RESPONSE OF MEDITERRANEAN BENTHIC CORALLINE ALGAE AND CORALS TO ELEVATED pCO_2 AND TEMPERATURE

S. Martin[1], R. Rodolfo-Metalpa[2], S. Reynaud[2], C. Ferrier-Pagès[2] and J.-P. Gattuso[1]

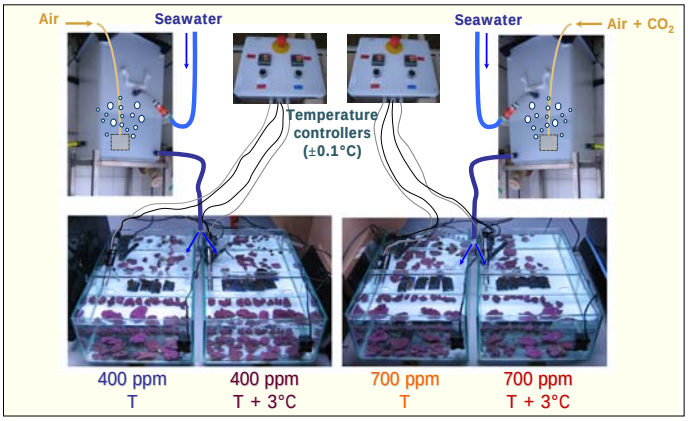
[1]Laboratoire d'Océanographie de Villefranche, CNRS-University of Paris VI, 06234 Villefranche-sur-Mer, France
[2]Centre Scientifique de Monaco, Av. St Martin MC98000, Monaco

INTRODUCTION

CO_2 partial pressure (pCO_2) and temperature are two important factors that affect calcification rates of benthic calcifying organisms. However, very few studies have investigated the interactive effects of these two parameters. The effect of increases of pCO_2 and temperature similar to those expected at the end of this century were examined in the temperate coralline alga, *Lithophyllum cabiochae* and the zooxanthellate coral *Cladocora caespitosa*.

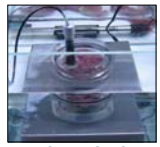

Photo D. Lidquet

MATERIAL AND METHODS



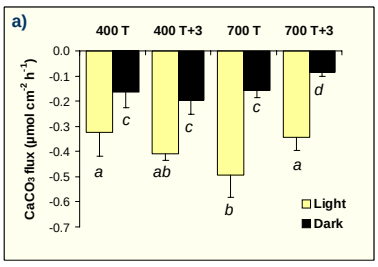
Coralline algae and corals were collected in the NW Mediterranean Sea (Bay of Villefranche, France) at *ca*. 30 m depth in summer 2006 and grown for one month at a temperature of 22°C (normal temperature) or 25°C (elevated temperature) and pCO_2 of *ca*. 400 ppm (normal pCO_2) or *ca*. 700 ppm (elevated pCO_2).

Coralline algae and corals were incubated in the light and dark and calcification rates were measured using the alkalinity anomaly technique.

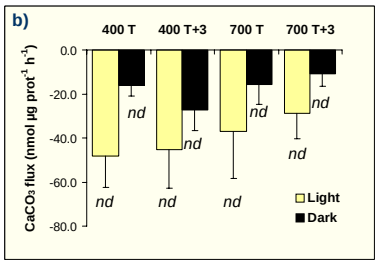

Incubation chamber

The experimental set up comprised four culture conditions: normal pCO_2 and normal temperature (400 ppm, T), normal pCO_2 and elevated temperature (400 ppm, T+3°C), elevated pCO_2 and normal temperature (700 ppm, T), and elevated pCO_2 and elevated temperature (700 ppm, T+3°C). pCO_2 was adjusted by bubbling normal air and air with elevated pCO_2 in Mediterranean seawater that was continuously supplied to the aquaria. The temperature was controlled in each aquarium to within ±0.1°C.

RESULTS




The coralline alga, *Lithophyllum cabiochae*




The zooxanthellate coral, *Cladocora caespitosa*

(a) Algal and (b) coral net calcification in $CaCO_3$ fluxes measured in the light and dark in the four culture conditions. Mean irradiance was 35 µmol m^{-2} s^{-1} (mean irradiance at ca. 30 m depth in summer). Different letters on bars indicate significant differences ($p < 0.05$) among means (mean ± SD, n = 5 to 6); nd, no difference.

Lithophyllum cabiochae. We observed a strong interaction between pCO_2 and temperature in the light and dark with a different response in calcification rate to a change in temperature depending on the level of pCO_2.

Cladocora caespitosa. We observed an decrease in calcification rates in response to elevated pCO_2 and temperature. However, they did not show significant differences between treatments, both in the light and dark.

CONCLUSION

This is the first study on the effects of elevated pCO_2 and temperature on temperate coralline algae and zooxanthellate corals. It shows a decrease in calcification rates when both parameters are elevated.

The diel net calcification estimated by summing calcification during the light and dark periods showed a surprising increase by *ca*. 30 % with elevated pCO_2 and a decrease by *ca*. 10% when temperature and pCO_2 were both elevated for *L. cabiochae* and a decrease by *ca*. 30% with elevated pCO_2 irrespective of the temperature level considered for *C. caespitosa*.

	Response to increased pCO_2	Response to increased pCO_2 and temperature
Tropical corals	0 to -56 % (Kleypas et al. 2006)	-50 % (Reynaud et al. 2003)
Tropical coralline algae	-25 % (Agegian 1985)	?
Coccolithophores	-9 to -29 % (Kleypas et al. 2006)	?
Foraminifera	-4 to -8 % (Kleypas et al. 2006)	?
L. cabiochae	+30 %	-10 %
C. caespitosa	-30 %	-30 % (this study)

This table shows that there is a lack of knowledge on the interacting effects of pCO_2 and temperature on calcification rates and that these two parameters must be investigated in combination to help predicting the response of marine organisms to global environmental changes.

References

Agegian (1985). The biogeochemical ecology of *Porolithon gardineri* (Foslie). Ph.D. Dissertation. University of Hawaii.
Kleypas et al. (2006). Impacts of ocean acidification on coral reef and other marine calcifiers: A guide for future research. Report from a workshop sponsored by NSF, NOAA, and U.S. Geological Survey.
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