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Can mineralogical features affect the distribution patterns of sessile gastropods? The Vermetidae case in the Mediterranean Sea

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Spatial distribution patterns of two sessile gastropods belonging to Vermetidae, *Vermetus triquetrus* and *Dendropoma petraeum*, were studied in June 2001 in north-eastern Sardinia (Mediterranean Sea, Italy). Density of individuals was assessed within quadrats positioned on a shallow (0.1–1 m depth) rocky substrate of different lithological types (limestone and granite), at a hierarchy of spatial scales. Density of *D. petraeum* is significantly greater on granite than on limestone, while *V. triquetrus* does not show any differences related to rock type.

Vermetids are sessile gastropods with a tubular, irregularly uncoiled shell cemented (in the adult life) to hard substrates such as coral or rocks. They preferentially thrive in intertidal or shallow subtidal zones in temperate and tropical regions, and may be solitary or form dense aggregates of colonial individuals. In the Mediterranean Sea, two species, *Vermetus triquetrus* Bivona Ant., 1832 and *Dendropoma petraeum* (Monterosato, 1884), may form clusters. *Dendropoma petraeum*, in particular, may produce conspicuous biogenic platforms called *trottoir* in the warmest areas of the basin, which play an important role in preventing rock erosive processes (Antonioli et al., 1999).

Recently, it has been inferred that the mineralogical features of substrates (e.g. the amount of quartz) could affect the marine community structure of soft bottom infauna, sessile sublittoral benthos (Bavestrello et al., 2000; Cattaneo-Vietti et al., 2002, and references therein), and some fish species (Guidetti & Cattaneo-Vietti, 2002). However, no attempts have been made to quantify distribution and abundance of vermetids in lithologically complex areas, where different typologies of rocks characterize shallow subtidal substrates.

The aim of this study was, therefore, to investigate, over a local scale, whether the distribution patterns of the two most common Mediterranean vermetids, *D. petraeum* and *V. triquetrus*, differ between shallow granite and limestone rocky substrates.

Surveys were carried out in June 2001 in north-eastern Sardinia (Tyrrhenian Sea, Italy) in the upper layer of the subtidal zone (0.1–1 m depth). This area is characterized by highly indented rocky shores, mainly constituted by granite. The stretch of the investigated coast encompassed tens of kilometres of granitic rocks, except for Capo Figari Promontory and Tavolara Island characterized by gigantic limestone–dolomite slabs. In the study area, three different species of vermetids were found: *V. triquetrus*, *D. petraeum* and *Serpulorbis arenaria* (Linnaeus, 1758). The latter species, however, is too rare to be reliably assessed. The other two investigated species are intermixed, concurring to form, both in limestone and granite sites, bioconstructions of the '*cornice*' or '*ledge*' type (Antonioli et al., 1999). Four locations (situated at a scale of kilometres from each other) were sampled: two carbonatic (limestone), Capo Figari (thereafter named as CF; 40°59′N 9°39′E) and Tavolara (TA; 40°54′N 9°43′E), and two quarzitic (granite), Molara (MO; 40°52′N 9°43′E) and Capo Ceraso (CC; 40°55′N 9°38′E). Three sites (located hundreds of metres from each other) were investigated at each location, with three replicate random quadrats (at a distance of metres) at each site. The random selection of sites was appropriate to avoid any confounding interpretation attributable to habitat complexity: environmental variables (e.g. slope) did not change significantly between granite and limestone sites (data not reported). Density of vermetids (individuals/0.25 m^{-2}) was estimated using a plastic frame. All the living vermetids (with a visible operculum) having a shell aperture diameter of 3 mm, were counted. As the two species are intermixed, they were assessed on different series of quadrats to ensure independence of data. Analysis of variance (ANOVA) was used to assess differences in average density: 'Mineralogy' was considered as a fixed factor; 'Location' was random nested within 'Mineralogy', and 'Site' nested within 'Location'. Analyses were performed by GMAV 5 software package (University of Sydney, Australia), and homogeneity of variance was tested by Cochran *C*-test.

The summary of ANOVAs carried out on density of *D. petraeum* and *V. triquetrus* is reported in Table 1. *Dendropoma petraeum* is significantly more abundant on granite than on limestone. Average density, in addition, does not vary significantly between locations, while it shows a marked variability among sites within locations (Figure 1A). On the contrary, *V. triquetrus* does not show any differences in abundance between limestone and granite, or over the spatial scale of locations, whereas it displays a significant variability among sites within locations (Figure 1B).

The present note provides evidence that density of *D. petraeum* is greater on granite than on limestone, while *V. triquetrus* does not change. The assessment of such distribution patterns does not logically allow us to invoke any specific casual processes, but these outcomes suggest some hypotheses that could be tested in the future. Space availability is a limiting factor for most sessile organisms, and solitary sessile animals are generally restricted to marginal zones as the intertidal. Vermetids may adopt two strategies to enhance competitiveness: the raising of the tube aperture above the substratum or the formation of monospecific aggregates. *Dendropoma petraeum* has developed coloniality, while *V. triquetrus* produces '*feeding-tubes*'

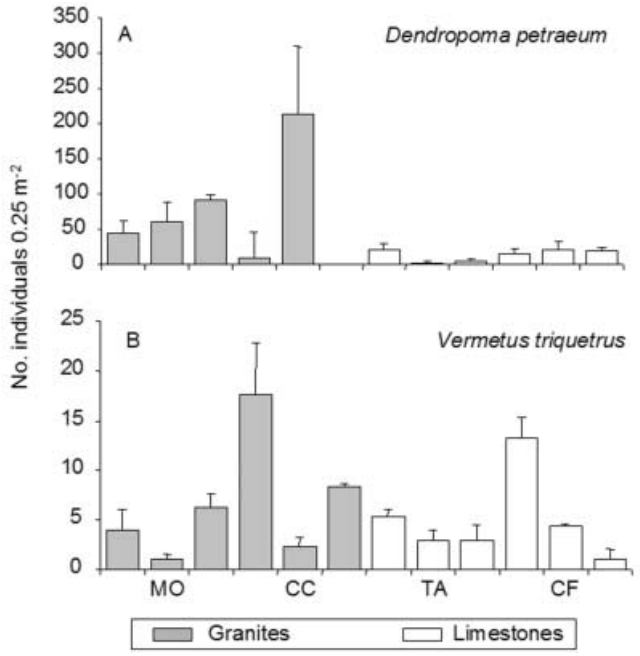

Figure 1. Mean density (±SE) of (A) *Dendropoma petraeum* and (B) *Vermetus triquetrus* in relation to the two rock types (MO, Molara; CC, Capo Ceraso; CF, Capo Figari; TA, Tavolara).

(Schiaparelli & Cattaneo-Vietti, 1999). The presence of feeding-tubes in a vermetid population may be interpreted as a response to a massive presence of erect macroalgae (e.g. during the spring algal bloom) which, due to their continued whiplash, obstruct feeding activity. Therefore, the higher coverage of erect macroalgae on limestone than on granite (unpublished data) can be considered the cause of a lower density of *D. petraeum* on the previous substrate, since this species, unable to produce feeding-tubes, is particularly sensitive to the macroalgal whiplash. This suggests a possible direct effect of rock type on macroalgal assemblages (see Bavestrello et al., 2000 and Cattaneo-Vietti et al., 2002), then reflecting on the distribution patterns of vermetid molluscs.

Another possible explanation could be the different behaviour of the vermetid juveniles in the presence of the different mineralogical composition and/or the microtopographic features of the two rock types. In fact, young snails, which are mobile and may crawl for a few hours before settling, are known to be highly selective in the choice of the substratum and, whenever possible, settle on living colonies of Cheilostome bryozoans. But, the ecology of vermetid post-metamorphic stages is still too scanty to infer a possible direct selection of the lithology, and no data are available regarding the Cheilostome bryozoan cover on the two rock types. We could also exclude an influence of the encrusting calcareous algae, considered the main competitor at least for *D. petraeum*, as the average cover of calcareous algae does not change between granite and limestone in the studied sites (unpublished data).

Table 1. *Analysis of variance testing for differences in density of vermetids between two rock types (granites vs carbonates), two locations within each rock type, and three sites within each location. Significance levels: n.s.,* $P > 0.05$; *, $P < 0.05$; **, $P < 0.01$.

		Dendropoma petraeum		*Vermetus triquetrus*	
Source	df	MS	F	MS	*F*-values
Mineralogy=M	1	457877.8	83.56 *	2.86	0.27 n.s.
Location=L (M)	2	5479.6	0.03 n.s.	10.54	0.82 n.s.
Sites=S (L(M))	8	183438.2	21.22 **	12.79	8.48 **
Residual	24	8644.9		1.51	
Cochran's test			n.s.		n.s.
Transform			nil		sqrt(x+1)

The above issues suggest that there are several alternative hypotheses potentially explaining the differences we observed in the distribution patterns of *D. petraeum* and *V. triquetrus*. From this perspective, field manipulations of erect macroalgae, and appropriate experimentation on settlement rates of juveniles in aquaria on different rock types, could help to test which of the hypotheses are plausible. These preliminary observations, however, stress the importance of taking into account both direct and indirect effects of rock type on associated sessile and vagile assemblages.

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