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THE EFFECT OF CONSUMERS' DEPLETION ON THE RESISTANCE OF THE SEAGRASS *POSIDONIA OCEANICA* TO THE INVASION OF THE MACROALGA *CAULERPA RACEMOSA* IN A MEDITERRANEAN MPA

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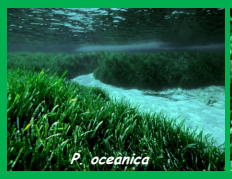
INTRODUCTION

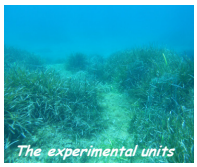
Few field studies have investigated how changes at one trophic level can affect the invasibility by aliens of other trophic levels. We examined the hypothesis that the spread of the introduced green alga *Caulerpa racemosa* (Forsskål) J. Agardh in degraded seagrass beds of the key-stone species *Posidonia oceanica* (L.) Delile depends on the depletion of large consumers such as the fishes *Salpa sarpa* (Linneo, 1758) and *Diplodus sargus sargus* (Linneo, 1758), which have recently introduced *C. racemosa* in their diet (Ruittton et al., 2006; Terlizzi et al., 2011).



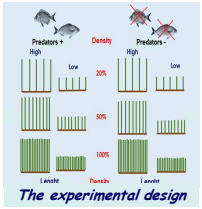
? THE INVASION SUCCESS OF *C. RACEMOSA* IS GREATER IN DISTURBED *P. OCEANICA* CANOPIES WHERE CONSUMERS ARE DEPLETED.

MATERIALS & METHODS

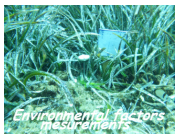
In the summer of 2013 a field experiment was done in Tavolara Punta Coda Cavallo Marine Protected Area (NW Mediterranean).We mimicked the degradation of a *Posidonia oceanica* canopy by clipping shoot density (100%, 50%, 20% of its natural density) and reducing leaf length (natural and halved of 1/3) obtained at the edge of the bed (*n=3*).



Stolons of *C. racemosa* were transplanted into all plots and large predators were excluded from half of them using cages. Procedural controls were used to assure that no other variables were introduced by the cages. Cover and size of *C. racemosa* were considered as response variables to assess its growth.



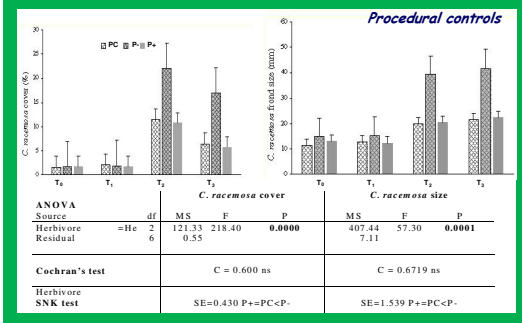
To be sure that no other variables than herbivore exclusion were introduced, open cages were used and the environmental factors generally affecting *P. oceanica* understory assemblages (irradiance, scour, water flow and sediment deposition) were measured.



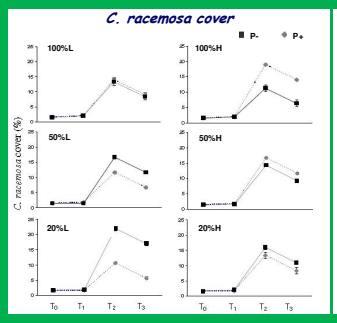
Variables were analysed with 3-way ANOVAs (herbivory, canopy density and height: fixed orth. factors).

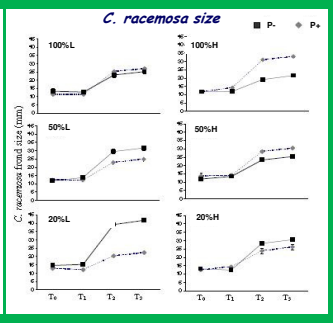
RESULTS

The development of the macroalga varied across treatments depending on herbivory, grass height and shoot density interaction. No effect of caging and seagrass manipulation was detected.



ANOVA Source		df	MS	F	P	MS	F	P
			C. racemosa cover			*C. racemosa* size		
Herbivore	=He	2	121.33	218.40	**0.0000**	407.44	57.30	**0.0001**
Residual		6	0.55			7.11		
Cochran's test			C = 0.600 ns			C = 0.6719 ns		
Herbivore **SNK test**			SE=0.430 P+=PC<P-			SE=1.539 P+=PC<P-		





C. racemosa growth variables (staystical analyses)

ANOVA Source	df	*C. racemosa* cover MS	F	P	*C. racemosa* size MS	F	P
Herbivore =He	1	2.25	2.53	0.1247	16.00	8.79	0.0067
Canopy Density =CD	2	79.08	88.97	0.0000	220.42	121.15	0.0000
Canopy Height =CH	1	1.36	1.53	0.2279	10.03	5.51	0.0275
HexCD	2	25.58	28.78	0.0000	85.15	46.80	0.0000
HexCH	1	17.36	19.53	0.0002	40.11	22.05	0.0001
CDxCH	2	63.03	70.91	0.0000	153.75	84.51	0.0000
HexCDxCH	2	4.53	5.09	**0.0143**	9.84	5.41	**0.0115**
Residual	24	0.88			1.82		
Cochran's test		C = 0.2188 ns			C = 0.2328 ns		

SNK test	*C. racemosa* cover SE=0.544	*C. racemosa* size SE=0.7784
HxCDxCH	100% P+ H>L	100% P+ H>L
	100% P- H>L	100% P- H>L
	50% P+ H>L	50% P+ H>L
	50% P- H<L	50% P- H<L
	20% P+ H<L	20% P+ H<L
	20% P- H<L	20% P- H<L
	LP+ 50%<100%<20%	LP+ 50%<100%<20%
	LP- 100%<50%<20%	LP- 100%<50%<20%
	HP+ 50%<20%<100%	HP+ 50%≥20%<100%
	HP- 50%<20%≤100%	HP- 50%<100%≤20%
	L100% P+=P-	L100% P+=P-
	L50% P+<P-	L50% P+<P-
	L20% P+=P-	L20% P+=P-
	H100% P-<P+	H100% P-<P+
	H50% P-<P+	H50% P-<P+
	H20% P+<P-	H20% P+<P-

He: P-=Fenced units; P+=Unfenced units - CD: 100%; 50%; 20% - CH: H= High; L= Low

Where the seagrass was at natural conditions, *C. racemosa* growth was higher in plots without cages while, where the canopy was degraded, caging had the reverse effect.

IN CONCLUSION…

These results revealed that the invasion resistance of seagrass beds is dependent on conserving competitors and consumers and that its alteration enhanced the spread of *C. racemosa* only when large consumers were absent.

This work is dedicated to the memory of Giuseppe Bernardi, efficient collaborator of Tavolara Punta Coda Cavallo Marine Protected Area prematurely passed away.

Ruitton S., Verlaque M., Boudouresque, C.F. (2006) Sharing an Caulerpa racemosa var. cylindracea (Caulerpales, Chlorophyta) in the Mediterranean Sea: by herbivorous fishes and sea urchins. Vie et Milieu, 56(1), 33-42.
Terlizzi A., Fraschetti S., Gianguzza P., Faimali M., Bevilacqua S., Boero F. (2001). Sublethal physiological effects of the invasive alga Caulerpa racemosa on the Mediterranean white sea bream Diplodus sargus. Aquatic Biology, 16, 109-117.