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EXPLORING THE USE OF ROCKY SHORE MACROALGAE AS INDICATORS OF ENVIRONMENTAL CONDITION

Abstract

We attempted to use macroalgae to discriminate between seven sites around the Maltese Islands displaying different water quality. The study focused on the macroalgal communities from the mediolittoral to upper infralittoral zones, since these assemblages can be easily accessed from the shore. The results obtained showed that distinct macroalgal assemblages inhabit the selected sites and that the assemblage at the reference site was the most dissimilar. Interannual variation in macroalgal assemblage structure at each site was minimal. All taxonomic levels considered (genus, order, family, class and phylum) were able to distinguish between sites. Chlorophyll a content, water turbidity and dissolved phosphates were the physico-chemical parameters that discriminated between sites.

Key-words: Rocky shores, Macroalgal assemblages, Malta, Water quality, Multivariate analysis.

Introduction

Currently, the most widely used approach in pollution impact studies is the analysis of the whole assemblage of species in an area (Clarke and Warwick, 2001). In this study we attempted to use macroalgae inhabiting the uppermost infralittoral and the mediolittoral zones in the Maltese Islands to discriminate between sites chosen *a priori* and displaying different water quality. Another aim was to examine how the level of taxonomic identification affects the analyses.

Materials and methods

Seven locations around the Maltese coast (Fig. 1) were selected. All had the same substratum type and comparable slopes but were affected by different degrees of anthropic impact. Selection was based on the results of a long-term monitoring of levels of nutrients, chlorophyll and water transparency as indicators of environmental quality (Axiak, 2004). Five replicate 0.5 m × 0.05 m quadrats were placed at random in the upper infralittoral/mediolittoral zones at each site and the percentage cover of each species of macroalgae was recorded on three separate occasions each year in 2003 and 2004. Annual percentage cover values are presented here. The results were analysed using multivariate methods: group average linkage hierarchical cluster analysis, Non-metric Multidimensional Scaling ordination (MDS) and Principal Component Analysis (PCA). Computations were made using the PRIMER 6 suite of programs (Clarke and Gorley, 2006).

Results

PCA ordination based on environmental variables (mean values of salinity, temperature, dissolved nitrates, dissolved phosphates, Beam Attenuation Coefficient (BAC) and chlorophyll a content recorded between 1998 and 2003; data from Axiak, 2004) clearly distinguished the sites, with PC1 and PC2 collectively explaining 77.3% of the variation; PC1 appeared related to chlorophyll a content and BAC, and PC2 to dissolved phosphate. The sites could therefore be arranged in a series with Qbajjar as the reference site and, in order of deteriorating water quality, St. Paul's Bay, Marsascala-J, St. Angelo, Manoel Island, Birzebbuga and Marsascala-W. Distinct macroalgal

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assemblages inhabited the seven sites as indicated by hierarchical cluster analysis and MDS ordination (Fig. 2). The assemblage at the reference site (Qbajjar) was the most dissimilar. Interannual variation in macroalgal assemblage structure at each site was minimal. MDS plots distinguished between sites at all taxonomic levels with acceptable stress values that ranged from 0.09 (genus level) to 0.133 (family level) (Fig. 3).

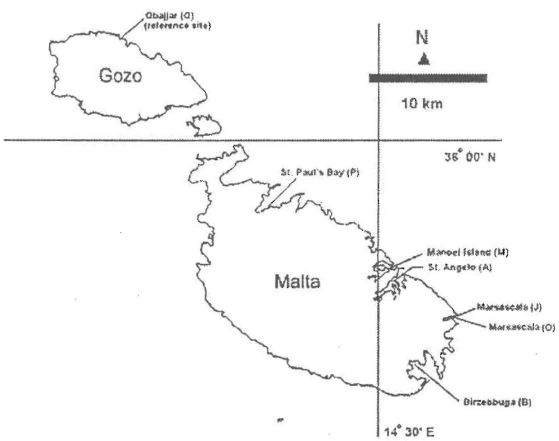

Fig.1: Map of the Maltese Islands showing the location of the sites studied.

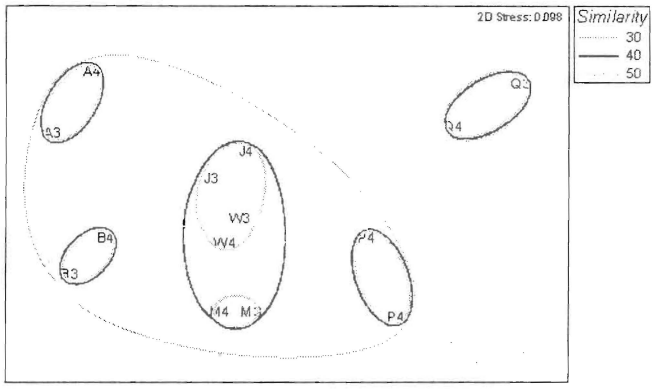

Fig.2: Overlay (at 30, 40 and 50% similarity) of the results of hierarchical cluster analysis on a non-Metric Multidimensional Scaling Ordination plot of the annual mean values of the percentage cover of macroalgal species at all sites recorded in 2003 (labels ending in '3') and 2004 (labels ending in '4'). (Site codes are as given in Fig. 1).

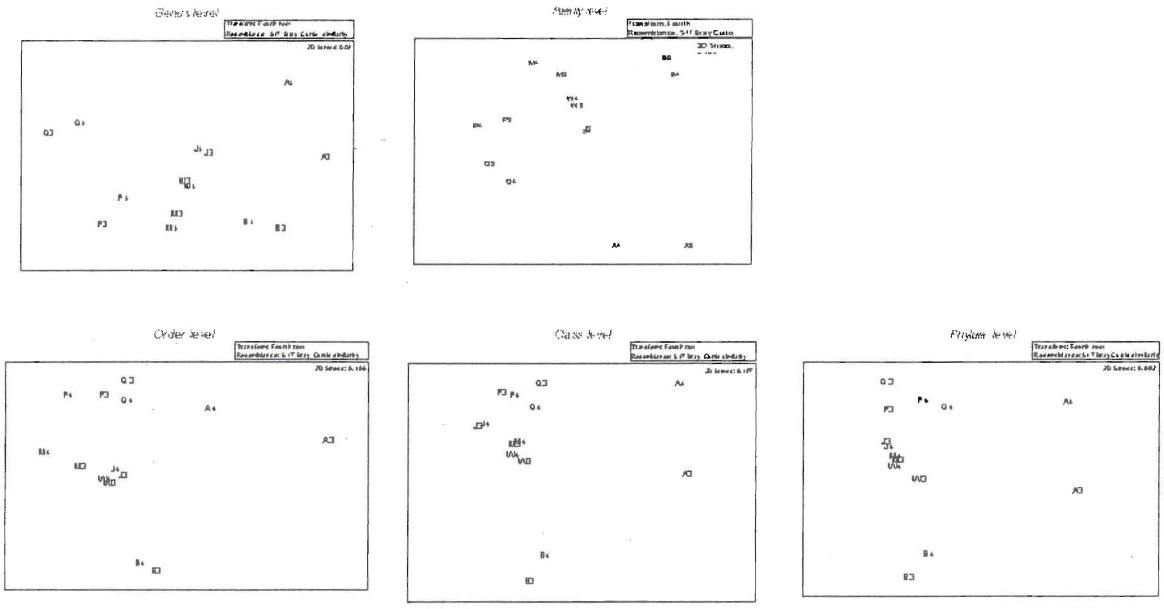

Fig. 3: The results of non-Metric Multidimensional Scaling Ordination of the annual mean values of the percentage cover of macroalgae at all sites recorded in 2003 (labels ending in '3') and 2004 (labels ending in '4') for the genus, order, family, class and phylum taxonomic levels. (Site codes are as given in Fig. 1).

Conclusion

The use of macroalgae to assess water quality seems to be justified. Since no specialised equipment is necessary and there is no need for identification to species level, this technique may provide a relatively rapid and low cost method of assessing water quality in rocky coastal areas.

Acknowledgments

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