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.

INTRODUCTION

The Mediterranean littoral fish communities have been traditionally studied on rocky bottoms (Dufour, Jouveunel 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.

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 Dystiopteris spp.
250 m². Cryptic fishes were counted in a transect 20 m long and 5 m wide, and a total area of 100 m². 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 m²) 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 m²) 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 α = 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:

\[ IA = \frac{(A_h \cdot O_n)}{(A_t \cdot O_t)} \]

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, \( O_n \) is the occurrence of the studied specie in all habitats, \( O_t \) is the occurrence of the studied specie in all habitats.

Niche breadth was calculated by applying the formula \( B = 1/\sum p_i^2 \), as used in trophic ecology studies of fishes (Smith, 1982), where \( p_i \) 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 Diplodus 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 Coris julis (22.28 %), A. imberbis (15.71 %), Diplodus vulgaris (12.09 %), and Salpa 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 Diplodus vulgaris, Diplodus sargus and Diplodus annularis are
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).
over rocky bottoms (1.78 indiv/transect) (anova, p < 0.005).

In the Labridae family, we considered the congereneric 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 Esplà, 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-Vivien, 1982; Harmelin-Vivien, 1983b; Reñones *et al*., 1995; Sánchez Jerez and Ramos Esplà, 1996; Francour, 1997; Jiménez *et al*., 1997). *S. rostratus*, *S. tinca*, *S. mediterraneus* and *S. doderleinii* 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 Esplà, 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 ob-
No habitat preference in mixed meadows and rocky bottoms for Labridae and Sparidae species associated with vegetated habitats are likely to be responding to needs for food and shelter. Garcia-Rubies and E. Macpherson (1995) reported high abundances of several fish species (Rozas and Odum, 1988), and some authors (Harmelin-Vivien, Harmelin and Francour, 1992) have documented recruitment of several fish species. In addition, Garcia-Rubies and E. Macpherson (1995) observed that the more abundant labrid at several locations is S. ocellatus. Posidonia oceanica provides both of these requirements for fishes and is a key habitat in healthy coastal ecosystems. Environment and temporal pattern of recruitment in juvenile fishes of between depths in protected and unprotected areas was not consistent with other studies. However, recent evidence from the French Mediterranean (1999, 2000) suggests that the connectivity of shallow Posidonia beds and rocky bottoms with adjacent habitats is important. The presence of several fish species in Posidonia beds can be attributed to the presence of S. ocellatus, which is a key species in healthy coastal ecosystems. Environment and temporal pattern of recruitment in juvenile fishes of between depths in protected and unprotected areas was not consistent with other studies. However, recent evidence from the French Mediterranean (1999, 2000) suggests that the connectivity of shallow Posidonia beds and rocky bottoms with adjacent habitats is important. The presence of several fish species in Posidonia beds can be attributed to the presence of S. ocellatus, which is a key species in healthy coastal ecosystems.


