Evolutionary Applications ISSN 1752-4571

ORIGINAL ARTICLE

An *in situ* assessment of local adaptation in a calcifying polychaete from a shallow CO_2 vent system

Noelle M. Lucey,[1,2,3] Chiara Lombardi,[2] Maurizio Florio,[1,2] Lucia DeMarchi,[4,5] Matteo Nannini,[2,6] Simon Rundle,[3] Maria Cristina Gambi[7] and Piero Calosi[8]

1 Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy
2 Marine Environment Research Centre ENEA, La Spezia, Italy
3 Marine Biology and Ecology Research Centre, Plymouth University, Plymouth, UK
4 CNR-ISMAR, La Spezia, Italy
5 Department of Biology, University of Aveiro, Aveiro, Portugal
6 Department of Biology, University of Pisa, Pisa, Italy
7 Department Integrative Marine Ecology, Villa Dohrn-Benthic Ecology Center, Stazione Zoologica "Anton Dohrn", Ischia, Napoli, Italy
8 Département de Biologie, Chimie et Géographie, Université du Québec à Rimouski, Rimouski, Quebec, Canada

Keywords
evolutionary constraints, *in situ* transplant, Mediterranean Sea, ocean acidification, phenotypic plasticity, Serpulidae.

Correspondence
Noelle M. Lucey, Department of Earth and Environmental Sciences, University of Pavia, Pavia 27100, Italy.
Tel.: +1 781 488 8911;
fax: +39 018 797 8213;
e-mail: noelle.lucey@gmail.com

Received: 11 November 2015
Accepted: 23 May 2016

doi:10.1111/eva.12400

Abstract

Ocean acidification (OA) is likely to exert selective pressure on natural populations. Our ability to predict which marine species will adapt to OA and what underlies this adaptive potential is of high conservation and resource management priority. Using a naturally low-pH vent site in the Mediterranean Sea (Castello Aragonese, Ischia) mirroring projected future OA conditions, we carried out a reciprocal transplant experiment to investigate the relative importance of phenotypic plasticity and local adaptation in two populations of the sessile, calcifying polychaete *Simplaria* sp. (Annelida, Serpulidae, Spirorbinae): one residing in low pH and the other from a nearby ambient (i.e. high) pH site. We measured a suite of fitness-related traits (i.e. survival, reproductive output, maturation, population growth) and tube growth rates in laboratory-bred F2 generation individuals from both populations reciprocally transplanted back into both ambient and low-pH *in situ* habitats. Both populations showed lower expression in all traits, but increased tube growth rates, when exposed to low-pH compared with high-pH conditions, regardless of their site of origin suggesting that local adaptation to low-pH conditions has not occurred. We also found comparable levels of plasticity in the two populations investigated, suggesting no influence of long-term exposure to low pH on the ability of populations to adjust their phenotype. Despite high variation in trait values among sites and the relatively extreme conditions at the low pH site (pH < 7.36), response trends were consistent across traits. Hence, our data suggest that, for *Simplaria* and possibly other calcifiers, neither local adaptations nor sufficient phenotypic plasticity levels appear to suffice in order to compensate for the negative impacts of OA on long-term survival. Our work also emphasizes the utility of field experiments in natural environments subjected to high level of pCO_2 for elucidating the potential for adaptation to future scenarios of OA.

Introduction

Ocean acidification (OA) is the process by which anthropogenically derived atmospheric carbon dioxide (CO_2) is absorbed into surface seawater, lowering the pH and concentration of carbonate ions in the global ocean (Caldeira and Wickett 2003; Doney et al. 2009). These changes have a large potential to impact marine biodiversity, as many marine species are expected to be affected detrimentally (Kroeker et al. 2013; Wittmann and Pörtner 2013;