J. Mar. Biol. Ass. U.K. (2002), **82**, 1043–1044
Printed in the United Kingdom

Can mineralogical features influence distribution patterns of fish? A case study in shallow Mediterranean rocky reefs

P. Guidetti*‡ and R. Cattaneo-Vietti†

*Laboratorio di Zoologia e Biologia Marina, DiSTeBA, CoNISMa, Università di Lecce, Via Prov.le Monteroni, 73100 Lecce, Italy. †DipTeRis, Università di Genova, Corso Europa 26, 16132 Genova, Italy. ‡Corresponding author, e-mail: paolo.guidetti@unile.it

Spatial distribution patterns of two small serranids, *Serranus scriba* and *S. cabrilla*, have been investigated in June 2001 in north-eastern Sardinia (Tyrrhenian Sea, Italy). Density and size of both species were estimated by visual census on shallow (5–7 m) rocky reefs constituted by different mineralogical types (granites vs carbonates), at different locations (several kilometres apart from each other) and sites (hundreds of metres from each other). *Serranus scriba* was significantly more abundant on granite rocks (where it also showed a greater frequency of large specimens) than on carbonates, while *S. cabrilla* displayed opposite patterns.

Serranus scriba (L.) and *S. cabrilla* (L.) are among the most common sedentary fish in the Mediterranean littoral (Fischer et al., 1987). *Serranus scriba* thrives in rocky bottoms and *Posidonia oceanica* sea grass beds, from shallow depth to about 30 m (Tortonese, 1975), but exceptionally it has been found down to 150 m (Fischer et al., 1987). It shows a violet-reddish body with 5–7 darkish vertical strips on the dorsal part of the body. *Serranus cabrilla* inhabits sea grass beds, rocky, sandy and muddy bottoms, with a wider bathymetric range than *S. scriba* (from shallow depth to 500 m). It displays a yellowish-reddish body with 7–9 vertical brownish strips; a paler livery is typical of specimens living in deeper areas and on sandy–muddy bottoms (Tortonese, 1975, but see also Medioni et al., 2001). Both species achieve maximum length (TL) of ~35–40 cm; in spite of some differences in their specific feeding habits, they are considered among the most important predators of early stages of fish and vagile invertebrates (Tortonese, 1975; Fasola et al., 1997).

Recent studies provided evidence that mineralogical features of rocky substrates (e.g. amount of quartz) may influence the structure of sublittoral benthic communities in the Mediterranean (Bavestrello et al., 2000, but see also Cerrano et al., 1999). Biological cover (together with physical complexity) in rocky habitats has the potential to dramatically affect the associated fish fauna (Levin & Hay, 1996; Guidetti et al., 2002). Rock type could thus indirectly influence distribution patterns of associated benthic and nectobenthic fish. This study aimed at investigating, over a local scale, distribution patterns of two common site-attached fish, *S. scriba* and *S. cabrilla*, in shallow temperate reefs constituted by different rock types.

Visual census surveys were carried out in June 2001 in north-eastern Sardinia (Tyrrhenian Sea, Italy), where the highly indented rocky shore is mostly constituted by granitic formations. The stretch of coast investigated here encompassed tens of kilometres of granitic rocks with the exceptions of Capo Figari Promontory and Tavolara Island, both made by gigantic limestone–dolomite slab (Bavestrello et al., 2000). Visual censuses were performed at shallow depth (5–7 m) along transects 25 m long and 5 m wide, randomly placed at four locations: two carbonatic, Capo Figari (thereafter named as CF; 40°59′N 9°39′E) and Tavolara (TA; 40°54′N 9°43′E), and two granitic, Molara (MO; 40°52′N 9°43′E) and Capo Ceraso (CC; 40°55′N 9°38′E). Preliminary analyses on sessile assemblages provided evidence of clear-cut differences between carbonatic and granitic substrates (unpublished data). Three sites were surveyed at each location, with five visual censuses at each site. Abundance data were expressed as number of individuals 125 m^{-2}. The size of each fish was referred to three size-classes: large, medium and small, each corresponding to one-third of the maximum TL reported in the literature (Fischer et al., 1987). Analysis of variance (ANOVA) was used to assess differences in average fish abundance: 'Mineralogy' was considered as a fixed factor; 'Location' was random nested within 'Mineralogy', and 'Site' nested within 'Location'. Homogeneity of variance was tested by Cochran C-test (Underwood, 1997).

Average density of *S. scriba* was significantly higher on granites than on carbonates (3.4 ±0.2 vs 1.3 ±0.1 no. of ind 125 m^{-2}, mean ±SE). No differences were detected among locations within each substrate type, nor among sites within location (Table 1; Figure 1A). *Serranus cabrilla*, by contrast, was significantly more abundant on carbonatic than on granitic rocks (3.1 ±0.2 vs 1.1 ±0.1 no. of ind 125 m^{-2}, mean ±SE), whereas average density did not significantly differ at location level, nor among sites within location (Table 1; Figure 1B). The individuals of *S. cabrilla* recorded on carbonatic rocks were usually paler than those observed on granites.

With regard to size, large *S. scriba* accounted for 24.8%, and medium for 75.2% of all specimens of this species recorded on granites. On carbonates, instead, large *S. scriba* accounted for 14.9%, and medium 85.1% of the specimens censused in this rock type. *Serranus cabrilla* showed an opposite pattern with large specimens accounting for 2.9 vs 17.4%, and medium 97.1 vs 82.6%, on granites and carbonates, respectively.

The present note reports the first data about the potential effects of rock type on the spatial distribution and size of two congeneric fish in shallow Mediterranean rocky-reefs. Both species showed

Table 1. *Summaries of ANOVAs testing for effects of substrate type and spatial differences in average abundance (no. individuals 125 m^{-2}) of the two studied fish.*

	Serranus scriba			*Serranus cabrilla*		
Source of variation	df	MS	*F*-values	df	MS	*F*-values
Mineralogy=M	1	62.01	12.70*	1	58.02	139.24***
Location=L (M)	2	4.88	3.41 n.s.	2	0.42	0.45 n.s.
Site=S (L (M))	8	1.43	1.31 n.s.	8	0.92	1.16 n.s.
Residuals	48	1.09		48	0.79	
Total	59			59		

Probability levels: n.s., not significant; *, $P<0.05$; ***, $P<0.001$.

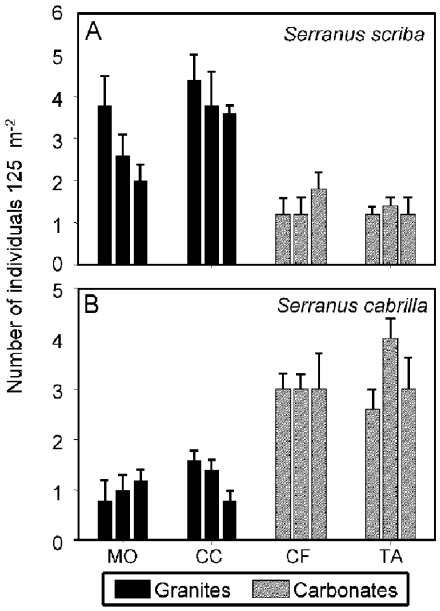

Figure 1. Mean abundance (±SE) of *Serranus scriba* (A) and *S. cabrilla* (B) at the studied locations (MO, Molara; CC, Capo Ceraso; CF, Capo Figari; TA, Tavolara) in relation to the two rock types.

fairly homogeneous distribution patterns at location and site scale, but displayed clear-cut and opposite patterns of abundance (and size) related to rock type. Many authors reported that the two species usually show complementary distributions related to depth (Harmelin, 1990; Fasola et al., 1997; Vacchi et al., 1998), but this pattern does not seem to be the same everywhere (Garcià-Rubies & Zabala, 1990; Dufour et al., 1995). The results of this study suggest that other factors (e.g. rock type) could thus be involved in affecting the distribution patterns of the two *Serranus* spp. Most papers dealing with fish associated with Mediterranean rocky reefs did not mention mineralogical features of the regions investigated, which makes it difficult to compare our data with those in literature from a 'biomineralogical' (*sensu* Cerrano et al., 1999) point of view. Guidetti (2000) and Guidetti et al. (2002), however, observed that in shallow (5–6 m depth) carbonatic rocky-reefs in Apulia (south-east Italy), densities of *S. cabrilla* were higher than or comparable with those of *S. scriba*, which supports the hypothesis that densities of *S. cabrilla* can be greater in shallow carbonatic reefs. Mineralogical features, anyway, seem to be able to affect not only the two *Serranus* spp., but also whole fish assemblages (unpublished data). The putative effects of rock types on sedentary fish are likely to be ascribed to indirect mechanisms. Direct effects involving interactions between rocks (i.e. their mineralogical composition) and fish, in fact, could only be plausible for species, for instance, laying eggs directly on substrates. In the case of *Serranus* spp., nevertheless, other factors must be invoked as potentially affecting distribution patterns. The random selection of sites and transects was appropriate to avoid any confounding interpretation attributable to habitat complexity (data not reported), at least considering macro-complexity. However, we cannot exclude a priori that the geological nature of substrates may display a different micro-complexity (e.g. holes and small overhangs due to different reaction to erosion). There are anyway further and more plausible explanations: (1) the colour of carbonatic and granitic rocks is different, with carbonatic reefs often being lighter than granites (this often depending on the presence of barrens). The fact the *S. cabrilla* is more abundant on carbonates (where it displays a paler livery) could thus be related to its more effective mimetic ability; (2) different benthic assemblages (i.e. macroalgae and zoobenthos) related to mineralogical rock types may provide different architectural structures as well as different food resources (e.g. vagile invertebrates and juvenile fish including most preys of the two species studied; Fasola et al., 1997), which involves 'bottom-up' mechanisms (*sensu* Menge, 2000).

This research was funded by MURST-COFIN99 Project 'Ecological and biochemical interactions between aquatic biosystems and natural substrates'. Many thanks are due to S.D. Connell (University of Adelaide, Australia) for his useful comments on the manuscript and to three anonymous referees for their helpful suggestions.

REFERENCES

Bavestrello, G., Bianchi, C.N., Calcinai, B., Cattaneo-Vietti, R., Cerrano, C., Morri, C., Puce, S. & Sarà, M., 2000. Biomineralogy as a structuring factor for marine epibenthic communities. *Marine Ecology Progress Series*, **193**, 241–249.

Cerrano, C. et al., 1999. Organism–quartz interactions in structuring benthic communities: towards a marine biomineralogy? *Ecology Letters*, **2**, 1–3.

Dufour, V., Jouvenel, J.Y. & Galzin, R., 1995. Study of a Mediterranean reef fish assemblage. Comparisons of population distributions between depths in protected and unprotected areas over one decade. *Aquatic Living Resources*, **8**, 17–25.

Fasola, M., Canova, L., Foschi, F., Novelli, O. & Bressan, M., 1997. Resource use by a Mediterranean rocky slope fish assemblage. *Marine Ecology*, **18**, 51–66.

Fischer, W., Schneider, M. & Bauchot, M.L., 1987. Fiches FAO d'identification des éspèces pour les besoins de la pêche. Médeterranée et Mer Noire. Zone 37. II. Vertebrés. *FAO, Rome*, **2**, 761–1530.

Garcìa-Rubies, A. & Zabala, M., 1990. Effects of total fishing prohibition on the rocky fish assemblages of Medes Islands marine reserve (NW Mediterranean). *Scientia Marina*, **54**, 317–328.

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., Fanelli, G., Fraschetti, S., Terlizzi, A. & Boero, F., 2002. Coastal fish indicate human-induced changes in the Mediterranean littoral. *Marine Environmental Research*, **53**, 77–94.

Harmelin, J.G., 1990. Ichtyofaune des fonds rocheux de Méditerranée: structure du peuplement du coralligène de l'ile de Port-Cros (Parc National, France). *Mesogée*, **50**, 23–30.

Levin, P.S. & Hay, M.E., 1996. Responses of temperate reef fishes to alterations in algal structure and species composition. *Marine Ecology Progress Series*, **134**, 37–47.

Levin, P.S., Chiasson, W. & Green, J.M., 1997. Geographic differences in recruitment and population structure of a temperate reef fish. *Marine Ecology Progress Series*, **161**, 23–35.

Medioni, E., Lecomte Finiger, R., Louveiro, N. & Planes, S., 2001. Genetic and demographic variation among colour morphs of cabrilla sea bass. *Journal of Fish Biology*, **58**, 1113–1124.

Menge, B.A., 2000. Top-down and bottom-up community regulation in marine rocky intertidal habitats. *Journal of Experimental Marine Biology and Ecology*, **250**, 257–289.

Tortonese, E., 1975. *Osteichthyes. Pesci Ossei*, (parte seconda). Bologna: Calderini Editore. [Fauna d'Italia, vol. XI.]

Underwood, A.J., 1997. *Experiments in ecology: their logical design and interpretation using analysis of variance*. Cambridge: Cambridge University Press.

Vacchi, M., Bussotti, S., Guidetti, P. & La Mesa, G., 1998. Study of the coastal fish assemblage in the marine reserve of the Ustica Island. *Italian Journal of Zoology*, **65**, 281–286.

Submitted 20 May 2002. Accepted 30 August 2002.