

# ASSESSMENT OF THE ECOLOGICAL STATUS OF MALTESE COASTAL WATERS USING THE RHODOPHYTA/PHAEOPHYTA MEAN RATIO INDEX (R/P RT. I.)

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## Abstract

Macroalgae from seven sites along the rocky upper infralittoral of Malta and Gozo were sampled in the spring, summer and winter seasons of 2003 and 2004. The aim was to apply the Rhodophyta/Phaeophyta mean ratio index (R/P rt. I.), a biological index which makes use of macroalgae, to discriminate between the sites, which are subject to different degrees of anthropogenic stress and which were therefore expected to have a different ecological status as defined by the EU's Water Framework Directive. The R/P rt. I. generally discriminated between sites, however, two sites gave anomalous results.

**Keywords:** *Algae, Coastal Waters, Rocky Shores*

## Introduction

Benthic macroalgae are a reliable indicator of the trophic status of coastal waters and are one of the Biological Quality Elements for the evaluation of ecological quality required by the European Union's Water Framework Directive (WFD, 2000/60/EE). The aim of the present study was to apply the Rhodophyta/Phaeophyta mean ratio index (R/P rt. I.) [1], a biological index which makes use of macroalgae for the implementation of the WFD, to discriminate between seven sites in Malta, which are subject to different degrees of anthropogenic stress and which were therefore expected to have a different ecological status. Site locations included the Malta Freeport (a large transshipment centre), the Grand Harbour (considered highly eutrophic), and a reference site in Gozo.

## Methods

Seven shores around Malta were selected to have the same substratum type and comparable slopes but different degrees of anthropogenic impact. Site selection was based on the results of a long-term monitoring programme of local inshore waters based on measurement of levels of nutrients, chlorophyll *a* and water transparency as indicators of environmental quality [2]. Five replicate 0.5 m x 0.5 m quadrats were placed at random in the upper infralittoral fringe (the zone from 0-50 cm depth) at each site and the percentage cover of each species of macroalgae present was recorded three times a year in 2003 and 2004. For each site, the R/P rt. I. was worked out in three different ways, (i) for each season separately in 2003 and 2004, (ii) combining the annual seasonal data so as to produce a single value for each year, and (iii) over the whole two-year period. The results were analysed using non-metric multidimensional scaling (nMDS) and cluster analysis based on the Bray-Curtis similarity measure, and Principal Components Analysis (PCA). Computations were made using the PRIMER (ver 6) suite of programs [3].

## Results & Discussion

PCA ordination based on environmental variables (Fig. 1) clearly distinguished the sites with PC1 and PC2 collectively explained 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. In total, 86 taxa were recorded, comprising 19 Chlorophyta, 24 Phaeophyta, 42 Rhodophyta and 1 Heterokontophyta. For each site, the same ecological status was obtained in 2004 as in 2003 when considering the respective annual macroalgal datasets. A cluster analysis and nMDS ordination were made on the percentage cover of Rhodophyta and Phaeophyta over the two-year period (Fig. 2). Three clusters resulted: (1) Qbajjar, St. Paul's Bay and Manoel Island with 'high' ecological status, (2) Marsascala-J and -W with 'low' status, and (3) St. Angelo and Birzebbuga with a 'bad' status. The St. Angelo site gave a consistently 'bad' status in all seasons during both years, due to a lack of Phaeophyta at this site. The same site groupings were obtained when calculating the R/P rt. I. Generally, the R/P rt. I. varied with season, for example, the ecological status for St. Paul's Bay was 'moderate' in spring 2003, 'bad' in summer and 'high' in winter. It may be concluded that the R/P rt. I. discriminated between sites, however, Marsascala-J and -W gave anomalous results since a 'moderate' ecological status was expected from the physico-chemical analysis and based on expert judgment; these sites had a high percentage cover of Chlorophyta, which distorted the index.

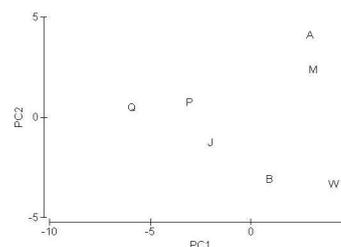


Fig. 1. PCA ordination of the sites based on mean values of salinity, temperature, dissolved nitrate, dissolved phosphate, Beam Attenuation Coefficient (BAC) and chlorophyll *a* content, recorded between 1998 and 2003 as given in [2]. (Q – Qbajjar; P – St. Paul's Bay; J – Marsascala-J; B – Birzebbuga; A – St. Angelo; M – Manoel Island; W – Marsascala-W).

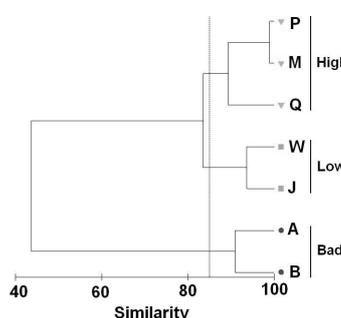


Fig. 2. Hierarchical group-average linkage clustering plots for the percent cover of Rhodophyta and Phaeophyta. (Site codes are as in Fig. 1)

## References

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