The effects of an invasive seaweed on native communities vary along a gradient of land-based human impacts

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ABSTRACT

The difficulty in teasing apart the effects of biological invasions from those of other anthropogenic perturbations has hampered our understanding of the mechanisms underpinning the global biodiversity crisis. The recent elaboration of global-scale maps of cumulative human impacts provides a unique opportunity to assess how the impact of invaders varies among areas exposed to different anthropogenic activities. A recent meta-analysis has shown that the effects of invasive seaweeds on native biota tend to be more negative in relatively pristine than in human-impacted environments. Here, we tested this hypothesis through the experimental removal of the invasive green seaweed, *Caulerpa cylindracea*, from rocky reefs across the Mediterranean Sea. More specifically, we assessed which out of land-based and sea-based cumulative impact scores was a better predictor of the direction and magnitude of the effects of this seaweed on extant and recovering native assemblages. Approximately 15 months after the start of the experiment, the removal of *C. cylindracea* from extant assemblages enhanced the cover of canopy-forming macroalgae at relatively pristine sites. This did not, however, result in major changes in total cover or species richness of native assemblages. Preventing *C. cylindracea* re-invasion of cleared plots at pristine sites promoted the recovery of canopy-forming and encrusting macroalgae and hampered that of algal turfs, ultimately resulting in increased species richness. These effects weakened progressively with increasing levels of land-based human impacts and, indeed, shifted in sign at the upper end of the gradient investigated. Thus, at sites exposed to intense disturbance from land-based human activities, the removal of *C. cylindracea* fostered the cover of algal turfs and decreased that of encrusting algae, with no net effect on species richness. Our results suggests that competition from *C. cylindracea* is an important determinant of benthic assemblage diversity in pristine environments, but less so in species-poor assemblages found at sites exposed to intense disturbance from land-based human activities, where either adverse physical factors or lack of propagules may constrain the number of potential native colonizers. Implementing measures to reduce the establishment and spread of *C. cylindracea* in areas little impacted by land-based human activities should be considered a priority for preserving the biodiversity of Mediterranean shallow rocky reefs.

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