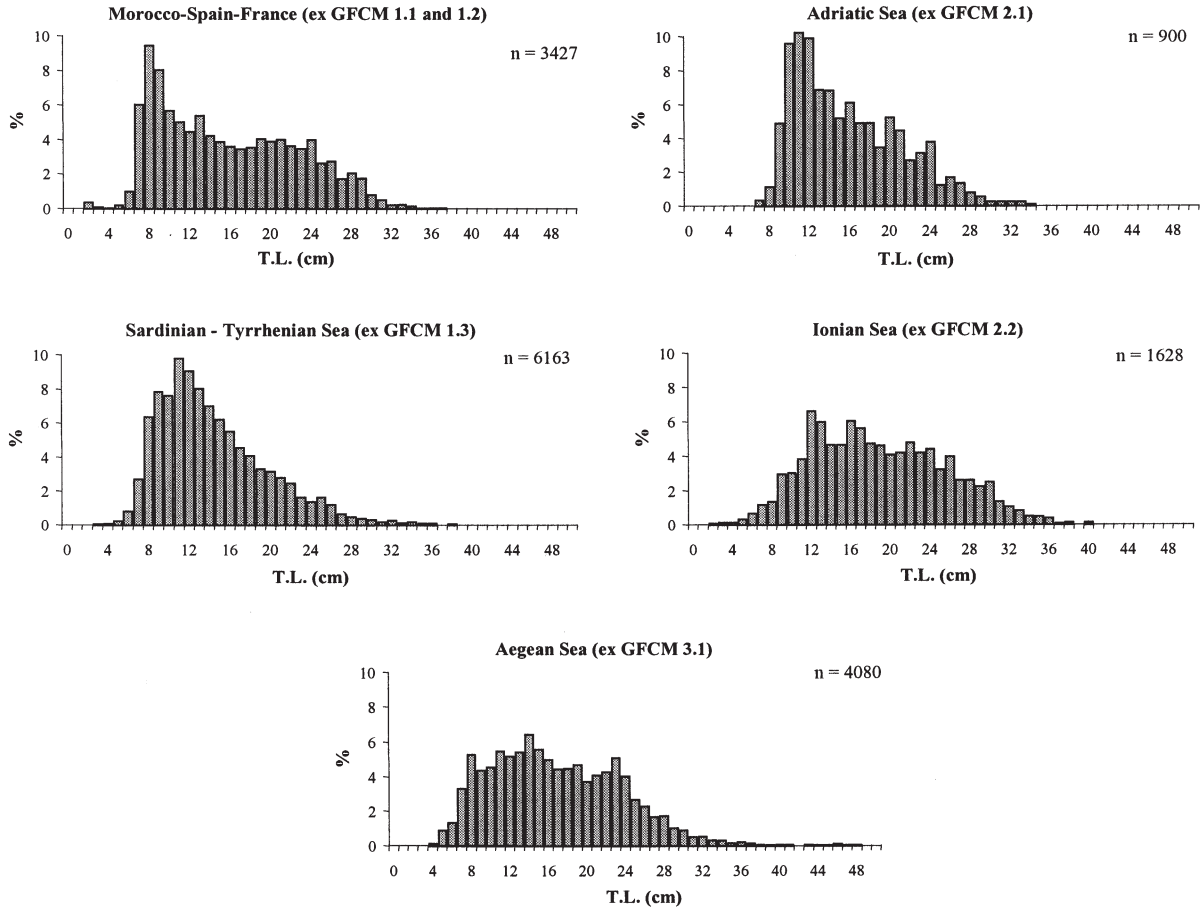

FIG. 4. – Overall length frequency distributions of *Lepidorhombus boscii* in the GFCM macro-areas: results from "MEDITS" 1994-1999 trawl surveys.

Catches of *L. boscii* were characterised by a very wide size range, from 2 to 48 cm TL, although presence of specimens smaller than 5 cm TL and larger than 36 cm TL was only occasional. Some differences were found in the population demography at macro-area level (Fig. 4). Catches obtained in the Aegean Sea showed the widest size range (from 2 to 48 cm TL). However, it was difficult to single out a predominant size from the histogram, as specimens were equally shared among several size classes. In the other four macro-areas the size range proved to be more restricted, especially in the Adriatic Sea (from 7 to 34 cm TL). The histograms showed a fairly similar shape, with the first modal class ranging from 8 to 11 cm TL. The number of specimens smaller than 12 cm TL was higher in the western areas (about 35.5% of the total catch) than in the Adriatic Sea and the eastern macro-areas (from 13.6 to 26.0%).

Solea vulgaris

The Common Sole was found in all macro-areas, but with a much lower frequency of occurrence with respect to the other two species, always lower than 12%. *S. vulgaris* was never caught in south-east Corsica, the north-west Ionian Sea and many sectors of the south-west Adriatic Sea (Tables 9 and 10). The distribution range of this species was mostly restricted to the first two depth strata. Only in a few cases notable abundance was also observed between 100 and 200 m (West Morocco, West Gulf of Lions and East Ionian Sea).

Results of analysis of deviance from the GLM model, performed for the first three depth strata, are shown in Table 11. The macro-area and depth stratum proved to be significant ($p<0.0001$) factors in explaining the differences in biomass indices (Table 12), as well as the interaction between stratum and macro-area ($p<0.01$) and between year and stratum ($p<0.05$). This model accounted for 78.6% of total deviance, with most of the variation being due to differences between the three depth strata (32.9%). Biomass indices were significantly higher in strata 10-50 m and 50-100 m (Table 12). Results for the macro-areas showed that differences were particularly evident for the Adriatic macro-area, although

TABLE 9. – *Solea vulgaris*: Mean biomass (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 10 kg/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	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0
112a	Alicante	0	1.4	0	0	0	0	1.3	0	0	0	0	0	0	0	0
113a	Catalan Sea	0	0.7	0	0	0	2.5	2.2	0	0	0	0	0.9	0	0.7	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	2.7	1.9	**14.2**	0	0	**17.8**	4.1	0	0	0	6.1	3.9	0	0	0
121b	E Gulf of Lions	9.3	1.8	0	0	0	**19.3**	**16.8**	1.2	0	0	1.2	6.3	0.6	0	0
131a	NE Corsica	*	0	0	0	0	*	2.7	0	0	0	0	0	0	0	0
131b	SE Corsica	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	3.1	0	0	0
132b	E Ligurian Sea	0.8	1.3	0	0	0	1.9	0	0	0	0	3.3	0	0	0	0
132c	N Tyrrhenian	2.2	0	0	0	0	6.7	2.9	1.0	0	0	8.0	0	0	0	0
132d	C Tyrrhenian	1.4	0	0	0	0	0	1.1	0	0	0	0	0	0	0	0
133a	SE Sardinia	0	0	0	0	0	0	4.6	0	0	0	0	0	0	0	0
133b	NE Sardinia	0	2.6	0	0	0	0	0.6	0	0	0	0	4.8	0	0	0
133c	N Sardinia	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	1.9	0	0	0	*	0	0	0	0	0	0	0	0	0
133e	W Sardinia	3.8	0	0	0	0	9.7	3.4	0	0	0	**45.4**	1.9	0	0	0
133f	SW Sardinia	**16.4**	1.8	0	0	0	**11.6**	4.4	0.3	0	0	3.7	2.3	0	0	0
133g	S Sardinia	0	0	0	0	0	4.0	*	0	0	0	0	0	0	0	0
134a	SE Tyrrhenian	0	0	0	0	0	0	2.1	0	0	0	0	3.4	0.7	0	0
134b	SW Tyrrhenian	0	2.2	0	0	0	0	0	0	0	0	0	0	2.4	0	0
134c	Sicilian Chan.	5.6	0	1.8	0	0	0	0.3	0	0	0	0	0	0	0	0
211a	N Adriatic Sea	0	0.1	*	*	*	0.7	0	*	*	*	0.1	0	*	*	*
211b	Central Adriatic	0.2	0	0	0	0	1.1	1.1	0	0	0	0	0	0	0	0
211c	N Adriatic-Slov	*	0	*	*	*	**11.8**	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	0	*	*	*	*	*	*	*	*	4.1	0.6	0	0	*
221a	E Sicily	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	5.0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0.3	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0
221i	SE Adriatic	*	0	*	*	*	*	*	*	*	*	4.0	1.2	1.5	0	0
222a	E Ionian Sea	2.6	5.4	0	0	0	1.2	0	4.7	0	0	**12.5**	1.6	7.2	0	0
223a	Argosaronikos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
224a	N Aegean Sea	9.9	2.9	0	0	0	4.6	1.9	0	0	0	**20.0**	5.0	0	0	0
225a	S Aegean Sea	0	0.6	0.5	0	0	0	0.6	0	0	0	0	0	0	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	0	4.4	0	0	0	**36.0**	0	0	0	0	0	0	0	0	0
112a	Alicante	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113a	Catalan Sea	0	0.7	0.6	0	0	0	0	0	*	0	0	0	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	0	9.1	**21.8**	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	4.0	0	0	0	0
121a	W Gulf of Lions	4.2	0.5	3.4	0	0	2.1	1.5	0	0	0	3.1	1.6	0	0	0
121b	E Gulf of Lions	1.7	1.4	0	0	0	0	1.9	0	0	0	6.9	3.3	0	0	*
131a	NE Corsica	0	0	*	0	0	0	4.2	0	0	0	0	0	0	0	0
131b	SE Corsica	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	5.4	0	0	0
132b	E Ligurian Sea	0.2	1.4	0	0	0	1.4	0	0	0	0	2.2	0	0	0	0
132c	N Tyrrhenian	2.4	0	1.0	0	0	3.7	0	0	0	0	2.6	2.1	0	0	0
132d	C Tyrrhenian	0	0	0	0	0	1.2	0	0	0	0	0.8	1.3	0	0	0
133a	SE Sardinia	0	0	0	0	0	3.1	0	0	0	0	0	0	0	0	0
133b	NE Sardinia	2.0	4.0	0	0	0	0.7	0	0	0	0	0	3.7	0	0	0
133c	N Sardinia	0.8	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	4.7	0	0	0	0	5.7	0	0	0	0	**12.0**	0	0	0
133e	W Sardinia	0.2	**45.4**	0	0	0	6.0	3.4	0	0	0	**19.1**	7.8	0	0	0
133f	SW Sardinia	**58.9**	5.0	0	0	0	7.9	0	0.3	0	0	**25.3**	4.3	0	0	0
133g	S Sardinia	4.6	0	2.8	0	0	4.8	0	1.6	0	0	0.9	0	0	0	0
134a	SE Tyrrhenian	0	0	0	0	0	0	0	0	0	0	1.3	0	0.9	0	0
134b	SW Tyrrhenian	0.9	5.5	0	0	0	0	0	0	0	0	0	3.6	0	0	0

TABLE 9 (Cont.). – *Solea vulgaris*: Mean biomass (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 10 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
134c	Sicilian Chan.	0.8	0.9	0.5	0	0	0	1.4	0	0	0	0	1.2	0	0	0
211a	N Adriatic Sea	0.5	0	*	*	*	1.2	0	*	*	*	2.0	0	*	*	*
211b	Central Adriatic	0	0	0	0	0	0	0.6	0	0	*	1.6	0	0	0	*
211c	N Adriatic-Slov	1.4	*	*	*	*	**10.5**	*	*	*	*	8.7	*	*	*	*
211d	NE Adri Croatia	0.7	1.0	0	0	*	0	0.5	0	0	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0
221i	SE Adriatic	2.7	1.8	1.8	0	0	3.9	2.1	0.7	0	0	0	0.4	0	0	0
222a	E Ionian Sea	7.5	2.5	3.1	0	0	1.0	5.2	0	0	0	**12.4**	2.4	1.1	0	0
223a	Argosaronikos	0	0	2.4	0	0	0	5.5	0	0	0	0	0	0	0	0
224a	N Aegean Sea	4.2	1.2	0	0	0	4.1	1.0	0	0	0	5.3	2.0	0	0	0
225a	S Aegean Sea	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0	0

TABLE 10. – *Solea vulgaris*: 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 100 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	Alborán Sea	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
112a	Alicante	0	4	0	0	0	0	5	0	0	0	0	0	0	0	0
113a	Catalan Sea	0	2	0	0	0	12	6	0	0	0	0	2	0	2	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	11	6	21	0	0	57	11	0	0	0	24	11	0	0	0
121b	E Gulf of Lions	60	6	0	0	0	**104**	51	5	0	0	5	52	2	0	0
131a	NE Corsica	*	0	0	0	0	*	7	0	0	0	0	0	0	0	0
131b	SE Corsica	*	0	0	0	0	*	0	0	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0
132b	E Ligurian Sea	5	7	0	0	0	12	0	0	0	0	21	0	0	0	0
132c	N Tyrrhenian	24	0	0	0	0	81	7	2	0	0	50	0	0	0	0
132d	C Tyrrhenian	4	0	0	0	0	0	3	0	0	0	0	0	0	0	0
133a	SE Sardinia	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0
133b	NE Sardinia	0	9	0	0	0	0	3	0	0	0	0	12	0	0	0
133c	N Sardinia	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	5	0	0	0	*	0	0	0	0	0	0	0	0	0
133e	W Sardinia	36	0	0	0	0	74	22	0	0	0	**383**	13	0	0	0
133f	SW Sardinia	**103**	16	0	0	0	**264**	23	5	0	0	37	13	0	0	0
133g	S Sardinia	0	0	0	0	0	37	*	0	0	0	0	0	0	0	0
134a	SE Tyrrhenian	0	0	0	0	0	0	7	0	0	0	0	7	2	0	0
134b	SW Tyrrhenian	0	6	0	0	0	0	0	0	0	0	0	0	3	0	0
134c	Sicilian Chan.	30	0	4	0	0	0	3	0	0	0	0	0	0	0	0
211a	N Adriatic Sea	0	2	*	*	*	2	0	*	*	*	14	0	*	*	*
211b	Central Adriatic	4	0	0	0	0	4	3	0	0	0	0	0	0	0	0
211c	N Adriatic-Slov	*	0	*	*	*	41	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	0	*	*	*	*	*	*	*	*	12	1	0	0	*
221a	E Sicily	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
221d	N Ionian Sea	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	*	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0
221i	SE Adriatic	*	0	*	*	*	*	*	*	*	*	22	4	6	0	0
222a	E Ionian Sea	17	9	0	0	0	18	0	8	0	0	80	6	15	0	0
223a	Argosaronikos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
224a	N Aegean Sea	46	10	0	0	0	25	10	0	0	0	87	27	0	0	0
225a	S Aegean Sea	0	4	22	0	0	0	3	0	0	0	0	0	0	0	0

TABLE 10 (Cont.). – *Solea vulgaris*: 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 100 individuals/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	0	8	0	0	0	42	0	0	0	0	0	0	0	0	0
112a	Alicante	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113a	Catalan Sea	0	3	3	0	0	0	0	0	*	0	0	0	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	0	47	25	0	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	33	0	0	0	0
121a	W Gulf of Lions	12	2	9	0	0	8	3	0	0	0	14	4	0	0	0
121b	E Gulf of Lions	17	6	0	0	0	0	3	0	0	0	16	11	0	0	*
131a	NE Corsica	0	0	*	0	0	0	14	0	0	0	0	0	0	0	0
131b	SE Corsica	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0
132a	N Ligurian Sea	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0
132b	E Ligurian Sea	3	6	0	0	0	8	0	0	0	0	10	0	0	0	0
132c	N Tyrrhenian	14	0	2	0	0	31	0	0	0	0	10	9	0	0	0
132d	C Tyrrhenian	0	0	0	0	0	7	0	0	0	0	4	6	0	0	0
133a	SE Sardinia	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
133b	NE Sardinia	7	14	0	0	0	7	0	0	0	0	0	7	0	0	0
133c	N Sardinia	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0
133d	NW Sardinia	0	16	0	0	0	0	23	0	0	0	0	60	0	0	0
133e	W Sardinia	14	**328**	0	0	0	44	27	0	0	0	99	42	0	0	0
133f	SW Sardinia	**384**	29	0	0	0	**121**	0	2	0	0	**678**	20	0	0	0
133g	S Sardinia	15	0	6	0	0	17	0	5	0	0	9	0	0	0	0
134a	SE Tyrrhenian	0	0	0	0	0	0	0	0	0	0	11	0	2	0	0
134b	SW Tyrrhenian	6	11	0	0	0	0	0	0	0	0	0	5	0	0	0
134c	Sicilian Chan.	6	5	2	0	0	0	5	0	0	0	0	3	0	0	0
211a	N Adriatic Sea	4	0	*	*	*	5	0	*	*	*	17	0	*	*	*
211b	Central Adriatic	0	0	0	0	0	0	2	0	0	*	9	0	0	0	*
211c	N Adriatic-Slov	12	*	*	*	*	47	*	*	*	*	43	*	*	*	*
211d	NE Adri Croatia	2	3	0	0	*	0	2	0	0	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221c	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221d	N Ionian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
221i	SE Adriatic	14	7	7	0	0	26	15	2	0	0	0	2	0	0	0
222a	E Ionian Sea	30	10	10	0	0	7	16	0	0	0	81	11	4	0	0
223a	Argosaronikos	0	0	3	0	0	0	10	0	0	0	0	0	0	0	0
224a	N Aegean Sea	17	5	0	0	0	21	6	0	0	0	31	13	0	0	0
225a	S Aegean Sea	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0

TABLE 11. – *Solea vulgaris*: analysis of deviance table for generalised linear models fitted to MEDITS biomass indices (g/km^2) obtained in the years 1994-1999.

Source of variation	Deviance	df	% explained	Residual deviance	Residual df	F	Probability of F
NULL				197.2	89		
Main Effects							
Macroarea	24.3	4	12.3	105.3	78	7.802	0.00010
Stratum	64.9	2	32.9	129.5	82	41.741	0.00000
Year	2.8	5	1.4	194.5	84	0.703	0.62441
Interactions							
Stratum : Macroarea	20.5	8	10.4	42.3	40	3.291	0.00561
Year : Macroarea	23.7	20	12.0	62.7	48	1.522	0.12725
Year : Stratum	18.9	10	9.6	86.4	68	2.424	0.02308
Total explained			78.6	155.0	49		
Residual				42.2	40		

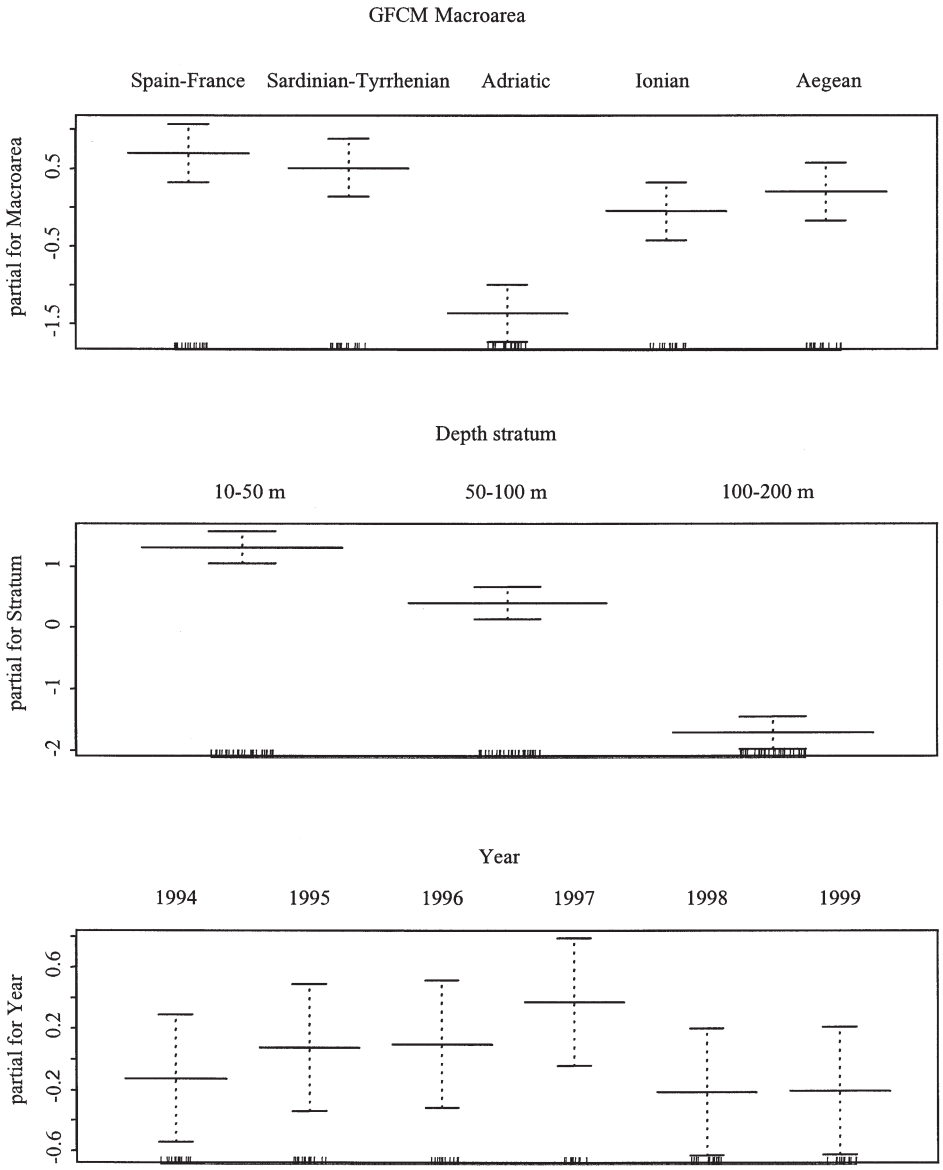

FIG. 5. – Results of main effects of the model fitted to *Solea vulgaris* biomass indices, incorporating logarithmic link and gamma variance functions. Each plot represents the contribution of the corresponding variable to the fitted linear predictor: macro-area (above), depth stratum (centre) and year (below). The fitted values are adjusted to average zero; broken vertical bars indicate standard errors. The width of the solid bars at the base of the plots is proportional to the number of observations at each level of the factors.

TABLE 12. – *Solea vulgaris*: mean biomass indices, expressed in kg/km^2 (with standard error, in brackets), estimated from the MEDITS trawl surveys by macro-area, depth stratum and year.

MACROAREA	Spain-France	Sardinian-Tyrrhenian	Adriatic	Ionian	Aegean	
	2.110 (0.563)	1.716 (0.381)	0.767 (0.314)	0.570 (0.096)	1.341 (0.375)	
DEPTH STRATUM	10-50 m	50-100 m	100-200 m			
	2.503 (0.375)	1.131 (0.214)	0.268 (0.100)			
YEAR	1994	1995	1996	1997	1998	1999
	1.025 (0.285)	1.745 (0.604)	1.418 (0.467)	1.221 (0.366)	1.291 (0.508)	1.104 (0.313)

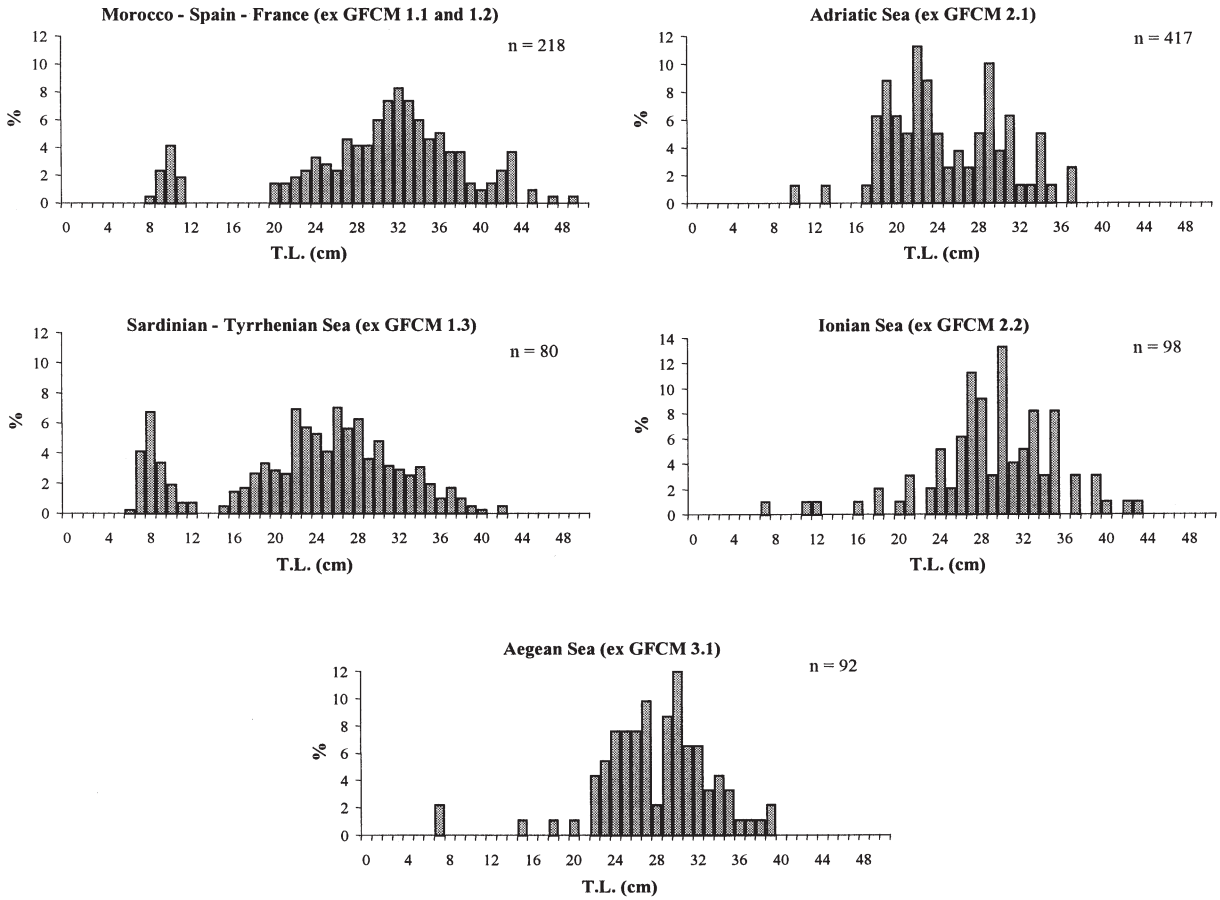

FIG. 6. – Overall length frequency distributions of *Solea vulgaris* in the GFCM macro-areas: results from "MEDITS" 1994-1999 trawl surveys.

the lowest observed biomass index was found in the Ionian macro-area (Fig. 5; Table 12).

Sizes of the specimens collected ranged between 6 and 49 cm TL. Given the low number of specimens in the catches, difficulty was encountered in examining the demographic characteristics of this species. A similar size frequency distribution characterised by two distinct groups was observed in the macro-areas of the Western Mediterranean: the histograms were characterised by specimens smaller than 14 cm TL and by larger individuals with modal class varying from 26 to 32 cm TL, representing the majority of the catches (Fig. 6). In the other three macro-areas the catches were mostly characterised by specimens greater than 15 cm TL, the group of small individuals being absent.

DISCUSSION

The species forming the object of this study, *Citharus linguatula, Lepidorhombus boscii* and *Solea vulgaris*, constitute the most important fishing resources among Mediterranean flatfish. The "MEDITS" project has represented an important tool in order to provide large scale data on their distribution and abundance patterns and demographic structure, which constitutes useful information for assessment purposes.

The three species showed a wide geographical distribution, since they were collected in all the macro-areas investigated, but with some differences in occurrence patterns among the 40 geographic sectors studied. Thus, while *L. boscii* was found practically everywhere, *C. linguatula* and *S. vulgaris* showed some discontinuities, being absent in some areas of the Corsican, Sardinian, Ionian and Adriatic Seas. The scarcity of *C. linguatula* and *S. vulgaris* in some sectors could be due to the reduced extension of the continental shelf and/or of the soft bottoms.

In agreement with our results, *L. boscii* has been reported as most abundant on muddy bottoms between 200 and 400 m depth (Bello and Rizzi, 1987; Reale *et al.*, 1990; Ungaro and Martino, 1998). Similarly, *C. linguatula* is mostly distributed

on muddy bottoms with greater abundance from 50 to 100 m depth (Giovanardi, 1984; Reale *et al*., 1990; García-Rodríguez and Esteban, 2000). *S. vulgaris* has been collected on different substrata of the coastal zone: from coarse sand to muddy bottoms (Relini *et al.*, 1986), on clay or sandy bottoms (Reale *et al*., 1990), on "dirty" or "residual sand" bottoms (Giovanardi, 1984).

The biomass of the species studied showed highest values in some regions such as the Gulf of Lions and the Greek seas. *S. vulgaris* was also abundant along the Moroccan and Sardinian coasts. This distribution pattern could be due to differences both in environmental features (shelf/slope ratio, availability of resources, presence of nursery areas) and in the exploitation pattern due to the local fishing fleets.

Particularly for *L. boscii* and *C. linguatula,* an important fraction of the catch was represented by juveniles. In these species, the first mode of the size distributions of the catch can be identified as belonging to specimens in the first year of life, according to the estimations of Planas and Vives (1956), Vassilopoulou and Papaconstantinou (1994) and García-Rodríguez and Esteban (2000) for *C. linguatula*, and of Bello and Rizzi (1987), Mannini *et al*. (1990) and Ungaro and Martino (1998) for *L. boscii*. In addition, for the latter species, most of the population sampled was constituted by immature specimens. Assuming that the female's first maturity size is 23.6 cm TL (Ungaro and Martino, 1998), the percentage of catch under this size was greater than 80%.

With regard to *S. vulgaris*, most of the catch was constituted by adults. About 60% of the specimens collected were larger than the size at first maturity (25 cm TL, Fischer *et al*., 1987, corresponding to two-three years of life, Froglia and Giannetti, 1986). Specimens belonging to the first size group, when present in the catch, were juveniles, assuming that size at one year is 15-20 cm TL (Ramos, 1982b; Piccinetti and Giovanardi, 1984; Froglia and Giannetti, 1985; Vianet and Quignard, 1986; Pagotto and Piccinetti, 1988; Paci *et al*., 1989). The low catches of juveniles obtained in some areas could be attributable to the spatio-temporal pattern of the recruitment of these species. Froglia (1993) reported that the juveniles of *S. vulgaris* in the Adriatic Sea are concentrated in lagoons and in coastal areas of the northern part of this basin from spring to late summer. This could probably be the main reason for the absence of recruits observed with the "MEDITS" surveys in the Adriatic Sea.

However, the high percentage of small size specimens in the catch is not necessarily an index of overexploitation, because the picture obtained through this study only refers to one season of the year, which may correspond to the recruitment period. For example, along the coast of Tuscany, Abella *et al*. (1997) reported the smallest specimens (mean TL of 8 cm) of *C. linguatula* in May, a period coinciding with that of "MEDITS" surveys.

For these species, very few studies focusing on the exploitation state are available at present. In the Gulf of Lions, the observation on commercial landings of *S. vulgaris* showed a declining trend from 1972 to 1996 (Farrugio and Marin, 1999), suggesting an overexploitation state of this species. A first approach based on analytical models was undertaken for *L. boscii* in the South Adriatic Sea (Ungaro and Marano, 1995), with results showing an exploitation level close to equilibrium.

However, it is important to take into account that some behavioural characteristics of flatfish, such as circadian activity rhythms (Walsh and Hickey, 1993; Burrows, 2001), could naturally contribute to protecting populations against high fishing intensity, reducing the catchability coefficient. The results of this study highlighted the need to increase the amount of information collected. Such information should concern not only biological and ecological aspects, but also data on landings, catch and effort. At the moment, given the lack of information on the exploitation status of these species, a precautionary approach is recommended in the management of these resources.

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