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INVESTIGATING ON THE FACTORS RESPONSIBLE FOR *CAULERPA RACEMOSA* INVASION

INDAGINI SUI FATTORI RESPONSABILI DELL'INVASIONE DI CAULERPA RACEMOSA

Abstract *- The introduced alga* Caulerpa racemosa *(Forsskal) J. Agardh (Caulerpales, Chlorophyta) has become an important component of rocky assemblages in the subtidal of the Mediterranean. Understanding the factors that regulate the establishment and spread of this species is, therefore, crucial to predicting future pathways of invasion and susceptible locales. Further, the aim of this study was to investigate on the factors responsible for the successful invasion of* C. racemosa *in the Asinara Gulf (NW-Sardinia).*

Key-words: Caulerpa racemosa, *rocky shores, seagrass, seaweed, spreading.*

Introduction - Several studies evaluated the effects of introduced species on native communities at different organizational level (Grosholz, 2002), while other studies tried to highlight mechanisms which regulate the success of the invasion (Mack *et al.*, 2000).

The introduced alga *Caulerpa racemosa* (Forsskal) J. Agardh has become an important component of rocky assemblages in the subtidal of the Mediterranean (Klein & Verlaque, 2008) and it has been indicated as a species able to change natural patterns of distribution and abundance of resident assemblages, both on rocky (Piazzi *et al.*, 2001) and soft bottoms (Argyrou *et al.*, 1999). Understanding the factors that regulate the establishment and spread of this species is, therefore, crucial to predicting future pathways of invasion and susceptible locales. Although the occurrence of *C. racemosa* has been reported in a variety of habitat the performance seems to significantly depend on the habitat where it establishes. This study was conducted in the Asinara Gulf (NW Sardinia) where *Caulerpa racemosa* has been spreading since 2002. The aim was to investigate on the factors responsible for the successful invasion of the introduced alga *C. racemosa.*

Materials and methods - In the study area 4 sites were considered: 2 outside (Porto Torres: PT1 and PT2) and 2 inside (AS1 and AS2) the Isola dell'Asinara Marine Protected Area. In each site 2 areas about 400 m×400 m in size were chosen, about 100s m apart. At each area data were collected along four 30 m long transects, randomly positioned within 5-15 m of depth in rocky reefs. In each transect the extension of each type of habitat (*Posidonia oceanica*, dead matte, sand, coralligenous, algal turfs, barren, *Cystoseira* spp.) was measured. This allowed us to estimate the relative importance of habitats. Then, bottom complexity was evaluated along the transect using a metal chain and measuring the distance between the two ends once it is laid on the bottom surface. Further, ten plots 400 cm^2 in size were randomly considered along each transect (total plot=160). In each of them the structure of assemblages and the cover of *C. racemosa* were estimated by underwater photographs of the plot. Data were analysed using univariate, multivariate and correlative techniques to identify both the factors responsible of *C. racemosa* distribution and which habitats were mostly invaded. A four-way ANOVA was used to test for difference in *C. racemosa* cover at all spatial scales considered: 'Protection' was fixed (no MPA and

MPA), while 'Site' (2 levels: PT1, PT2, and AS1, AS2, respectively), 'Area' (2 levels) and 'transect' (4 levels) were considered random and nested. Correlations were used to estimate the relationship among *C. racemosa* cover and considered factors both at plot and transect scale.

Results - The percent cover of *Caulerpa racemosa* was extremely different among sites. An overwhelmingly higher abundance was observed outside rather than inside the MPA, where the occurrence of the introduced alga was recorded just in one plot in AS1. Unfortunately, ANOVA was not run because of variance heterogeneity.

Difference in benthic assemblages were found between no MPA and MPA sites. Specifically in unprotected sites the abundance of taxa and the habitat quality, at the plot scale and transect scale, respectively, were lower as indicated by a higher occurrence of *Posidonia oceanica* dead matte. At plot scale, the correlation between the mean percent cover of *C. racemosa* and the number of taxa highlighted a reverse negative relationship (R^2=0.72). Alike, at transect scale, a correlation was evidenced between the mean percent cover of *C. racemosa* and the cumulative quantity of canopy habitats (*Posidonia oceanica*, *Cystoseira* spp., photofilic algae) (R^2=0.49). Bottom complexity at transect scale was higher in MPA sites than outside but it was not found to affect the spread of *C. racemosa*.

Conclusions - The results suggest that patterns of distribution of *Caulerpa racemosa* on rocky reefs are largely dependent upon biotic characteristics of benthos both the diversity of taxa and habitats, depending on the scale considered. Although correlative studies cannot identify a cause-effect relationship, the results suggest that pristine Mediterranean habitats are much unlikely invaded by *C. racemosa* than degraded habitats (Bulleri *et al.*, 2010).

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