

MEDITERRANEAN MARINE DEMERSAL RESOURCES: THE MEDITS INTERNATIONAL TRAWL SURVEY (1994-1999).
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Geographical distribution, abundance and some population characteristics of the species of the genus *Pagellus* (Osteichthyes: Perciformes) in different areas of the Mediterranean*

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SUMMARY: The objective of this paper was to investigate the local distribution, abundance and population structure of *Pagellus erythrinus*, *Pagellus bogaraveo* and *Pagellus acarne* on the continental shelf and slope over a wide geographic area from Gibraltar to the Aegean Sea. The analysis was based on the data collected during six trawl surveys, from 1994 to 1999, carried out yearly in spring within the MEDITS EU project. *P. acarne* was mainly distributed on the continental shelf, with a relatively higher abundance in the western part of the Mediterranean basin, where the biomass indices of *P. bogaraveo* were also important on the continental slope. Throughout the studied area, *P. erythrinus* was mainly distributed on the continental shelf, with remarkable abundance indices in the eastern part of the Mediterranean and in Corsica's waters. Mean total lengths showed a highly significant decreasing trend from the western to the eastern geographical sectors.

Key words: *Pagellus acarne*, *Pagellus erythrinus*, *Pagellus bogaraveo*, Mediterranean Sea, abundance indices, mean length.

INTRODUCTION

Pagellus acarne (Risso, 1826), *Pagellus bogaraveo* (Brünnich, 1768) and *Pagellus erythrinus* (Linnaeus, 1758) are three widely distributed Sparidae species whose distribution area encompasses both hemispheres, from Scandinavia to Senegal and Angola (Tortonese, 1975), and represent the target of different fisheries (trawl, longline, gillnet). In the East Atlantic these species are of great commercial interest and are common in the small-scale fisheries. Thus, aspects of their population biology and fishery have been investigated in different areas (e.g. Santos

et al., 1995; Erzini *et al.*, 1998; Pajuelo and Lorenzo, 1998; Sousa *et al.*, 1999).

Also in the Mediterranean, these fishes represent appreciated fishery resources (Abellan and Basurco, 1999) and occur throughout the basin (*P. erythrinus* also in the Black Sea), although with difference in frequency of occurrence and relative abundance between the western and eastern regions. The Axillary Seabream (*P. acarne*) and the Common Pandora (*P. erythrinus*) preferably inhabit the continental shelf bottoms, while the Blackspot Seabream (*P. bogaraveo*) is commoner on the slope. In some areas, a size-dependent distribution by depth has also been reported for the three species, with the juveniles appearing mainly concentrated in shallow-

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er waters (e.g. Orsi Relini *et al.*, 1984; Orsi Relini and Fida, 1992).

These species are generally recognised as being hermaphroditic, proterandric (*P. acarne* and *P. bogaraveo*) and proterogynous (*P. erythrinus*). Nevertheless, their sexual pattern seems to be characterised by a considerable complexity, and gonocoric individuals, as well as primary females or males, are frequently identified (D'Ancona, 1949; Larrañeta, 1964; Lissia Frau, 1968; Sánchez, 1983; Krug, 1990). The amount of information available on their biology and population dynamics varies considerably among the three species and geographical regions. Biological characteristics and demographic parameters of *P. erythrinus*, such as maturity, reproductive season, recruitment time, growth and mortality, have been investigated in different areas of the western Mediterranean (e.g. Larrañeta, 1964, 1967; Girardin and Quignard, 1985; Orsi Relini and Romeo, 1985; Abella *et al.*, 1997), central Mediterranean (Rijavec and Zupanovic, 1965; Jukic and Arneri, 1984; Andaloro and Prestipino Giarritta, 1985; Jarboui *et al.*, 1998) and eastern Mediterranean (Livadas, 1988; Mytilineou, 1988; Vasilopoulou *et al.*, 1986). There is also some information on *P. acarne* and *P. bogaraveo*, but it is more limited in terms of areas and topics, such as reproductive biology and growth (Andaloro, 1983a, b; Campillo, 1992; Orsi Relini and Fida, 1992; Stergiou *et al.*, 1997). Moreover, the interest of the different *Pagellus* species for aquaculture also stimulated studies on their reproduction, feeding and growth (Cejas *et al.*, 1993; Greco *et al.*, 1995; Micale and Genovese, 1998; Spedicato *et al.*, 1998).

Depending on the species, more or less detailed information related to the biology and population dynamics is thus available for some geographical zones. Nevertheless, data on large-scale geographical distribution and relative abundance, as well as on population characteristics, are scarce. The objective of this paper was to carry out a preliminary analysis and comparison of different geographical areas from Gibraltar to the Aegean Sea by investigating the local distribution, abundance and population size structure of *P. erythrinus*, *P. bogaraveo* and *P. acarne*, on the continental shelf and upper and middle slope. Data collected by trawl surveys throughout the Mediterranean using the same methodology and gear (Bertrand *et al.*, 2000, 2002) represent a particularly suitable base for comparing abundance and length structure among several geographical regions and over time (Pennington and Strømme, 1998).

MATERIAL AND METHODS

Among the 30 reference species of the European Union research project "MEDITS" (Bertrand *et al.*, 2000, 2002), six members of the Sparidae family were included. Of these, only the three species examined in this study were considered as target species from the beginning of the project (1994), and they were therefore selected for the present study since the time series on their distribution and population characteristics was more complete. The analysed data were collected from 1994 to 1999, during six trawl surveys carried out yearly in spring (May-June) within the framework of the above mentioned project. The sampling procedures were standardised and a common protocol was applied. Further details on the stratification scheme (stratified random sampling with five bathymetric limits: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time), area subdivision in geographical sectors, and sample allocation (proportional to each depth stratum area) by geographical sector and year (1994-1999) are given in Bertrand *et al.* (2000, 2002).

The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end was employed in the different geographical zones. Data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). The horizontal net opening ranged between 14 and 19.5 m, according to the warp length, which in turn depended on the sampling depth. When the wing spread could not be directly measured it was estimated by the asymptotic relationship proposed by Souplet (1996), on the basis of a wide set of experimental data. The hauls were carried out during daylight only and each lasted 30 minutes in the 10-200 m strata and 60 minutes in the strata deeper than 200 m.

Total catches of the three *Pagellus* species were weighed and all the individuals counted. Thus, the abundance indices (biomass and density) were calculated in the standardised form ($\text{kg}\cdot\text{km}^{-2}$; $\text{Number}\cdot\text{km}^{-2}$, respectively) on the basis of the following parameters: kg or number of individuals, distance covered and wing spread of each tow ("swept area method"; Pauly, 1983).

The length data (total length) were collected on board, with the individuals measured to the lower half centimetre. Length frequency distributions were constructed for each geographical sector and depth

TABLE 1. – Occurrence of *Pagellus acarne*, *Pagellus bogaraveo* and *Pagellus erythrinus* in the MEDITS hauls (all surveys 1994-1999). Total occurrence and percentage for shelf and slope.

Geographical sector	<i>Pagellus acarne</i>			<i>Pagellus bogaraveo</i>			<i>Pagellus erythrinus</i>			Number of hauls
	Total occurrence	shelf %	slope %	Total occurrence	shelf %	slope %	Total occurrence	shelf %	slope %	
SE Adriatic-Albania	9	88.89	11.11	10	60.00	40.00	23	95.65	4.35	160
Alboran Sea-Alicante-Catalan Sea	204	79.90	20.10	153	41.83	58.17	134	100.00	0.00	614
Gulf of Lions-Corsica	170	86.47	13.53	90	53.33	46.67	163	93.87	6.13	548
N Aegean Sea	28	60.71	39.29	52	21.15	78.85	32	96.88	3.13	344
Argosaronikos	40	90.00	10.00	38	52.63	47.37	79	98.73	1.27	241
S Aegean Sea	64	76.56	23.44	73	13.70	86.30	74	97.30	2.70	323
NE Adriatic-Croatia	19	94.74	5.26	16	93.75	6.25	81	100.00	0.00	151
Ligurian, N and Central Tyrrhenian Sea	140	85.00	15.00	166	36.75	63.25	256	98.05	1.95	918
Sardinia	79	84.81	15.19	81	18.52	81.48	197	100.00	0.00	729
S Tyrrhenian Sea-Sicily Strait	114	79.82	20.18	137	37.96	62.04	145	99.31	0.69	846
E Sicily-N Ionian Sea-SW Adriatic	76	84.21	15.79	33	21.21	78.79	100	98.00	2.00	876
NW and Central Adriatic Sea	29	79.31	20.69	13	61.54	38.46	121	99.17	0.83	515
Morocco	14	64.29	35.71	8	25.00	75.00	6	83.33	16.67	63
N Adriatic-Slovenia							9	100.00	0.00	8
TOTAL	986	82.25	17.75	870	36.67	63.33	1420	98.24	1.76	6336

macro-stratum (shelf/slope). Mean length values have been estimated for every geographical sector, depth macro-stratum and year.

In this paper the data from each geographical sector and depth stratum are reported. The distribution patterns of the abundance indices and mean lengths were analysed at the shelf (depth <200 m) and slope (depths between 200 and 800 m) levels for each geographical sector.

In order to detect any temporal tendency, the biomass and density indices exceeding arbitrary threshold values of 5 kg·km⁻² and 100 individuals·km⁻², respectively, were analysed through a linear regression of the log-transformed data [$\ln(x+1)$] versus year, assuming a log-normal distribution of the trawl survey catches (Grosslein, 1971). The correlation coefficients were statistically tested. The mean lengths were compared among the geographical sectors after averaging the weighted yearly means in each sector. The presence of a linear trend from west to east was then analysed and the coefficients of correlation statistically tested.

RESULTS

Along the European coasts of the Mediterranean Sea, from the Straits of Gibraltar to the Aegean Sea (extended to Morocco since 1999), a total of 6,336 hauls was carried out on board several vessels. A total of 986, 870 and 1,420 occurrences of *Pagellus acarne*, *Pagellus bogaraveo* and *Pagellus erythrinus* were, respectively, analysed (Table 1).

On the whole, *P. erythrinus* was the most frequent species (Table 1), with a percentage of occurrence on the shelf close to 100%. *P. acarne* also exhibited a similar pattern, although occurring with a lower frequency. Conversely, the tows giving a higher presence of the less common species, *P. bogaraveo*, were mainly located on the slope.

Pagellus erythrinus

This species was predominantly distributed in the two shallower strata (10-100 m), although it showed remarkable biomass and density indices at depths from 100 to 200 m, mainly in North East and South East Corsica waters (Tables 2 and 3). The highest values were generally recorded in Argosaronikos at depths shallower than 50 m. Considering the shelf, *P. erythrinus* was more abundant in Corsica waters, East Ionian, Argosaronikos and South Aegean Sea. In these areas, the biomass indices were generally greater than 20 kg·km⁻², reaching the maximum value of 58.5 kg·km⁻² (CV%=50.5) in Corsica waters in 1999. A comparable value was also observed in Argosaronikos in 1995. In the North Aegean Sea the biomass increased in the last three years, from 13.4 (CV%=87.6) to 24.9 kg·km⁻² (CV%=84.8). Low values were conversely observed in the western sectors, from the Alborán Sea to the Gulf of Lions. The density indices showed a pattern analogous to that of biomass, reaching the maximum of 1,212 individuals·km⁻² (CV%=33.2) in the East Ionian Sea in 1996.

Figure 1 shows the mean lengths per geographical sector and year with the corresponding

TABLE 2. – *Pagellus erythrinus*: mean biomass (kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 10 kg/km² are presented in bold.

Sector code	Sector	1994					1995					1996				
		Depth (m)					Depth (m)					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	43.3	8.3	0	0	0	0	34.3	0.9	0	0	1.1	2.6	0	0	0
112a	Alicante	0	0.4	0	0	0	2.2	1.7	0	0	0	1.5	4.9	0	0	0
113a	Catalan Sea	6.0	4.2	0	0	0	4.5	2.5	0.2	0	0	8.6	6.1	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	2.1	2.4	1.1	0	0	0.7	0.1	0	0	0	3.6	0.2	0	0	0
121b	E Gulf of Lions	5.2	5.4	0	0	0	3.5	0	0	0	0	6.9	0	2.6	0	0
131a	NE Corsica	*	21.0	68.3	0	0	*	28.9	74.0	0	0	*	46.2	32.9	1.1	0
131b	SE Corsica	*	36.8	10.3	0	0	*	24.1	30.4	0	0	*	52.7	31.2	0	0
132a	N Ligurian Sea	2.5	12.7	0	0	0	11.7	0.6	1.8	0	0	12.1	3.1	0	0	0
132b	E Ligurian Sea	22.7	11.7	7.9	0	0	9.6	7.0	3.6	0	0	41.6	7.8	2.1	0	0
132c	N Tyrrhenian	32.0	1.1	0	0	0	56.3	4.1	0	0	0	51.4	6.3	0	0	0
132d	C Tyrrhenian	9.1	9.1	1.2	0	0	8.3	1.1	3.5	0	0	7.9	0.6	1.6	0	0
133a	SE Sardinia	4.7	11.6	0	0	0	7.2	2.3	0	0	0	4.4	5.4	0	0	0
133b	NE Sardinia	0	3.5	8.7	0	0	0	3.1	0	0	0	8.4	14.2	4.3	0	0
133c	N Sardinia	5.9	8.5	0	0	0	5.2	1.1	0	0	0	5.9	12.1	0	0	0
133d	NW Sardinia	28.6	37.3	0	0	0	*	19.3	4.9	0	0	34.8	8.4	2.0	0	0
133e	W Sardinia	28.1	*	1.4	0	0	14.3	7.8	0	0	0	39.3	2.3	0	0	0
133f	SW Sardinia	1.0	3.2	0	0	0	9.5	1.5	0	0	0	7.5	26.7	0	0	0
133g	S Sardinia	7.8	0	0	0	0	12.6	*	0	0	0	1.2	2.1	0	0	0
134a	SE Tyrrhenian	11.1	0.6	0.2	0	0	12.9	0.4	0	0	0	13.3	0.4	0.8	0	0
134b	SW Tyrrhenian	6.2	63.8	5.7	0	0	24.3	24.7	15.3	0	0	65.9	48.3	0	0	0
134c	Sicilian Chan.	1.4	5.0	0	0	0	4.9	0.9	1.5	0	0	3.4	5.2	0.1	0	0
211a	N Adriatic Sea	0.3	1.5	*	*	*	0.3	1.5	*	*	*	0.4	0.9	*	*	*
211b	Central Adriatic	0.6	2.7	0	0	0	0.4	0	0	0	0	1.3	2.6	0	0	0
211c	N Adriatic-Slov	*	*	*	*	*	136.4	*	*	*	*	14.1	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	12.2	19.9	0.2	0	*
221a	E Sicily	3.5	0	0	0	0	5.7	2.9	1.9	0	0	11.7	5.2	5.4	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	4.4	2.7	0	0	0	0.0	3.5	0	0
221c	N Ionian Sea	2.0	0	0	0	0	1.0	0	0	0	0	0	1.3	0	0	0
221d	N Ionian Sea	*	0	0	0	0	1.9	0	0	0	0	0	1.9	0	0	0
221e	SW Adriatic	0	0	0	0	0	*	0	0	0	0	*	0	0	0	0
221f	SW Adriatic	0.5	0	0	0	0	1.2	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	0.1	0	0	0	0	0.1	0	0	0	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	15.7	5.5	0	0	0
222a	E Ionian Sea	0	54.2	0	0	0	6.2	28.0	0	0	0	81.8	34.0	0	0	0
223a	Argosaronikos	109.4	19.1	0	0	0	226.2	7.6	0	0	0	114.2	69.9	4.5	0	0
224a	N Aegean Sea	1.2	1.9	5.4	0	0	21.4	18.6	0.2	0	0	21.9	0.3	2.8	0	0
225a	S Aegean Sea	13.9	21.1	0	0	0	83.6	18.8	11.2	0	0	13.8	53.3	4.8	0	0

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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	27.9	3.2	0	0	0	0	9.1	0	0	0	0	4.8	0	0	0
112a	Alicante	1.3	1.3	0	0	0	1.9	4.4	0	0	0	22.3	11.9	0	0	0
113a	Catalan Sea	22.2	5.2	0	0	0	9.8	9.1	1.0	*	0	35.0	12.5	0.8	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	3.8	0	0	1.5
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	18.1	1.7	0	0	0
121a	W Gulf of Lions	2.5	0	0	0	0	7.9	0.3	0	0	0	6.8	1.2	0	0	0
121b	E Gulf of Lions	0.4	3.3	0	0	0	6.1	4.7	0	0	0	41.3	3.5	0	0	*
131a	NE Corsica	*	26.7	*	2.2	0	*	22.3	33.5	0.3	0	*	40.8	18.4	3.2	0
131b	SE Corsica	*	13.8	0	0	*	*	18.8	10.8	0	0	*	110.6	1.2	0	0
132a	N Ligurian Sea	31.2	2.4	0	0	0	29.1	49.8	0.5	0	0	36.4	1.6	0	0	0
132b	E Ligurian Sea	27.1	4.4	2.6	0	0	24.8	9.7	3.5	0.1	0	44.8	12.8	4.4	0	0
132c	N Tyrrhenian	29.0	0.4	0.2	0	0	25.9	0.5	0	0	0	40.3	5.4	0	0	0
132d	C Tyrrhenian	8.2	3.7	1.4	0	0	12.1	8.0	1.1	0	0	23.6	4.9	2.4	0.5	0
133a	SE Sardinia	2.2	11.4	0	0	0	5.4	16.2	0	0	0	7.7	3.8	0	0	0
133b	NE Sardinia	7.7	13.0	0	0	0	16.7	11.4	8.9	0	0	2.9	7.6	5.3	0	0
133c	N Sardinia	3.0	10.6	0	0	0	22.9	11.5	0	0	0	25.7	12.2	0	0	0
133d	NW Sardinia	26.0	17.7	0	0	0	27.3	18.2	0	0	0	32.1	25.6	0.6	0	0
133e	W Sardinia	2.9	19.4	0	0	0	17.6	5.4	0	0	0	22.4	20.8	0	0	0
133f	SW Sardinia	2.6	18.4	0	0	0	17.5	6.1	0	0	0	9.1	20.9	0.3	0	0
133g	S Sardinia	1.1	1.1	0	0	0	5.0	0	2.3	0	0	4.1	7.1	0	0	0
134a	SE Tyrrhenian	7.5	6.8	0.7	0	0	26.8	4.1	0	0	0	14.9	17.3	0.1	0	0
134b	SW Tyrrhenian	55.8	71.4	0	0	0	25.0	31.7	5.7	0	0	26.7	36.6	2.7	0	0

TABLE 2 (Cont.). – *Pagellus erythrinus*: mean biomass (kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 10 kg/km² are presented in bold.

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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
134c	Sicilian Chan.	1.6	8.2	0.4	0	0	2.8	27.0	0.1	0	0	3.4	7.5	0.2	0	0
211a	N Adriatic Sea	0.8	0.9	*	*	*	0.4	0.5	*	*	*	7.1	1.1	*	*	*
211b	Central Adriatic	1.8	1.9	0	0	0	0.4	0.4	0	0.1	*	3.0	0.6	0	0	*
211c	N Adriatic-Slov	37.9	*	*	*	*	52.2	*	*	*	56.0	*	*	*	*	*
211d	NE Adri Croatia	10.5	35.6	2.5	0	*	32.6	14.7	1.8	0	*	0	*	*	*	*
221a	E Sicily	17.2	7.4	0	0	0	36.5	6.7	4.6	0	0	28.2	0.4	0	0	0
221b	NW Ionian Sea	0	5.4	0.3	0	0	2.0	12.9	1.1	0	0.1	5.4	0	0	0	0
221c	N Ionian Sea	11.1	0	0	0	0	2.1	6.0	0	0	0	2.3	3.2	0	0	0
221d	N Ionian Sea	6.5	0	0	0	0	3.3	1.0	0	0	0	30.4	0	0	0	0
221e	SW Adriatic	*	0	0	0	0	*	0	0	0	0	*	0	0.2	0	0
221f	SW Adriatic	1.0	0.1	0	0	0	8.3	0.1	0.3	0	0	5.2	0	0	0	0
221g	SW Adriatic	0.8	0	0	*	0	1.6	0.2	0	*	0	3.0	0	0	*	0
221h	SW Adriatic	0.2	0.5	0	0	0	0.4	0	0	0	0	2.5	0.4	1.0	1.3	0
221i	SE Adriatic	18.9	3.6	0	0	0	10.4	6.5	0	0.1	0	71.6	16.4	0	0	0
222a	E Ionian Sea	30.1	26.7	0	0	0	75.4	14.8	1.2	0	0	41.3	16.0	1.7	0	0
223a	Argosaronikos	163.5	44.1	1.8	0	0	72.0	51.7	3.9	0	0	71.0	82.5	18.5	0	0
224a	N Aegean Sea	89.1	0.3	3.0	0	0	51.3	0.2	2.0	0	0	48.1	0.8	1.2	0	0
225a	S Aegean Sea	14.4	20.8	9.4	0.1	0	134.8	28.9	5.8	0.1	0	60.5	25.3	11.4	0.3	0

TABLE 3. – *Pagellus erythrinus*: mean density (in number of individuals /km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 200 individuals /km² are presented in bold.

Sector code	Sector	1994					1995					1996				
		Depth (m)					Depth (m)					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	163	30	0	0	0	0	151	6	0	0	11	31	0	0	0
112a	Alicante	0	4	0	0	0	27	14	0	0	0	16	35	0	0	0
113a	Catalan Sea	123	36	0	0	0	78	23	2	0	0	99	52	0	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	17	8	10	0	0	3	1	0	0	0	27	1	0	0	0
121b	E Gulf of Lions	54	19	0	0	0	7	0	0	0	0	54	0	10	0	0
131a	NE Corsica	*	490	863	0	0	*	685	779	0	0	*	873	473	7	0
131b	SE Corsica	*	743	98	0	0	*	415	336	0	0	*	1049	479	0	0
132a	N Ligurian Sea	77	61	0	2	0	220	7	38	0	0	208	54	0	0	0
132b	E Ligurian Sea	332	159	49	0	0	189	127	38	0	0	878	97	20	0	0
132c	N Tyrrhenian	952	18	0	1	0	2235	45	0	0	0	1505	80	0	0	0
132d	C Tyrrhenian	123	95	9	0	0	151	13	20	0	0	111	7	14	0	0
133a	SE Sardinia	186	95	0	0	0	262	53	0	0	0	80	122	0	0	0
133b	NE Sardinia	0	41	54	0	0	0	48	0	0	0	97	185	43	0	0
133c	N Sardinia	104	73	0	0	0	127	11	0	0	0	120	106	0	0	0
133d	NW Sardinia	246	403	0	0	0	*	215	43	0	0	342	59	58	0	0
133e	W Sardinia	581	*	12	0	0	497	90	0	0	0	896	13	0	0	0
133f	SW Sardinia	21	37	0	0	0	432	29	0	0	0	62	251	0	0	0
133g	S Sardinia	371	0	0	0	0	317	*	0	0	0	12	11	0	0	0
134a	SE Tyrrhenian	180	11	2	0	0	324	7	0	0	0	267	7	9	0	0
134b	SW Tyrrhenian	140	777	67	0	0	412	232	140	0	0	626	376	0	0	0
134c	Sicilian Chan.	36	32	0	0	0	140	24	3	0	0	92	73	2	0	0
211a	N Adriatic Sea	16	24	*	*	*	9	29	*	*	*	12	17	*	*	*
211b	Central Adriatic	11	22	0	0	0	10	0	0	0	0	17	16	0	0	0
211c	N Adriatic-Slov	*	*	*	*	*	1307	*	*	*	*	94	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	279	388	1	0	*
221a	E Sicily	71	0	0	0	0	105	44	21	0	0	263	31	40	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	22	11	0	0	0	0	12	0	0
221c	N Ionian Sea	31	0	0	0	0	26	0	0	0	0	0	14	0	0	0
221d	N Ionian Sea	*	0	0	0	0	42	0	0	0	0	0	19	0	0	0
221e	SW Adriatic	0	0	0	0	0	*	0	0	0	0	*	0	0	0	0
221f	SW Adriatic	7	0	0	0	0	75	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	8	0	0	0	0	8	0	0	0	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	256	73	0	0	0
222a	E Ionian Sea	0	497	0	0	0	212	236	0	0	0	3268	543	0	0	0
223a	Argosaronikos	2057	83	0	0	0	2692	68	0	0	0	2218	894	38	0	0
224a	N Aegean Sea	10	19	16	0	0	71	113	2	0	0	355	4	26	0	0
225a	S Aegean Sea	253	125	0	0	0	1096	283	93	0	0	969	774	35	0	0

TABLE 3 (Cont.). – *Pagellus erythrinus*: mean density (in number of individuals /km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 200 individuals /km² are presented in bold.

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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	231	17	0	0	0	0	24	0	0	0	0	20	0	0	0
112a	Alicante	9	8	0	0	0	11	31	0	0	0	287	107	0	0	0
113a	Catalan Sea	217	44	0	0	0	231	70	6	*	0	471	92	4	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	21	0	0	5
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	276	11	0	0	0
121a	W Gulf of Lions	14	0	0	0	0	133	3	0	0	0	48	10	0	0	0
121b	E Gulf of Lions	3	17	0	0	0	151	83	0	0	0	524	20	0	0	*
131a	NE Corsica	*	282	*	15	0	*	534	512	6	0	*	763	221	46	0
131b	SE Corsica	*	234	0	0	*	*	304	149	0	0	*	1627	9	0	0
132a	N Ligurian Sea	1105	24	0	0	0	677	706	7	0	0	310	21	0	0	0
132b	E Ligurian Sea	795	51	22	0	0	520	160	27	2	0	602	143	33	0	0
132c	N Tyrrhenian	683	7	2	0	0	659	7	0	0	0	569	73	2	0	0
132d	C Tyrrhenian	2371	46	9	0	0	252	139	9	0	0	265	75	23	3	0
133a	SE Sardinia	87	119	0	0	0	123	336	0	0	0	759	45	0	0	0
133b	NE Sardinia	107	164	0	0	0	390	134	83	0	0	34	114	32	0	0
133c	N Sardinia	45	141	0	0	0	317	104	0	0	0	359	115	0	0	0
133d	NW Sardinia	215	180	0	0	0	297	245	0	0	0	222	333	8	0	0
133e	W Sardinia	29	223	0	0	0	317	41	0	0	0	592	156	0	0	0
133f	SW Sardinia	38	152	0	0	0	713	61	0	0	0	269	301	4	0	0
133g	S Sardinia	39	11	0	0	0	173	0	18	0	0	94	60	0	0	0
134a	SE Tyrrhenian	147	93	7	0	0	503	82	0	0	0	298	250	2	0	0
134b	SW Tyrrhenian	437	649	0	0	0	443	235	45	0	0	408	295	19	0	0
134c	Sicilian Chan.	45	93	4	0	0	73	200	2	0	0	57	77	4	0	0
211a	N Adriatic Sea	42	14	*	*	*	24	9	*	*	*	384	15	*	*	*
211b	Central Adriatic	84	23	0	0	0	5	6	1	1	*	90	8	0	0	*
211c	N Adriatic-Slov	360	*	*	*	*	315	*	*	*	*	778	*	*	*	*
211d	NE Adri Croatia	237	577	13	0	*	628	213	15	0	*	0	*	*	*	*
221a	E Sicily	296	84	0	0	0	694	78	38	0	0	801	11	0	0	0
221b	NW Ionian Sea	0	33	11	0	0	23	151	11	0	1	69	0	0	0	0
221c	N Ionian Sea	96	0	0	0	0	22	58	0	0	0	37	44	0	0	0
221d	N Ionian Sea	65	0	0	0	0	44	22	0	0	0	1620	0	0	0	0
221e	SW Adriatic	*	0	0	0	0	*	0	0	0	0	*	0	3	0	0
221f	SW Adriatic	39	7	0	0	0	515	8	4	0	0	158	0	0	0	0
221g	SW Adriatic	24	0	0	*	0	54	15	0	*	0	106	0	0	*	0
221h	SW Adriatic	3	4	0	0	0	13	4	0	0	0	108	15	19	26	0
221i	SE Adriatic	304	51	0	0	0	249	110	0	1	0	1886	376	0	0	0
222a	E Ionian Sea	557	351	0	0	0	1946	283	16	0	0	2206	316	18	2	0
223a	Argosaronikos	3042	722	6	0	0	1540	563	21	0	0	1447	1166	76	0	0
224a	N Aegean Sea	760	4	29	0	0	673	2	25	0	0	474	16	13	0	0
225a	S Aegean Sea	272	259	105	1	0	2586	474	78	1	0	1261	522	127	4	0

standard deviations. The data are only presented for the shelf (19,900 individuals), since only 82 fish were caught on the slope. The largest absolute length of 38 cm was observed in the Alborán Sea and the smallest (2 cm) in Ligurian-North Central Tyrrhenian Sea. However, even in the western side, juveniles of 4 cm length occurred in the samples.

The smallest mean length (7.8 cm) was recorded in Ligurian-North Central Tyrrhenian Sea in 1997, while the largest (26.0 cm) was found in Alicante and in the Gulf of Lions in 1994 and 1995, respectively. The greater mean lengths were mainly found in the western sectors, from Alborán to the Gulf of Lions, but also in the North Aegean Sea. The mean lengths from west to east showed a highly significant ($p < 0.05$) decreasing trend.

Pagellus acarne

This species was mainly distributed on the continental shelf, in the strata from 10 to 200 m, although high biomass indices were also recorded from 200 to 500 m, especially so in the East Gulf of Lions (Table 4), where, however, the corresponding densities (Table 5) were not as high, indicating the occurrence of larger specimens. The highest density was observed in the eastern part of Morocco in 1999 at the shallowest depths. A comparable value was also recorded in 1998 in the South Aegean Sea (Table 5). Considering the shelf, the catches recorded in the Alborán Sea dominated the scenario, with biomass values up to 406.3 kg·km⁻² (CV%=37.0) in 1994. The corresponding density index was 2,898 individuals·km⁻² (CV%=27.7), a number considerably

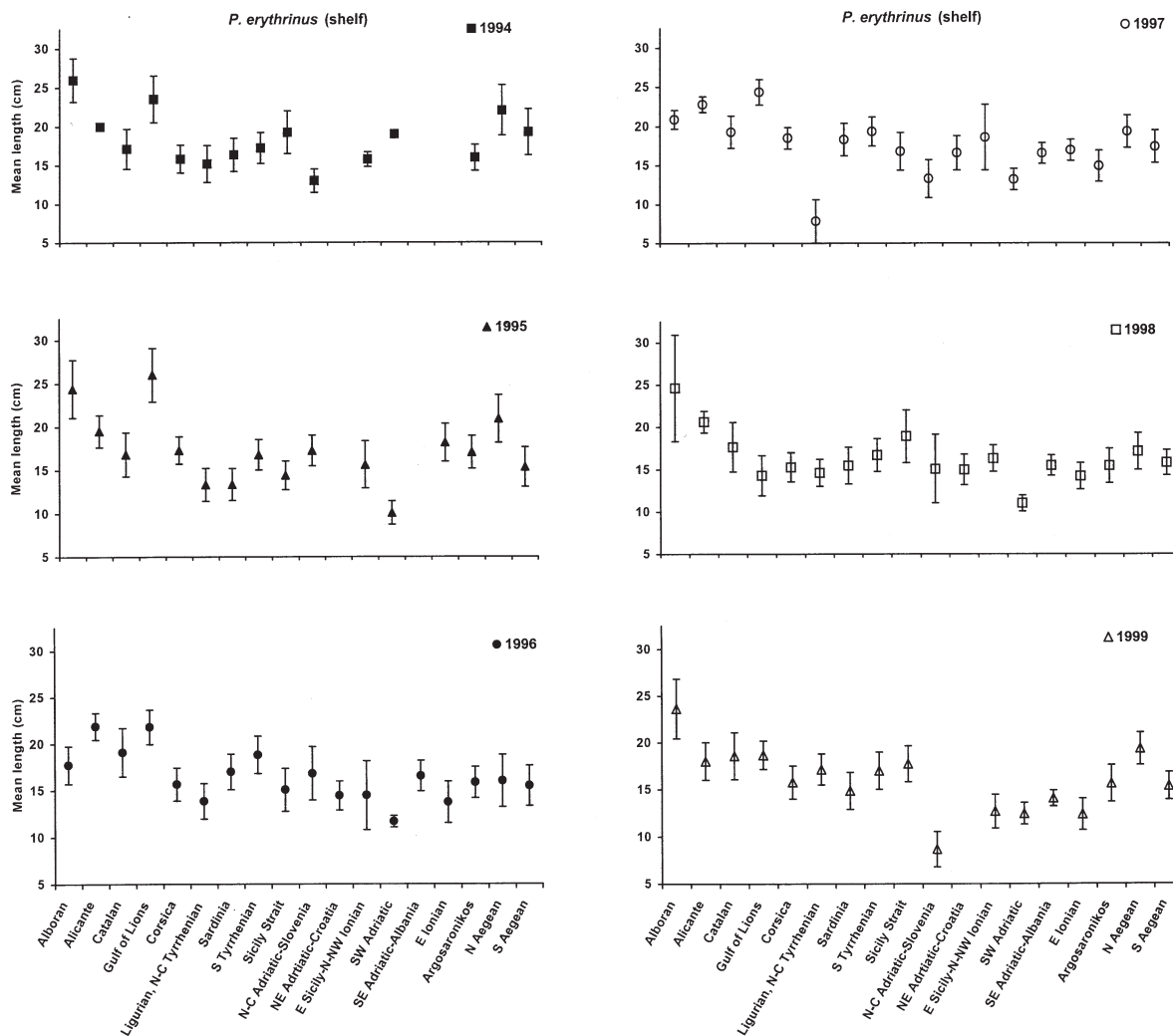


FIG. 1. – Mean total length (\pm S.D.) of *Pagellus erythrinus* on the continental shelf by geographical region and year.

lower than that observed in 1998 in the South Aegean Sea, where the density reached the value of 5,084 individuals·km⁻² (CV%=78.6), but with a biomass of 75.0 kg·km⁻² (CV%=73.8). This was due to the occurrence of smaller fishes in the easternmost area. *P. acarne* also showed a remarkable biomass (146.3 kg·km⁻²; CV%=38.5) and density (6,579 individuals·km⁻² (CV%=61.0) on the continental shelf of Morocco, where the trawl survey started in 1999. Catches on the slope were very poor and density was highly variable with less than 33 individuals·km⁻², except in the South Aegean Sea (76 individuals·km⁻²; CV%=96.5). The biomass indices were below 9.1 kg·km⁻² (CV%=113.2), which was the highest value, recorded in 1999 in the Gulf of Lions. Significant declines of the density indices were found only for the Alborán Sea with $r=0.84$ ($p<0.05$).

The mean lengths estimated for the shelf (28,335 individuals) and slope (1,432 individuals) strata are

shown in Figure 2. The smallest length (2 cm) was recorded from the Ligurian-North Central Tyrrhenian Sea shelf in 1994 and the largest (30 cm) from the Catalan Sea slope in 1996. Juveniles ranging in size from 5–8 cm occurred in most areas.

In all the geographical sectors, the average lengths observed for the shelf were generally smaller than those on the slope. Most of the estimated values for this stratum were greater in the westward geographical sectors. Considering the whole depth range, the mean lengths from west to east showed a highly significant ($p<0.05$) decreasing trend, both on the shelf and slope.

Pagellus bogaraveo

This species was distributed throughout the sampled bathymetric range with higher relative abundance in the deeper strata (200–800 m), except in

TABLE 4. – *Pagellus acarne*: mean biomass (kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 10 kg/km² are presented in bold.

Sector code	Sector	1994					1995					1996				
		Depth (m)					Depth (m)					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	583.0	561.9	66.5	0.5	0	135.5	281.0	2.8	0.4	0.1	199.9	131.9	118.5	3.1	0.2
112a	Alicante	3.0	0.4	0	0	0	23.1	20.5	0	0.1	0	1.4	92.1	0	1.2	0
113a	Catalan Sea	0.1	28.1	3.5	0.9	0	13.4	9.1	2.2	0.2	0	1.6	18.3	20.8	3.9	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	8.1	26.5	3.2	0.8	0	8.3	37.1	23.8	0	0	9.4	9.9	5.9	0	0
121b	E Gulf of Lions	0.6	0.8	8.9	11.9	0	0	1.9	12.2	19.8	0	0	0.6	13.6	29.5	0
131a	NE Corsica	*	0	0	8.6	0	*	0	0.5	6.2	0	*	0.3	0	0.3	0
131b	SE Corsica	*	0	6.1	0	0	*	1.1	198.1	0	0	*	67.0	0	1.1	0
132a	N Ligurian Sea	9.5	0	0	0	0	0	0	0.5	3.5	0.2	0	10.1	0	5.4	0
132b	E Ligurian Sea	0.8	2.2	0.8	0.2	0	4.1	0	0.4	0.1	0	0	2.7	0.5	0.1	0
132c	N Tyrrhenian	0	0.2	5.1	0.1	0	1.2	0	1.1	0	0	0	0	1.6	0.1	0
132d	C Tyrrhenian	0.9	0	0.6	0	0	2.6	0.9	0	0.6	0	0.5	0	0.5	0	0
133a	SE Sardinia	2.3	0	6.6	3.3	0	2.0	1.5	0	1.5	0	1.6	0	0	0.8	0
133b	NE Sardinia	0	0	0	0	0	0	0	0	2.3	0	1.3	0	0	0	0
133c	N Sardinia	0	1.1	0	31.3	0	0.6	0	0	56.3	0	0	36.4	0	0	0
133d	NW Sardinia	0	17.8	0	0	0	*	0	0	0	0	0	0	0	0	0
133e	W Sardinia	17.6	*	0.9	0	0	0	0	0	0	0	11.6	0.6	0	0	0
133f	SW Sardinia	0	1.0	0	0	0	16.0	0	0	0	0	0	0	1.0	2.4	0
133g	S Sardinia	0	0	0	3.0	0	6.7	*	0	0	0	0.2	0	0	0	0
134a	SE Tyrrhenian	3.8	0.3	0.2	4.8	0	8.3	0	1.1	0.6	0	7.9	0	0.6	0.5	0
134b	SW Tyrrhenian	179.3	16.1	0	0	0	16.5	7.1	2.6	1.3	0	0	0.3	1.1	0	0
134c	Sicilian Chan.	0.4	1.2	0	0.1	0	0	0.9	0.1	0.1	0	0	2.2	0.0	1.2	0
211a	N Adriatic Sea	0	0.2	*	*	*	0	0	*	*	*	0.1	0	*	*	*
211b	Central Adriatic	0	0.2	0	0	0	0	0	0	0	0	0.4	0.5	0.1	0.4	0
211c	N Adriatic-Slov	*	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	0.3	1.2	0	0.1	*
221a	E Sicily	2.0	3.3	0	0	0	1.2	4.0	0.7	0	0	5.5	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	1.1	0	0	0	0.8	0	0	0.4	0
221c	N Ionian Sea	0.4	0.5	0	0	0	0	0.4	0.6	0	0	0	0	0	0	0
221d	N Ionian Sea	*	0	0	0	0	0	0	0	0.1	0	0	1.1	0	0	0
221e	SW Adriatic	0	6.7	0	0	0	*	0	0.4	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	0.5	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0.1	0	0	4.5	0	0	0.1	0	22.4	0	0.3	0	0	0	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	0.4	0	0	0	0
222a	E Ionian Sea	0.4	38.9	0	0	0	0.4	0.6	0	0	0	0	4.4	0.8	0	0
223a	Argosaronikos	0	4.0	0	0	0	12.7	0	0	0	0	0	1.1	0	0	0
224a	N Aegean Sea	0	0	0	0	0	0	5.1	0.3	1.0	0	0.4	0.6	0.6	0.6	0
225a	S Aegean Sea	49.6	55.1	0.3	0.3	0	47.8	1.2	1.6	0.0	0	0	31.1	29.2	10.9	0

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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	57.4	68.3	164.5	2.2	0.5	945.2	86.3	137.2	1.7	0.6	32.1	11.3	85.4	1.8	0.4
112a	Alicante	0.6	5.5	0.8	0	0	2.1	28.2	0	0.4	0.1	42.2	47.2	0.3	0.1	0
113a	Catalan Sea	3.9	43.5	2.2	0	0	24.6	23.7	0	*	0	16.1	6.8	1.1	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	107.7	79.7	2.3	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	600.9	0	0	3.7	0
121a	W Gulf of Lions	14.2	38.7	6.5	0	0	38.8	17.4	0	0	0	49.9	20.6	7.8	0	0
121b	E Gulf of Lions	0.5	2.0	7.3	25.2	0	0.4	2.2	7.8	0	0	1.9	0.2	12.8	36.1	*
131a	NE Corsica	*	0	*	0	0	*	0	0	0.1	0	*	0	0	4.2	0
131b	SE Corsica	*	0	0	0	*	*	10.9	0	1.9	0	*	0	16.1	0	0
132a	N Ligurian Sea	31.5	0.3	0	0	0	0	1.3	0	4.8	0	0	0.4	0	0	0
132b	E Ligurian Sea	11.5	0.5	0.8	0.2	0	0.8	1.1	0	0.1	0	3.8	2.0	0.3	1.9	0
132c	N Tyrrhenian	7.5	0.2	1.3	0.2	0	4.2	0	1.7	0	0	2.7	1.8	2.8	0	0
132d	C Tyrrhenian	2.7	0	0	0	0	28.0	0.4	5.4	0.1	0	6.7	0.3	0.9	0.1	0
133a	SE Sardinia	0	0	0	0	0	1.0	1.2	0	0	0	19.5	0	0	0.7	0
133b	NE Sardinia	28.0	1.9	0	0	0	12.4	0	0	0	0	0	0.8	10.5	0	0
133c	N Sardinia	0	1.4	0	0	0	0.9	0	0	0	0	14.2	0.9	1.0	76.0	0
133d	NW Sardinia	0	0.6	0	0	0	0	5.4	6.5	0	0	0	0	0	0	0
133e	W Sardinia	0.7	0	0	0	0	4.9	0.5	0	0	0	7.2	23.9	0	0	0
133f	SW Sardinia	1.3	3.5	0.1	0	0	10.1	0	0.5	0	0	4.3	0	1.2	0.7	0
133g	S Sardinia	0	0	0	0.3	0	0	0	0	0	0	0.4	0	0.2	0	0
134a	SE Tyrrhenian	10.31	0	2.3	0.5	0	4.4	0.2	0.5	0.1	0	18.1	4.0	0.3	0.1	0
134b	SW Tyrrhenian	88.3	12.3	0.5	21.7	0	403.9	27.2	6.4	0.2	0	0	4.6	6.5	0	0

TABLE 4 (Cont.). – *Pagellus acarne*: mean biomass (kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by ‘*’. Values higher than 10 kg/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
134c	Sicilian Chan.	0.6	2.6	0	0	0	0	2.7	0.1	0	0	0	7.3	0	0	0
211a	N Adriatic Sea	0	0.1	*	*	*	0	1.4	*	*	*	0.3	0	*	*	*
211b	Central Adriatic	0	0.8	0.1	0.3	0	0	0.1	0.1	0	*	1.9	0	0	0.1	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	0.5	0	0	*	0.2	0.4	0.2	0	*	0	*	*	*	*
221a	E Sicily	59.34	0.7	3.1	0	0	17.2	7.9	4.7	5.0	0	0.5	0.1	0.8	0	0
221b	NW Ionian Sea	0	0	0	0	0	0.5	0	1.5	0	0	0.5	0	0.7	0	0
221c	N Ionian Sea	0.4	0.8	0.6	0	0	0.7	0.6	1.0	0	0	0	0	0.8	0	0
221d	N Ionian Sea	0	0	0.7	0	0	0	0	0	0	0.1	0	0	1.0	0	0
221e	SW Adriatic	*	0.3	0.2	0	0	*	0	0	0	0	*	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	9.1	0	0	*	0
221h	SW Adriatic	0	0.3	0	1.2	0	0.1	0	0	0.4	0	0	0.4	0	0.2	0
221i	SE Adriatic	0	0.3	0	0	0	0	0.5	0.3	0	0	0.5	0	0	0.2	0
222a	E Ionian Sea	0	0	0	0	0	19.8	1.3	0.4	0	0	82.3	3.6	2.3	0.3	0
223a	Argosaronikos	37.66	3.4	0	0	0	12.2	0	0.1	0.3	0	193.8	0	0	1.5	0
224a	N Aegean Sea	6.2	0.1	0.1	0	0	6.0	0	0.1	0	0	1.4	0.4	0	0	0
225a	S Aegean Sea	0	2.6	2.1	0.1	0	286.4	62.9	0.4	0.8	0	17.6	15.4	0.1	3.9	0

TABLE 5. – *Pagellus acarne*: mean density (in number of individuals /km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by ‘*’. Values higher than 200 individuals /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	8427	2991	423	5	0	9908	4386	38	3	1	2528	1958	654	24	3
112a	Alicante	192	4	0	0	0	1693	228	0	1	0	33	603	0	8	0
113a	Catalan Sea	22	252	32	5	0	172	76	14	2	0	21	125	112	11	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	80	91	21	7	0	60	145	104	0	0	110	48	9	0	0
121b	E Gulf of Lions	6	4	30	36	0	0	8	39	61	0	0	2	41	73	0
131a	NE Corsica	*	0	0	52	0	*	0	10	40	0	*	7	0	2	0
131b	SE Corsica	*	0	122	0	0	*	21	2218	0	0	*	1680	0	6	0
132a	N Ligurian Sea	9154	0	0	0	0	0	0	6	12	1	0	512	0	14	0
132b	E Ligurian Sea	22	34	11	1	0	103	0	3	1	0	3	26	8	1	0
132c	N Tyrrhenian	0	3	28	1	0	112	0	4	0	0	0	0	8	1	0
132d	C Tyrrhenian	11	0	6	2	0	42	10	0	3	0	11	0	5	0	0
133a	SE Sardinia	65	0	202	16	0	104	23	0	11	0	96	0	0	4	0
133b	NE Sardinia	0	0	0	0	0	0	0	0	7	0	26	0	0	0	0
133c	N Sardinia	0	8	0	259	0	8	0	0	408	0	0	485	0	0	0
133d	NW Sardinia	0	227	0	0	0	*	0	0	0	0	0	0	0	0	0
133e	W Sardinia	392	*	4	0	0	0	0	0	0	0	308	13	0	0	0
133f	SW Sardinia	0	12	0	0	0	324	0	0	0	0	0	0	12	16	0
133g	S Sardinia	0	0	0	9	0	598	*	0	0	0	24	0	0	0	0
134a	SE Tyrrhenian	294	4	4	40	0	581	0	17	7	0	511	0	7	3	0
134b	SW Tyrrhenian	11633	272	0	0	0	512	153	44	8	0	0	6	14	0	0
134c	Sicilian Chan.	6	12	0	1	0	0	13	2	1	0	0	32	0	7	0
211a	N Adriatic Sea	0	2	*	*	*	0	0	*	*	*	1	0	*	*	*
211b	Central Adriatic	0	1	0	0	0	0	0	0	0	0	6	3	2	6	0
211c	N Adriatic-Slov	*	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	6	30	0	3	*
221a	E Sicily	402	33	0	0	0	24	55	7	0	0	88	0	0	0	0
221b	NW Ionian Sea	0	0	0	0	0	0	11	0	0	0	22	0	0	4	0
221c	N Ionian Sea	8	8	0	0	0	0	7	12	0	0	0	0	0	0	0
221d	N Ionian Sea	*	0	0	0	0	0	0	0	2	0	0	19	0	0	0
221e	SW Adriatic	0	90	0	0	0	*	0	3	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	37	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	5	0	0	29	0	3	4	0	85	0	10	0	0	0	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	7	0	0	0	0
222a	E Ionian Sea	17	416	0	0	0	35	6	0	0	0	0	71	8	0	0
223a	Argosaronikos	0	21	0	0	0	440	0	0	0	0	0	47	0	0	0
224a	N Aegean Sea	0	0	0	0	0	0	61	7	13	0	7	12	10	12	0
225a	S Aegean Sea	2373	1226	7	2	0	512	54	25	0	0	0	2175	524	170	0

TABLE 5 (Cont.). – *Pagellus acarne*: mean density (in number of individuals /km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 200 individuals /km² are presented in bold.

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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	863	900	703	7	5	6091	1107	831	17	5	465	125	414	7	3
112a	Alicante	9	57	8	0	0	22	172	0	1	2	636	548	3	1	0
113a	Catalan Sea	42	277	17	0	0	239	107	0	*	0	190	59	4	0	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	63	500	10	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	31160	0	0	35	0
121a	W Gulf of Lions	108	163	27	0	0	383	79	0	0	0	389	78	27	0	0
121b	E Gulf of Lions	3	8	26	72	0	4	12	26	0	0	21	2	67	114	*
131a	NE Corsica	*	0	*	0	0	*	0	0	1	0	*	0	0	28	0
131b	SE Corsica	*	0	0	0	*	*	384	0	13	0	*	0	264	0	0
132a	N Ligurian Sea	1487	8	0	0	0	0	42	0	13	0	0	7	0	0	0
132b	E Ligurian Sea	679	6	9	2	0	33	16	0	1	0	58	28	4	16	0
132c	N Tyrrhenian	138	3	8	2	0	291	0	12	0	0	87	27	27	0	0
132d	C Tyrrhenian	81	0	0	0	0	555	4	48	1	0	175	3	9	2	0
133a	SE Sardinia	0	0	0	0	0	123	23	0	0	0	2018	0	0	3	0
133b	NE Sardinia	594	34	0	0	0	273	0	0	0	0	0	11	84	0	0
133c	N Sardinia	0	24	0	0	0	18	0	0	0	0	225	7	13	630	0
133d	NW Sardinia	0	8	0	0	0	0	76	31	0	0	0	0	0	0	0
133e	W Sardinia	14	0	0	0	0	221	14	0	0	0	151	468	0	0	0
133f	SW Sardinia	26	82	2	0	0	269	0	6	0	0	97	0	16	5	0
133g	S Sardinia	0	0	0	3	0	0	0	0	0	0	60	0	4	0	0
134a	SE Tyrrhenian	370	0	36	7	0	442	4	9	1	0	466	83	5	1	0
134b	SW Tyrrhenian	1076	180	7	184	0	12029	275	132	1	0	0	126	92	0	0
134c	Sicilian Chan.	6	43	0	0	1	0	36	2	0	0	0	102	0	1	0
211a	N Adriatic Sea	0	2	*	*	*	0	23	*	*	*	13	0	*	*	*
211b	Central Adriatic	0	13	1	4	0	0	2	1	0	*	94	0	0	2	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	10	1	0	0	5	7	4	0	*	0	*	*	*	*
221a	E Sicily	6211	42	63	0	0	2556	157	84	43	0	8	11	15	0	0
221b	NW Ionian Sea	0	0	0	0	0	11	0	32	0	0	11	0	11	0	0
221c	N Ionian Sea	7	15	11	0	0	15	15	21	0	0	0	0	11	0	0
221d	N Ionian Sea	0	0	7	0	0	0	0	0	0	1	0	0	23	0	0
221e	SW Adriatic	*	7	3	0	0	*	0	0	0	0	*	0	0	0	0
221f	SW Adriatic	0	0	0	0	0	0	0	0	0	0	270	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	0	520	0	0	*	0
221h	SW Adriatic	0	4	0	15	0	3	0	0	6	0	3	8	0	3	0
221i	SE Adriatic	0	2	0	0	0	0	9	4	0	0	15	2	0	1	0
222a	E Ionian Sea	0	0	0	0	0	1331	32	16	0	0	7594	104	169	5	0
223a	Argosaronikos	910	34	0	0	0	714	0	3	6	0	5116	0	0	39	0
224a	N Aegean Sea	146	2	2	0	0	148	0	2	0	0	51	9	0	0	0
225a	S Aegean Sea	0	45	44	3	0	20536	2966	10	18	0	1542	1029	3	56	0

1994 in the Alborán Sea, where a biomass of 135.5 kg·km⁻² (density: 4,545 individuals·km⁻²) was recorded (Tables 6 and 7). Considering the whole shelf, a great difference in biomass (maximum 33.9 kg·km⁻²; CV%=75.7) and density (maximum 614 individuals·km⁻²; CV%=69.2) indices between the Alborán Sea and all the other regions was recorded. Captures from the slope were generally greater than those from the shelf, particularly in Corsica waters and in the Alborán Sea, where values as high as 181.4 (CV%=51.0) in 1998 and 146.0 kg·km⁻² (CV=106.3) in 1996 were recorded. Remarkable biomass indices were also obtained on the slope in the Gulf of Lions, especially in 1998 and 1999, when values of 33.7 (CV%=128.4) and 28.6 kg·km⁻² (CV%=84.9) were recorded. Concerning the density indices, the highest values were observed on the

slope of the Alborán Sea (205 individuals·km⁻², CV%=98.5) in 1996, in the North Aegean Sea (182 individuals·km⁻², CV%=38.0) in 1999, and in the South Aegean Sea (193 individuals·km⁻², CV%=38.0) in 1998.

Mean lengths (Fig. 3) correspond to 2,937 individuals from the shelf and to 4,017 individuals from the slope. The smallest fish (3 cm) were observed in the Ligurian-North Central Tyrrhenian Sea and the South Tyrrhenian Sea shelves, in 1994 and 1996, respectively. The largest length (48 cm) was recorded on the slope in the Gulf of Lions in 1996 and 1998. Generally, the mean lengths of fish from the shelf were lower than those from the slope. The mean lengths from west to east showed a highly significant (p<0.05) decreasing trend both on the shelf and slope.

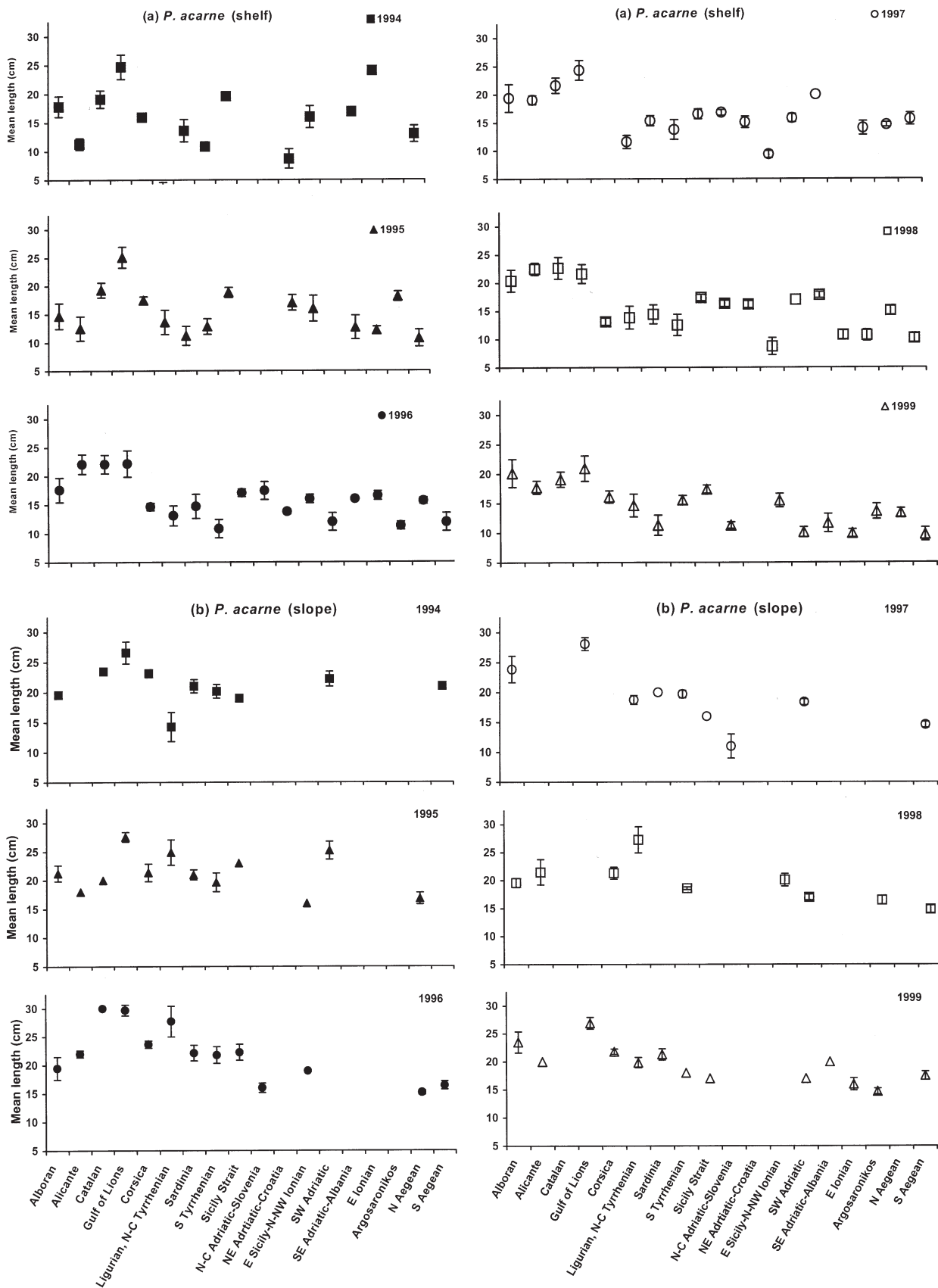


FIG. 2. – Mean total length (\pm S.D.) of *Pagellus acarne* on the shelf (a) and slope (b) by geographical region and year.

TABLE 6. – *Pagellus bogaraveo*: mean biomass (kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 10 kg/km² are presented in bold.

Sector code	Sector	1994					1995					1996				
		Depth (m)					Depth (m)					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	135.5	0.3	1.1	17.8	39.0	0	19.9	2.6	9.3	2.1	0	0.6	1.4	2.5	246.4
112a	Alicante	0	0.2	0	2.8	0	0	1.0	0.3	1.1	1.2	0	2.7	0	1.1	0
113a	Catalan Sea	0	1.5	0.8	0	0	0.3	0.1	0.2	0.7	0	0	0.6	0.4	0.6	0.9
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	0	0	0	3.1	1.9	0	0.1	2.0	0	1.2	0.1	0	6.8	0	0
121b	E Gulf of Lions	0	0.2	0.3	34.0	0	0	0	0	51.7	28.8	0	0.2	0.2	0	56.1
131a	NE Corsica	*	0	0	0.7	3.5	*	0	0	0.8	0	*	0	0	0.5	2.2
131b	SE Corsica	*	0	0	0	0	*	0	0	0	0	*	4.3	0	0.6	0.7
132a	N Ligurian Sea	0	0	0	2.0	0.3	0	0	0	0.6	0.6	0	0	0	14.9	7.9
132b	E Ligurian Sea	0.1	0.2	0.1	25.5	11.6	0	0	1.0	2.7	46.2	24.5	0.3	2.1	2.4	2.6
132c	N Tyrrhenian	1	0	2.8	0.2	0.4	0	0	0.2	1.0	0.6	0	0	0.8	0.7	0.2
132d	C Tyrrhenian	0	0	0	0.3	0.6	0	0	0	0.4	1.0	0	0	0.6	0.6	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	0.8	0	0	0	0	0
133c	N Sardinia	0	0	0	0	0	0	0	0	3.4	4.0	0	0	0	0	0
133d	NW Sardinia	0	0	0	0	0	*	0	0	0	13.5	0	0	2.3	0	0
133e	W Sardinia	0	*	0	0	0	0	0	0	2.0	0	0	0	0	0	0
133f	SW Sardinia	0	0	0	0.4	0	0	1.8	0	1.2	9.3	18.7	1.6	0.3	0	29.5
133g	S Sardinia	0	0	0	0	0	0	*	0	0	0.9	0	0	0	88.1	0
134a	SE Tyrrhenian	0	0	0.4	0.5	0.3	0.9	0	0.1	0.9	5.8	0.4	0.4	0.5	0	0
134b	SW Tyrrhenian	0	13.3	1.4	2.5	0.4	0.6	0	0.1	2.6	1.2	0	24.8	5.2	1.0	0
134c	Sicilian Chan.	0	0	0	0.3	0.3	0	0	0.8	0.7	0	0	0.3	1.7	0.5	0
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0	0.1	*	*	*
211b	Central Adriatic	0	0	0	0	0	0	0	0	0.2	0	0	0	0.1	0.1	0
211c	N Adriatic-Slov	*	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	0	0.4	0.2	0	*
221a	E Sicily	0	0	0	0.8	0	0	0	0	0.6	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0.4	0	0	0	0	0	0.1	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	0.2
221e	SW Adriatic	0	0	0.3	0.7	0	*	0	0	0	0.6	*	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	0.1	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	3.6	0	0	0	0.6	0	0	0	0	0.3	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	0	0	0.7	0.1	0
222a	E Ionian Sea	0	0.1	0	0	0	0	0	0	0	0	0.1	0.5	0	0.1	0
223a	Argosaronikos	0	1.5	1.3	12.9	0	0.2	0	0.3	0	0	0	0.1	0	0	0
224a	N Aegean Sea	1.5	0	0.1	0.3	1.7	0	0	0	0	0	0	0	0	3.3	0.3
225a	S Aegean Sea	0	9.5	0	0.9	0.9	0.3	0.1	0.3	2.5	2.5	0	0	0	3.8	0.6

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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	1.1	5.4	5.8	5.7	6.9	8.9	87.8	0.5	0.4	0	0	0.3	0.8	1.5
112a	Alicante	0	7.1	0.3	3.2	1.5	0	5.6	0	0	0	0.2	7.5	0	0	0
113a	Catalan Sea	0	0.7	0.9	2.8	1.0	0	0.2	0.4	*	2.6	0	0	0.6	0.4	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	0	10.2	2.2	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	0	0	0.5	1.5	2.2
121a	W Gulf of Lions	0.1	1.5	0	0	0	0	0	0.7	0	1.2	2.2	0.3	0	0.8	0
121b	E Gulf of Lions	0	0.1	0.2	1.1	0	0	0	1.2	129.0	4.8	6.7	1.2	1.5	113.5	*
131a	NE Corsica	*	0	*	0	0	*	0	0	0.2	0	*	0	0	0.4	2.2
131b	SE Corsica	*	0	0	0.9	*	*	0	0	0.4	591.1	*	0	0	0	108.4
132a	N Ligurian Sea	0	0	0	3.0	1.6	0	0.7	0	100.7	0.7	0	1.4	0.8	6.8	8.6
132b	E Ligurian Sea	1.3	0.2	8.3	13.0	0	0	0	0	5.2	2.9	3.3	0.2	1.5	10.7	2.0
132c	N Tyrrhenian	0.4	0	0	0.9	0.5	0	0	0.7	0	0.6	0	0	0.2	0.4	0.6
132d	C Tyrrhenian	0	0	0.2	0	0	0	0	0.3	0.3	0.3	4.2	0.3	0.3	1.1	0.6
133a	SE Sardinia	0	0	0	0.6	1.4	0	0	0	0	2.2	0	0	0	0	4.3
133b	NE Sardinia	0	0	0	0	0	0	0	0	1.4	1.1	0	0	0	0.6	0.4
133c	N Sardinia	0	0	0	0	2.3	0	0	0	0.9	4.4	0	0	0	0	2.2
133d	NW Sardinia	0	0	0	0	0	0	0	0	0	0.9	0	0	1.9	1.0	0
133e	W Sardinia	0	0	0.4	0	0	0	0	2.1	2.9	2.0	0	0	0.7	0.5	4.9
133f	SW Sardinia	0	0.2	0	0.2	0.3	0	0	0.2	2.8	2.4	1.5	7.5	1.4	1.2	11.3
133g	S Sardinia	0	0	0.8	0	0	0	0	0	1.0	0.2	0	0	0	8.1	7.2
134a	SE Tyrrhenian	0.5	0	0.1	0.5	0.5	1.2	0	0.3	0.8	0.5	0.2	0.4	0.4	1.5	0.6
134b	SW Tyrrhenian	0	32.7	1.7	0	0.3	0	15.1	0	1.1	0	0	43.7	15.9	2.3	0

TABLE 6 (Cont.). – *Pagellus bogaraveo*: mean biomass (kg/km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 10 kg/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
134c	Sicilian Chan.	0	0	0.1	0	0.1	0	0	0.1	0.1	0.3	0	0.4	0.2	0.2	0
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0.1	0	*	*	*
211b	Central Adriatic	0	0	0.1	0.5	0	0	0	0.1	0	*	1	0	0	0	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	0.6	0.2	0	*	0	0.2	0	0.9	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	2.3	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	0.6	0.2	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	0.4	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	*	0	0	0	0	*	0	0	0.3	0	*	0	0	0.3	0
221f	SW Adriatic	0	0	0	0	1.1	0	0	0	0	0	1.5	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	7.3	0.1	0	0	*	0
221h	SW Adriatic	0	0	0	0.3	0	0	0	0	0	0	0.1	0	0	0	3.7
221i	SE Adriatic	0	0	0.2	0.3	0.9	0	0	0	0	1.6	1.6	0	0	0.3	0
222a	E Ionian Sea	0	0	0	0.5	0	0	0.2	0	5.7	1.0	0	0	0.3	7.7	28.5
223a	Argosaronikos	7.5	0	0.5	0.1	0	0	1.8	0.1	0.9	0.2	0	0.2	0.2	0.3	0
224a	N Aegean Sea	0	1.4	6.1	4.6	1.8	0	0	3.9	8.7	3.7	0	0.2	0	21.1	1.4
225a	S Aegean Sea	0	0.9	0	9.2	0.4	0	0	0	18.8	7.9	0	0	0.1	9.2	10.4

TABLE 7. – *Pagellus bogaraveo*: mean density (in number of individuals /km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by '*'. Values higher than 200 individuals /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	4545	5	7	120	82	0	409	44	58	9	0	22	30	16	338
112a	Alicante	0	4	0	20	0	0	14	5	5	5	0	47	0	6	0
113a	Catalan Sea	0	28	12	0	0	8	3	2	2	0	0	12	6	2	3
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
121a	W Gulf of Lions	0	0	0	2	4	0	1	28	0	2	3	0	100	0	0
121b	E Gulf of Lions	0	2	2	76	0	0	0	0	103	32	0	2	2	0	35
131a	NE Corsica	*	0	0	6	3	*	0	0	6	0	*	0	0	2	3
131b	SE Corsica	*	0	0	0	0	*	0	0	0	0	*	173	0	3	5
132a	N Ligurian Sea	0	0	0	9	1	0	0	0	4	2	0	0	0	147	4
132b	E Ligurian Sea	8	3	1	32	11	0	0	14	9	37	1115	6	38	20	2
132c	N Tyrrhenian	133	0	22	2	1	0	0	2	6	3	0	0	10	6	1
132d	C Tyrrhenian	0	0	0	3	1	0	0	0	2	3	0	0	18	5	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	3	0	0	0	0	0
133c	N Sardinia	0	0	0	0	0	0	0	0	15	20	0	0	0	0	0
133d	NW Sardinia	0	0	0	0	0	*	0	0	0	42	0	0	6	0	0
133e	W Sardinia	0	*	0	0	0	0	0	0	7	0	0	0	0	0	0
133f	SW Sardinia	0	0	0	3	0	0	6	0	10	22	349	26	2	0	34
133g	S Sardinia	0	0	0	0	0	0	*	0	0	4	0	0	0	35	0
134a	SE Tyrrhenian	0	0	10	6	1	102	0	2	6	28	168	7	11	0	0
134b	SW Tyrrhenian	0	284	37	43	2	6	0	3	25	6	0	617	114	8	0
134c	Sicilian Chan.	0	0	0	3	2	0	0	15	4	0	0	5	25	2	0
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	0	2	*	*	*
211b	Central Adriatic	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0
211c	N Adriatic-Slov	*	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	*	*	*	*	*	*	*	*	*	*	2	18	5	0	*
221a	E Sicily	0	0	0	12	0	0	0	0	3	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	5	0	0	0	0	0	1	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	1
221e	SW Adriatic	0	0	5	7	0	*	0	0	0	2	*	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	12	0	0	*	0	0	0	0	*	0	0	0	0	*	0
221h	SW Adriatic	0	0	0	0	10	0	0	0	5	0	0	0	0	6	0
221i	SE Adriatic	*	*	*	*	*	*	*	*	*	*	0	0	10	3	0
222a	E Ionian Sea	0	9	0	0	0	0	0	0	0	0	13	28	0	3	0
223a	Argosaronikos	0	21	13	129	0	20	0	5	0	0	0	8	0	0	0
224a	N Aegean Sea	137	0	5	5	8	0	0	0	0	0	3	0	0	44	3
225a	S Aegean Sea	0	242	0	13	5	27	3	6	38	16	0	0	0	31	5

TABLE 7 (Cont.). – *Pagellus bogaraveo*: mean density (in number of individuals /km²) estimated from the MEDITS trawl surveys by depth stratum, geographical sector and year (1994-1999). Strata that were not sampled are indicated by ‘*’. Values higher than 200 individuals /km² are presented in bold.

Sector code	Sector	1997					1998					1999				
		Depth (m)					Depth (m)					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	21	43	39	16	116	175	1396	3	2	0	0	4	4	4
112a	Alicante	0	221	8	31	8	0	147	0	0	0	6	144	0	0	0
113a	Catalan Sea	0	13	12	9	3	0	3	6	*	10	0	0	6	2	0
114a	W Morocco	*	*	*	*	*	*	*	*	*	*	*	0	160	14	0
114b	E Morocco	*	*	*	*	*	*	*	*	*	*	0	0	12	4	5
121a	W Gulf of Lions	2	22	0	0	0	0	0	5	0	2	39	4	0	2	0
121b	E Gulf of Lions	0	1	2	6	0	0	0	15	176	8	111	7	16	179	*
131a	NE Corsica	*	0	*	0	0	*	0	0	3	0	*	0	0	2	8
131b	SE Corsica	*	0	0	9	*	*	0	0	3	399	*	0	0	0	104
132a	N Ligurian Sea	0	0	0	21	1	0	21	0	158	1	0	29	37	17	13
132b	E Ligurian Sea	150	3	108	18	0	0	0	0	23	2	549	3	24	10	2
132c	N Tyrrhenian	5	0	0	4	2	0	0	6	0	3	0	0	2	3	2
132d	C Tyrrhenian	0	0	1	0	0	0	0	3	2	1	75	3	3	5	2
133a	SE Sardinia	0	0	0	4	4	0	0	0	0	8	0	0	0	0	18
133b	NE Sardinia	0	0	0	0	0	0	0	0	10	6	0	0	0	4	2
133c	N Sardinia	0	0	0	0	10	0	0	0	6	22	0	0	0	0	21
133d	NW Sardinia	0	0	0	0	0	0	0	0	0	3	0	0	13	5	0
133e	W Sardinia	0	0	4	0	0	0	0	26	17	11	0	0	5	5	22
133f	SW Sardinia	0	6	0	1	1	0	0	2	13	5	32	85	9	6	36
133g	S Sardinia	0	0	11	0	0	0	0	0	6	2	0	0	0	3	24
134a	SE Tyrrhenian	38	0	2	5	4	44	0	5	5	2	6	17	11	7	2
134b	SW Tyrrhenian	0	752	35	0	1	0	460	0	6	0	0	1048	384	15	0
134c	Sicilian Chan.	0	0	2	0	1	0	0	2	1	1	0	8	4	1	0
211a	N Adriatic Sea	0	0	*	*	*	0	0	*	*	*	4	0	*	*	*
211b	Central Adriatic	0	0	1	6	0	0	0	1	0	*	46	0	0	0	*
211c	N Adriatic-Slov	0	*	*	*	*	0	*	*	*	*	0	*	*	*	*
211d	NE Adri Croatia	0	16	3	0	0	0	6	1	10	*	0	*	*	*	*
221a	E Sicily	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0
221b	NW Ionian Sea	0	0	0	8	1	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	1	0	0	0	0	0	0	0	0	0	0
221e	SW Adriatic	*	0	0	0	0	*	0	0	2	0	*	0	0	2	0
221f	SW Adriatic	0	0	0	0	11	0	0	0	0	0	105	0	0	0	0
221g	SW Adriatic	0	0	0	*	0	0	0	0	*	32	12	0	0	*	0
221h	SW Adriatic	0	0	0	6	0	0	0	0	0	0	5	0	0	0	14
221i	SE Adriatic	0	0	5	4	4	0	0	0	0	4	131	2	0	3	0
222a	E Ionian Sea	0	0	0	6	0	0	5	0	50	9	0	0	4	65	168
223a	Argosaronikos	14	0	6	5	0	0	39	3	15	3	7	24	3	8	0
224a	N Aegean Sea	0	41	131	57	19	0	0	91	109	36	0	4	0	312	16
225a	S Aegean Sea	0	8	0	115	2	0	0	0	242	63	0	0	2	95	95

DISCUSSION

All the three species of *Pagellus* were widely distributed throughout the sampling area. However, *P. erythrinus* was the species of the genus most frequently occurring in the samples, even though its preferential habitat is more restricted to the inshore waters (continental shelf) compared with *P. acarne* and especially *P. bogaraveo*. This outcome could mean that at the mesoscale level *P. erythrinus* is more extensively distributed with less patchy aggregations than the other two species or that its behaviour is less gregarious. However, this hypothesis needs to be tested by further specific analysis, like for example the geostatistical study of the spatial structure of abundance. Moreover, other factors, such as the availability of the different species to the

trawl (i.e. change of habitat in relation with increasing size, daily vertical distribution and movements) or seasonal migration could affect the catch pattern in terms of yield and variability. Seasonal or local aggregations of any stock fractions could, thus, influence the catch abundance. With regard to *P. bogaraveo* a local distribution of larger fishes in the vicinity of offshore outcrops has been reported, for example, in the Ligurian Sea (e.g. Orsi Relini and Fida, 1992). Furthermore, wide ranging migrations from nursery areas to foraging grounds and vice-versa seem to take place in the Atlantic (Desbrosses, 1932; Sánchez, 1983). This behavioural pattern of the *Pagellus* species can have influenced the sampling efficiency, as only a proportion of the stock could be available and accessible (Harden Jones, 1974) to the trawl. Indeed, along the Mediterranean

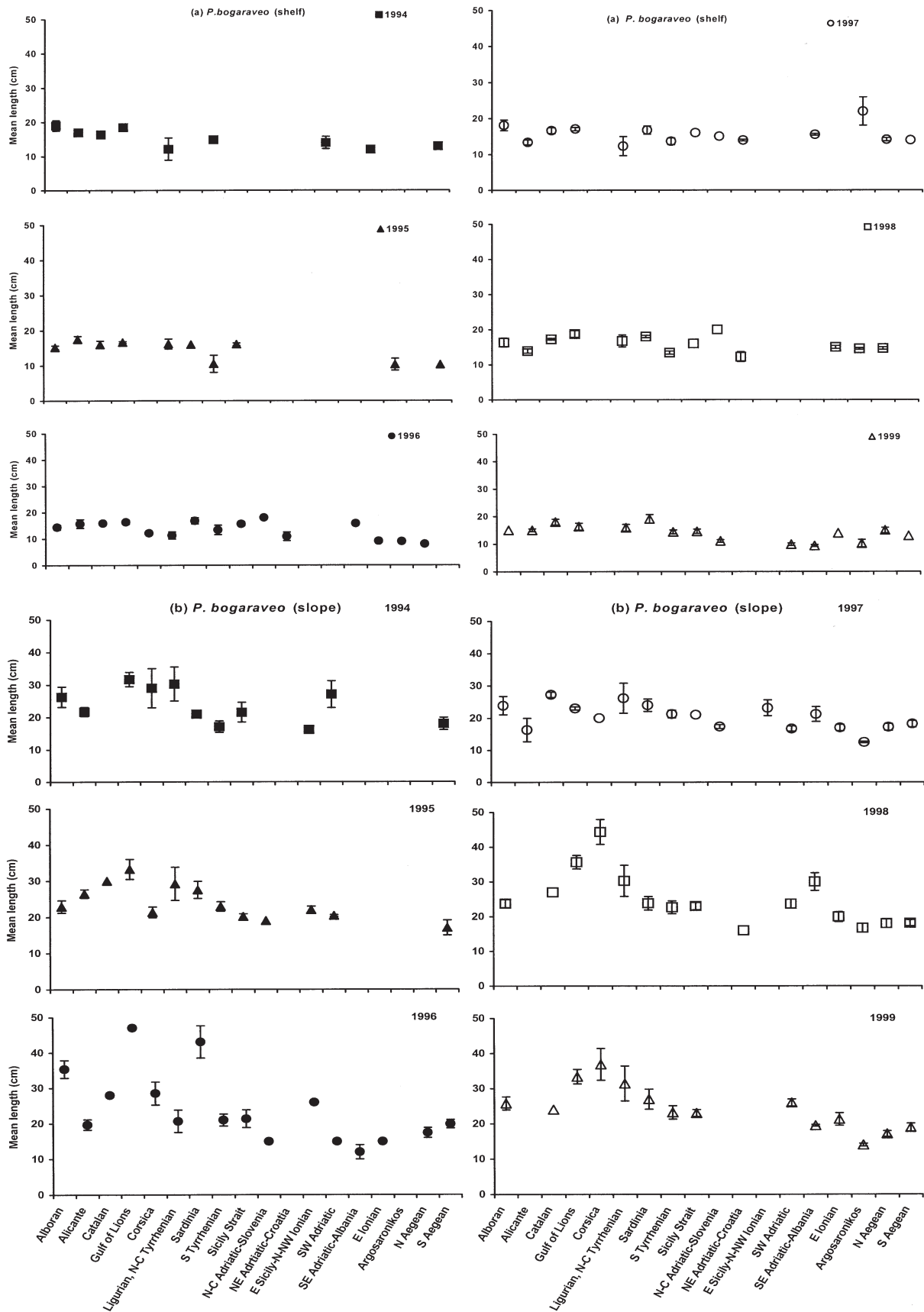


FIG. 3. – Mean total length (\pm S.D.) of *Pagellus bogaraveo* on the shelf (a) and slope (b) by geographical region and year.

and East Atlantic, the larger sizes of these fishes are mainly targeted by different gears, such as gill nets, longlines, and traps (e.g. Petrakis and Stergiou, 1996; Erzini *et al.*, 1998; Pajuelo and Lorenzo, 1998; Sousa *et al.*, 1999). Nevertheless, although the bias associated with the trawl survey indices makes it difficult to predict the absolute stock abundance, they can however be adopted as relative estimates of density and biomass related to a stock proportion. In this sense, especially for the juvenile fraction of the *Pagellus* populations, indices of relative abundance such as number of individuals or weight per square kilometre can be used as indicators of the geographical and inter-annual variations, provided that the trawl survey sampling scheme and protocols (e.g. stratification, gear, hauls, timing) are standardised.

The three *Pagellus* species showed different levels of abundance in the diverse geographical sectors, probably owing to the influence of several factors, such as the different fishing pressure in the area, the recruitment occurrence, or the specific environmental features. Although, for example, *P. erythrinus* was generally less abundant in the western sectors (from Alborán Sea to the Gulf of Lions), it was not possible to detect any gradient from west to east. Levels of density and biomass similar to the westward ones were also observed in central regions, such as in the North-Central Adriatic Sea and East Sicily-Ionian-South Adriatic. By contrast, high abundance indices were recorded in Corsica waters and not negligible values occurred in the first stratum of the Alborán Sea, as well. Low density and biomass were estimated in the South Tyrrhenian Sea due to the scarcity of *P. erythrinus* in the northern side of the Sicily Strait sub-area. Conversely, this species seems to be important for the commercial fisheries in the southern side of this basin, and namely in the Gabes Gulf and along the Tunisian coasts (Jarbouli *et al.*, 1998). Relationships between levels of abundance and differences in fishing pressure among the geographical sectors are difficult to ascertain, due to the scarce information available on effective fishing effort and its distribution. However, the hypothesis of attributing, for example, the lower *P. erythrinus* abundance in the westernmost geographical sectors to a higher fishing effort than in the other zones is not consistent with the larger biomass and density of *P. acarne* in the same area. In fact, these two resources are supposed to be exposed to a comparable fishing pressure exerted by the same vessels operating on the shelf. On the other hand, a different occurrence of the recruits could essentially

have affected the variations of the density indices among the geographical sectors, but did not substantially influence the relative biomass indices. Although the fishing pressure effect needs to be more deeply investigated, it seems that other factors, related to environmental conditions (oceanographic characteristics, prey availability and abundance, etc.) or fish movements, might play a role in determining the observed differences in abundance. Further studies are thus necessary to better clarify these aspects. The biomass indices of *P. acarne* and *P. bogaraveo* estimated in the Alborán Sea would indicate that these species are more abundant in the westernmost side of the Mediterranean. However, the remarkable density indices estimated in the eastern regions for *P. acarne*, in some cases (South Aegean in 1998) even higher than those observed in the Alborán Sea, suggest that this sparid does not exhibit a western preferential distribution.

The mean length of *P. acarne* and *P. bogaraveo*, estimated for shelf and slope, highlighted the occurrence of smaller individuals in the shallower stratum over most of the geographical range. This indicates, especially for *P. bogaraveo*, that migrations to deeper water take place with increasing length, as for example reported by Orsi Relini and Fida (1992) for the Ligurian Sea.

Small mean lengths of *P. erythrinus* were mainly observed in some areas (Ligurian-North Central Tyrrhenian Sea, South Tyrrhenian Sea, East Ionian, Argosaronikos) and a significant decreasing trend in the mean lengths from west to east was found. This condition also held for *P. acarne* and *P. bogaraveo* and in many cases was determined by the larger number of juveniles occurring in the central-eastern regions. The presence of *P. erythrinus* as small as 2-3 cm length is in accordance with a spring-summer spawning time (e.g. Larrañeta, 1964; Girardin and Quignard, 1985; Livadas, 1988; Mytilinéou, 1988). It is worth mentioning that in captive conditions with a natural thermo-photoperiod, *P. erythrinus* behaves as a sequential spawner, releasing egg batches from the middle of April to the middle of August (Spedicato *et al.*, 1998). Thus, the recruitment could consist of several micro-cohorts entering the stock in successive phases. *P. bogaraveo* also seems to be characterised by a wide spawning period, lasting from November to May (e.g. Orsi Relini and Fida, 1992) and the presence of pelagic eggs of *P. acarne* is reported in summer and autumn in the Strait of Messina (De Gaetani, 1935). These fishes could also display a recruitment pattern similar to

that supposed for *P. erythrinus*, with juveniles occurring in late spring-summer and autumn, according to the species. The decreasing trend of the mean lengths from west to east could also be attributed to possible differences in the growth pattern among the areas. However, this hypothesis requires further investigation. For *P. erythrinus*, for example, the available literature data (e.g. Larrañeta, 1964; Rijavec and Zupanovic, 1965; Andaloro and Prestipino Giarritta, 1985; Girardin and Quignard, 1985; Orsi Relini and Romeo, 1985; Livadas, 1988; Mytilineou, 1988) would indicate the existence of such a diversity. Nevertheless, the data are not strictly comparable, as different methods of estimation and measures (i.e. fork length, total length) were employed. On the other hand, the hypothesis of a higher fishing pressure determining lower mean lengths in the eastern sectors does not seem justified on the basis of the available information. Indeed, a proper analysis on this aspect would require specific historical data on geographical allocation of fishing effort and fishing intensity that are not available at present in all the Mediterranean regions, where abundance data have been collected since many years but no long data series of catch and effort exist. However, the indications from the long and short-term trend analyses of Mediterranean landings by Fiorentini *et al.* (1977) do not highlight an apparently different condition of the *Pagellus* species fishery from west to east. In addition, a landing and effort survey conducted in some sample ports of the Mediterranean (Anonymous, 2000), although with the limitation of the number of sampling sites, has not shown a higher fishing effort in the east side of the basin (Greek waters). Thus, the higher productivity of the western areas that are closest to the Atlantic inflow and whose shelves contribute more to the Mediterranean fishery production (in 1989: 4.78-8.15 versus 1.42-2.20 tons·km⁻² of the east side; Caddy, 1997) could be a probable cause of mean lengths decreasing from west to east, although further investigations are necessary to confirm this hypothesis.

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