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Investigating on the occurrence of *Paracentrotus lividus* in rocky and *Posidonia oceanica* habitat

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Abstract

The sea urchin *Paracentrotus lividus* (Lamarck) is the most common grazer in the Mediterranean infralittoral that at high densities overgrazes complex algal assemblages turning them into barren areas. This study has the aim to investigate whether abundance and population structure of *P. lividus* is consistent between rocky boulders and *Posidonia oceanica* habitat. At this aim, we have sampled *P. lividus* at six sites in the Gulf of Alghero (North West Sardinia), 3 fished (sea urchin are harvested) and 3 controls (no harvest is allowed) and at each site the two habitats, 6-10 m deep, were considered. For each combination site×habitat 10 replicates were taken. Density of *P. lividus* was assessed using quadrats of 1×1 m. The size of 20 individuals (test diameter without spines) per site was measured by means of a calliper (± 0.1mm). Sea urchins, finally were grouped into size classes to examine frequency distributions. Sampling was performed at the end of a harvesting period (April-May 2006). Analyses of data have highlighted a significant variability for both response variables among sites while in *Posidonia oceanica* habitat a lower density and a higher size were found rather than in rocky habitat. Further data collected at three types of *Posidonia oceanica* (patches close to rocky habitat, far from rocky habitat and patches bordered by sediment) suggest that the abundance of adults in the seagrass is probably sustained by immigration from the rocky habitat.

Keywors: MPA; *Paracentotus lividus;Posidonia oceanica*; Rocky habitat; seaurchin harvest

1. Introduction

Sea urchins are among the invertebrates that play a major role in structuring and controlling benthic macrophyte communities. They are often considered strong interactors as changes in their relative abundance can dramatically change community composition and structure (Paine 1992, Sala & Graham 2002), sometimes causing severe overgrazing events either of algal or seagrass communities (see reviews by Lawrence & Sammarco 1982 or Valentine & Heck 1999). Their key role in benthic communities explains the interest of marine ecologists in different aspects of their biology and ecology, and the extensive literature devoted to these issues (e.g. Lawrence & Sammarco 1982, Jangoux & Lawrence 1983, Lawrence 2001). Several processes (e.g. predation, recruitment, migration, disease) exert a crucial role in sea urchin population dynamics and therefore influence their structure (e.g. Watanabe & Harrold 1991, Hagen 1995, McClanahan 1998, Scheibling et al. 1999).

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Paracentrotus lividus (Lamarck) is one of the most important invertebrate herbivores in Mediterranean (Boudouresque & Verlaque 2001) either on algae (Palacín et al. 1998a) and on seagrass communities (Alcoverro et al. 1997). Whereas *P. lividus* is generally found at low density in *Posidonia oceanica* (L.) Delile meadows (0 to 6 individuals ind./m^2 (e.g. Verlaque & Nédelec 1983, Palacín et al. 1998b), in shallow, hard substrate density is often encountered from 10 to 30 ind./m^2 (e.g. Fenaux et al. 1987, Benedetti-Cecchi & Cinelli 1995, Sala et al. 1998). *P. lividus* recruits are typically found in dense algal assemblages, rocky crevices and under boulders (e.g. Kempf 1962, Verlaque 1984, Sala & Zabala 1996). In contrast, *P. lividus* juveniles are generally absent or at very low densities in *P. oceanica* meadows (Azzolina 1988, San Martin 1995, but see Azzolina & Willsie 1987). The apparently contrast in population structure of *Paracentrotus lividus* between these 2 habitats could be the result of different settlement and recruitment patterns (Tomas et al. 2004). This study has the aim to investigate whether protection affects the abundance and size of *P. lividus* and whether this effect is consistent between two representative, as well as contrasting, habitats in the Mediterranean: rocky boulders and *Posidonia oceanica*.

2. Materials and methods

This study was carried out at the end of the harvesting period (April-May 2006) in the Gulf of Alghero (north-western coast of Sardinia, Italy). We have considered six sites between 6 and 10 m depth: 3 fished (sea urchin are harvested) and 3 controls (no harvest is allowed), within the Capo-Caccia Isola Piana MPA. At each site the two habitats, rocks an *P. oceanica*, were considered. For each combination site×habitat 10 replicates were taken for the density and 20 for the size. Density of *P. lividus* was assessed using quadrats 1×1 m in size while *P. lividus* size (test diameter, without spines) was measured by means of a calliper (± 0.1mm). Data were analysed by three-way ANOVAs: Protection (2 levels) treated as fixed, Site (3 levels) treated as random and nested in Protection, and Habitat (2 levels), treated as fixed and orthogonal.

3. Results

Analyses of data have highlighted the lack of the influence of protection for both the density and size of *Paracentrotus lividus* (Fig. 1 and 2) and a significant variability among sites, regardless of protection. Further, differences between habitats were found: in *Posidonia oceanica* a lower density and a higher size were found rather than on rocks (Table 1).

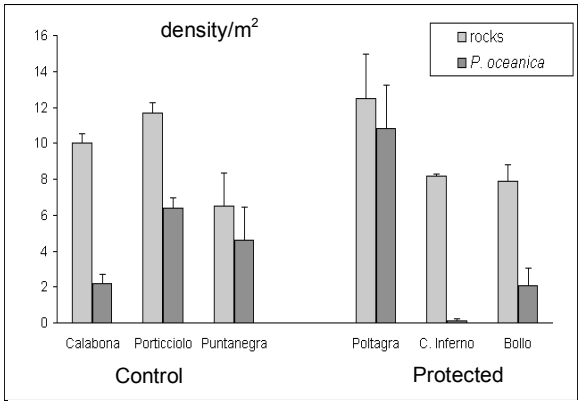

Fig. 1. Variation in *P.lividus* density (mean + SE) among sites and habitats.

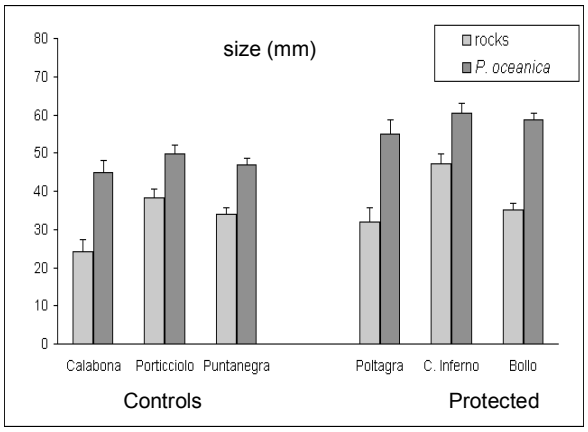

Fig. 2. Variation in *P.lividus* size (mean + SE) among sites and habitats.

Table 1 Three-way ANOVAs on the effects of Protection, Site and Habitat on *P. lividus* density and size. Significant tests are indicated in bold.

		density			size		
Source of variation		df	MS	F	df	MS	F
Protection	=P	1	0.2352	0.03	1	2.3361	1.91
Site(P)	=S	4	7.3226	**15.46**	4	1.2247	**5.36**
Habitat	=H	1	35.678	**15.82**	1	13.755	**46.16**
P×H		1	0.3348	0.15	1	0.1343	0.45
H×S(P)		4	2.2549	4.76	4	0.2980	1.30
Residual		108	0.4737		228	0.2284	
Transf.			Sqrt(x+1)			Ln(x+1)	
Cochran's Test			C= 0.2516			C= 0.2869	

4. Discussion and conclusions

The lack of a significant effect of protection on density and size of *Paracentrotus lividus* at this study location was a very unexpected result since at the Gulf of Alghero the harvest of this sea urchin has become extremely popular, and historically, it has been conducted for decades. However, this finding can be explained on several possible reasons such as the high heterogeneity among sites, the possibility that poaching fisheries of this species occur regardless of restrictions and also the few time elapsed since MPA establishment (2 years).

The higher density at the rocky habitat rather than at *Posidonia oceanica* habitat were consistent with the recent findings obtained by Tomas et al. (2004) who investigated the settlement and recruitment of this species at the same habitats. Indeed, they have suggested that recruitment of *P. lividus* occurs at both habitats, although it is less important in *P. oceanica*. These authors also hypothesized that a great contribution to the abundance of *P. lividus* in the seagrass meadow could be due to immigration of adult specimens from the near rocky habitat. The finding of the present study about the large size of *P. lividus* in *P.oceanica* habitat could support their model. Also observations made during field surveys about the abundance of *P. lividus* in *P. oceanica* habitat suggested that the higher occurrence would be found where rocky habitat is next to the seagrass in contrast to where a sandy bottom surrounds the meadow.

Overall, these data indicate the possibility that the seascape of seagrass patches (patch size, neighbour habitat, nearest seagrass patch) could play a very important role in sheltering adults of *P. lividus*.

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