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Effects of ocean acidification vary depending on light and nutrient levels

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Ocean acidification is expected to be detrimental to many calcified algae, but beneficial to those non-calcified forms that are able to capitalise on increased carbon availability for photosynthesis. Shifts in dominance between primary producers will have knock-on effects on marine ecosystems and will likely vary regionally, depending on factors such as light and nutrients. Here, we investigated physiological responses of macroalgae near a CO_2 seep (in zones with mean 500, 700-800 and 1200 µatm CO_2) in oligotrophic waters off Vulcano (Italy). *Cystoseira compressa* (Phaeophyceae, Fucales) and *Padina pavonica* (Phaeophyceae, Dictyotales) were incubated at 0.5 m depth *in situ* in well-lit *vs* shaded conditions and in nutrient (N, P, and K) enriched *vs* non-enriched treatments.

A suite of biochemical assays and *in vivo* chlorophyll *a* fluorescence parameters showed that elevated CO_2 levels benefitted these macroalgae, although their responses varied depending on light and nutrient availability. In *C. compressa*, elevated CO_2 treatments had higher carbon content and antioxidant activity in shaded conditions both with and without nutrient enrichment - they had more Chla, phenolic and fucoxanthin with nutrient enrichment and higher quantum yield (F_v/F_m) and photosynthetic efficiency (α_{ETR}) without nutrient enrichment. In *P. pavonica*, elevated CO_2 treatments had higher carbon content, F_v/F_m, α_{ETR}, and Chl*a* regardless of nutrient levels - they had higher concentrations of phenolic compounds in nutrient enriched, fully-lit conditions and more antioxidants in shaded, nutrient enriched conditions. Nitrogen content increased significantly in fertilised treatments, confirming that the algae are nutrient limited in this oligotrophic part of the Mediterranean.

Our findings strengthen evidence for the prediction that brown macroalgae could proliferate as the oceans acidify where other physicochemical conditions, such as nutrient levels and light, permit.