INFLUENCE OF NUTRIENT ENRICHMENT AND TURBIDITY ON MACROALGAL SPECIES COMPOSITION OF FOULING ASSEMBLAGES IN THE MALTESE ISLANDS

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Abstract

The species composition of macroalgal assemblages was compared within and between impacted and non-impacted sites in a number of Maltese localities with different levels of of nutrient enrichment and turbidity. Species composition in non-impacted sites differed significantly from that in impacted sites, and impacted sites also differed significantly among themselves. Differences among impacted sites were due to the presence or absence of chlorophytes, geniculate coralline rhodophytes, and filamentous rhodophytes.

Keywords: Malta Channel, Algae, Fouling

Introduction

Macroalgal assemblages are considered to be sensitive to changes in water quality [1]. Studies on natural substrata have shown that as nutrient levels increase, sensitive species are replaced by stress-tolerant and opportunistic ones [2]. Therefore, the composition of macroalgal fouling assemblages is expected to be different in areas with high levels of nutrient enrichment and turbidity compared to that of non-impacted areas.

Method

Seven study sites around Malta (Central Mediterranean) were selected based on previously collected environmental data [3]. Principal components analysis (PCA) was used to order sites according to beam attenuation coefficient (BAC), and nitrate and phosphate concentration, in relation to a minimally impacted reference site. The abiotic data used were collected during a previous monitoring survey [3]. At each site, ten spherical buoys of circumference 70 – 90 cm and anchored to blocks of stone on the seabed were selected and all fouling macroalgal species were collected from each buoy. These were sorted under a stereomicroscope and identified to the lowest possible taxonomic level using standard keys and manuals. ANOSIM and SIMPER analyses based on species presence/absence data were used to identify patterns in species composition between sites.

Results and Discussion

Ordination of the study sites based on abiotic data (Fig. 1) indicated three groups: (i) Marsalforn (the reference site) and St. Paul's Bay; (ii) Isla, Kalkara, Manoel Island (S) and Manoel Island (N); and (iii) Birzebbuga. Groups (ii) and (iii) were characterised by higher levels of nitrates, phosphates and turbidity, and are therefore considered to be impacted, while group (i) is considered non-impacted. Component 1 of the PCA plot (Fig. 1) accounts for 65.0 % of the total variance of the dataset, while Component 2 accounts for 30.3 %.

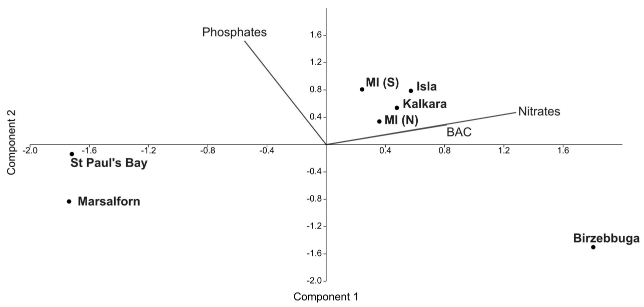

Fig. 1. PCA plot showing ordination of the study sites according to levels of dissolved nitrates and phosphates, and turbidity (as BAC). MI (S) and MI (N) refer to Manoel Island (S) and Manoel Island (N) respectively.

One-way ANOSIM showed that species composition does not differ significantly between the two non-impacted sites ($p=0.0648$) but as expected, the non-impacted sites differ significantly from all impacted sites ($p<0.05$); this appears to be due to the presence of *Lophosiphonia* spp. and other filamentous rhodophytes. However, the impacted sites also differ significantly among themselves in terms of species composition ($p<0.05$). SIMPER indicates that three main groups of macroalgae are contributing to this phenomenon: geniculate coralline rhodophytes, filamentous and sheet-like chlorophytes, and filamentous rhodophytes (Table 1). Kalkara and Manoel Island (S) present an abundance of geniculate coralline forms, with Manoel Island (S) also supporting numerous chlorophytes. Isla supports chlorophytes such as *Ulva* spp. and *Cladophora* spp., but is depauperate in comparison to other sites. Finally, Birzebbuga and Manoel Island (N) are characterised by filamentous rhodophytes such as *Polysiphonia* spp., along with chlorophytes. These variations in species composition do not appear to be related to differences in the abiotic variables considered here, and future studies should therefore be concerned with investigating the factors structuring macroalgal fouling assemblages in areas with some degree of environmental impact.

Tab. 1. SIMPER results showing the 10 genera that contributed most to the dissimilarity between the three functional groups tested.

Taxon	Avg. dissimilarity	Contribution %	Cumulative %
Polysiphonia	5.62	8.84	8.84
Ulva	5.30	8.33	17.17
Ceramium	5.29	8.32	25.49
Lophosiphonia	5.25	8.26	33.74
Cladophora	4.78	7.52	41.26
Lyngbya	4.45	7.00	48.26
Ellisolandia	4.12	6.49	54.75
Chaetomorpha	3.82	6.01	60.75
Amphiroa	3.36	5.28	66.03
Antithamnion	2.53	3.98	70.01

Acknowledgements

This research was funded by the ENDEAVOUR Scholarship Scheme (Malta), part-financed by the European Union – European Social Fund (ESF) under Operational Programme II – Cohesion Policy 2014-2020, "Investing in human capital to create more opportunities and promote the wellbeing of society".

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