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ARTICLE

Adaptive responses along a depth and a latitudinal gradient in the endemic seagrass *Posidonia oceanica*

Marlene Jahnke[1] · Daniela D'Esposito[1] · Luigi Orrù[2] · Antonella Lamontanara[2] · Emanuela Dattolo[1] · Fabio Badalamenti[3] · Silvia Mazzuca[4] · Gabriele Procaccini[1] · Luisa Orsini[5]

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Abstract

Seagrass meadows provide important ecosystem services and are critical for the survival of the associated invertebrate community. However, they are threatened worldwide by human-driven environmental change. Understanding the seagrasses' potential for adaptation is critical to assess not only their ability to persist under future global change scenarios, but also to assess the persistence of the associated communities. Here we screened a wild population of *Posidonia oceanica*, an endemic long-lived seagrass in the Mediterranean Sea, for genes that may be target of environmental selection, using an outlier and a genome-wide transcriptome analysis. We identified loci where polymorphism or differential expression was associated with either a latitudinal or a bathymetric gradient, as well as with both gradients in an effort to identify loci associated with temperature and light. We found the candidate genes underlying growth and immunity to be divergent between populations adapted to different latitudes and/or depths, providing evidence for local adaptation. Furthermore, we found evidence of reduced gene flow among populations including adjacent populations. Reduced gene flow, combined with low sexual recombination, small effective population size, and long generation time of *P. oceanica* raises concerns for the long-term persistence of this species, especially in the face of rapid environmental change driven by human activities.

Introduction

Organisms have historically responded to changes in the environment by migrating, tolerating, or adapting (Hessen et al. 2013). However, human activities exacerbate the environmental changes, imposing shifts in ecological niches that often surpass the adaptive potential of species (Hoegh-Guldberg et al. 2007) and lead to local extinctions (Cardinale et al. 2012; Smith et al. 2007). Stress imposed by temperature changes has been associated with loss of biodiversity (Both et al. 2006; Corlett and Westcott 2013; Franks et al. 2014; Van Der Wal et al. 2013), with severe consequences on sessile species (Rivetti et al. 2014). Indeed, range reduction of the large majority of benthic marine species has been associated with global warming (Bay and Palumbi 2014; Jueterbock et al. 2016; Sanford and Kelly 2011). However, because of the complex interplay among temperature and other environmental stressors, it remains a challenge to disentangle the impact of temperature stress from one or the other environmental factors.

Here we investigated local adaptation of populations of the seagrass *Posidonia oceanica* sampled along a latitudinal and a bathymetric gradient, using a genome scan and a

These authors contributed equally: Gabriele Procaccini, Luisa Orsini

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✉ Gabriele Procaccini
gpro@szn.it

[1] Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, Villa Comunale, 80121 Napoli, Italy

[2] Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria, Centro di ricerca per la genomica vegetale, 29017 Fiorenzuola d'Arda, Italy

[3] CNR-IAMC, Via G. Da Verrazzano 17, 91014 Castellammare del Golfo, TP, Italy

[4] Department of Chemistry and Technology, University of Calabria, Rende, Italy

[5] Environmental Genomics Group, School of Biosciences, University of Birmingham, Birmingham B15 2TT, UK

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