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AN ESSAY OF THE USE OF THE HABITAT EVALUATION PROCEDURE IN THE PLANNING OF A MARINE RESERVE (PELAGIAN ISLANDS, SOUTH MEDITERRANEAN)

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The Pelagian archipelago includes 2 major islands : Linosa, further north, Lampedusa, about 30 mls south, with the rock of Lampione. The former is an extinct volcano, made up of recent olivinic and feldspathic basalts rising on a platform of eruptive debris; the latter isles are a calcareous protrusion of the African shelf; their substrata are a mixture of holocoenic sandstone and miocoenic dolomitic rocks. The good state of their coastal environment and the high landscape diversity makes the Pelagian islands an appreciated touristic resort and a major biological reserve as well. The need for a conservative management of the coastal system has boosted a comprehensive bionomic survey (CHEMELLO and DI GERONIMO, 1992), whose results are still under examination. The perspective of setting up a marine reserve has led us to apply to the Pelagian biotopes some of the most advanced methods used to assess the value of terrestrial areas. A major drawback has been to find marine biological indicators corresponding to the terrestrial ones; the rarity of endemic and/or significant taxa has made our task particularly difficult. Therefore we have adjusted the available information in order to fit the main guidelines of the U.S. Fish & Wildlife Service and worked out the data according to a modified version of the H.E.P. (Habitat Evaluation Procedures) applied to the conservation of marine coastal areas (CHEMELLO, 1991). Methods and results are summarily reported in the following text : three different scales of indicators of ecological interest have been chosen, values have been assigned to single areas, and the results have been combined to obtain a comprehensive coefficient of the importance of each biotope and/or community. The Mollusc syntaxon has been used as basic descriptor. Twelve major environmental units (EU) have been identified, each encompassing a homogeneous coastal section, suited for one sampling and two bionomic transects, statistically representative of the biotic systems. The following parameters have been chosen: extension (EX); environmental health (EH); anthropic interest (AI); protection of terrestrial systems (SP); environmental diversity (ED). From paired comparison of the main values, the most important criteria have been referred to as : EH, SP, ED. Criteria and relative weights (RW) assigned to each EU have been arranged in a matrix, where numbers were respectively 0.1, 0.5, 1.0. Relative values (UVR) of EUs have been obtained by multiplying the value of each EU by the RW assigned to the single criteria. The actual value (HRV) calculated for each EU has been obtained by the UVR/MUVR (= maximum recorded UVR) ratio. The highest numbers have characterized the 11th and 12th sector of Linosa as well as the 4th sector of Lampedusa, whereas the lowest HRVs have been recorded in in the 1st, 2nd and 8th sectors of the same island. The following 7 criteria have been selected for the calculation of the naturalistic, scientific, and recreational index (NSRV): naturality (NA), aesthetics (AE), biotic diversity (BD), water quality (WQ), naturalistic (NI), economic (EI) and recreational interest (RI) : NA, EI and AE have been identified as highly significant. The 12 EUs have been ordered in a matrix using the same procedure as above. The 7th, 2nd and 1st sectors of Lampedusa have shown, in the order, the highest values, especially referred to BD. From cross comparison of the HRVs and NSRVs a scale of importance of the coastal sectors has been created : the 11th and 12th sectors of Linosa and the 7th sector of Lampedusa have ranged in the top three.

A list of significant biotopes has then been made, using the following selective criteria : extension (ET), resilience (RE), diversity according to Shannon (DH); early sensitivity (ES), that is, the ability to respond quickly to habitat alterations; easiness of control (CE), expressing the availability of monitoring facilities; anthropic importance (AT), related to educational and economic fruition; autochthonicity (AH), quantification of the importance of endemic or rare organisms. DH, ET and CE have appeared most suited to our survey; RE and ES have been of less use. The following parameters have been chosen to calculate the sensitivity index (SI): resilience (RL), species richness (SR), biotic diversity (BD), species rarity (SY), size criticity (SC), functional specificity (FS), specific sensitivity (SS), generic sensitivity (GS). BD has been confirmed as the most signficant sensitivity criterion, followed by SS, FS, SC, GS. Use of SI has stressed the primary role of the Posidonia oceanica meadow, followed by the photophilous infralittoral settlements and the fringe communities. Our results have enabled us to identify and assign importance values to the areas more worth conservation, and therefore put forward an overall plan of the forthcoming reserve, as illustrated in Fig. 1.

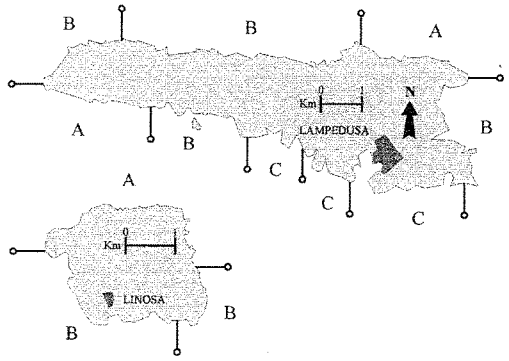

Fig. 1: the Islands Lampedusa and Linosa, with location of zones A, B and C, suggested by HEP.

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LINKS BETWEEN SEDIMENT POLLUTION AND *CAULERPA TAXIFOLIA* PROLIFERATION

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Under laboratory conditions, the productivity of free-living Mediterranean samples of *Caulerpa taxifolia* (Vahl) C. Agardh is unremarkable. Winter-acclimated specimens exhibit rates of net photosynthesis that fall well within the range of all reported productivity estimates for other species within the genus throughout the normal range of seawater temperatures encountered annually on the Côte d'Azur (GAYOL *et al.*, in press). Similarly, the growth rate of *C. taxifolia* is slow when samples are cultured in aquaria on beds of nutrient-free, glass beads (ca 2 mm diam.; unpubl. data). Typically, resources are directed toward stolon and rhizoid production rather than frond growth. These observations indicate that substrate chemistry may significantly influence the growth of *C. taxifolia* in the field.

During August and September 1994, we analysed a suite of biogeochemical properties of the interstitial waters of sediments removed from within: 1) the *C. taxifolia* population existing below the Musée Océanographique de Monaco; 2) a dense meadow of *Posidonia oceanica* in the Larvotto Reserve; 3) a mixed population of both species at Cap Martin; and 4) a mixed population of both species between the port of Fontvielle and Cap d'Ail.

Remarkable differences were observed in ammonium potentiality and production between the first two and the last two sites. At Cap Martin (3) and near Cap d'Ail (4), environments which now support vigorously growing populations of *C. taxifolia*, the microbial capacity of sediment interstitial waters to reduce a variety of added organic nitrogen substrates and generate ammonia was feeble. In contrast, actual ammonium production within sediment interstitial waters was much higher at sites 3) and 4) than at sites 1) and 2). These data indicate large supply rates of bacteria-laden organic material to the seabed at Cap Martin and near Cap d'Ail but almost no microbial activity within the sediment itself for subsequent transformation of organic nitrogen. These microbial contra-indicators are typical of sediments polluted by waste-water discharges.

Sediment interstitial water parameters below the Musée and in the Larvotto Reserve were for the most part comparable. It may be significant that photographic records now demonstrate a reduction in *C. taxifolia* abundance below the Musée. An optimistic view may be that ten years of vigorous *C. taxifolia* growth in this environment has had a remedial effect on sediment quality.

We tentatively conclude that anthropogenic pollution probably first causes degeneration of *P. oceanica* meadows. The resulting base of dead organic material, together with continuing inputs of human waste from sewage outfalls then creates a resource for *C. taxifolia* which appears better able to survive in polluted environments. Fluorescence and scanning electron microscopy confirms the presence of large numbers of bacteria living in association with the surface of the subterranean rhizoids. Preliminary measurements indicate that these populations are supplied with oxygen during photosynthesis thus facilitating aerobic microbial nutrient cycling, a process that would have obvious advantages in anaerobic sediments. Enhanced bacterial degradation of organic material and possibly also direct uptake of organic substances by *C. taxifolia* itself would serve to promote the remediation of polluted sedimentary environments.

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