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PROCEEDINGS OF 2nd MEDITERRANEAN SYMPOSIUM ON THE CONSERVATION OF CORALLIGENOUS AND OTHER CALCAREOUS BIO-CONCRETIONS

Portorož, Slovenia, 29-30 October 2014

ACTES DU 2ème SYMPOSIUM MÉDITERRANÉEN SUR LA CONSERVATION DU CORALLIGÈNE ET AUTRES BIO-CONCRÉTIONS

Portorož, Slovenie, 29-30 octobre 2014

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Institute of the Republic of Slovenia for Nature Conservation

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BETA DIVERSITY PATTERNS IN NORTHERN ADRIATIC CORALLIGENOUS OUTCROPS

Abstract
Recent studies have investigated spatial and temporal variability of coralligenous assemblages on coastal rocky cliffs, while structure and variability of platform banks have been rarely investigated. In the northern Adriatic continental shelf, coralligenous biogenic reefs are scattered on sandy and muddy bottoms, and may be separated by a few tens of meters to tens of kilometres. Their benthic assemblages were investigated by photographic sampling in two main areas about 100 km away: off Chioggia-Venice and Grado-Trieste. Within each area six outcrops, 1-2 km away, were sampled. Assemblages on reefs closer to the coast were dominated by algal turfs and boring sponges, while offshore they were generally characterised by the richest and most diverse communities. Contributions to the total species richness increased with the investigated spatial scale up to areas, while variation in species diversity monotonically decreased by increasing distance. Dominant species, including the main reef builders (i.e. encrusting calcified Rhodophyta), spatially changed following a geographical pattern. Among others, coralline algae (e.g. Lithophyllum incrustans), sponges (e.g. Chondrosia reniformis) and colonial ascidians (e.g. Polycitor adriaticus) were the main species responsible for the observed spatial differences, in terms of species replacement (β diversity).

Key-words: Bioconstructions; Species diversity; Tegnùe; Trezze; Adriatic Sea

Introduction
Recent studies have investigated spatial and temporal variability of coralligenous assemblages on coastal rocky cliffs (Balata & Piazzi, 2008; Piazzi & Balata, 2011; Piazzi *et al.*, 2010), while structure and variability of platform banks have been rarely investigated. In the northern Adriatic continental shelf, coralligenous biogenic reefs, ranging from a few to several thousand square metres in surface, and up to 4 m in height, occur. They are scattered on sandy and muddy bottoms and may be separated by a few tens of meters to tens of kilometres. Until now, spatial variability of the epibenthic assemblages living on the northern Adriatic coralligenous outcrops were investigated locally (Curiel *et al.*, 2012; Ponti *et al.*, 2011). The aim of the present study is to compare spatial variation in species diversity across different spatial scales, ranging from a single reef to the basin.

Materials and methods
Species composition and abundances of the epibenthic assemblages on coralligenous biogenic reefs were investigated in 2013-2014, on 12 randomly selected sites in two areas of the northern Adriatic basin: 6 off Chioggia-Venice and 6 off Grado-Trieste (Fig. 1). Within areas, sites are 1-2 km distant, while the two areas are about 100 km away. Sites were located between 15 and 25 m in depth, and 6–18 km from the coast.

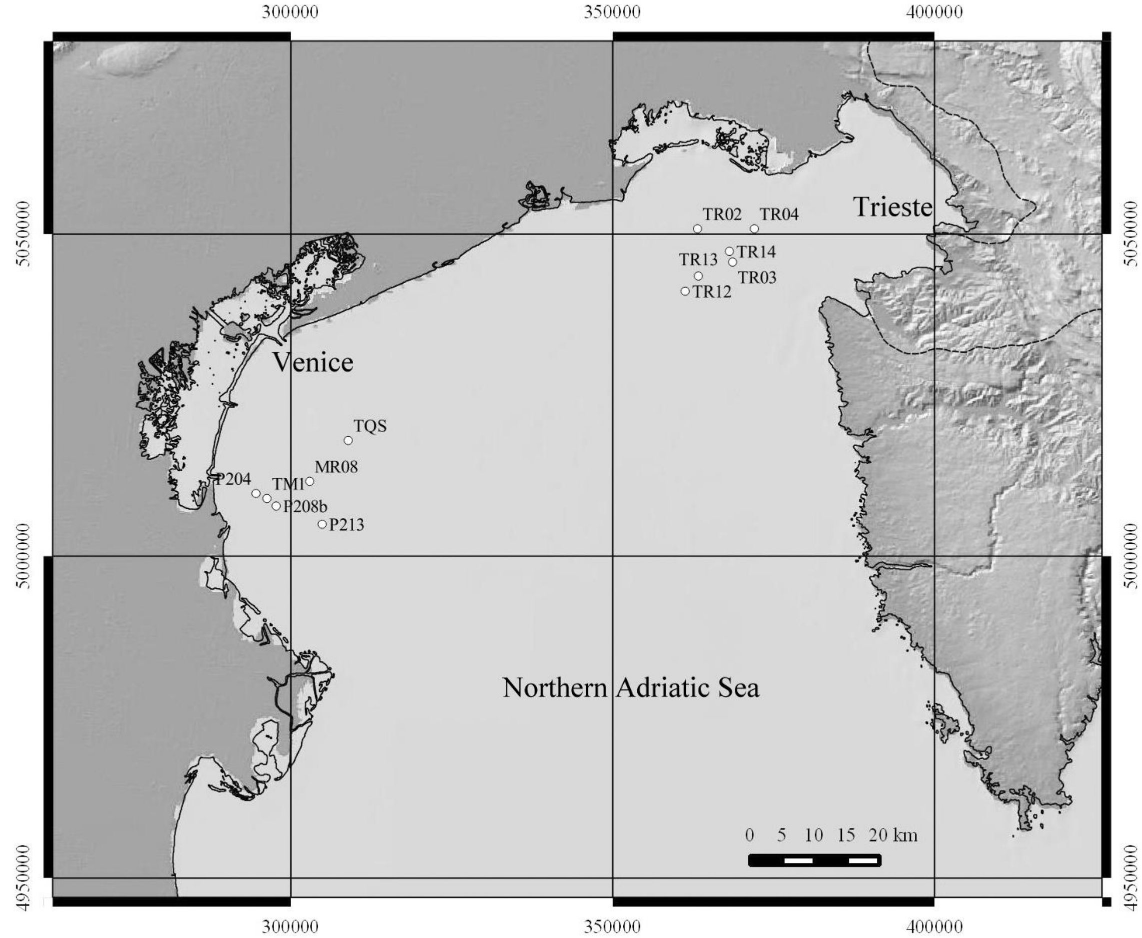

Fig. 1: Study area and sampling site (grid UTM33 WGS84).

Assemblages were sampled using a non-destructive photographic sampling method. Photographic samples (~0.06 m^2) were collected using a digital camera equipped with a strobe. Ten randomly selected photos were analysed at each site. Organisms were identified to the lowest possible taxonomical level according to a reference collection of specimens previously photographed and withdrawn from the same sites. Percent cover of sessile organisms was quantified by superimposing a grid of 400 cells (*i.e*. 0.25% each) using the free available photoQuad software (Trygonis & Sini, 2012). Slight differences among sampling areas, due to dark and blurred zone or portions covered by vagile organisms, were accounted by standardising to the total readable area of each image (Ponti *et al.*, 2011).The endolithic bioeroder bivalve *Rocellaria dubia* (Pennant, 1777) was identified and quantified by counting its typical '8-shaped' calcareous siphon holes. This photographic method could underestimate the abundance of some species, like the coralline algae, sometimes partially hidden by other organisms, but it has been widely used in studies dealing with spatial and temporal variability of hard bottoms epibenthic assemblages (Bianchi *et al.*, 2004 and references therein).
Species richness (number of taxa, *S*), species diversity (log base 2 Shannon's index, *H'*) and the corresponding evenness component (Pielou index, *J'*) were calculated for each replicate sample (Magurran, 2004). β diversity was analysed in terms of 'variation' in species diversity and community structure among sets of sample units (Anderson *et al.*, 2011). Species richness and species diversity were partitioned at the different spatial scale: within sites (α), among sites (β_{sites}), areas (β_{areas}) and whole basin (β_{basin}) using the

additive approach proposed by Crist *et al.* (2003). Multivariate measure of β diversity was obtained by the Jaccard similarity index, which is based on presence/absence data. Similarity patterns were displayed by unconstrained ordination plots using the principal coordinate analysis (PCoA, *i.e*. metric multidimensional scaling; Gower, 1966). Vectors superimposed on to the PCoA plot represented the correlations of the abundances of the most relevant taxa (Pearson correlation > 0.4) with the PCoA axes.

Results

A total of 56 taxa of macrobenthic invertebrates (18 Porifera, 4 Cnidaria, 3 Polychaeta, 1 Bivalvia, 6 Ascidiacea) and algae (17 Rhodophyta, 4 Ochrophyta, 2 Chlorophyta, plus mixed algal turf) were found, 33 of which were identified to species level. Assemblages on reefs closer to the coast were dominated by algal turfs and boring sponges, while offshore reefs were generally characterised by richest and most diverse communities. Contribution to the total species richness increased with the investigated spatial scaled up to the area level, which alone explained about 42%, while the variation of species richness at the basin scale is similar to that observed at the sites scale (Fig. 2).

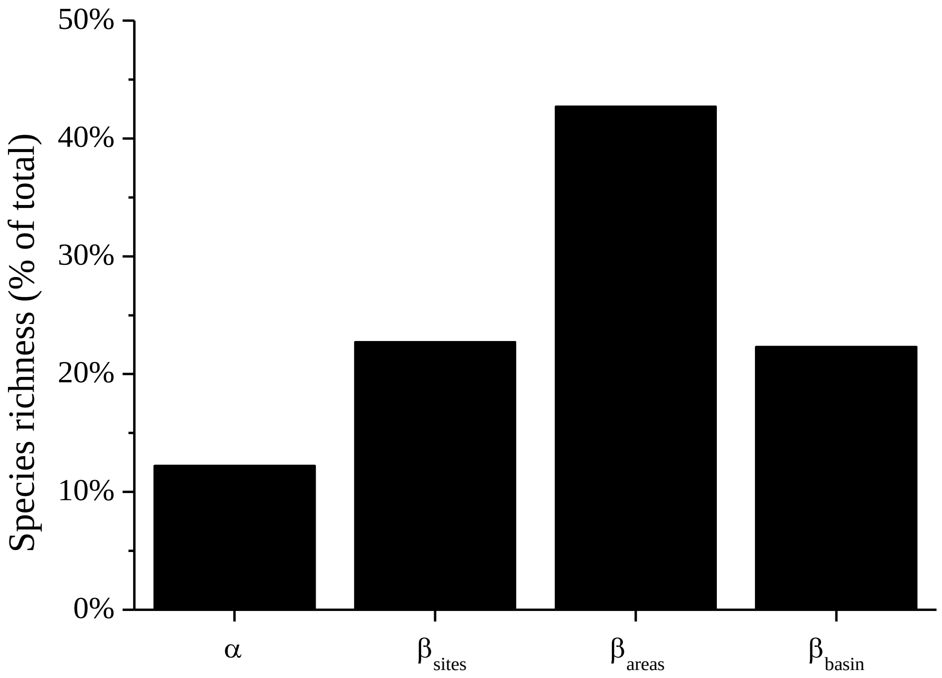

Fig. 2: Additive partition of species richness across three sampling spatial scales (α: within sites; β_{sites}: among sites; β_{areas}: between areas; and β_{basin} at the whole basin). Values are expressed as percent of the total diversity of epibenthic species explained by each hierarchical level.

Taking into account the species abundances, using the Shannon's index, the greater contribution to species diversity, on average, comes from α (within sites). Variation in species diversity monotonically decreases by widening the investigated zone (Fig. 3).

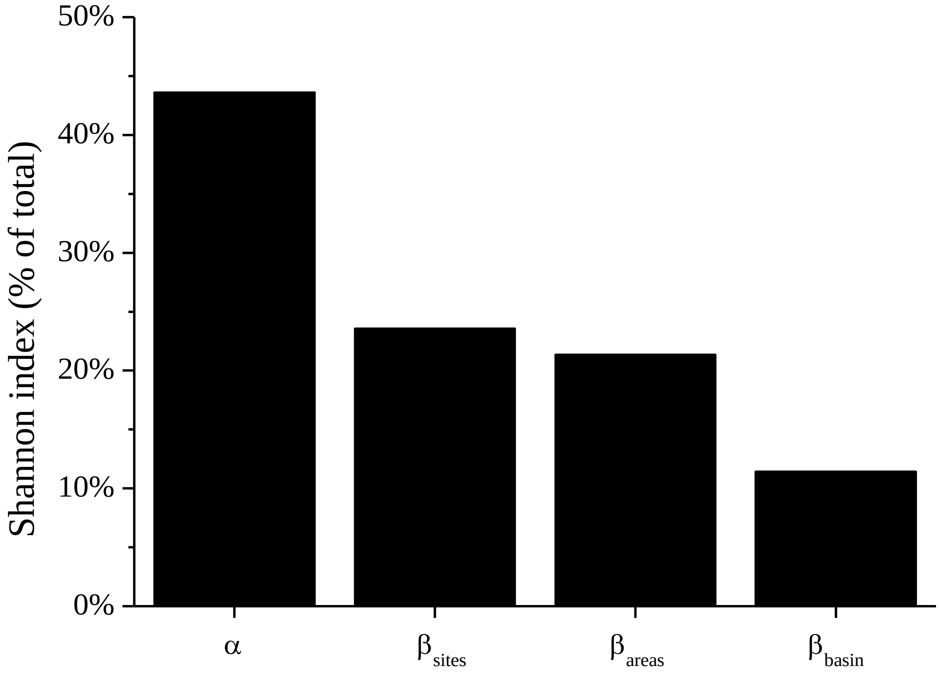

Fig. 3: Additive partition of Shannon's diversity index across three sampling spatial scales (α: within sites; β_{sites}: among sites; β_{areas}: between areas; and β_{basin} at the whole basin). Values are expressed as percent of the total diversity of epibenthic species explained by each hierarchical level.

Multivariate analysis, based on presence/absence data, revealed a complex similarity pattern with a clear shift in species composition between the Chioggia-Venice and the Grado-Trieste areas (Fig. 4). Moreover, within the Chioggia-Venice area, epibenthic assemblages tended to diverge in two compositional groups that mainly resembled the distance from the coast. The Grado-Trieste assemblages were characterised by the sponge *Chondrosia reniformis* Nardo, 1847 and the rhodophyte *Peyssonnelia rosa-marina* Boudouresque & Denizot, 1973 and *Lithothamnion* sp., the latter largely responsible for the bio-construction processes. Offshore Chioggia-Venice assemblages were characterised by the ascidian *Polycitor adriaticus* (Drasche, 1883), and the encrusting calcareous rhodophyte *Mesophyllum* sp. and *Lithophyllum incrustans* R.A. Philippi, 1837, while assemblages closer to the coast were dominated by the filamentous algae *Cladophora* sp. and *Antithamnion* sp., and by the boring bivalve *Rocellaria dubia*.

Discussion

Evidences that epibenthic assemblages on some northern Adriatic coralligenous reefs differed according to their distance from the coast, depth, water turbidity and sediment load were already provided by Ponti *et al.* (2011) and Curiel *et al.* (2012); nevertheless, variation in species diversity and community structure at different spatial scales have never been investigated. Surprisingly, areas distant about hundred kilometres, provide the greatest contribution to β species richness. The major proportion of species diversity, considering the relative abundances, was found within single coralligenous outcrops, supporting the existence of a high local heterogeneity.

Finally, dominant species, including the main reef builders (*i.e.* encrusting calcified red algae), varied in space following a geographical pattern.

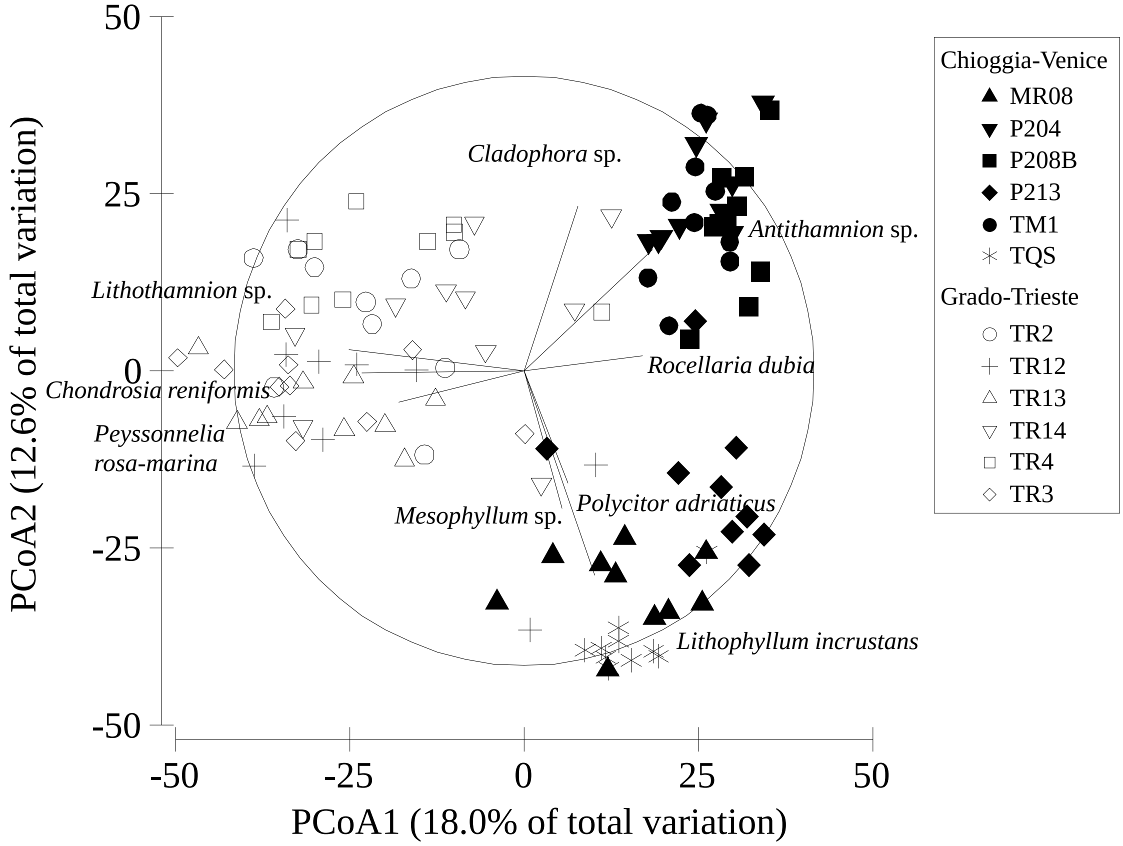

Fig. 4: PCoA based on Jaccard similarity index calculated on presence/absence data. Superimposed vectors represented the correlations of the abundances of the most relevant taxa (Pearson correlation > 0.4) with the PCoA axes.

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