

Combined effects of temperature and CO₂ on the growth performance of three intertidal red macroalgae (Rhodophyta)

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Hypothesis

Most marine macroalgae possess carbon concentrating mechanisms (CCMs). The CCM performance probably influences the relative sensitivity of the species to CO₂. Published data suggest that the CCM activity changes with habitats and taxonomic classes¹⁻³. Furthermore, it has been discussed that elevated CO₂ may act through a release of energy saved from reduced CCM activity. As our experimental material possesses major differences in their CCM performance acc. to published evidence¹⁻³, we hypothesized (1) that growth increments at elevated CO₂ are species-specific and (2) that the energetic benefit induced by a better CO₂ supply will become more pronounced under sub-optimal growth conditions but again with differences between species. (References: 1:Giordano and Maberly 1989, 2: Murru and Sandgren 2004, 3: Moulin et al. 2011).

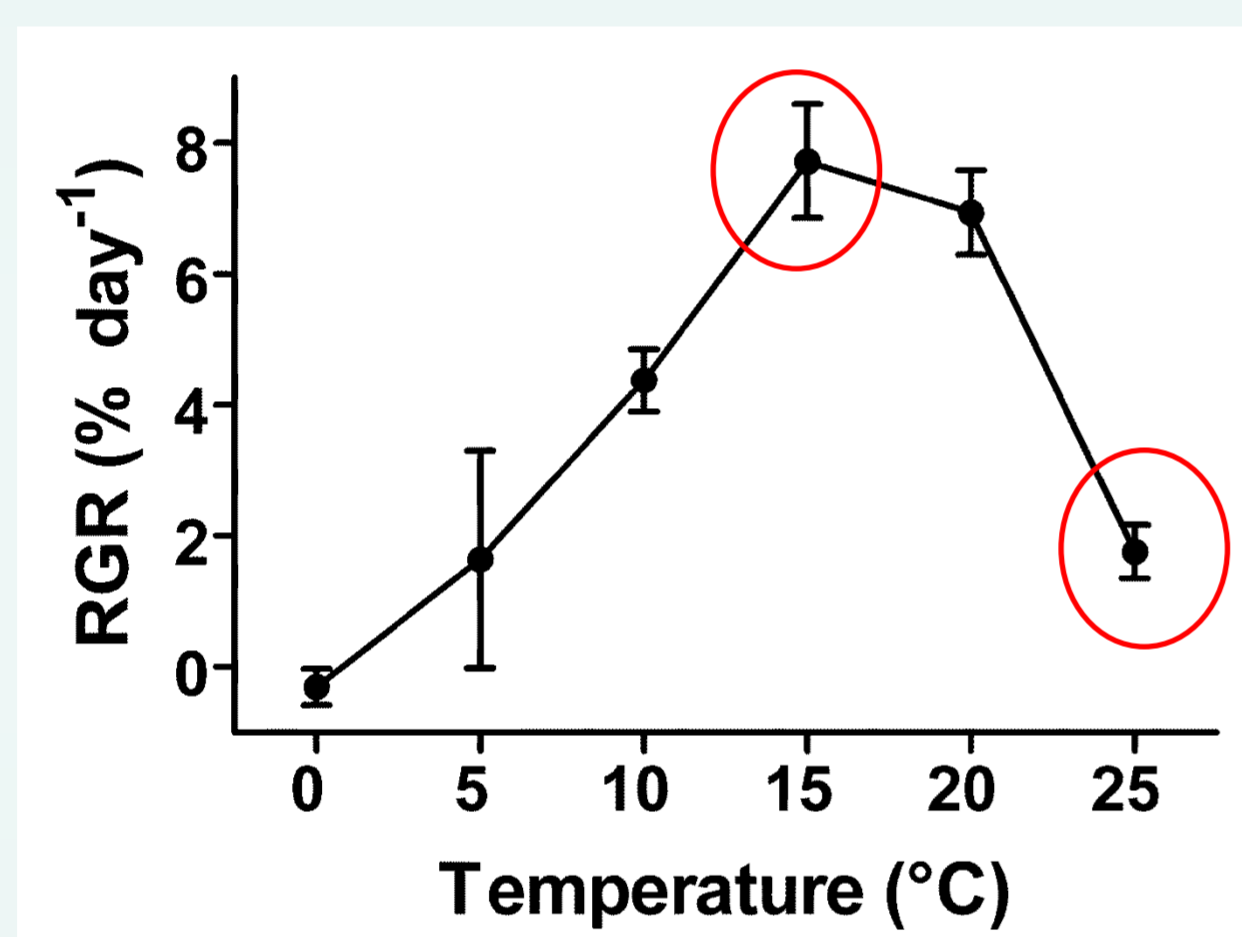
Methods: We investigated growth of three intertidal red algae (*Mastocarpus stellatus* – high to mid intertidal, *Chondrus crispus* – mid to low intertidal, *Palmaria palmata* – low intertidal to subtidal) in perturbation experiments (N=5-6) (Fig 1) during 9-18 days at different CO₂ target concentrations (280 / 700 or 800 / 1200 ppm) and optimal vs. suboptimal growth temperatures. The experiments were performed under saturating light conditions for growth.



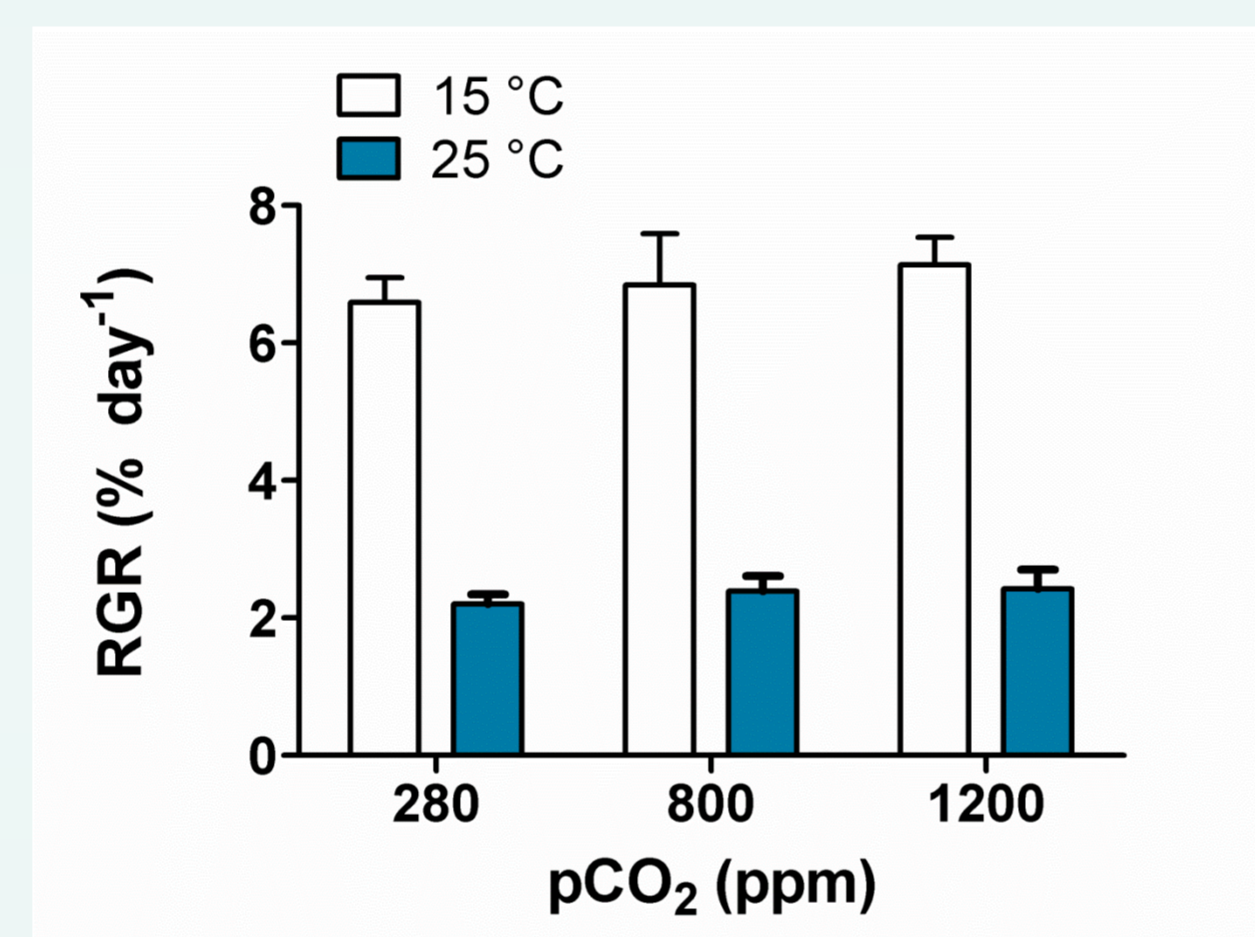
Results

Growth

Mastocarpus stellatus

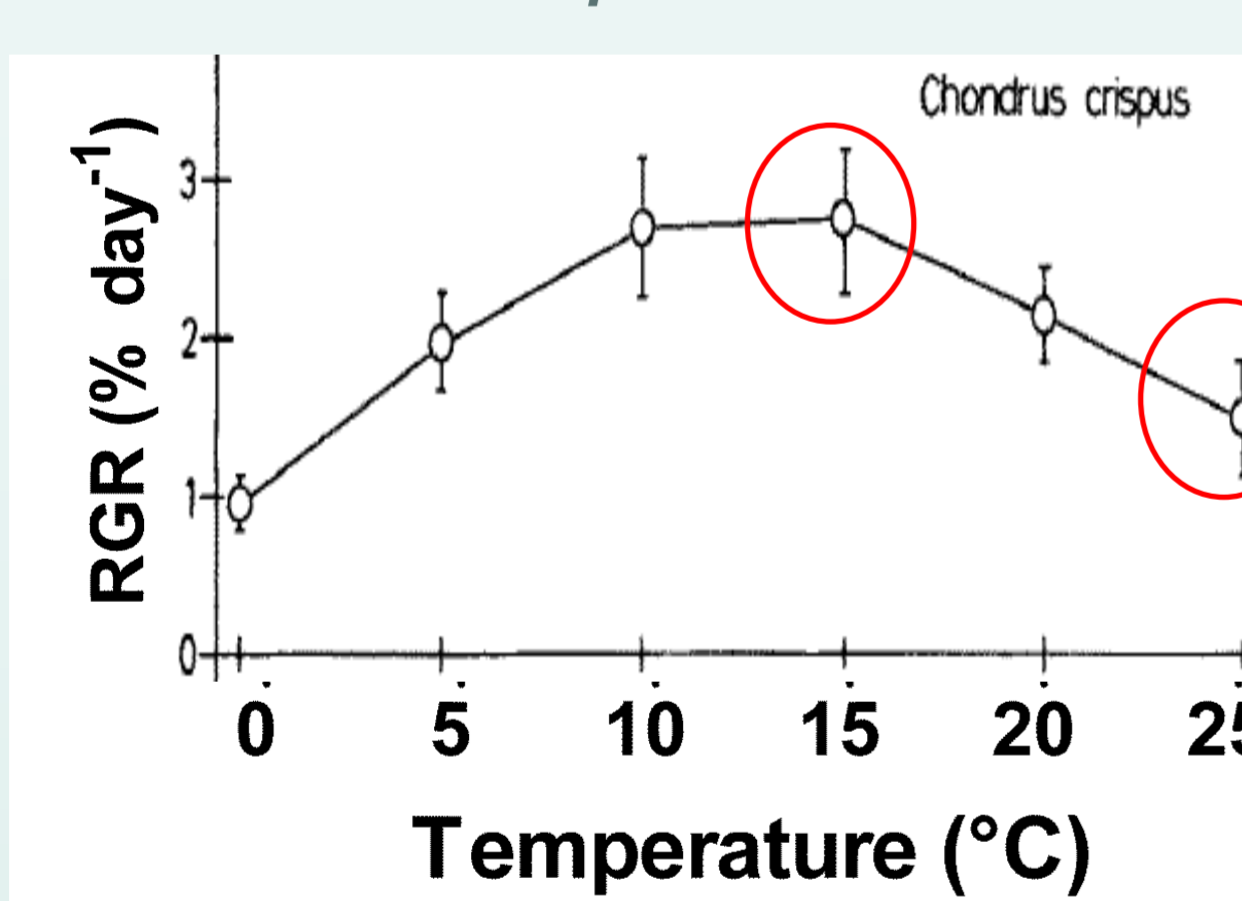


Data from: Seliger 2012

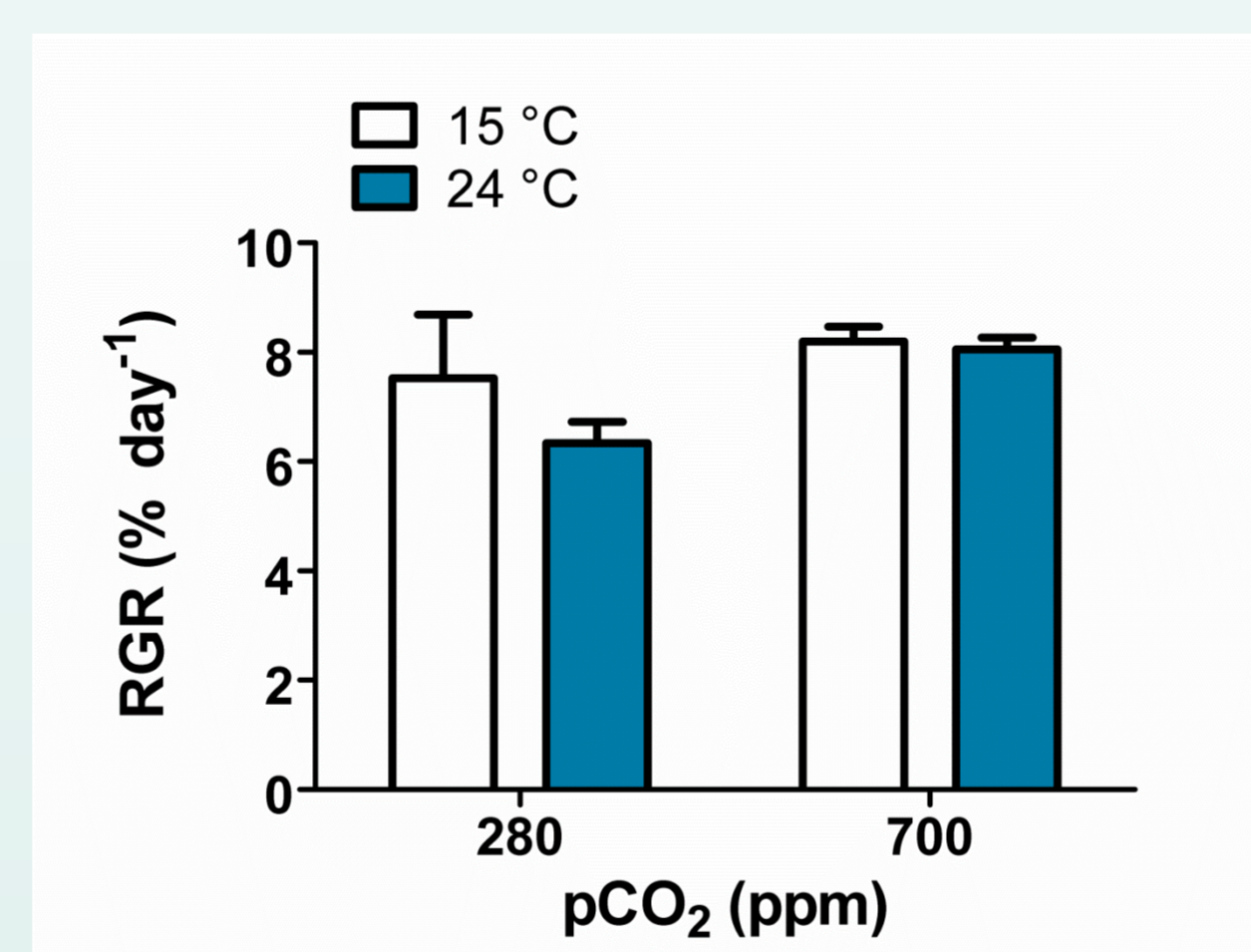


Data from: Seliger 2012

Chondrus crispus

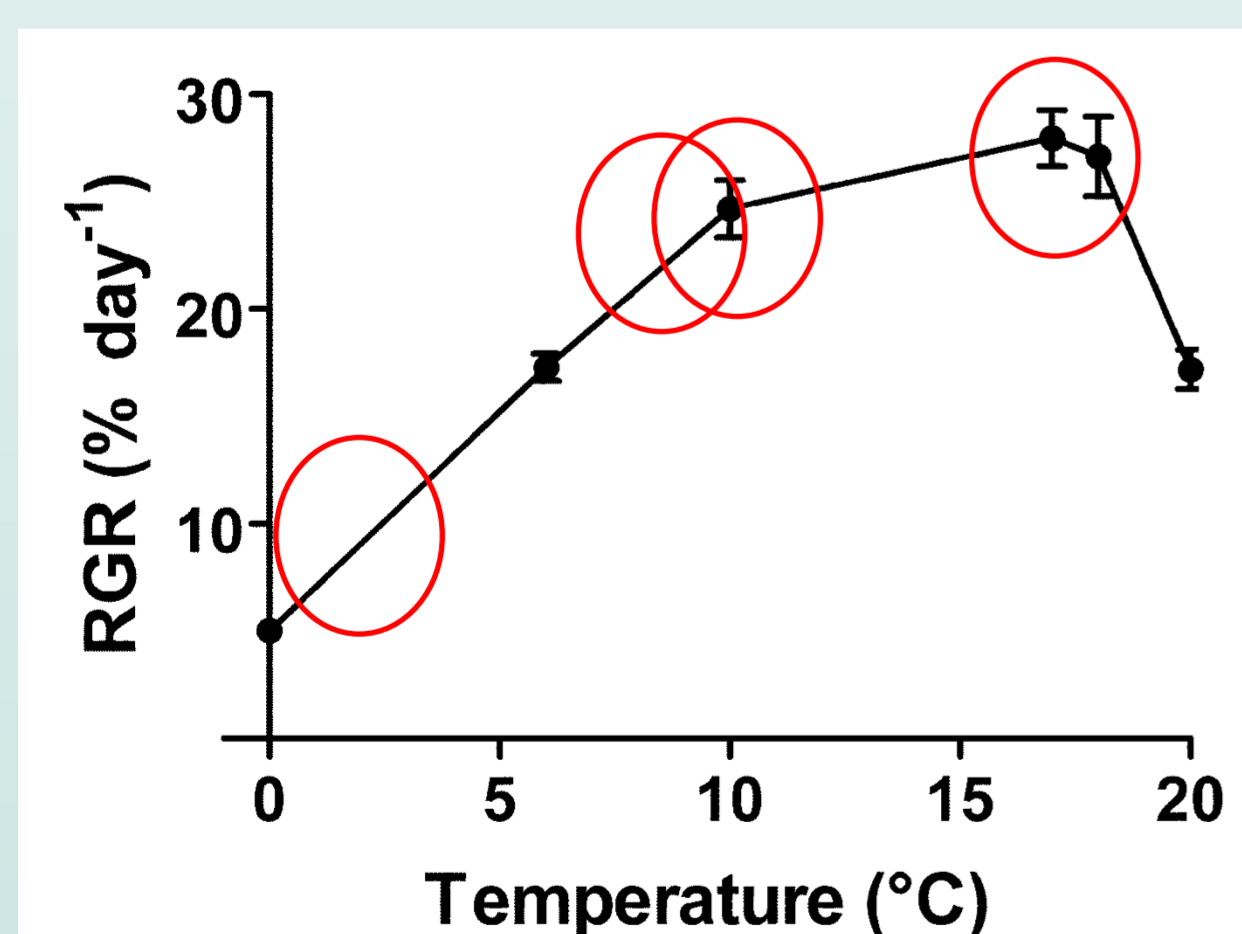
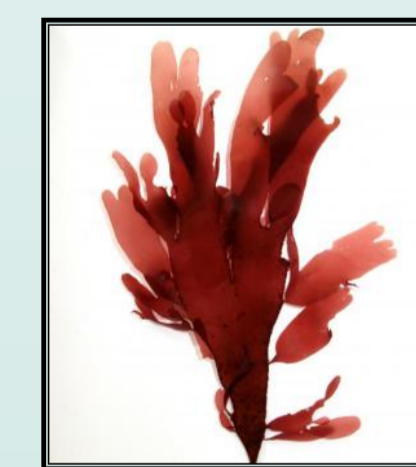


Fortes and Lüning 1980, Helg. Meeresunters 34: 15-29

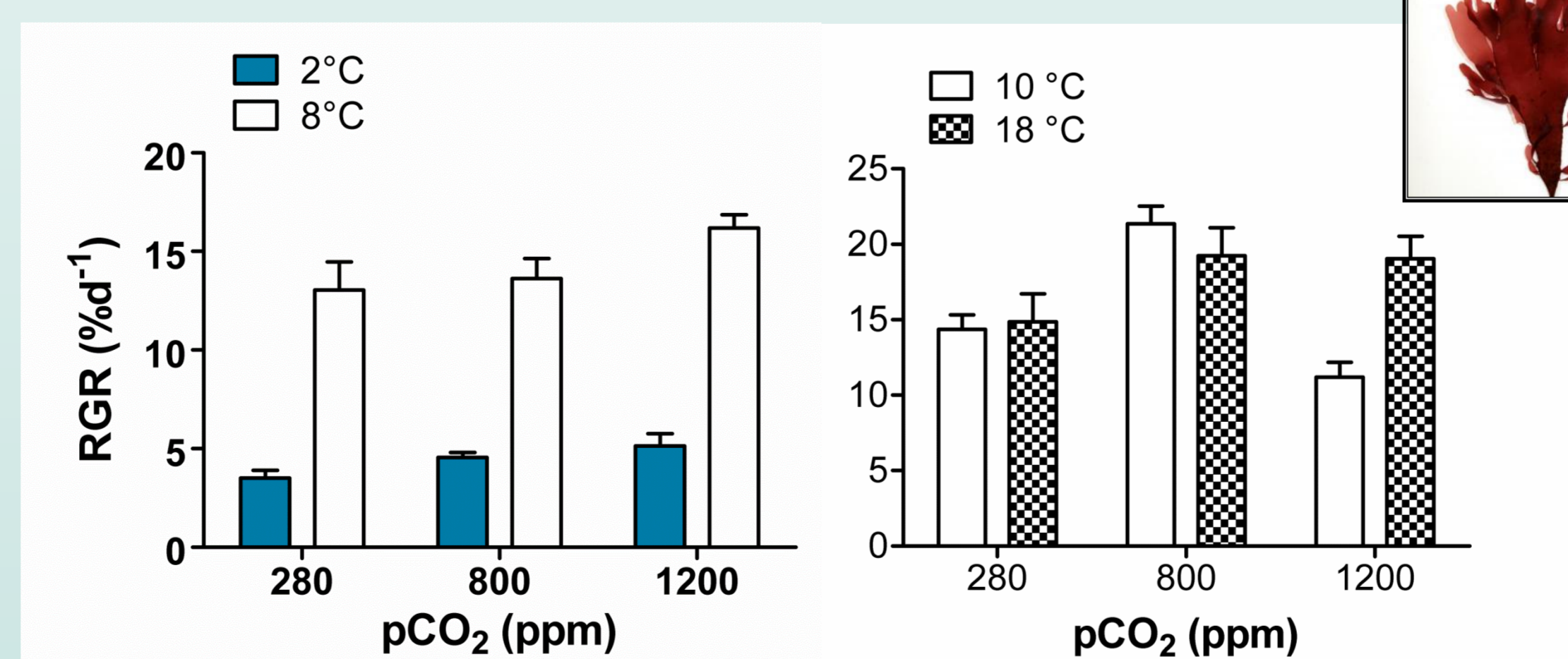


Sarker et al 2012, Bot. Mar., in press, modified

Palmaria palmata



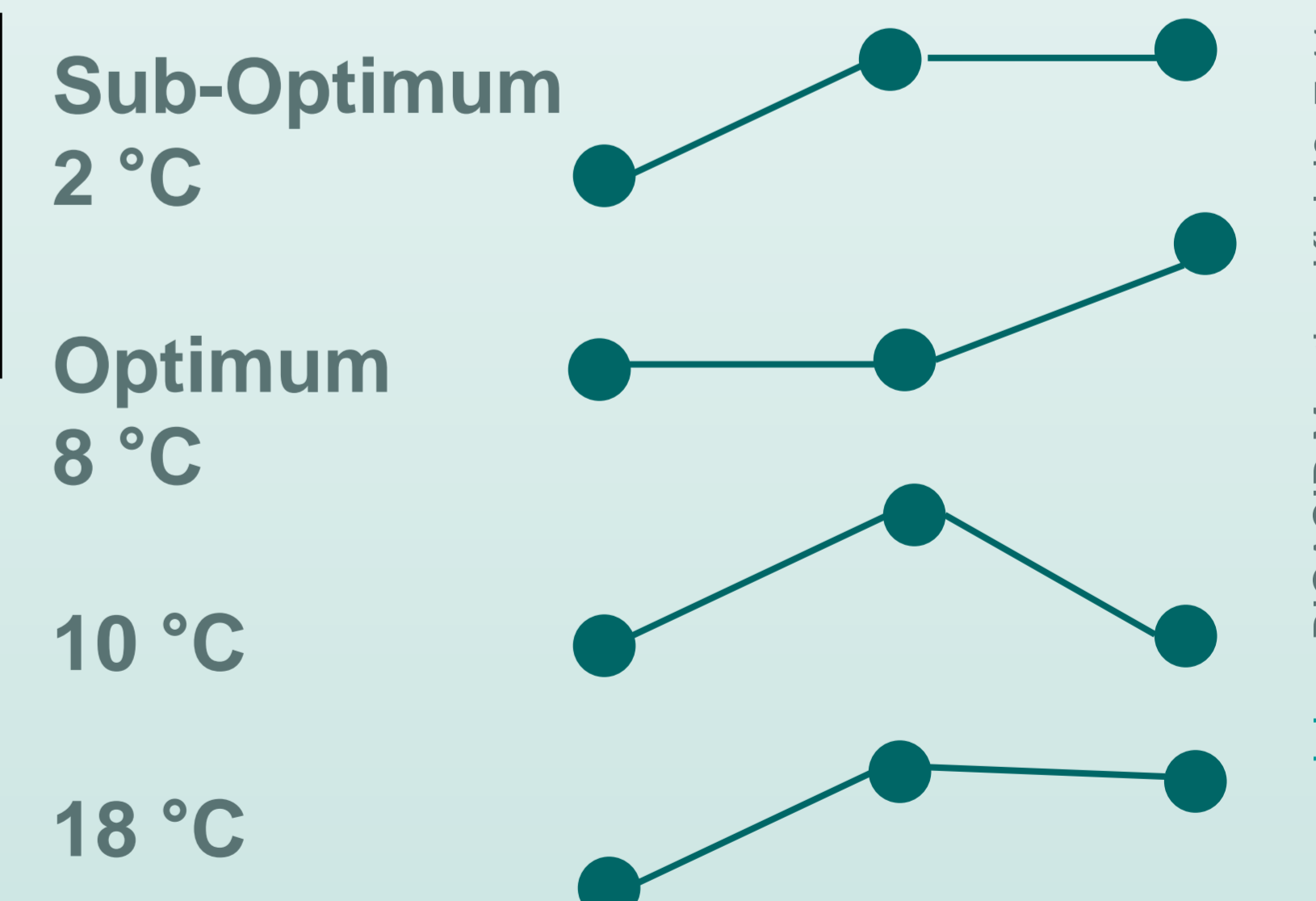
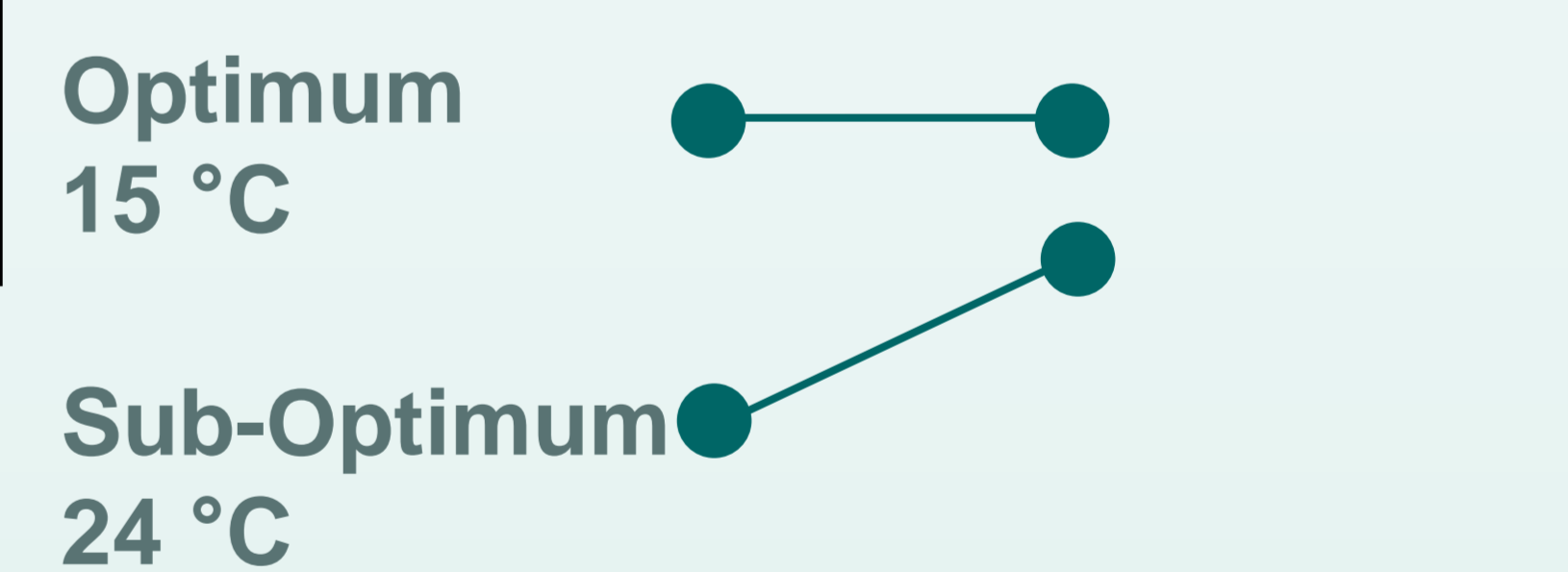
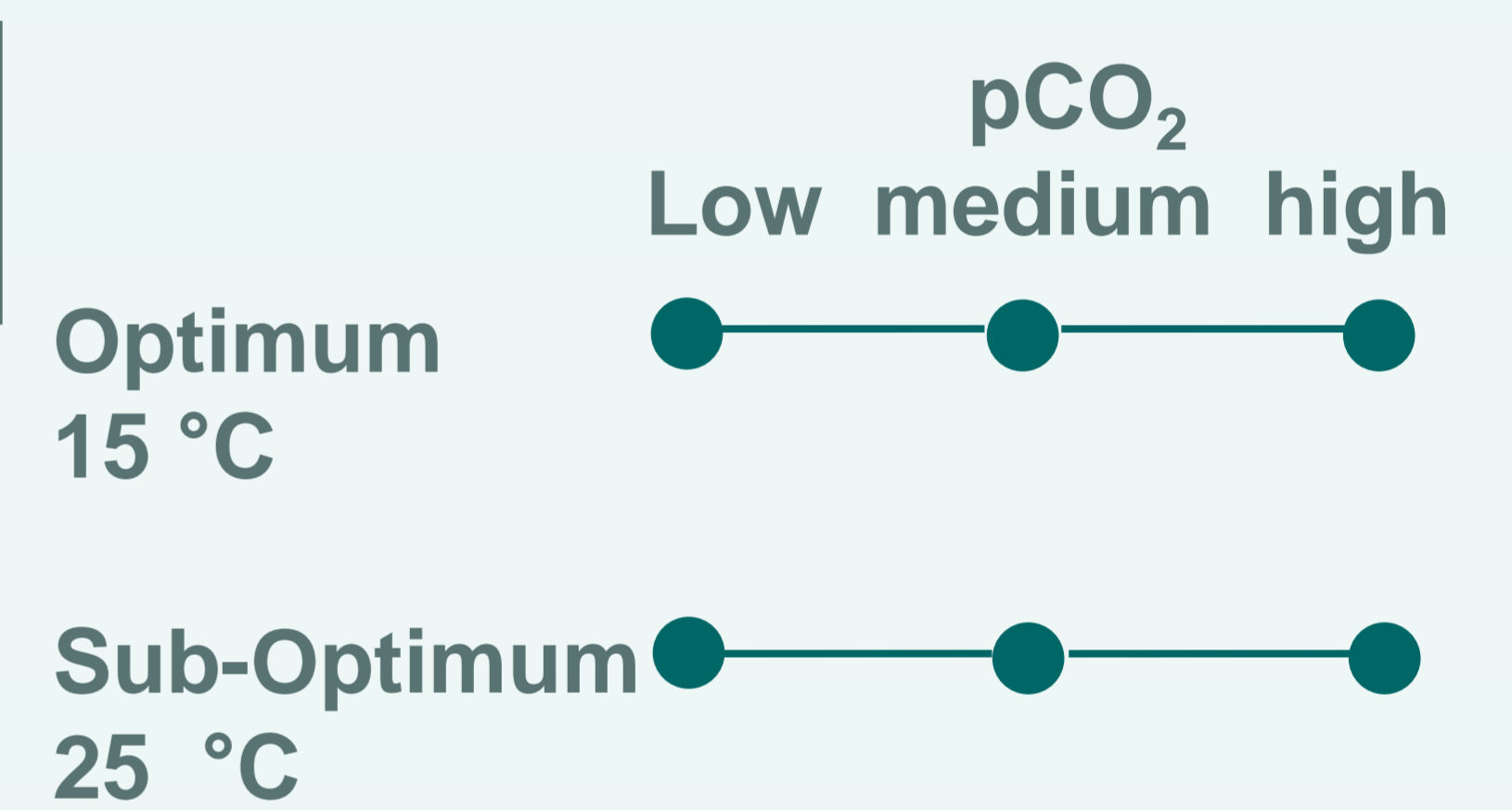
Data from: Teegen 2011



Data from: Babuder 2012

Data from: Teegen 2011

Response pattern



Different heights of points represent significant growth increase or decrease

Summary

Growth response of benthic red algae to CO₂ is species specific: the three investigated species which grow along an intertidal shore gradient, represent **three different CO₂ response types**:

- *Mastocarpus* is **insensitive** towards CO₂ variations irrespective of temperature
- *Chondrus* ameliorates its performance **under sub-optimum temperature conditions only**
- *Palmaria* **generally benefits** from enhanced CO₂ but to a varying degree depending on the temperature