Latitudinal Trends in Stable Isotope Signatures of Northeast Atlantic Rhodoliths

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Introduction

Rhodoliths are free-living calcifying red algae that form extensive beds in shallow marine benthic environments that provide important marine habitats and contribute to carbonate sediment accumulation. These organisms may be sensitive to global climate change, which will have important consequences for coastal productivity and stability. The goal of this study was to determine the plasticity of dissolved inorganic carbon (DIC) uptake mechanisms of rhodoliths using natural stable isotope signatures. The $\delta^{13}C$ signature of macroalgae can be used to provide an indication of the preferred inorganic carbon source (CO_2 vs. HCO_3^-).

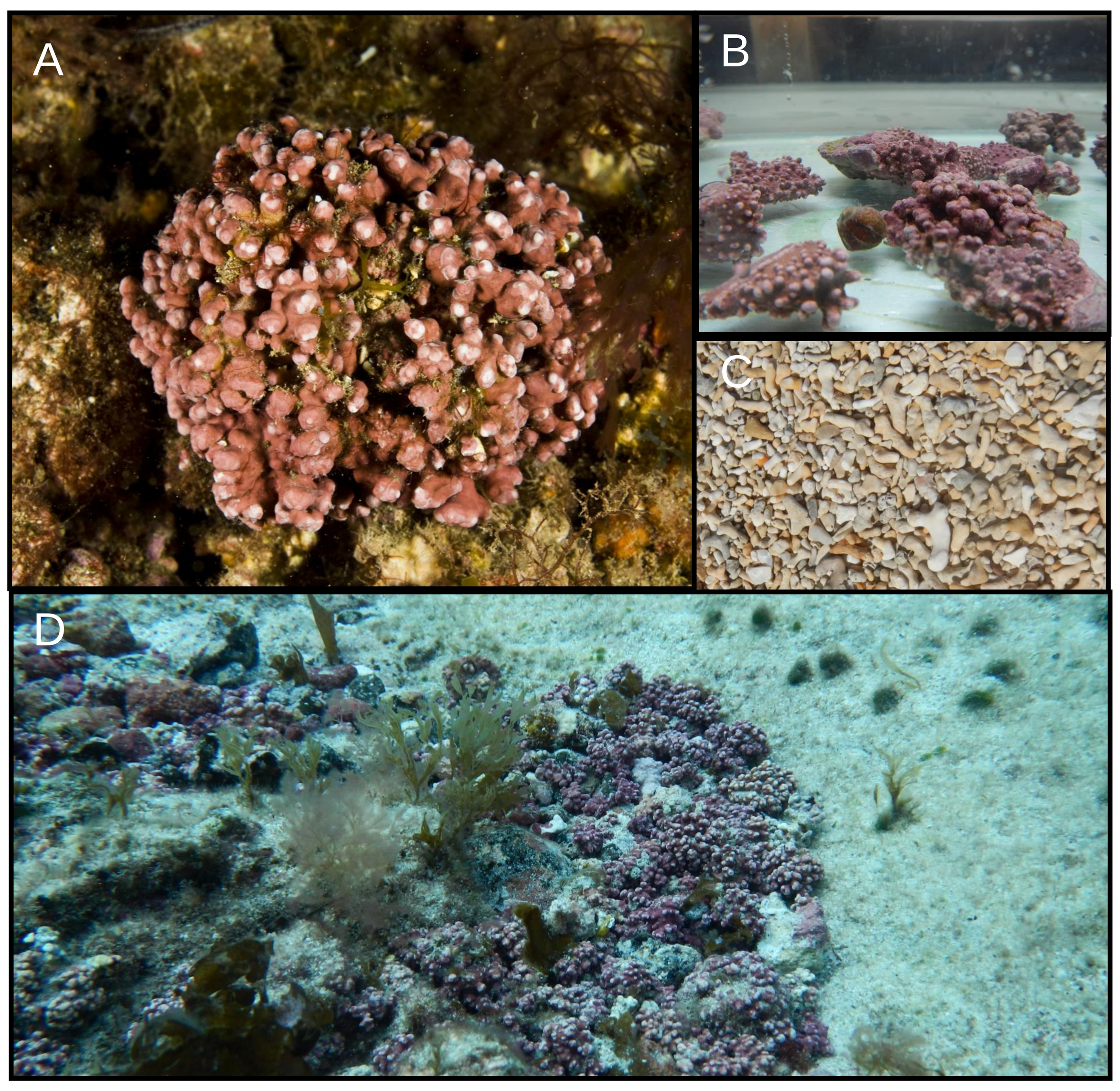


Fig. 1 Diversity of rhodoliths sampled along a latitudinal gradient. A) Grand Canaria, Spain B) Spitsbergen, Norway, C) Manin Bay, Ireland, D) Fuerteventura, Spain

Conclusions

The results from stable isotope analysis of rhodoliths along a latitudinal gradient in the NE Atlantic show that many species, particularly those at lower latitudes, have carbon concentrating mechanisms that facilitate HCO_3^- use for photosynthesis. This is an important adaptation for marine macroalgae, because HCO_3^- is available at higher concentrations than CO_2 in seawater, and this becomes even more extreme with increasing temperature. Rhodoliths at higher latitudes rely more on diffusive CO_2 uptake, most likely due to the higher DIC concentration in colder waters compared to lower latitudes.

Results

Here we present the total and organic $\delta^{13}C$ signatures of NE Atlantic rhodoliths with respect to changing temperature and DIC along a latitudinal gradient from the Canary Islands to Spitsbergen. We observed a decreasing trend in skeletal $\delta^{13}C$ signatures with increasing latitude and temperature (Fig. 2, Fig. 3), while organic $\delta^{13}C$ signatures were only significantly correlated to DIC (Fig. 3). These data suggest that rhodoliths rely solely on CO_2 as an inorganic carbon source at high latitudes, while those at low latitudes may be able to utilize HCO_3^-. However, depth also has a significant effect on both skeletal and organic $\delta^{13}C$ signatures (Fig. 3B & D), suggesting that both local and latitudinal trends influence the plasticity of rhodolith inroganic carbon acquisition and assimilation.

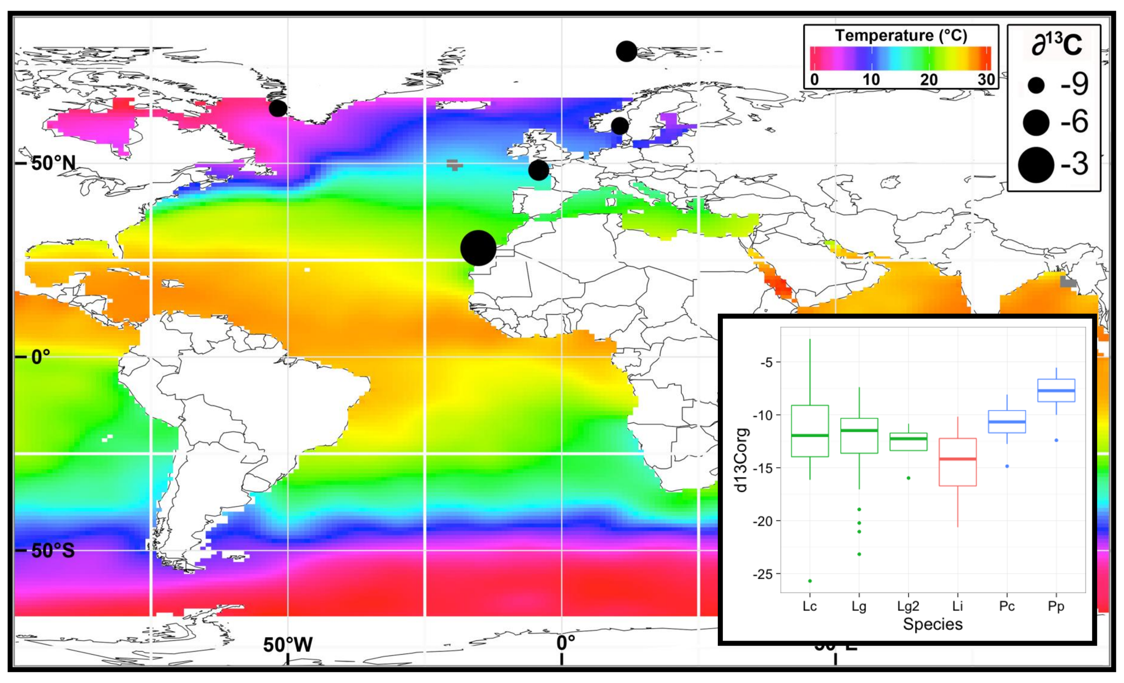


Fig. 2 Map of ocean temperature overlayed with the mean $\delta^{13}C$ signatures of rhodoliths from each sampling site along the latitudinal gradient in the NE Atlantic. Inlay shows the ranges and medians of organic $\delta^{13}C$ signatures measured for each rhodolith species, color coded by genus (Lc = *Lithothamnion corallioides*, Lg = *L. glaciale*, Li = *Lithophyllum incrustans*, Pp = *Phymatolithon purpureum*, Pc = *P. calcareum*

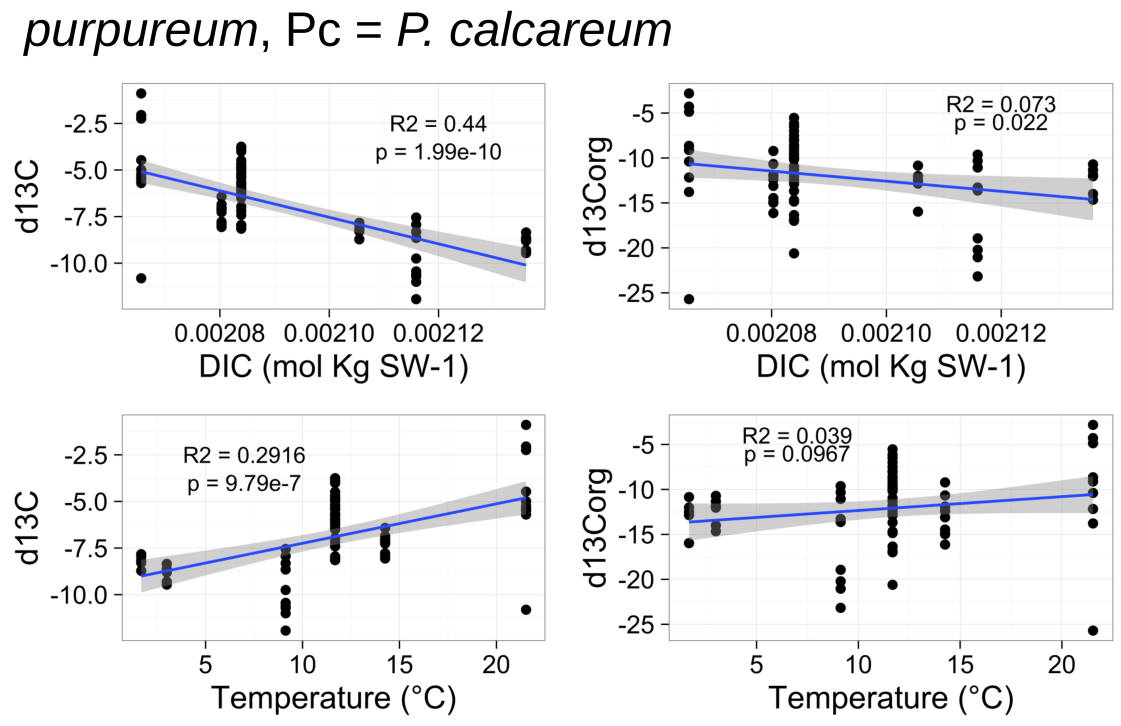
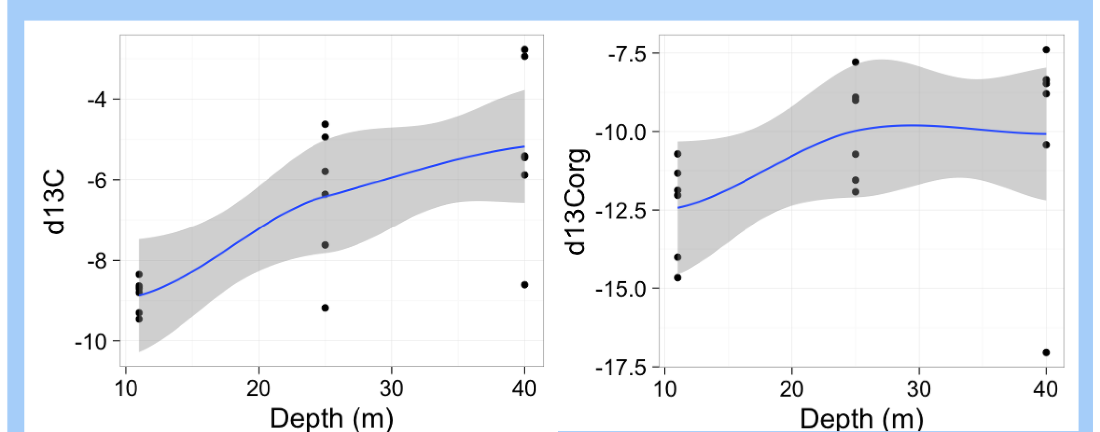


Fig. 3 skeletal (left panels) and organic (right panels) $\delta^{13}C$ signatures of rhodoliths as a function of surface DIC concentrations (top panels) and temperature (Bottom panels) along a latitudinal gradient in the NE Atlantic.

Perspectives

Latitudinal trends in $\delta^{13}C$ signatures show that the carbon concentrating mechanisms among rhodolith species are plastic, but we also found that CCMs can be plastic within species. Artic *Lithothamnion* collected from 79.53° N at three different depths showed significantly different skeletal and organic $\delta^{13}C$ signatures, suggesting that light plays an important role in CCMs. Although we do



not have light data along our latitudinal gradient, we can assume that the plasticity of CCMs in NE Atlantic rhodoliths is dependent on multiple co-dependent factors, including temperature, light, and DIC concentration. Finally, an interesting finding was that skeletal $\delta^{13}C$ signatures were more significantly linked to temperature and DIC fluctuations along the latitudinal gradient, suggesting that vital effects may have a stronger influence on organic $\delta^{13}C$ signatures than on skeletal $\delta^{13}C$ signatures.

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