

Effects of ocean acidification and global warming on Mediterranean coralline algae



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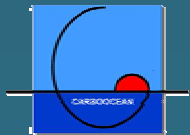
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Coralline algae

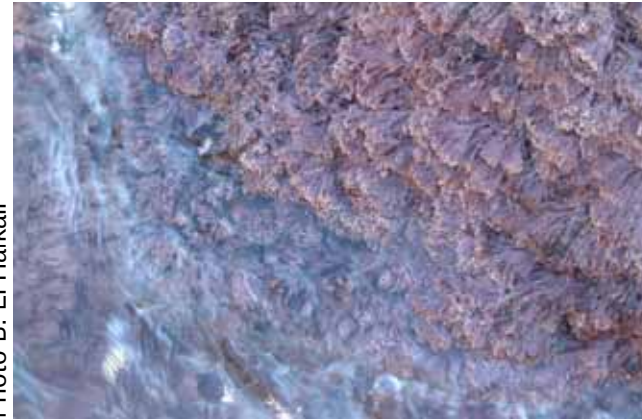
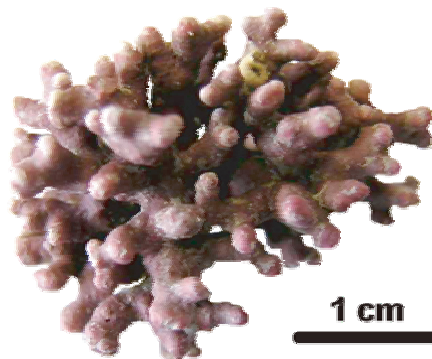
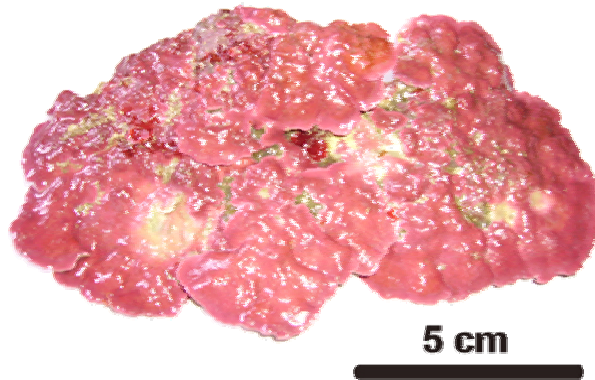
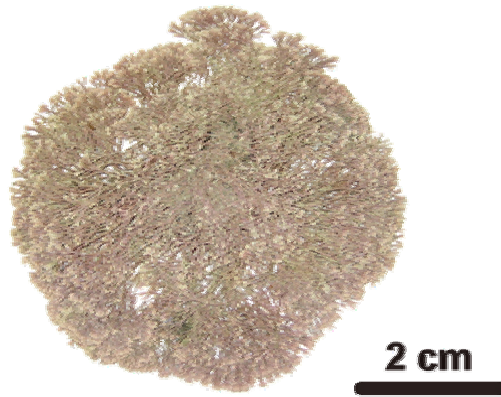


Photo B. El Haikali



Photo D. Luquet



Photo E. Amice

Mediterranean crustose coralline algae



Photos D. Luquet



Coralligenous
concretions

*Posidonia
oceanica*
meadows



Photos R. Rodolfo-Metalpa



- Significant **ecological importance** (high biodiversity)
- Major role in **carbon and carbonate cycles**

Coralligenous: $100\text{--}500 \text{ g CaCO}_3 \text{ m}^{-2} \text{ yr}^{-1}$

Seagrass meadows: $60\text{--}70 \text{ g CaCO}_3 \text{ m}^{-2} \text{ yr}^{-1}$ (Canals & Ballesteros, 1997)

Laboratory experiment



- **Effect of $\uparrow p\text{CO}_2$**
(doubling $p\text{CO}_2$, $\downarrow$ pH: 0.2 pH units)
- **Effect of $\uparrow$ temperature**
($+3^\circ\text{C}$)

Crustose CA
Lithophyllum
cabiochae



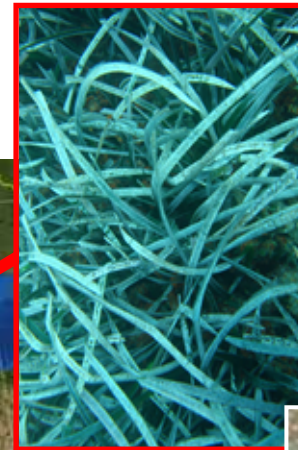
Mediterranean Sea

In situ study

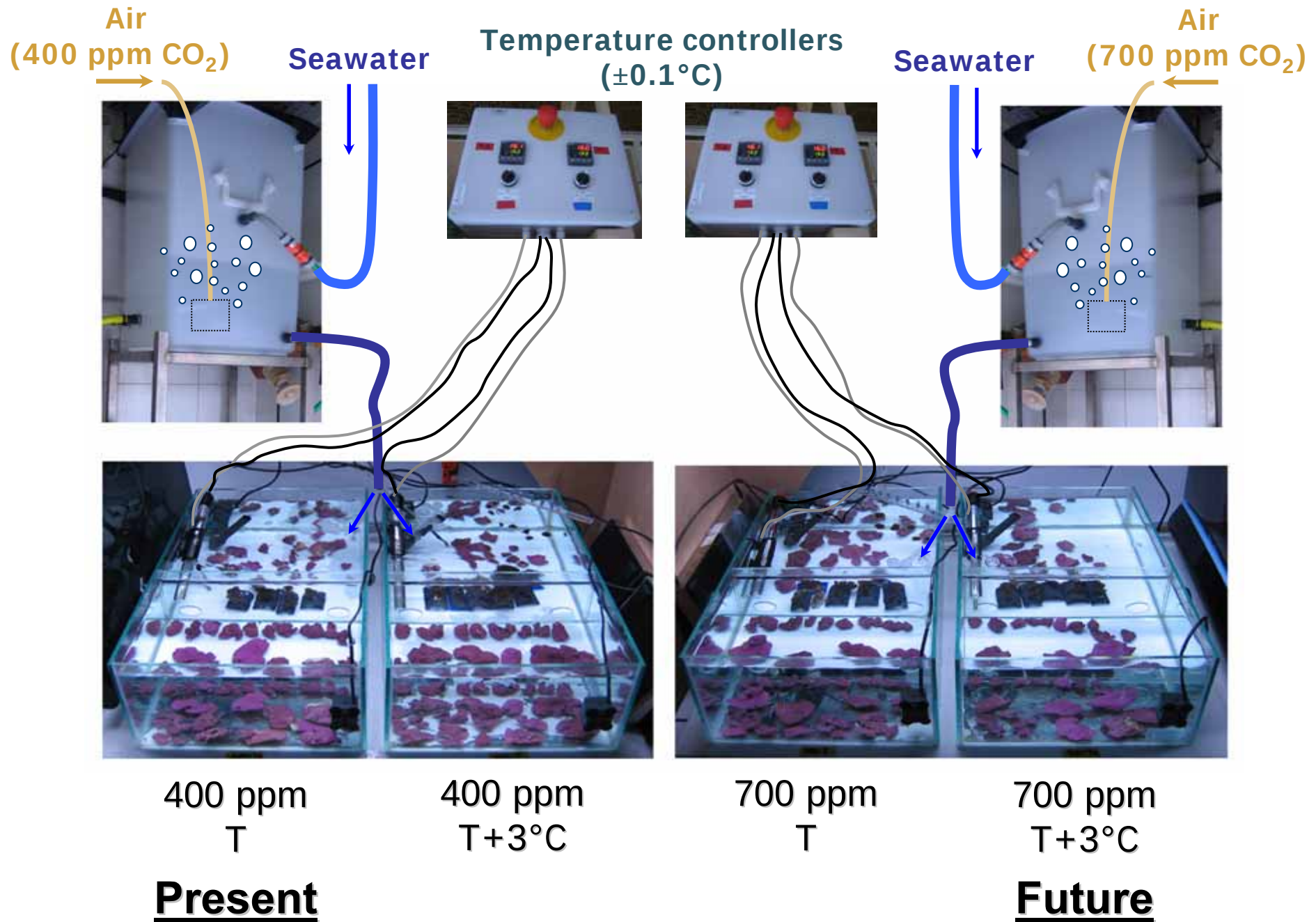


- **Effect of $\uparrow p\text{CO}_2$**
($\downarrow$ pH: 0-0.5 pH units)

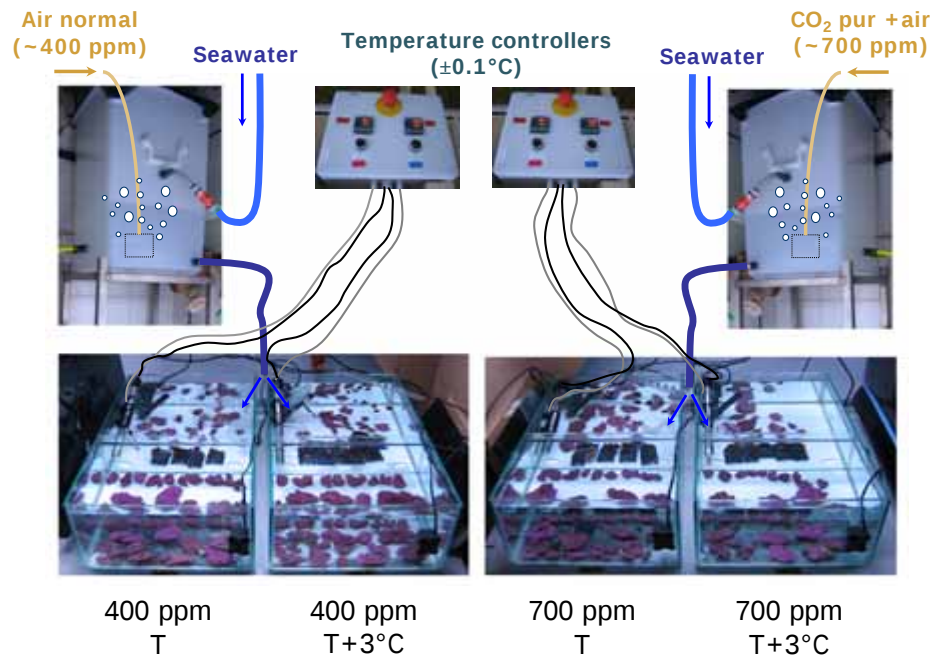
Epiphytic CA
Hydrolithon &
Pneophyllum sp.



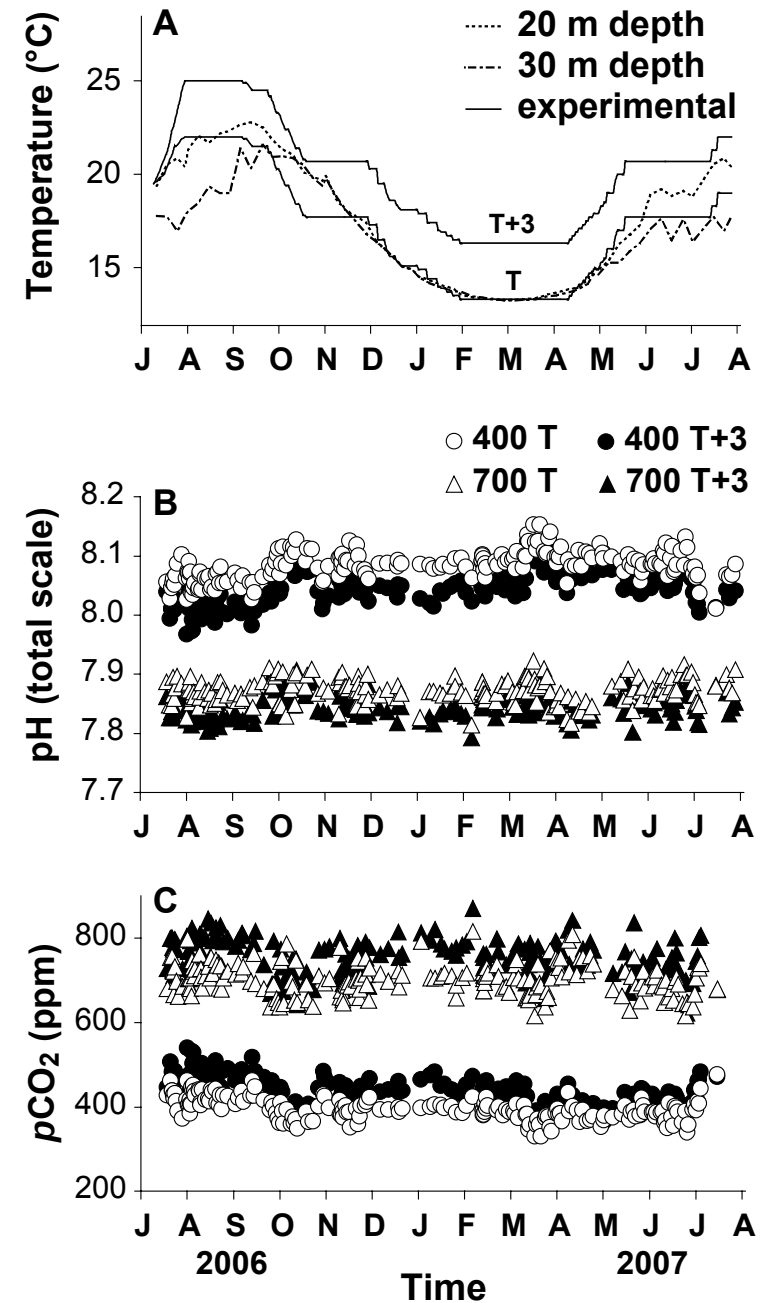
Lab experiment: experimental setup



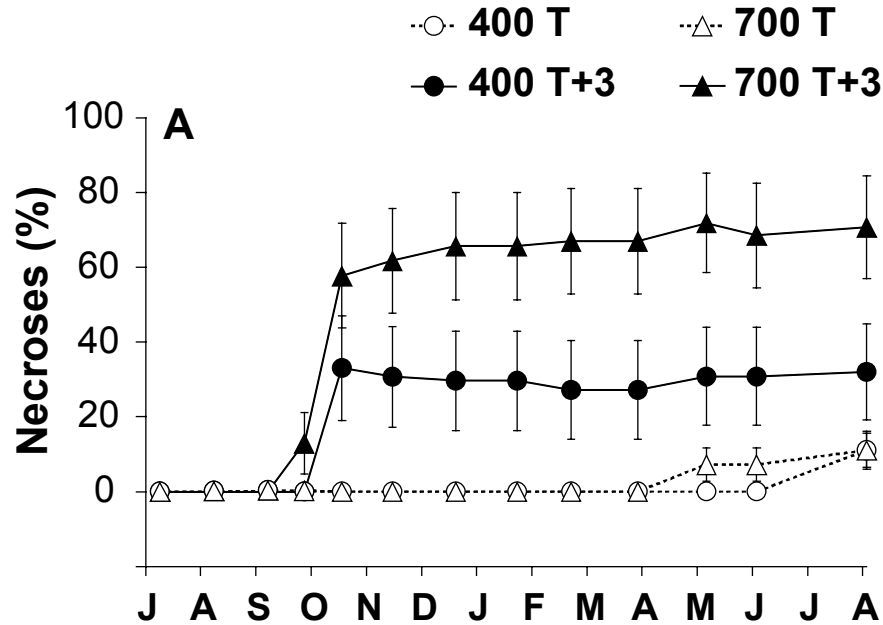
Lab experiment: experimental setup



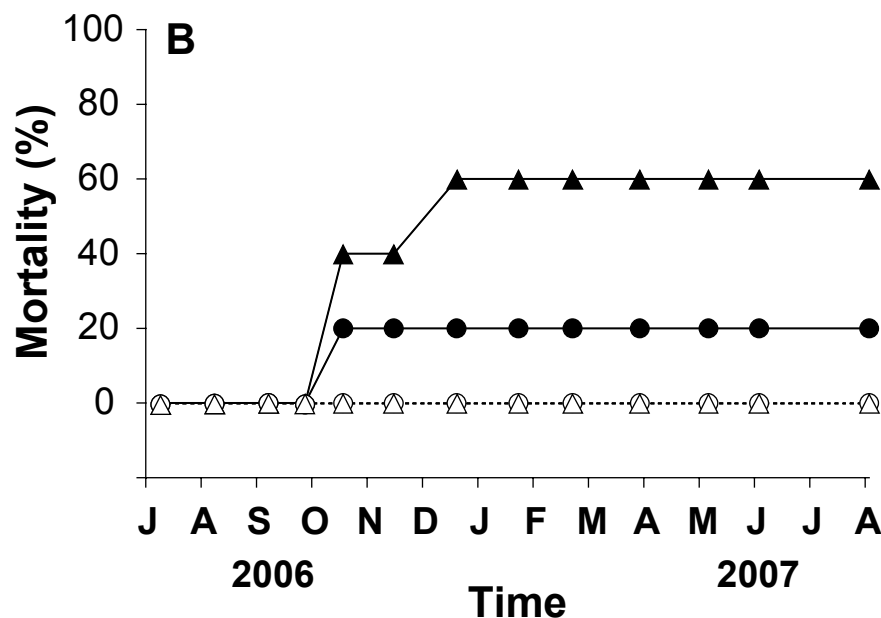
- One-year experiment (July 2006 - August 2007)
- Seasonal fluctuations of temperature and irradiance



Algal necrosis and mortality



↑ necroses and mortality at T+3°C at the end of summer



Necroses:

- 30% at 400 ppm
- 60% at 700 ppm

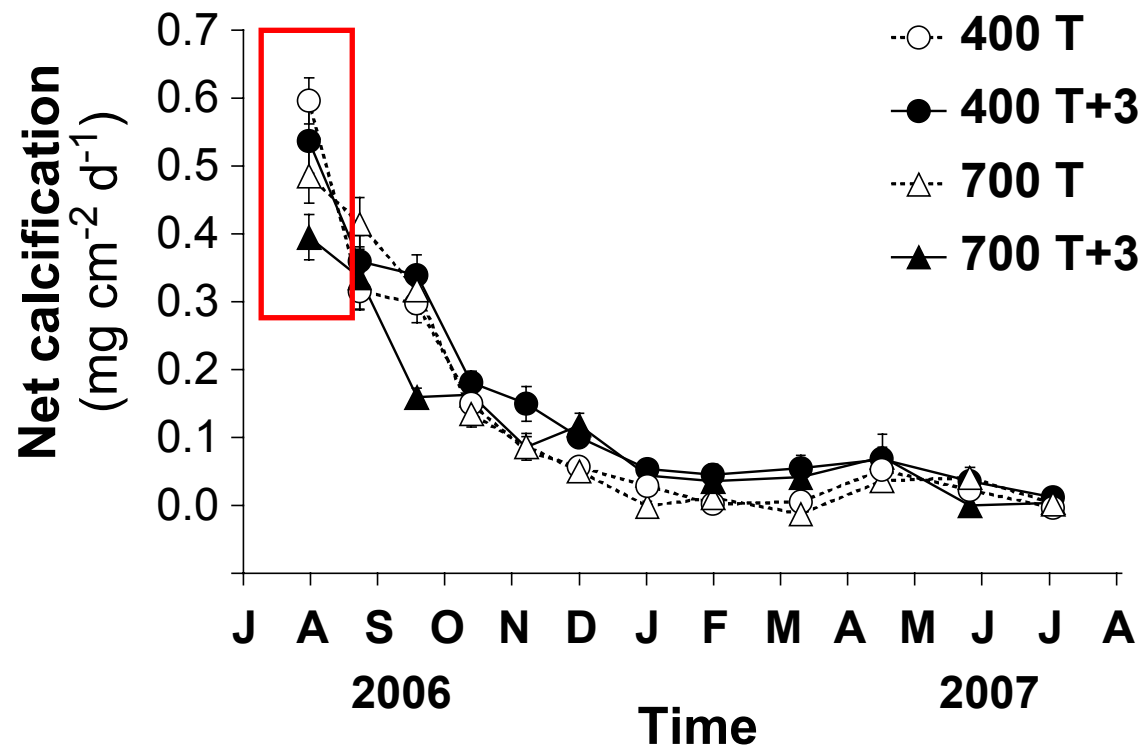
Mortality:

- 20% at 400 ppm
- 60% at 700 ppm

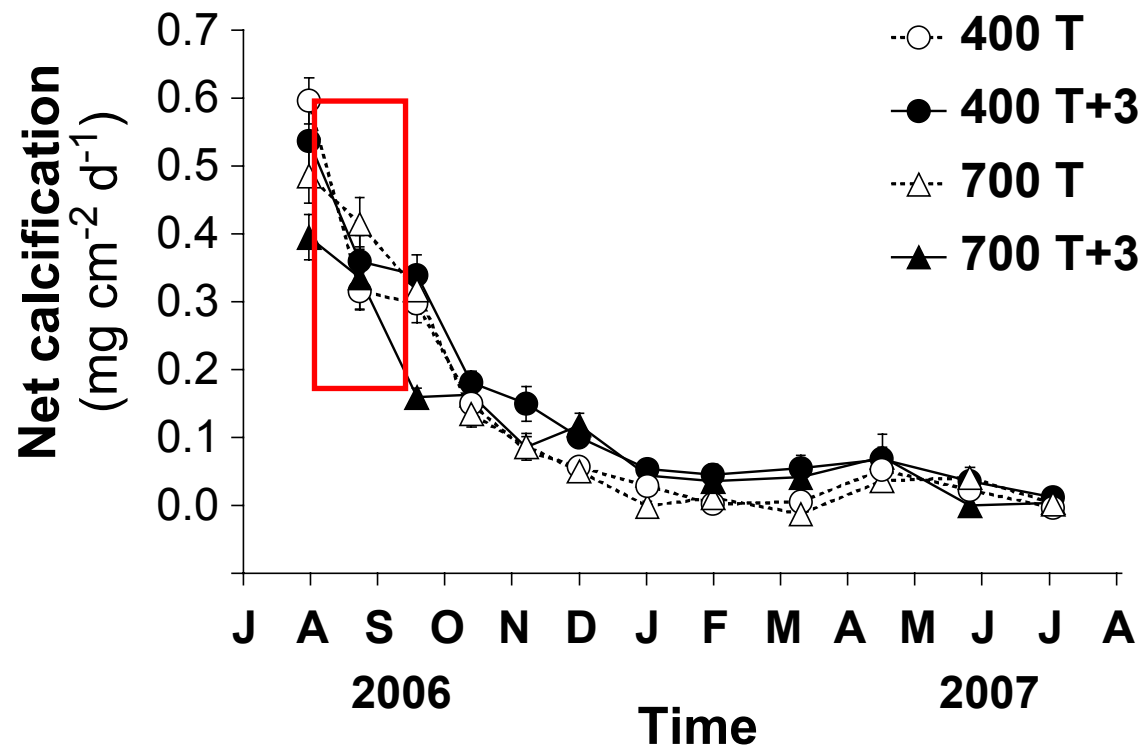
Healthy algae



- 1st month:
 $p\text{CO}_2$ effect :
700 ppm < 400 ppm

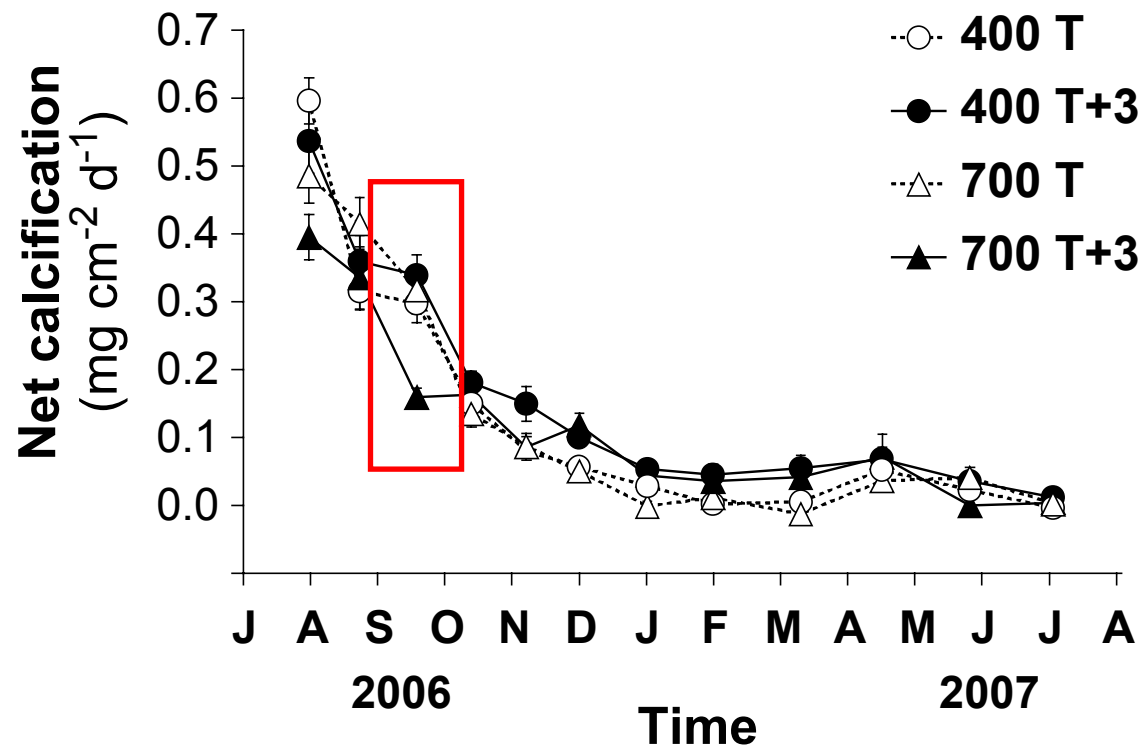


Healthy algae



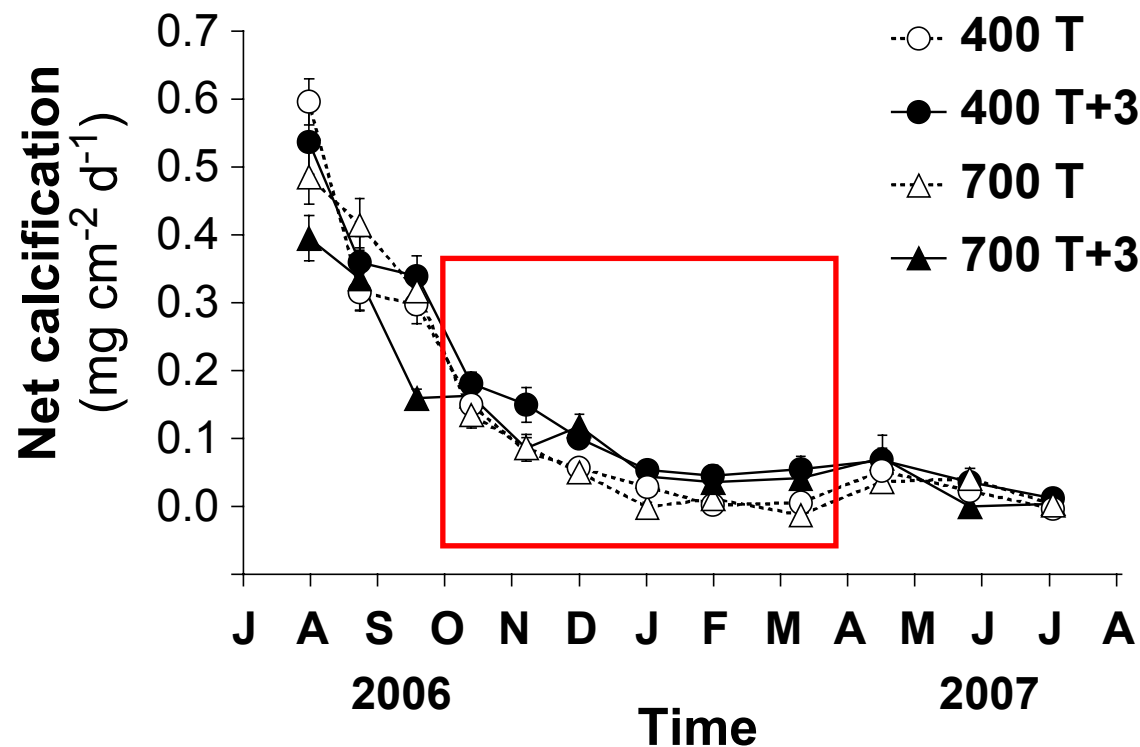
- 1st month:
 $p\text{CO}_2$ effect :
 $700 \text{ ppm} < 400 \text{ ppm}$
- 2^d month:
No effect

Healthy algae



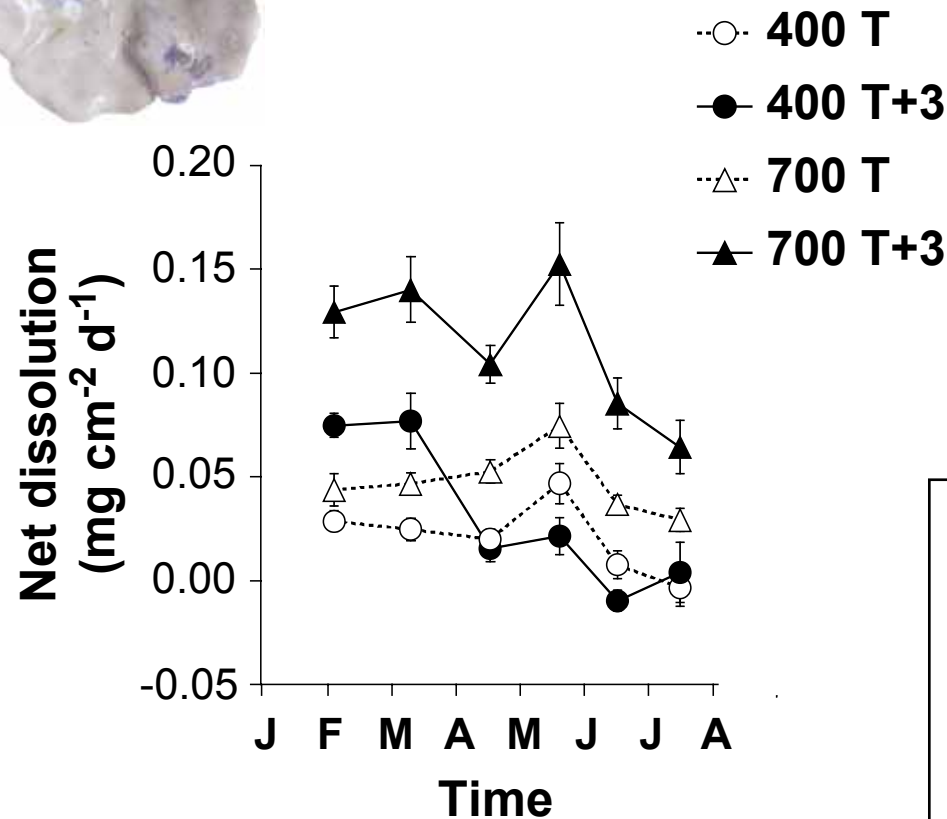
- 1st month:
 $p\text{CO}_2$ effect :
700 ppm < 400 ppm
- 2^d month:
No effect
- End of summer:
interaction $p\text{CO}_2 \times T$

Healthy algae



- 1st month:
 $p\text{CO}_2$ effect :
 $700 \text{ ppm} < 400 \text{ ppm}$
- 2^d month:
No effect
- End of summer:
interaction $p\text{CO}_2 \times T$
- Autumn-Winter:
Temperature effect
 $T+3 > T$

Dead algae

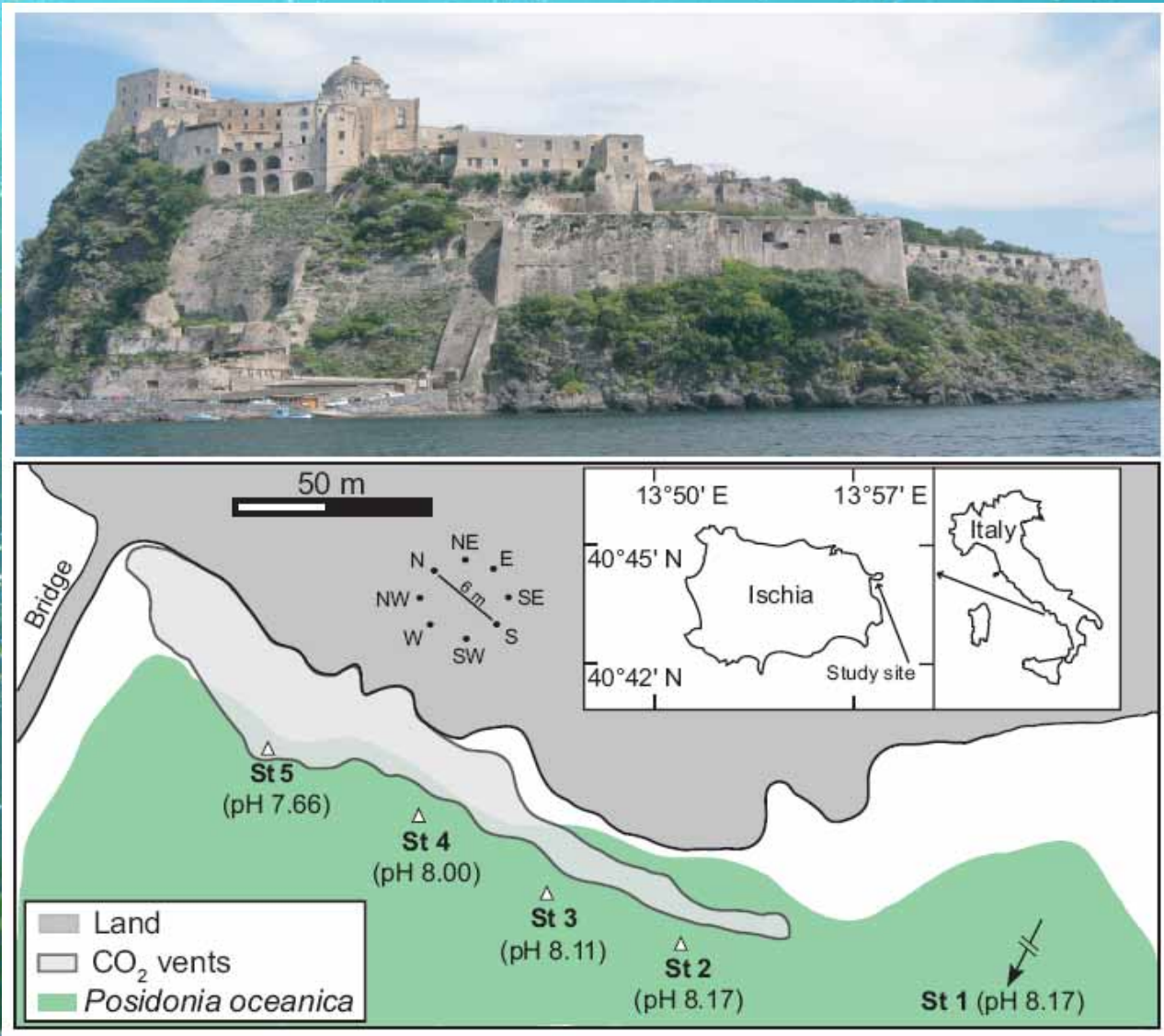


- $p\text{CO}_2$ effect :
700 ppm > 400 ppm
(2-4 fold higher)

- healthy algae at 700 T+3
 $\text{Calci}_{\text{net}} = 44 \text{ mg CaCO}_3 \text{ cm}^{-2} \text{ yr}^{-1}$
- dead algae at 700 T+3
 $\text{Disso}_{\text{net}} = 41 \text{ mg CaCO}_3 \text{ cm}^{-2} \text{ yr}^{-1}$
- 60% mortality at 700 T+3:
dissolution > calcification
by 2100

In situ study

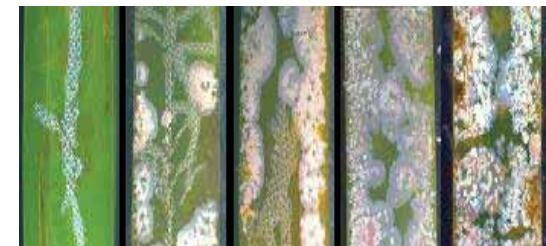
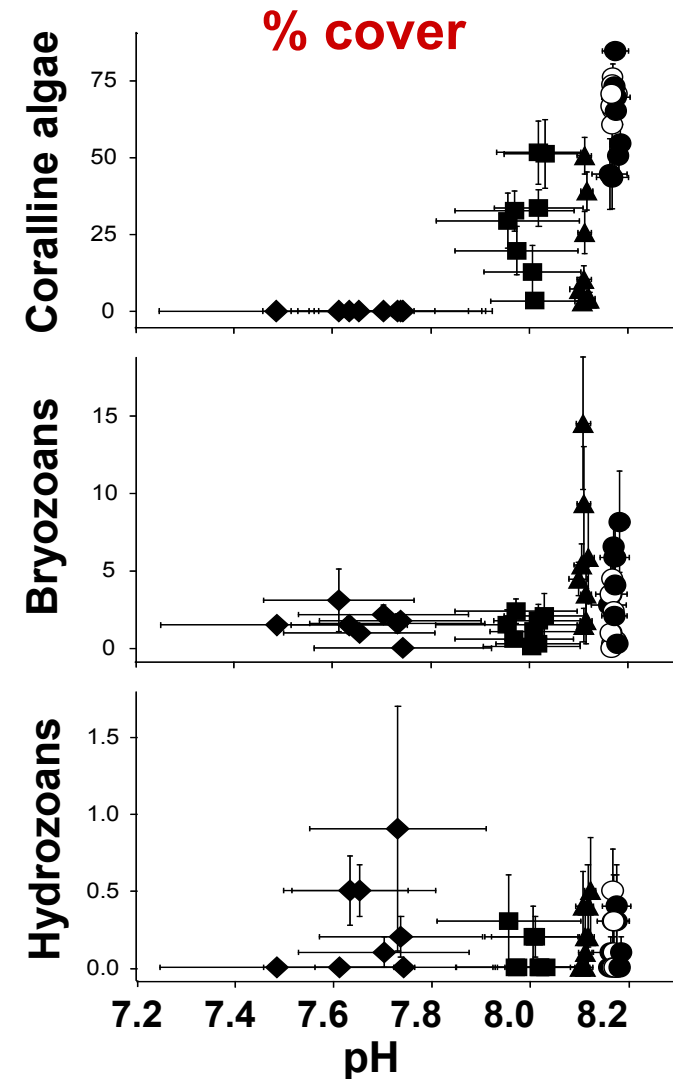
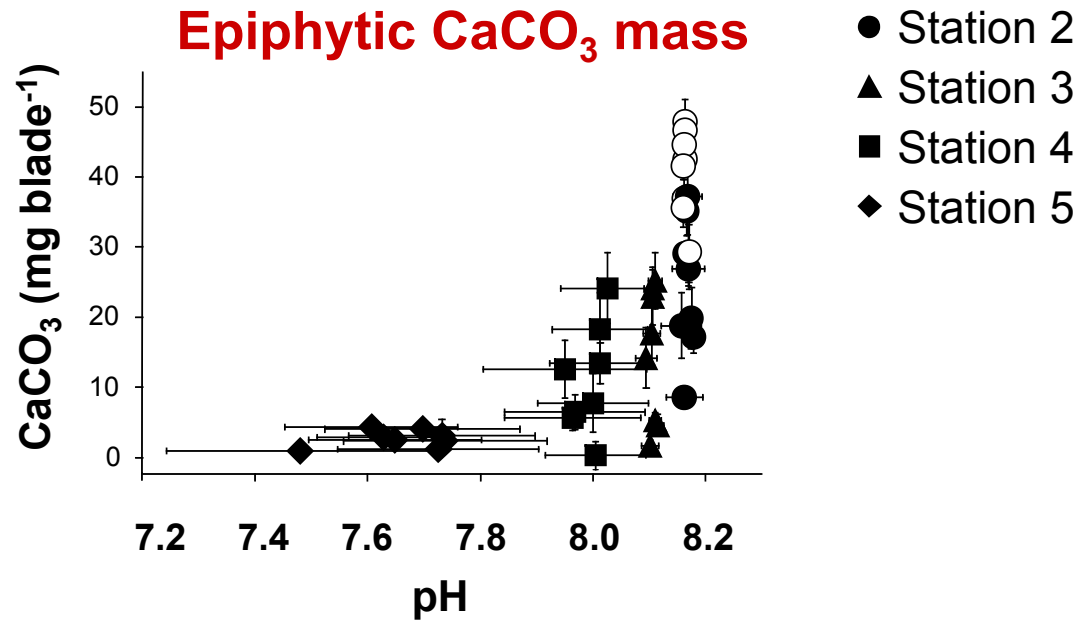




Castello Aragonese, Island of Ischia, Italy

Source: Martin *et al.* (2008, *Biol. Letters*); Hall-Spencer *et al.* (2008, *Nature*)

Epiphytic cover and carbonate mass



Source: Martin *et al.* (2008, *Biol. Letters*)

- Laboratory experiment:

Combined effects of elevated $p\text{CO}_2$ and temperature on:

- the **survival** of crustose coralline algae
- the **net calcification/dissolution budget** of coralline algal populations

- *In situ* study:

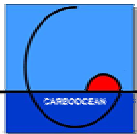
Effects of elevated $p\text{CO}_2$ on:

- the **survival** of epiphytic coralline algae
- the **algal CaCO_3 production**

Ocean acidification and global warming:

Major consequences for the biodiversity and biogeochemistry of Mediterranean coastal ecosystems dominated by corallines

Thank you for your attention



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