EFFECT OF MULTIPLE DRIVERS ON THE RECOVERY OF MARINE BENTHIC ASSEMBLAGES

Simonetta Fraschetti [1]*

[1] Università del Salento, CoNISMa, 73100, Lecce, Italy - simona.fraschetti@unisalento.it

Abstract

Human threats on the world ocean are multiple and escalating. Effects of multiple stressors can lead to the loss of resilience and an increased risk of regime shifts. The illegal fishery of the date mussel *Lithophaga lithophaga* (L.) is one of the most harmful human activities affecting subtidal rocky habitats in the Mediterranean Sea. I experimentally investigated the interactive effects of nutrient availability and sea urchin grazing on the recovery of subtidal benthic assemblages disturbed by date mussel fisheries. Results suggest that: 1) in enriched plots where grazers were removed, recolonization by macroalgae can be observed in 12 months; 2) the two factors have an antagonist effects; and 3) the presence of grazers imperils the restoration of disturbed assemblages.

Keywords: Biodiversity, Coastal Management, Conservation, Eutrophication, Coastal Processes

Introduction

Multiple stressors act in synergies. Their combined effect can be accumulative, fully additive, multiplicative, mitigative, or under the dominance of one or more stressors. The effects of some anthropogenic stressors are well documented, but the combined effects of multiple stressors are poorly known. Stressors are usually considered in isolation, with simplistic interpretations of the effects of human activities on coastal environments [1, 2]. In the Mediterranean Sea, shallow rocky calcareous habitats are heavily threatened due to the destructive fishery of the European date mussel *Lithophaga lithophaga* (L.), which leads to the desertification of tens of kilometres of rocky coast each year [3, 4]. The effects of this disturbance are well-known but the information is still scarce on patterns of recovery and potential for restoration [5]. We explored, through a manipulative experiment, the interplay between nutrient supply and grazing pressure in shaping the recovery trajectories of benthic assemblages impacted by the date mussel fishery.

Material and Methods

The experiment was carried out for 1 year within 12 square plots of $25m^2$ (2 plots for each combination of factors, plus two control artefacts) at about 6m depth, in the no take zone of the MPA of Porto Cesareo (SE Italy). Plots were sampled 9 times (separated at least by 1 month) through photographic sampling method. 10 randomly replicates of 16x23cm were done for a total of 720 replicates units. The experimental plots were enriched by a slow-release fertilizer (Osmocote-pro 18N:9P:10K, Scotts Company) contained in small mesh bags fixed on the rocky substrates. Four bags were used for each plot selected for the application of this treatment. The presence of grazers was manipulated removing by hand all sea urchins at the beginning of the experiment and every time was necessary through a twice-weekly monitoring activity

Results

Univariate and multivariate analyses showed that grazing pressure significantly affects the resilience of disturbed assemblages, strongly decreasing benthic recovery rates of disturbed assemblages. When herbivores are removed, experimental nutrient enrichment enhances recolonization patterns, significantly increasing the number of macroalgal taxa. Recolonization by macroalgae (such as *Anadyomene stellata* and Dyctiotales) occurred only when grazing activity is removed. The combined effect of herbivores in presence of enriched conditions decreased benthic diversity and cover.

Discussion and Conclusion

Results suggest that 1) in enriched plots where grazers were also removed, recolonization by macroalgae can be observed in less than one year; 2) the two factors have an antagonist effects; and 3) the presence of grazers imperils any potential of restoration of disturbed assemblages. These findings stress that the two drivers could act as antagonistic stressors, so that the restoration of our system can be a difficult task. This experimental study is likely to provide useful indications for the management of disturbed assemblages to promote the recovery of assemblages under different trophic conditions.

References

1 - Crain C.M., Kroeker K., Halpern B.S., 2008. Interactive and cumulative effects of multiple human stressors in marine systems. *Ecology Letters* 11: 1304-1315.

2 - Thrush S.F., Hewitt J.E., Dayton P.K., Coco G., Lohrer A. M., Norkko A., Norkko J., Chiantore M., 2009. Forecasting the limits of resilience: integrating empirical research with theory. *Proceedings of the Royal Society B: Biological Sciences*, 276: 3209-3217.

3 - Fanelli G., Piraino S., Belmonte G., Geraci S., Boero F., 1994. Human predation along apulian rocky coasts (SE Italy) - Desertification caused by *Lithophaga lithophaga* (Mollusca) fisheries. *Marine Ecology Progress Series*, 110: 1-8.

4 - Fraschetti S., Bianchi C.N., Terlizzi A., Fanelli G., Morri C., Boero F., 2001. Spatial variability and human disturbance in shallow subtidal hard bottom assemblages: a regional approach. *Marine Ecology Progress Series*, 212: 1-12.

5 - Bevilacqua S., Terlizzi A., Fraschetti S., Russo G., Boero F., 2006. Mitigating human disturbance: can protection influence trajectories of recovery in benthic assemblages? *Journal of Animal Ecology*, 75: 908-920.