Response of calcified and noncalcified southern California macroalgae to increased CO_2 and temperature

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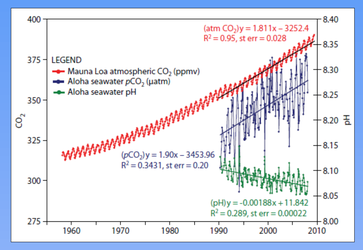
OCEAN ACIDIFICATION



Ocean Acidification (OA) is the result of increasing carbon dioxide (CO_2) in the atmosphere. CO_2 is absorbed by the ocean and results in a more acidic ocean with a lower pH_1

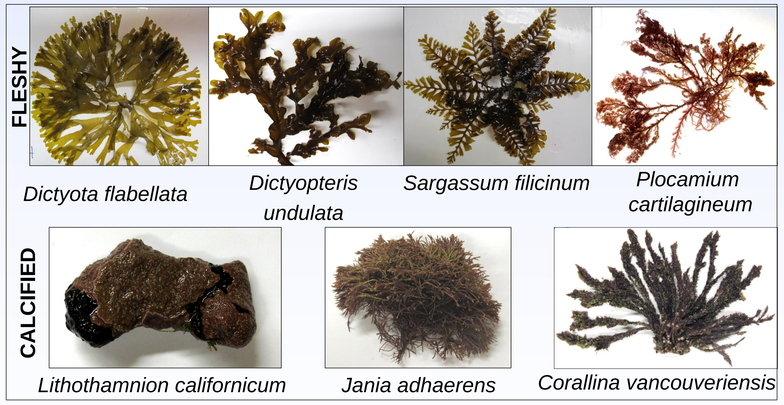
Species will respond differently to OA

- **Calcified** macroalgae may be **negatively** affected[2]; reduced carbonate concentration could make it harder to create a calcified skeleton
- **Fleshy** seaweed may be **positively** affected by being fertilized for productivity, **or not affected**

Increasing ocean temperature may further help or harm macroalgae

IMPORTANCE OF MACROALGAE

- 3-dimensional structures that define the habitat and provide primary productivity
- Shelter, food, protection and important juvenile and nursery habitats for fish and invertebrates
- Release chemical cues signaling invertebrate larvae to induce settlement and metamorphosis

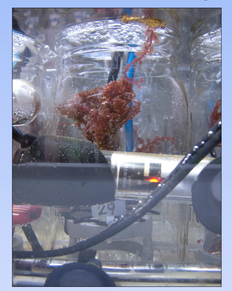


(1) Sabine CL, et al.,(2004), The Ocean Sink for Anthropogenic CO_2, *Science*, 305(5682): 367-371. (2) Orr JC, et al., (2005), Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms, *Nature*, 437:681-686. (3)Doney SC, et al., (2009), Ocean acidification: the other CO_2 problem, *Annu Rev Mar Sci* 1:169-192. (4) Todgham AE, Hofmann GE (2009) Transcriptomic response of sea urchin larvae *Strongylocentrotus purpuratus* to CO_2-driven seawater acidification, *J Exp Biol* 212:2579-2594.

METHODS

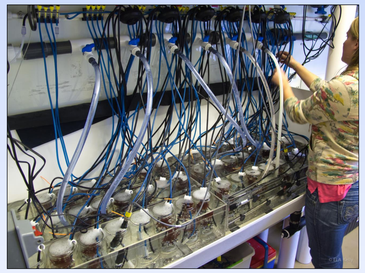
Specimens were placed in 1-liter glass mason jars and continuously supplied with flow-through filtered seawater

CO_2 treatment conditions were created by constantly bubbling a CO_2-air blend into each individual treatment mesocosm at a rate that lowered the pH_{SW} by 0.2 ± 0.05

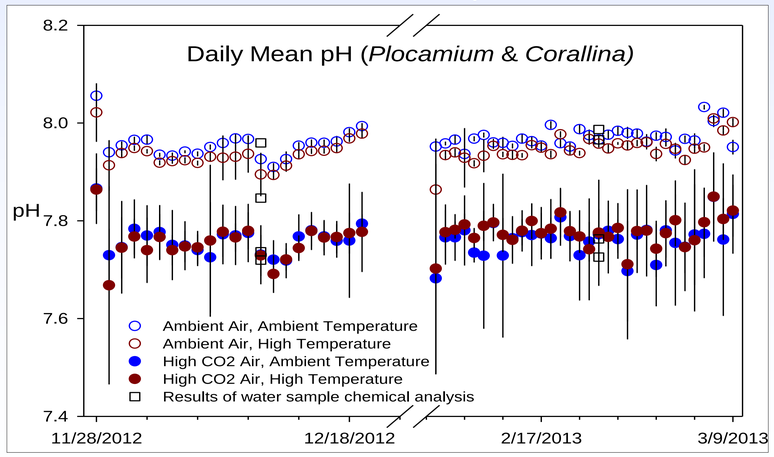


A temperature increase treatment of 2ºC ± 0.05ºC was included using water baths and aquarium heaters

Growth rates were calculated from change in weight



Maximum quantum yield of chlorophyll fluorescence was determined using pulse amplitude modulated fluorometer (Diving PAM, WALZ)



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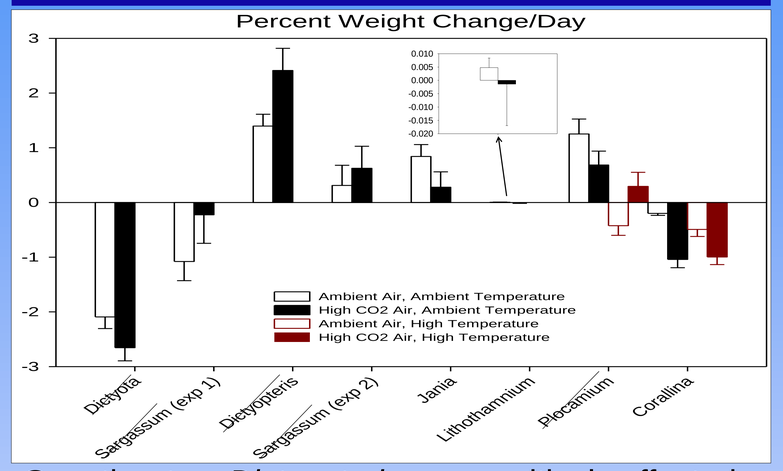
RESULTS



Growth rates: *Dictyopteris* was positively affected by CO_2. *Plocamium* was only affected by CO_2 under increased temperature and *Corallina* was affected by CO_2 and/or temperature increase. Chlorophyll fluorescence was not affected by either treatment

CONCLUSIONS

Most OA studies to date have focused on corals[3], and commercially important invertebrates[4]. Fewer studies have examined the effects of OA on macroalgae and this is one of the first studies to examine these fleshy and noncalcified species. While results varied, there were **significantly positive effects of increased CO_2 on one fleshy alga** and all three **calcified algae showed a negative growth trend**. Increased temperature negatively affected *Plocamium* and *Corallina*. However, when both temperature and CO_2 were increased, *Plocamium's* growth rate increased whereas *Corallina's* was not affected. **The combination of increased temperature and CO_2 affected both fleshy and calcified algae but in different ways, demonstrating the need to investigate the effects of ocean acidification and global warming together**