*Bol. Inst. Esp. Oceanogr.* 19 (1-4). 2003: 483-491
**BOLETÍN.** INSTITUTO ESPAÑOL DE OCEANOGRAFÍA
ISSN: 0074-0195


# No habitat preference in mixed meadows and rocky bottoms for Mediterranean Labridae and Sparidae fish species

*A. Frau, S. Deudero, S. Cerdeño and L. Alou*

Laboratorio de Biología Marina and GOI, Departamento de Biología, Facultat de Ciencias, Edif. Guillem Colom, Universitat de les Illes Balears, E-07122 Palma de Mallorca, Balearic Islands, Spain. E-mail: afraumayol@yahoo.es

*Received January 2003. Accepted December 2003.*

**ABSTRACT**

Fish species composition, abundance, diversity and niche breadth of Mediterranean littoral communities have been assessed for two types of habitat: rocky bottoms and mixed meadows of *Posidonia oceanica* (L.) Delile, 1813 and rocks. Labridae and Sparidae species have been considered to test differences in abundances between both habitats by means of underwater visual census. Data obtained suggests that these fish assemblages are very similar, and there are no significant differences in the niche breadth of both habitats. Differences in physical structure of the habitats are not enough to produce differences in the fish assemblages observed. A high fishing pressure in the study area may be removing the predator fish species, and consequently determining the species composition and abundance for rocky bottoms.

**Keywords:** Fish, visual census, niche, *Diplodus*, *Symphodus*, Mediterranean Sea.

***RESUMEN***

***Ausencia de predilección en lábridos y espáridos mediterráneos respecto a dos tipos de hábitat: fondos rocosos y fondos mixtos de praderas de fanerógamas marinas y roca***

*Se ha estudiado la composición específica, la abundancia, la diversidad y la amplitud de nicho de dos comunidades ícticas mediterráneas mediante censos visuales en dos tipos de hábitat: fondos rocosos y fondos mixtos de* Posidonia oceanica *(L.) Delile, 1813 y roca. Se han observado especies de lábridos y espáridos y no se han encontrado diferencias significativas en las variables analizadas de estas comunidades en ambos hábitats. Las diferencias en la estructura física de los dos tipos de hábitat no son suficientes para justificar la aparición de variaciones significativas en las comunidades ícticas estudiadas. Un factor condicionante puede ser la elevada tasa de presión pesquera, que elimina las especies depredadoras y deteminaría la composición específica y la abundancia de peces en los fondos rocosos.*

***Palabras clave:*** *Peces, censos visuales, nicho,* Diplodus*,* Symphodus*, Mediterráneo.*

## INTRODUCTION

The Mediterranean littoral fish communities have been traditionally studied on rocky bottoms (Dufour, Jouvenel and Galzin, 1995; Fasola *et al.*, 1997). Rocky habitats constitute an optimal habitat for some fish species (Harmelin-Vivien, Harmelin and Leboulleux, 1995). However, the studies carried out in vegetated ecosystems highlight the rule of the seagrass beds as spawning areas, recruitment and nursery zones for many fishes (Kikuchi and Peres, 1977; Bell and Pollard, 1989; Jiménez *et al.*, 1997), as well as their importance as refuge zones for many nocturnal species (Bell and Harmelin-Vivien, 1982) and as feeding areas (García-Rubies and Macpherson, 1995). In fact, *Posidonia oceanica* (L.) Delile, 1813 seagrass beds provide a habitat with a wide spatial heterogeneity for fish communities (Bell and Harmelin-Vivien, 1982; Harmelin-Vivien and Francour, 1992).

The aim of the present study was to compare a rocky habitat with mixed meadows of *Posidonia* and rocks. Previous studies on this subject have mainly centred on rocky bottoms (Dufour, Jouvenel and Galzin, 1995; Harmelin-Vivien, Harmelin and Leboulleux, 1995) or vegetated habitats (Guidetti, Bussotti and Boero, 2001; Bussotti and Guidetti, 1999; Valle, Bayle Sempere and Ramos Esplá, 2001). In the Mediterranean, most of the sublittoral seafloor is covered by rocky areas mixed with seagrass patches. However, there is an evident lack of studies concerning the comparison of rocky habitats with vegetated and mixed habitats (Guidetti, 2000). We expected to find a higher species diversity in the mixed habitat than for the rocky bottoms, since the niche breadth should be wider in the mixed meadows. Therefore, the data obtained in our study can be of great benefit for future investigations involving littoral fish communities.

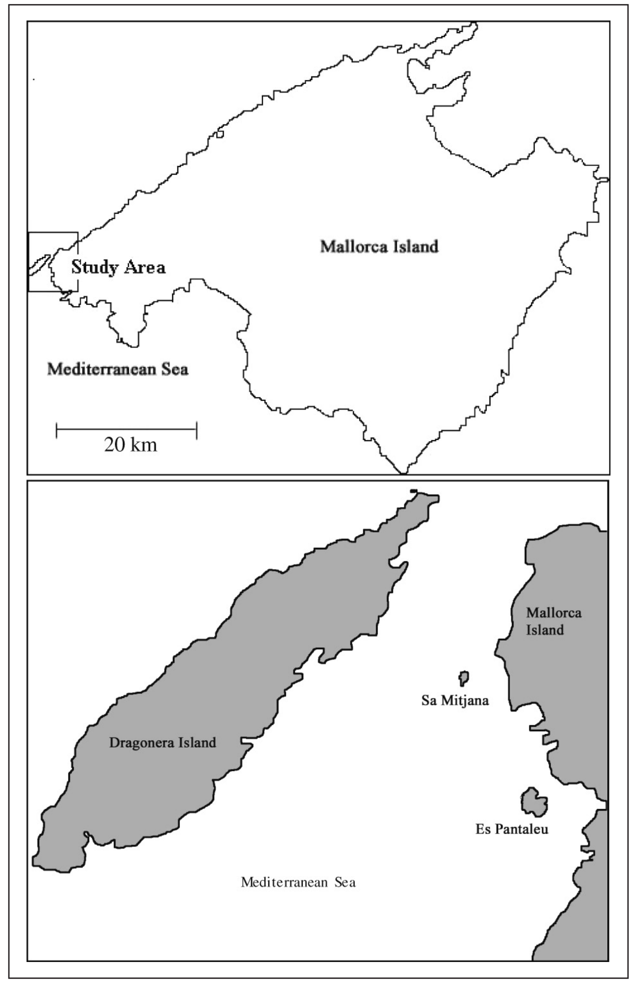


Figure 1. Map of the study area and location of the sampling sites in Dragonera Natural Park, western Mediterranean

## MATERIALS AND METHODS

### Study area

The study area cover the littoral zone of Dragonera Natural Park, in the western Mediterranean, and the influence zone that comprises Illa Mitjana and Illa Pantaleu (figure 1).

### Underwater visual census

We performed visual censuses at shallow depths (10-20 m) over rocky bottoms and mixed meadows (rocky reefs and *P. oceanica*). The study area is characterised by a patchy distribution of *P. oceanica* over rocky algal bottoms. The rocky shore was characterised by a large slope and an erect macroalgal canopy, mainly comprising *Cystoseira* spp. and *Dyctiopteris* spp.

The experimental design settled on a total of 9 sampling sites along the perimeter of Dragonera Natural Park (figure 1). A total of 52 replicates or transects were carried out: 21 transects for rocky habitat quantification, and 21 transects for mixed habitats. Depth was considered between 10 and 20 m. Visual censuses were carried out from 9-20 July 2002, between 9:00 and 14:00 GMT.

Fish species identification and quantification were performed by underwater visual census carried out along a strip transect as described by the standardised procedures of Harmelin-Vivien *et al.* (1985) and Harmelin and Francour (1992). This technique was selected among the available visual methods as more appropriate for smaller specimens and fast-swimming species (Harmelin-Vivien and Francour, 1992; Francour, 1997).

Mobile fishes were quantified along a transect 50 m long and 5 m wide, covering a total area of

250 $m^2$. Cryptic fishes were counted in a transect 20 m long and 5 m wide, and a total area of 100 $m^2$. Fish abundance was estimated in situ on the basis of pre-established discrete abundance classes (1, 2-5, 6-10, 11-30, 31-50, 51-100, 101-200, 201-500, > 500) (Harmelin-Vivien *et al.*, 1985). Fish density (indiv/250 $m^2$) was calculated by taking into account the mid point of each abundance class (Harmelin-Vivien *et al.*, 1985; Francour, 1997).

The coverage of the seagrass *P. oceanica* at each transect was quantified by setting a 50 m line and determining the discontinuities along the line. A transect with seagrass coverage of > 30 % was considered a mixed habitat, whereas < 30 % was classified as a rocky bottom.

### Data analysis

Differences among fish abundance for each type of habitat were tested with a one-way analysis of variance for the Sparidae and Labridae studied species. Three species of Sparidae were considered for the analyses: *Diplodus vulgaris, Diplodus annularis* and *Diplodus sargus.* A total of 7 Labridae species has been considered for the study: *Symphodus tinca, Symphodus mediterraneus, Symphodus ocellatus, Symphodus rostratus, Symphodus roissali, Symphodus melanocercus* and *Symphodus doderleini.*

Density data (no. of fishes/250 $m^2$) were transformed to log (x + 1) and the homogeneity of variances was tested using Cochran's test. To compensate for the increased likelihood of type I error, a setting of $\alpha = 0, 05$ was used.

To estimate the level of habitat preference of each studied species an Affinity Index of Habitat Preference was calculated. This links the abundance and the occurrence of each specie in relation to the total abundance and the total occurrence:

$$IA = (A_h \cdot O_h) / (A_t \cdot O_t)$$

where $A_h$ is the relative abundance of the studied specie in the studied habitat, $A_t$ is the relative abundance of the studied specie in all habitats, $O_h$ is the occurrence of the studied specie in the studied habitat, and $O_t$ is the occurrence of the studied specie in all habitats.

Niche breadth was calculated by applying the formula $B = 1/\Sigma\ p_i^2$, as used in trophic ecology studies of fishes (Smith, 1982). were $p_i$ is the abundance of the specie in the habitat of study.

The diversity indices calculated were species richness (S), number of individuals (N), equity (J') and the Shannon-Wiener diversity index (H').

The software used to calculate the indices was Primer (Clarke and Warwick, 1994), and the software used to calculate anova was SPSS.

## RESULTS

### Community structure

A total of 10 273 individuals were censused, with 4 909 fishes over rocky bottoms and 5 364 in mixed habitats. The entire fish community comprised 11 families (table I), with 38 species; 30 were present in both rocky and mixed habitats, and 4 species were found only in the mixed habitat (*S. cinereus, Labrus viridis, Labrus merula* and *Mycteroperca rubra*) and 4 species were exclusive to the rocky habitat (*Scorpaena maderensis, Mugil* spp., *Trypterigion trypteronotus,* and *Phycis phycis*).

The species that were most abundant in the rocky habitats were *D. vulgaris* (17.58 %), *Apogon imberbis* (17.83 %), *Coris julis* (17.81 %), and *Salpa salpa* (6.81 %). In the mixed meadows, the more abundant fish species were *C. julis (*22.28 %), *A. imberbis* (15.71 %), *D. vulgaris* (12.09 %), and *S. salpa* (11.68 %) (table I).

Most individuals belonged to the families Sparidae, Apogonidae and Labridae, representing 85.11 % of the total fish census (figure 2). In both habitats, Sparidae, Apogonidae and Labridae were the most relatively abundant families, although relative abundance values of Serranidae, Trypterigiidae and others were higher in rocky habitats than in mixed habitats.

The values of the diversity index were very similar for both habitats (table II), with no significant differences among them (anova, p > 0.05). The mean density of fishes per transect (N) was the parameter that showed the highest variability, with 45.2 % for the rocky habitat and 34.29 % for mixed meadows. Species richness (S), Equity (J') and the Shannon-Wiener index (H') showed very similar values for both habitats (table II).

### Abundance of Labridae and Sparidae

The mean abundance values of the Sparidae species *D. vulgaris, D. sargus* and *D. annularis* are

Table I. Species composition and abundance of fish species in Dragonera Natural Park. (n): number of individuals; (%): relative abundance; (SD): standard deviation

| Family | Species | n rocky | % Abundance rocky habitat | ± SD | n mixed | % Abundance mixed habitat | ± SD | n total | % Total abundance | ± SD |
|---|---|---|---|---|---|---|---|---|---|---|
| Labridae | *Coris julis* | 713 | 17.81 | 10.27 | 1148 | 22.28 | 7.16 | 1861 | 19.76 | 9.19 |
| | *Thalassoma pavo* | 192 | 4.27 | 3.14 | 176 | 3.59 | 2.89 | 368 | 3.93 | 3.03 |
| | *Symphodus tinca* | 114 | 2.48 | 2.33 | 269 | 5.21 | 2.62 | 383 | 3.84 | 2.84 |
| | *Symphodus mediterraneus* | 29 | 0.65 | 0.83 | 60 | 1.16 | 0.81 | 89 | 0.91 | 0.86 |
| | *Symphodus ocellatus* | 71 | 1.50 | 2.82 | 41 | 0.73 | 0.72 | 112 | 1.12 | 2.08 |
| | *Symphodus rostratus* | 8 | 0.14 | 0.39 | 36 | 0.73 | 0.69 | 44 | 0.43 | 0.64 |
| | *Symphodus roissali* | 12 | 0.26 | 0.84 | 34 | 0.73 | 1.11 | 46 | 0.49 | 1.01 |
| | *Symphodus melanocercus* | 16 | 0.38 | 0.62 | 30 | 0.65 | 0.75 | 46 | 0.52 | 0.70 |
| | *Symphodus cinereus* | 0 | 0.00 | 0.00 | 2 | 0.04 | 0.14 | 2 | 0.02 | 0.10 |
| | *Symphodus doderleini* | 21 | 0.54 | 1.33 | 22 | 0.45 | 0.75 | 43 | 0.49 | 1.07 |
| | *Labrus viridis* | 0 | 0.00 | 0.00 | 2 | 0.06 | 0.21 | 2 | 0.03 | 0.15 |
| | *Labrus merula* | 0 | 0.00 | 0.00 | 1 | 0.01 | 0.07 | 1 | 0.01 | 0.05 |
| Sparidae | *Diplodus vulgaris* | 912 | 17.58 | 11.98 | 746 | 12.09 | 9.21 | 1658 | 14.83 | 11.01 |
| | *Diplodus sargus* | 417 | 7.82 | 12.56 | 162 | 3.21 | 5.45 | 579 | 5.52 | 9.89 |
| | *Diplodus annularis* | 48 | 1.07 | 1.94 | 146 | 2.92 | 2.45 | 194 | 1.99 | 2.40 |
| | *Diplodus puntazzo* | 12 | 0.32 | 0.72 | 9 | 0.18 | 0.36 | 21 | 0.25 | 0.57 |
| | *Oblada melanura* | 106 | 2.14 | 3.06 | 109 | 2.08 | 3.14 | 215 | 2.11 | 3.10 |
| | *Spondyliosoma cantharus* | 4 | 0.11 | 0.32 | 6 | 0.13 | 0.33 | 10 | 0.12 | 0.33 |
| | *Sarpa salpa* | 427 | 6.81 | 9.88 | 641 | 11.68 | 9.89 | 1068 | 9.25 | 10.19 |
| | *Dentex dentex* | 6 | 0.26 | 1.04 | 4 | 0.05 | 0.18 | 10 | 0.16 | 0.75 |
| Mullidae | *Mullus surmulentus* | 142 | 3.53 | 3.42 | 150 | 3.10 | 3.21 | 292 | 3.32 | 3.32 |
| Sciaenidae | *Sciaena umbra* | 13 | 0.28 | 1.17 | 18 | 0.34 | 0.82 | 31 | 0.31 | 1.00 |
| Serranidae | *Epinephelus marginatus* | 20 | 1.18 | 1.13 | 9 | 0.49 | 0.77 | 29 | 0.83 | 1.03 |
| | *Epinephelus costae* | 5 | 0.08 | 0.29 | 3 | 0.02 | 0.12 | 8 | 0.05 | 0.22 |
| | *Serranus cabrilla* | 2 | 0.05 | 0.16 | 4 | 0.08 | 0.22 | 6 | 0.06 | 0.20 |
| | *Serranus scriba* | 177 | 4.09 | 2.33 | 157 | 3.11 | 2.04 | 334 | 3.60 | 2.24 |
| Scorpaenidae | *Scorpaena maderensis* | 3 | 0.03 | 0.16 | 0 | 0.00 | 0.00 | 3 | 0.02 | 0.11 |
| | *Scorpaena notata* | 5 | 0.14 | 0.72 | 3 | 0.07 | 0.33 | 8 | 0.10 | 0.56 |
| | *Scorpaena porcus* | 38 | 0.80 | 1.38 | 30 | 0.69 | 1.43 | 68 | 0.75 | 1.41 |
| Apogonidae | *Apogon imberbis* | 910 | 17.83 | 13.47 | 1085 | 19.23 | 15.71 | 1995 | 18.53 | 14.67 |
| Blenniidae | *Parablennius rouxi* | 38 | 4.68 | 4.53 | 25 | 2.61 | 3.10 | 63 | 3.65 | 4.01 |
| Muraenidae | *Muraena helena* | 33 | 0.63 | 1.43 | 3 | 0.47 | 0.71 | 35 | 0.55 | 1.12 |
| Sphyraenidae | *Sphyraena sphyraena* | 47 | 0.62 | 0.81 | 95 | 0.03 | 0.15 | 142 | 0.33 | 0.65 |
| Mugilidae | *Mugil* spp. | 102 | 1.03 | 3.03 | 0 | 1.77 | 7.30 | 102 | 1.40 | 5.64 |
| Tripterygiidae | *Trypterigion delaisi* | 215 | 1.12 | 2.84 | 128 | 0.00 | 0.00 | 343 | 0.56 | 2.07 |
| | *Trypterigion trypteronotus* | 13 | 0.28 | 1.04 | 0 | 0.00 | 0.00 | 13 | 0.14 | 0.74 |
| Gadidae | *Phycis phycis* | 1 | 0.06 | 0.28 | 0 | 0.00 | 0.00 | 1 | 0.03 | 0.20 |

Table II. Mean values of species richness (S), number of individuals (N), equity (J') and Shannon Diversity index (H') ± standard deviation at both habitats

| Habitat | Richness (S) | No. indiv (N) | Equitativity (J') | Diversity (H') |
|---|---|---|---|---|
| Rocky bottoms (n = 21) | 14.42 ± 2.48 | 172.62 ± 78.06 | 0.77 ± 0.08 | 2.04 ± 0.28 |
| Mixed meadows (n = 21) | 15.12 ± 2.5 | 182.0 ± 62.41 | 0.75 ± 0.09 | 2.03 ± 0.3 |

shown in table III. Abundance data for *D. vulgaris* and *D. sargus* for both rocky and mixed habitats (table III) were very similar, showing no statistical differences between habitats. However, *D. sargus* densities were slightly higher over rocky bottoms (16.15 indiv/transect) than for mixed habitats (6.23 indiv/transect). *D. annularis* was more abundant in mixed habitats (5.62 indiv/transect) than

Figure 2. Relative abundance of the main fish families for rocky habitats (A), mixed meadows (B), and total abundance (C)

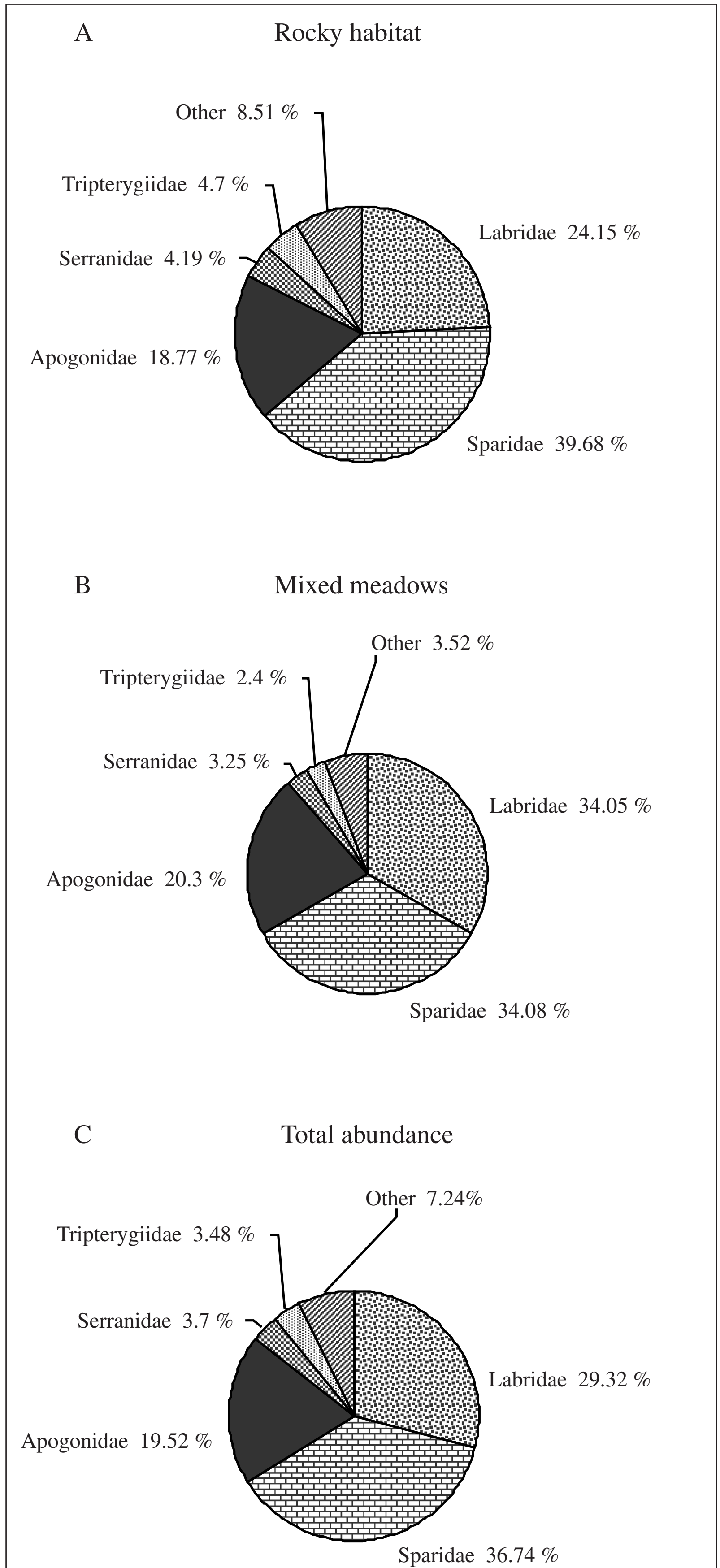

Table III. Mean abundance values of the three species of *Diplodus* spp. and *Symphodus* spp. at each habitat ± standard deviation. (p): stands for the significance level of the anova test

| Species | Rocky habitat | Mixed habitat | p |
|---|---|---|---|
| *Diplodus vulgaris* | 28.0 ± 3.29 | 28.69 ± 3.5 | 0.929 |
| *D. sargus* | 16.15 ± 5.65 | 6.23 ± 2.10 | 0.111 |
| *D. annularis* | 1.78 ± 0.65 | 5.62 ± 0.81 | 0.001 |
| *Symphodus tinca* | 4.52 ± 0.87 | 10.35 ± 1.03 | 0.000 |
| *S. mediterraneus* | 1.07 ± 0.25 | 2.31 ± 0.29 | 0.002 |
| *S. ocellatus* | 3.07 ± 1.15 | 1.58 ± 0.32 | 0.223 |
| *S. rostratus* | 0.3 ± 0.15 | 1.38 ± 0.27 | 0.001 |
| *S. roissali* | 0.44 ± 0.25 | 1.31 ± 0.35 | 0.051 |
| *S. melanocercus* | 0.59 ± 0.21 | 1.15 ± 0.25 | 0.091 |
| *S. doderleini* | 0.78 ± 0.36 | 0.85 ± 0.29 | 0.884 |

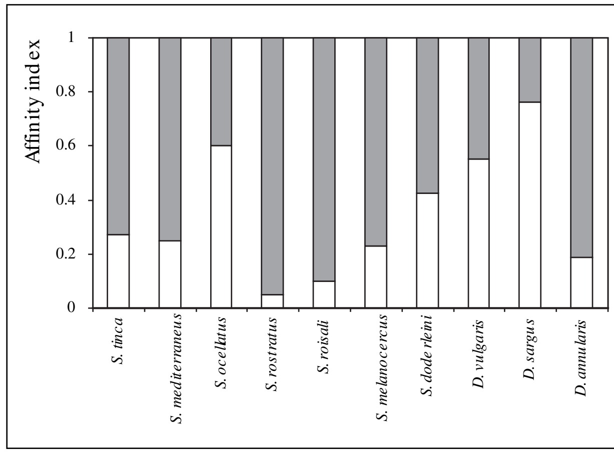


Figure 3. Affinity index values for the *Symphodus* spp. and *Diplodus* spp. species in the mixed habitats (black bars) and rocky habitats (white bars)

over rocky bottoms (1.78 indiv/transect) (anova, $p < 0.005$).

In the Labridae family, we considered the congenereric *Symphodus* species: *S. tinca*, *S. mediterraneus, S. ocellatus, S. rostratus, S. roissali, S. melanocercus* and *S. doderleini* (table III). The peacock wrasse *S. tinca* was more abundant in mixed habitat (10.35 indiv/transect) than over rocky bottoms (4.52 indiv/transect) (anova, $p < 0.005$) (table V). *S. mediterraneus* and *S. rostratus* were also more abundant in mixed habitats than over rocky bottoms (anova, $p < 0.005$). The other *Symphodus* species, *S. ocellatus, S. roissali, S. melanocercus* and *S. doderleini*, had similar abundance values for mixed and rocky habitats. *S. ocellatus* was the only species that showed higher abundance over rocky bottoms than in mixed habitats (table III), although this difference was not statistically significant.

### Habitat preference and ecological niche breadth

Affinity index values calculated for the *Diplodus* and *Symphodus* species show more affinity or preference for mixed habitats in *D. annularis, S. rostratus, S. tinca* and *S. mediterraneus* (figure 3). Conversely, *D. sargus* and *S. ocellatus* preferred rocky habitats, while *S. doderleini* and *D. vulgaris* showed a similar affinity for both types of habitats.

The niche breadth of the mixed habitat is slightly wider than that of rocky bottoms. However, we found no significant differences between the ecological niche breadth of rocky bottoms ($B = 5.1$) compared with mixed habitats ($B = 5.6$) (anova, $p > 0.05$).

## DISCUSSION

### Fish communities

The fish community under study was dominated by species belonging to the Sparidae, Apogonidae and Labridae families, which accounted for 80 % of the fish censused. The most abundant species in the study area were *C. julis*, *D. vulgaris, D. sargus* and *A. imberbis*. The values of fish abundance for mixed meadows and rocky bottoms were very similar. Thus, as observed by other authors (Guidetti, 2000), fish assemblages in physically structured environments tended to be more similar to each other than to those in unvegetated sand habitats. Some authors have found such a hierarchy in the distribution of fish species richness among seagrass systems characterised by different levels of habitat complexity related to shoot or leaf density (Heck and Orth, 1980). Similar results were also obtained by Jenkins and Wheatley (1998). They compared the fish fauna from shallow seagrass, rocky algal reefs, and unvegetated sand habitats off southern Australia. These authors attributed the observed differences in total abundance to the complementary effects of habitat type, location, and month of sampling. This leads to the conclusion that physical structure is one of the main factors affecting the general characteristics of the associated fish assemblages, e.g., fish abundance and species richness. The present study's results show that fish abundances for mixed meadows and rocky bottoms are very similar; therefore, the differences in the physical structure of both habitats are not enough to produce differences in fish assemblages.

The number of predator fish species that we found, such as *Epinephelus marginatus, Epinephelus costae, Scorpaena scrofa, Dicentrarchus labrax, Muraena helena, Dentex dentex* and *L. viridis,* are very low when compared with those reported by other authors (Reñones *et al.*, 1995). These are key species for spear-fishing, and therefore subjected to high fishing pressure in the study area (pers. obs.), which could explain the low densities that we observed.

**Abundances of Sparidae and Labridae**

The results obtained for Sparidae abundances are similar to previous studies from the same study area (Reñones *et al.*, 1995 -and pers. comm. in 2000-). However, *D. annularis* and *D. sargus* presented higher densities than those observed by other authors in similar habitats (Reñones *et al.*, 1995; Guidetti, 2000; Valle, Bayle Sempere and Ramos Esplá, 2001; Guidetti *et al.,* 2002).

Our sampling sites correspond with recruitment areas for *D. annularis, D. vulgaris* and *D. sargus,* which are commonly located in littoral zones with rocky bottoms and *Posidonia* seagrass beds (Harmelin-Vivien, Harmelin and Leboulleux, 1995). Moreover, the low abundances of predator fish species observed (*E. marginatus, E. costae, S. scrofa, D. labrax, M. helena, D. dentex* and *L. viridis*) may actually promote the survival of recruits and juveniles of *D. sargus and D. annularis* species, accounting for the high abundances of these two species. However, in our study the abundances of *D. vulgaris* were lower than those reported by other authors (Reñones *et al.*, 1995), perhaps due to recruitment variability (Macpherson, 1994; García-Rubies and Macpherson, 1995).

The densities of the *Symphodus* species in our study were in the same range of abundances observed by previous authors in similar areas (Reñones *et al.*, 1995; Jiménez *et al.*, 1997; Bussotti and Guidetti, 1999; Guidetti, Bussotti and Boero, 2001; Guidetti *et al.*, 2002). All of these studies show a wide variability in fish density, which constrains the establishment of abundance patterns for the *Symphodus* species.

**Habitat preference and ecological niche**

Distribution patterns of the studied fish species were very similar for both habitats for most species. However, *D. annularis, S. mediterraneus, S. tinca* and *S. rostratus* were more abundant in mixed habitats than over rocky bottoms, and *D. sargus* and *S. ocellatus* were predominant over rocky bottoms. However, according to other authors (Guidetti, 2000), *S. tinca* were more associated with rocky algal reefs, and *S. ocellatus* were found predominantly in *P. oceanica* meadows.

The higher abundance of *D. annularis* in mixed meadows can be explained by the fact that this species is commonly associated with *P. oceanica* seagrass beds (Francour, 1997). Previous authors (Harmelin-Vivien, 1983; Guidetti, 2000) have described a higher affinity of *D. annularis* for mixed habitats. *D. sargus* is more abundant over rocky bottoms than in mixed meadows, probably due to the suitability of these areas as recruitment zones for this species, as indicated by several studies (Harmelin-Vivien, Harmelin and Leboulleux, 1995). On the other hand, *D. vulgaris* did not show significant differences in abundance for either type of habitat, due to its ubiquitous character, since the species is usually found over rocky bottoms, sandy habitats or seagrass beds (Macpherson, 1994).

*S. rostratus* was more abundant over mixed meadows with *P. oceanica* and rocky bottoms. Our results are consistent with those reported by other authors in Mediterranean marine coastal areas (Bell and Harmelin-Viven, 1982; Harmelin-Vivien, 1983b; Reñones *et al.,* 1995; Sánchez Jerez and Ramos Esplá, 1996; Francour, 1997; Jiménez *et al.,* 1997).

*S. rostratus, S. tinca, S. mediterraneus* and *S. doderleini* showed a preference for mixed habitats, which could be a consequence of the food resources provided by the rocky bottoms, along with the use of *Posidonia* seagrass beds as refuge areas against predation (García-Rubies and Macpherson, 1995). These species share the same habitat and food resources (Pou, Comas and Gállego, 1988), and have developed several strategies to reduce interspecies competition, such as temporal food partitioning in their feeding habits (Valle, Bayle Sempere and Ramos Esplá, 2001). Thus, the distribution of the *Symphodus* species could be a result of their trophic structure, along with the greater structural complexity provided by mixed habitats. On the other hand, the clear preference for rocky habitats observed in *S. ocellatus* was not consistent with other data reported for Mediterranean coastal marine areas. Francour (1997) observed that *S. ocellatus* was the more abundant labrid at several *P. oceanica* stations in the Port-Cros Marine Park. Generally, fish species associated with vegetated habitats are likely to be responding to needs for food and shelter. *P. oceanica* provides both of these requirements for several fish species (Rozas and Odum, 1988), and some authors (Harmelin-Vivien, Harmelin and Leboulleux, 1995; Francour, 1997) have reported the role of *Posidonia* beds as nursery areas for several fish species. In addition, García-Rubies and Macpherson (1995) and Harmelin-Vivien, Harmelin and Leboulleux (1995) have observed the importance of rocky substrates with biotic cover, gravel and pebbles as preferential habitats for settlement of several fish species.

All of these results clearly show the high importance of habitat diversity in coastal areas, highlighting the need for protection measures for these areas in order to maintain their rich biodiversity.

## ACKNOWLEDGEMENTS

We thank the staff of the Dragonera Natural Park, especially its director, Martí Mayol, and the guards Oriol and Joan, for their logistical support. Thanks also to Isabel Moreno Castillo, Olga Reñones, Ramon Mas, Nuria Granados, Servei de Ports i Litoral d'Andratx, Isurus Subaquatic Center and Serveis Científico-Tècnics of the UIB for their collaboration. This study was supported by a research fellowship from the Consell Insular de Mallorca (CIM).

## REFERENCES

Bell, J. D. and M. Harmelin-Vivien. 1982. Fish fauna of French Mediterranean *Posidonia oceanica* seagrass meadows: I. Community structure. *Thetys* 10: 337-347.

Bell, J. D. and D. A. Pollard. 1989. Ecology of fish assemblages and fisheries associated with seagrasses. In*: Biology of seagrasses* (Aquatic Plant Studies 2) A. W. D. Larkum *et al.* (eds.). Elsevier. Amsterdam, The Nederlands.

Bussotti, S. and P. Guidetti. 1999. Fish communities associated with different seagrass systems in the Mediteranean sea. *Nat. Sicil.* 23 (suppl): 254-259.

Clarke, K. R. and R. M. Warwick. 1994. Change in marine communities: An approach to statistical analysis and interpretation.

Dufour, V., J. Y. Jouvenel and R. Galzin. 1995. Study of a mediterranean fish assemblage. Comparison of population distributions between depths in protected and unprotected areas over one decade. *Aquatic Living Resources* 8: 17-25.

Fasola, M., L. Canova, F. Foschi, O. Novelli and M. Bressnan. 1997. Resource use by Mediterranean rocky slope fish assemblages. *PSZNI. Marine Ecology* 18: 51-66.

Francour, P. 1997. Fish assemblages of *Posidonia oceanica* beds at Port-Cros (France, NW Mediterranean): Assessment of composition and long-term fluctuations by visual census. *PSZNI. Marine Ecology* 18: 157-173.

García-Rubies A. and E. Macpherson. 1995. Substrate use and temporal pattern of recruitment in juvenile fishes of the Mediterranean littoral. *Marine biology* 124: 35-42.

Guidetti, P. 2000. Differences among fish assemblages associated with nearshore *Posidonia oceanica* seagrass beds, rocky-algal reefs and unvegetated sand habitats in the Adriatic sea. *Estuarine, Coastal and Shelf Science* 50: 515-529.

Guidetti, P., S. Bussotti and F. Boero. 2001. Fish visual census in shallow meadows of mediterranean small-sized seagrasses *Rapp. Comm. Int. Mer Méditer.* 36.

Guidetti, P., G. Fanelli, S. Fraschetti, A. Terlizzi and F. Boero. 2002. Coastal fish indicate human-induced changes in the Mediterranean littoral. *Marine Environmental Research* 53: 77-92.

Harmelin-Vivien, M. L. 1983. Ichtyofaune des herbiers de Posidonies des côtes provençales françaises. *Rapp. Comm. Int. Mer Méditer.* 28 (3): 161-163.

Harmelin-Vivien, M. L. and P. Francour. 1992 Trawling or visual censuses? Methodological in the assesment of fish populations in seagrass beds. *PSZNI. Marine Ecology* 13: 41-51.

Harmelin-Vivien, M. L., J. G. Harmelin, C. Chauvet, C. Duval, R. Galzin, P. Lejeune, G. Barnabe, F. Blanc, R. Chevalier, J. Declerc and G. Laserre. 1985. Evaluation des peublements et populations de poissons. Mèthodes et problemes. *Rev. Ecol.* (Terre Vie) 40: 467-539.

Harmelin-Vivien, M., J. G. Harmelin and V. Leboulleux. 1995. Microhabitat requeriments for settlement of juvenile sparid fishes on Mediterranean rocky shores. *Hydrobiologia* 300-301, 309-320.

Heck, K. L., Jr., and R. J. Orth. 1980. Seagrass habitats: the roles of habitat complexity, competition and predation structuring associated fish and motile macroinvertebrate assemblages. In: *Estuarine Perspectives.* V. S. Kennedy (ed.): 449 - 464. Academic Press. New York.

Jenkins, G. P. and M. J. Wheatley. 1998. The influence of habitat structure on nearshore fish assemblages in a Southern Australian embayment: Comparison of shallow seagrass, reef-alga land and unvegetated sand habitats, with emphasis in their importance to recruitment. *Journal of Experimental Marine Biology and Ecology* 221: 147-172.

Jiménez, S., J. T. Bayle, A. A. Ramos Esplá and J. L. Sánchez Lizaso. 1997. Ictiofauna de dos praderas de *Posidonia oceanica* (Linnaeus) Delile, 1813 con distinto grado de conservación. In: *Investigaciones sobre el bentos marino. IX Simposio ibérico de estudios del bentos marino* (19-23 de febrero, 1996. Alcalá de Henares, Madrid, España). J. M. Viéitez and J. Junoy (eds.) 23: 255-264. *Publicaciones Especiales. Instituto Español de Oceanografía*: 294 pp.

Kikuchi, T. and J. M. Peres. 1997. Consumer ecology of seagrass beds. In: *Seagrass ecosystem: A Scientific Perspective.* C. P. McRoy and C. Helfferich (eds.): 147-193. Dekker. New York.

Macpherson, E. 1994. Substrate utilization in a Mediterranean littoral fish community. *Marine Ecology Progress Series* 114: 211-218.

Pou, M. N., M. A. Comas and L. Gállego. 1998. Régimen alimentario de los lábridos (Osteichties: Labridae) de las Baleares. In: *VI Simposio ibérico de estudios del bentos marino* (18-22 de septiembre, 1988. Palma de Mallorca, Islas Baleares, España). L. Gállego (ed.): 307-311. Bílbilis. España.

Reñones, O., E. Massutí, J. Moranta, J. Coll and I. Moreno. 1995. Fish fauna of *Posidonia oceanica* seagrass meadows in Palma bay (Balearic Islands). *Cybium* 19 (2): 201-206.

Rozas, L. P. and W. E. Odum. 1988. Occupation of submerged aquatic vegetation by fishes: Testing the roles of food and refuge. *Oecologia* 77: 101-106.

Sánchez Jerez, P. and A. A. Ramos Esplá. 1996. Detection of environmental impacts by bottom trawling on *Posidonia oceanica* (Linnaeus) Delile, 1813 meadows: Sensitive of fish and macroinvertebrate communities. *J. Ecosyst. Health* 5: 239-253.

Smith, E. P. 1982. Niche breadth, resource availability and inference. *Ecology* 63 (6): 1675-1681.

Valle, C., J. T. Bayle Sempere and A. A. Ramos Esplá. 2001. Estudio multiescalar de la ictiofauna asociada a praderas de *Posidonia* (L.) Delile, 1813 en Alicante (sudeste ibérico). In: *XI Simposio ibérico de estudios del bentos marino* (22-25 de febrero, 2000. Torremolinos, Málaga, España). J. E. García Raso (ed.) 17 (1-2): 49-60. *Boletín. Instituto Español de Oceanografía*: 218 pp.