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EPIBENTHIC ASSEMBLAGES AND CORAL RUBBLES: POSSIBLE EFFECTS OF HUMAN IMPACTS ON CORAL REEFS

POPOLAMENTI EPIBENTONICI E DETRITO CORALLINO: POSSIBILI EFFETTI DELL'IMPATTO ANTROPICO SULLE BARRIERE CORALLINE

Abstract - *Coral reefs assessment can be performed with different methodologies, focusing on target aspects of their ecology. We present the use of coral rubble covering to evaluate differences between control and impacted sites in the Marine Park of Bunaken (North Sulawesi, Indonesia), at different depths. In the impacted sites the amount of coral rubbles and the fine fraction are higher than in control.*

Key-words: *benthos, coral reefs, grain size, man-induced effects, Indonesia.*

Introduction – Coral reefs have a high ecological value with its most diverse marine habitat and species but also a social and economic ones with million of people depending on it for their supplies (Costanza *et al.*, 1997; Berg *et al.*, 1998). Unfortunately reefs are affected by human disturbances and the degree of degradation is increasing with time worldwide. The major anthropogenic physical disturbances that directly affect coral reefs are due to anchorages, destructive fishing practise as blast fishing and diving tourism (Chabanet *et al.*, 2005). The aim of the present study is to use the features and extend of coral rubbles to evaluate the human impact on the structure of epibenthic assemblages in the Bunaken Marine National Park (1°37'N 124°45'E, North Sulawesi, Indonesia).

Materials and methods – Impacted and control locations within the Bunaken Marine Park were defined considering the physical disturbance due to the increasing tourism close to the villages, according to the technical report of de Vantier and Turak (2004). Four study sites were randomly chosen in both impacted and control locations. The coral rubbles percentage cover was estimated measuring the size of rubble patches along 6 belt transects (10×1 m) at two depths (6-12 m) in each site. Grain size of the rubbles and the living coral fraction was evaluated collecting three replicate samples at three depths (6-12-18 m) in each site. Corals rubbles were divided into 5 size classes using a nested series of sieves (meshes 0.1, 0.5, 1.0, 2.0, 4.0, 8.0 cm) and weighted, while living corals fraction was estimated as relative percentage. Epibenthic assemblages were analysed in term of morphological categories, using a photographic sampling considering eight sites (5 impacts and 3 controls) at 6, 12, 18 metres depth.

Results – Coral rubbles percent cover was significantly higher in the impacted sites (ANOVA $p<0.05$). The average percentage of living corals among fragments was significantly higher in the control *vs.* impacted sites (ANOVA $p<0.05$). Moreover the relative quantity of living coral fragments appeared strongly dependent from depth (ANOVA $p<0.01$) in both controls and impacts, SNK test pointed out a higher amount at 6 m compared to 12 and 18 m in depth. Coral rubbles fine fraction (0.1-0.5 cm) was more abundant in impacted sites (ANOVA $p<0.05$), coarse fraction (4-8 cm) prevailed

at the controls (ANOVA $p<0.05$), while intermediate fractions didn't show differences between controls and impacts. Coarse fraction also showed differences between sites within controls (ANOVA $p<0.001$), which appeared more heterogeneous compared to the impacted sites. Data from epibenthic assemblages evidenced significant differences among study sites in relation to the anthropic presence (PERMANOVA: $p<0.05$). In impacted sites diversity and erect organisms decreased while encrusting sponges and encrusting hard corals increase. These results are strongly independent from depth. Branching hard corals were more abundant in the control sites.

Conclusions – In coral reefs monitoring, the use of indicators as tools to evaluate the health state of the ecosystems or/and the effectiveness of strategies in achieving sustainability, are essential (Chabanet *et al.*, 2005). Such indicators have to be based on scientific, social and economic research. The most common proposed indicators are the hard coral percentage cover (de Vantier, 1986), the broken corals percentage (BC) (Jameson *et al.*, 1999), the Reef Quality Index (RQI) (Jameson, 1998) and the Coral Damage Index (CDI) (Jameson *et al.*, 1999). In this study we used coral rubbles cover (Jameson *et al.*, 1999; de Vantier and Turak, 2004) and grain size fractions as possible indicator of human physical impact. In the impacted sites the amount of coral rubbles and the fine fraction are higher in comparison with control, probably due to the physical disturbances that led to a major destruction and erosion rate of hard corals. Instead living coral fraction within coral rubbles could be related to recent physical damage. The epibenthic assemblages shift their features from control to impacted sites with a lost of three-dimensional structural complexity with increasing physical disturbances (Aroson and Swanson, 1997). In the studied area the impact seems mainly due to boats striking and anchoring, which destroy lagoon corals and cause continuous coral rubbles rain towards the slope. In this way, the impact is directly performed on the flat and reef edge but its effect is transported also along the reef wall, transferring the negative effect of anthropic activities in the deep.

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