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Effects of ocean acidification on the growth of the flat-tree oyster, Isognomon alatus

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Effects of ocean acidification on the growth of the flat-tree oyster, *Isognomon alatus* (Gmelin, 1791)

By

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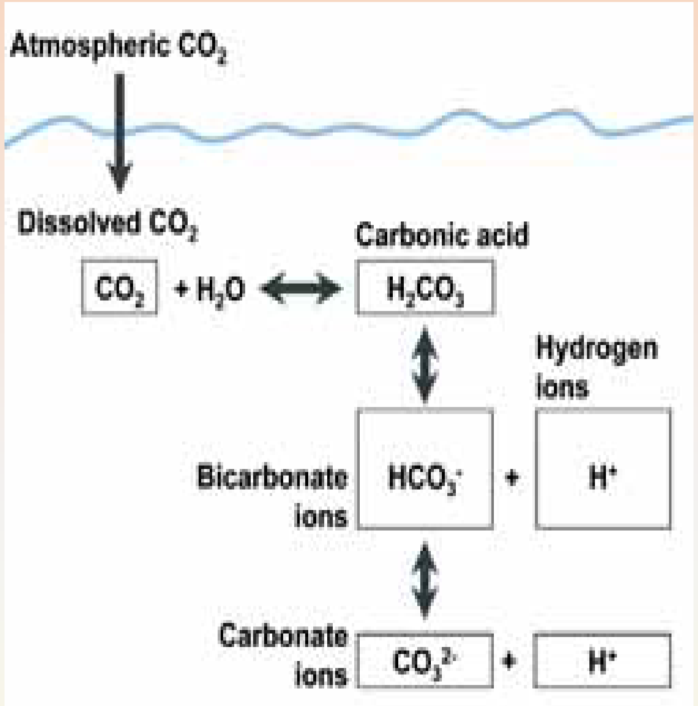
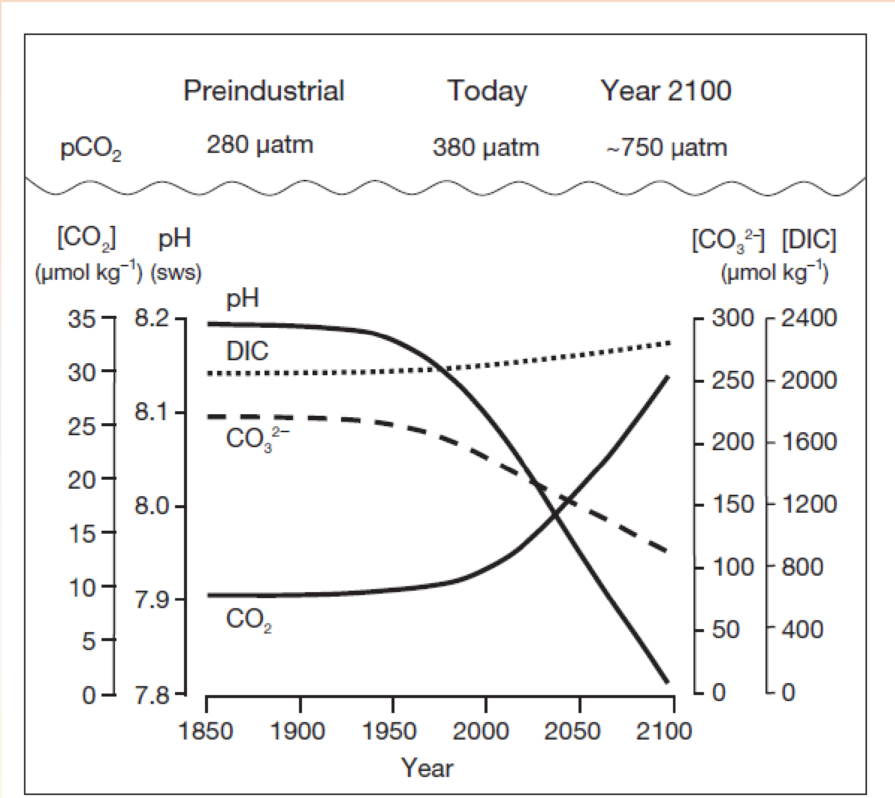
Background

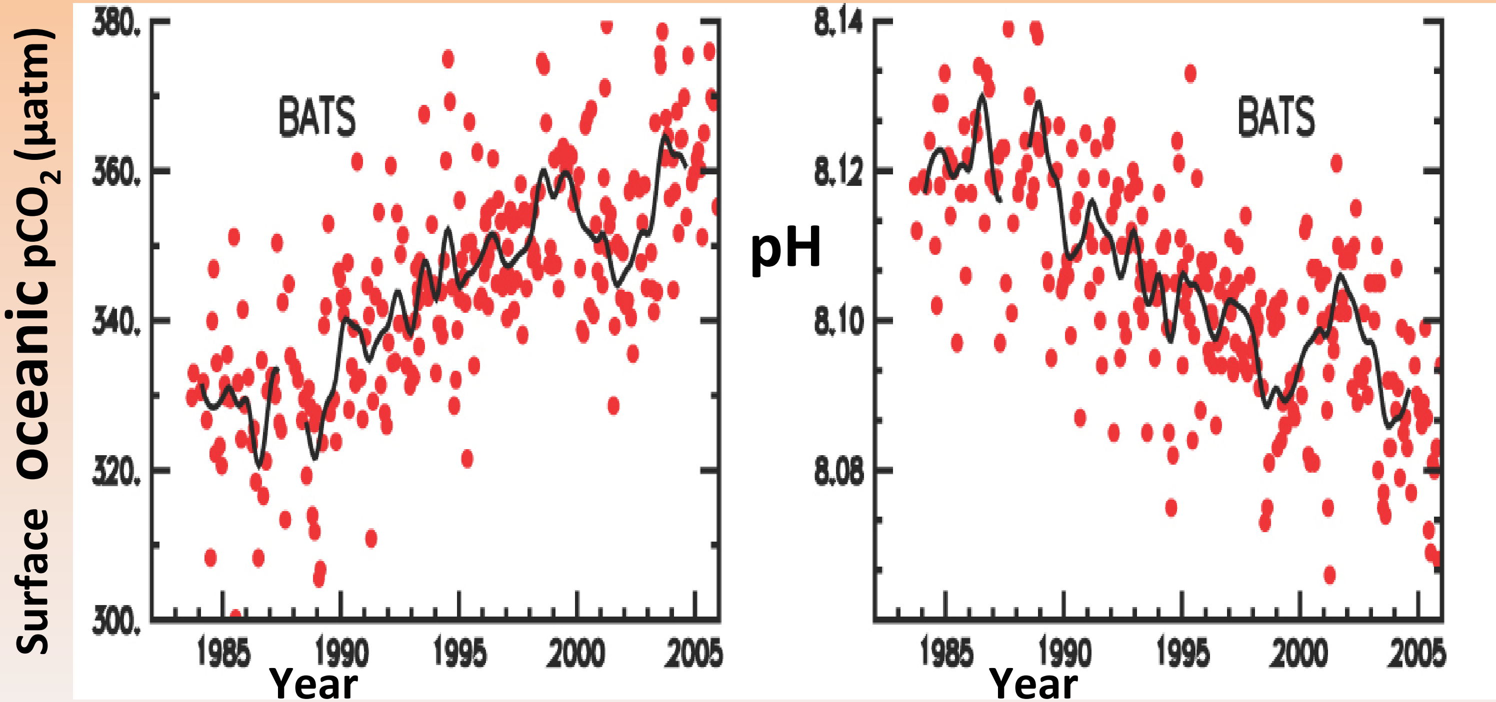
•Shift in the carbonate system equilibrium towards higher CO_2 and lower carbonate ion concentrations





Source : Wolf-Gladrow et al.,1999

Introduction



Source: Modified from IPCC, 2007

- Increasing pCO_2 , decrease pH, decrease carbonate ion (CO_3^{2-})
- 10 % decrease in calcification of oysters (~740 µatum , pH -7.8 , 2100)
- Economic importance of *Isognomon alatus*

Objective :

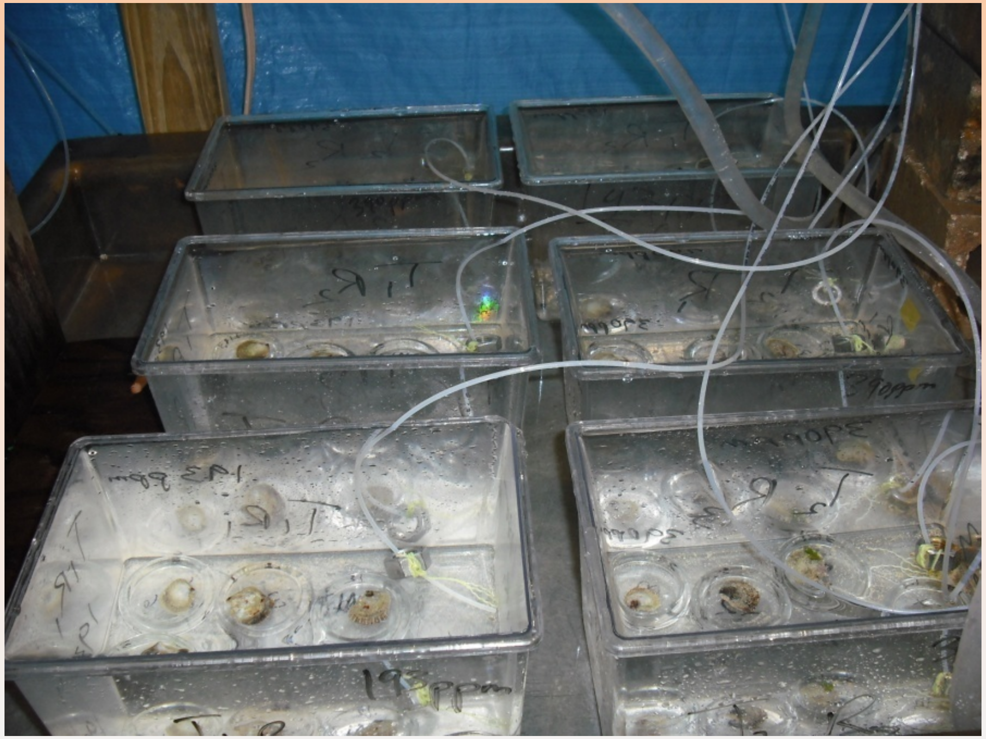
- To evaluate the effect of increased seawater pCO_2 (seawater pH, 7.8 -7.9) on growth rate of *Isognomon alatus* (flat-tree or mangrove oyster).

EFFECTS OF OCEAN ACIDIFICATION ON CALCIFYING ORGANISM

$$Ca^{2+} + CO_3^{2-} \leftrightarrow CaCO_3$$

Species	Cultured pH, CO_2	Duration	Results	Source
Limacina helicina	7.78	30 days	28% decrease in clarification rate	Comeau et al. 2009,
Mytilus edulis and *Crassostrea gigas* 	740 ppm	2 hours	decrease in calcification rate 25% and 15% respectively	Gazeau et al., 2007
Crassostrea gigas	7.4	48 hours	Inhibited larval development	Kurihara et al., 2007
Mytilus galloprovincialis	7.3	3 months	significant decrease of growth rate	Michealidis et al., 2005 Kurihara et al., 2009

EXPERIMENTAL SET UP



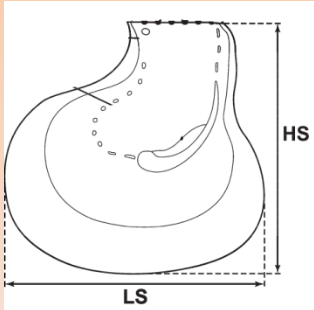
Control -Natural seawater, pH 8.1 - 8.2

Acidification - acidified seawater, pH 7.8 - 7.9

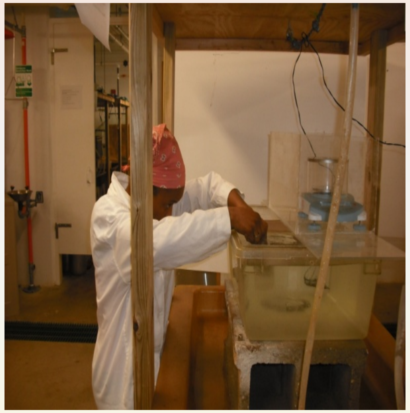
Field Experiment

3 stations transect (A to C) at Mangrove Bay, Ferry Reach, St George, Bermuda (32°37’16’’N, 64°41’38’’W, Area of 70m x 70m and average depth of1.014017m)

DETERMINATION OF SHELL MORPHOLOGICAL AND ENVIRONMENTAL PARAMETERS



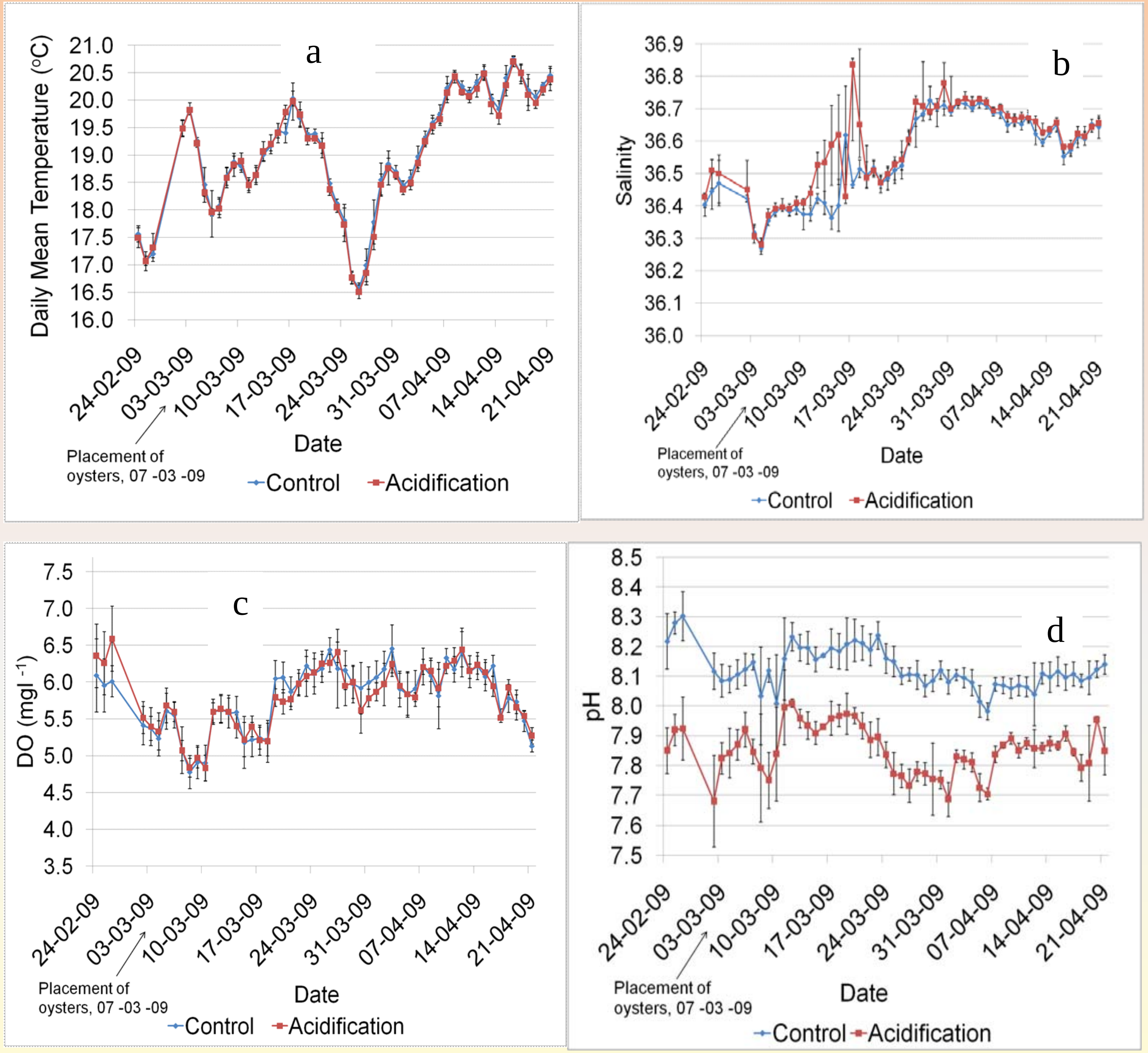
- Height
- Length
- Thickness



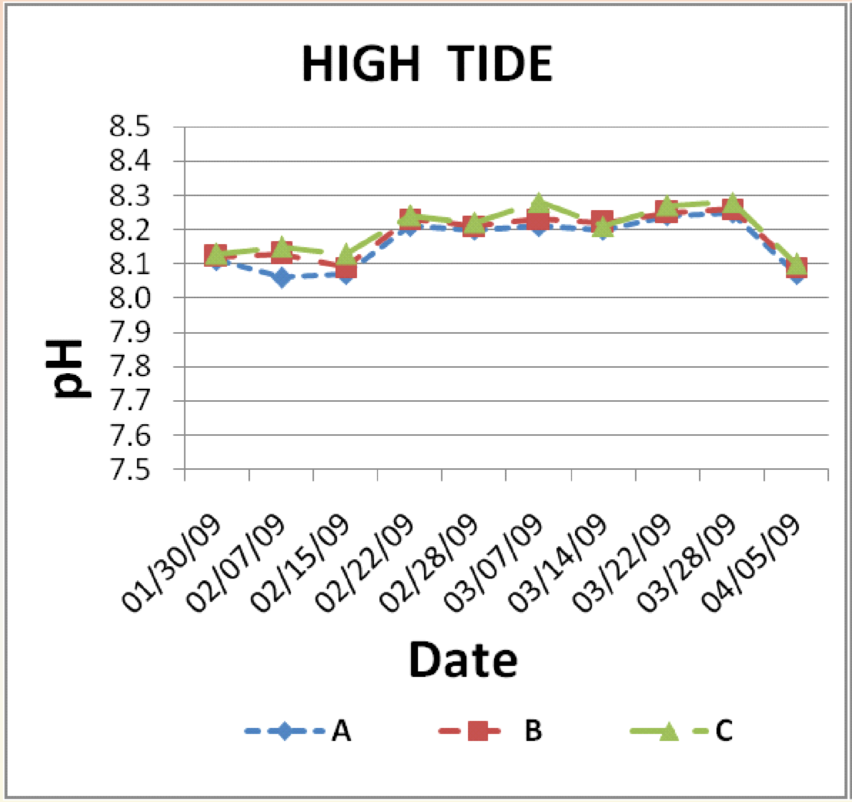
- Buoyant Weight Technique

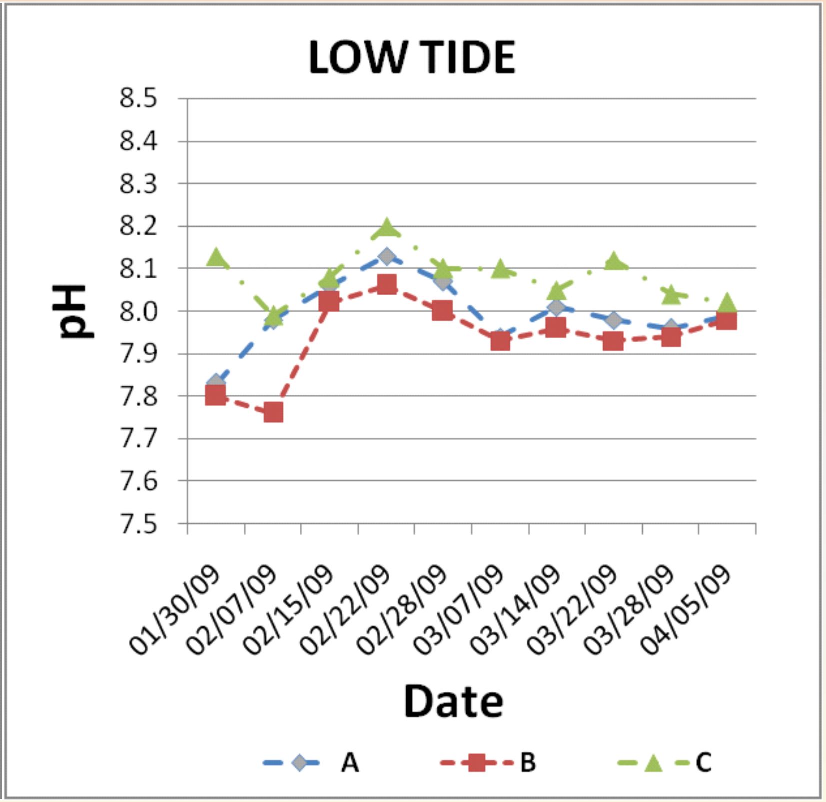
- Temperature
- Salinity
- DO (%)
- DO (mg/l)
- pH

Results: Environmental Parameters

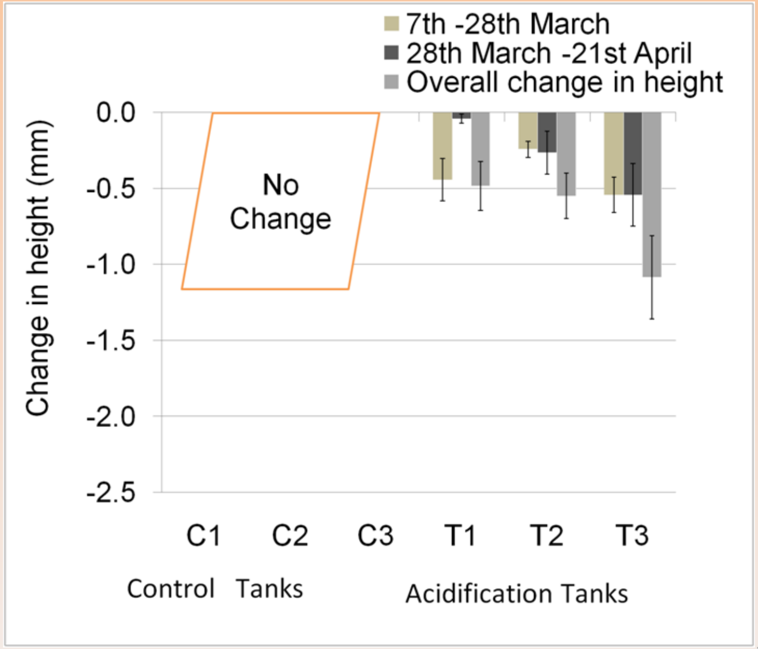


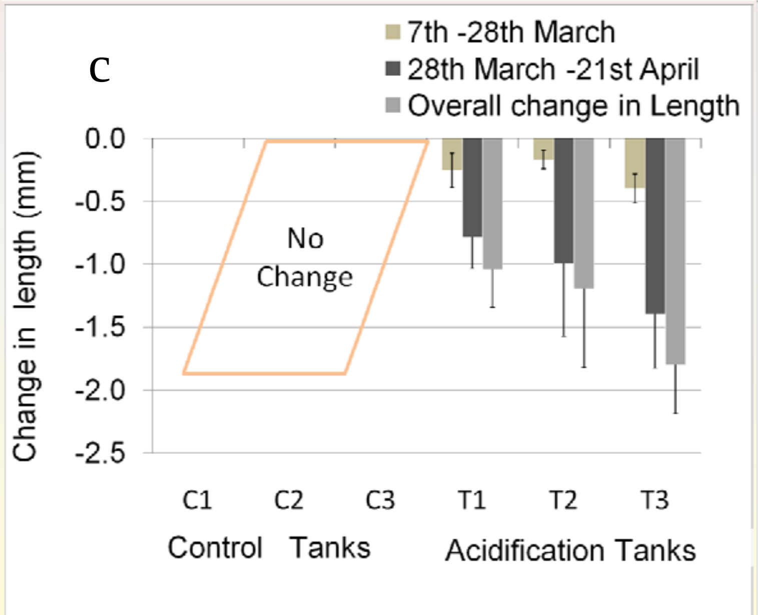
Natural variation of pH in Mangrove Bay

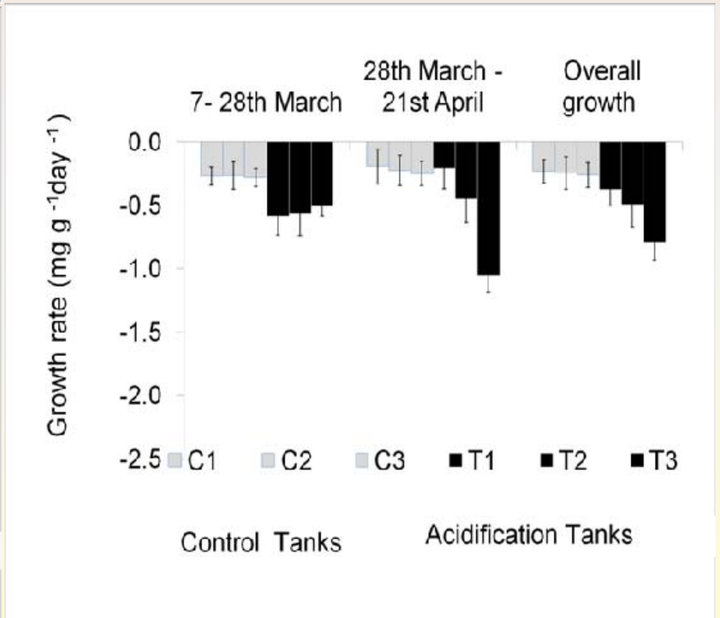




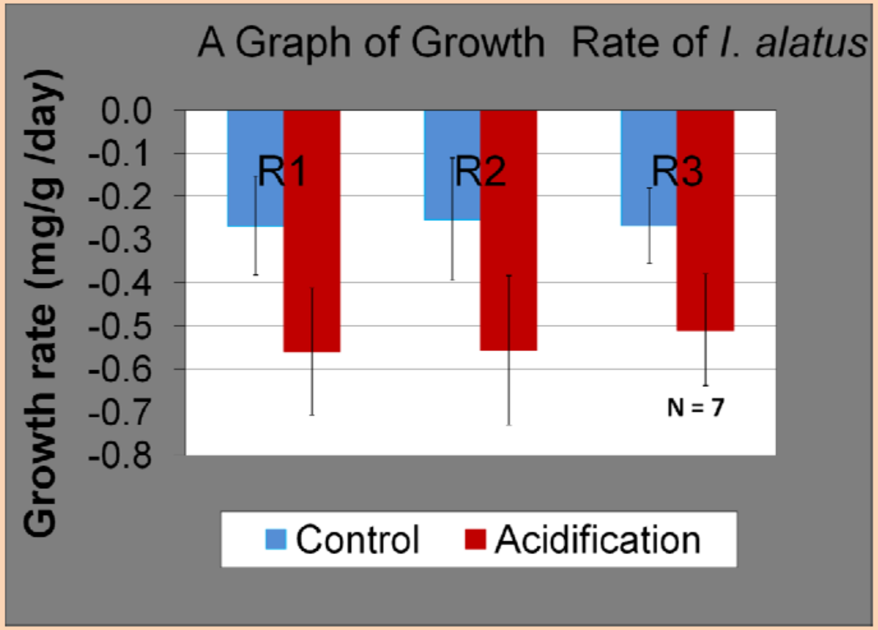
SHELL MORPHOLOGICAL PARAMETERS AND GROWTH RATE (1)



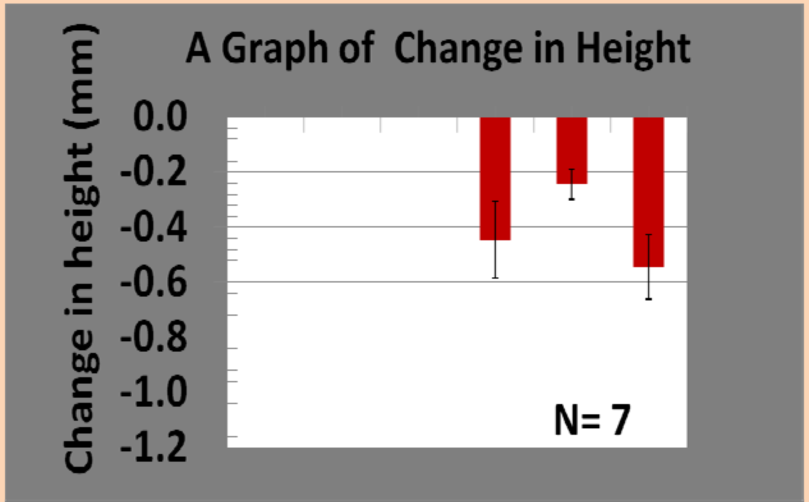


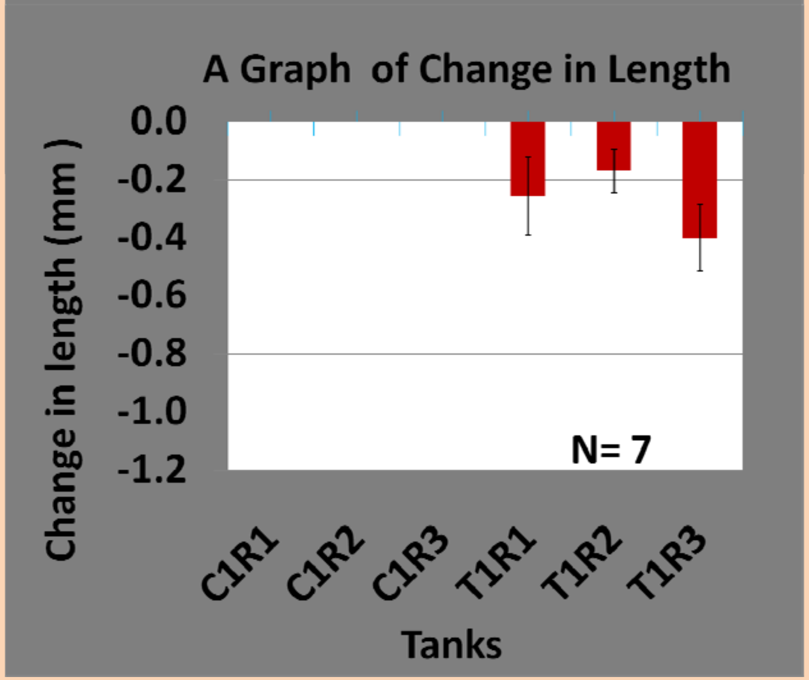


SHELL MORPHOLOGICAL PARAMETERS AND GROWTH RATE (2)

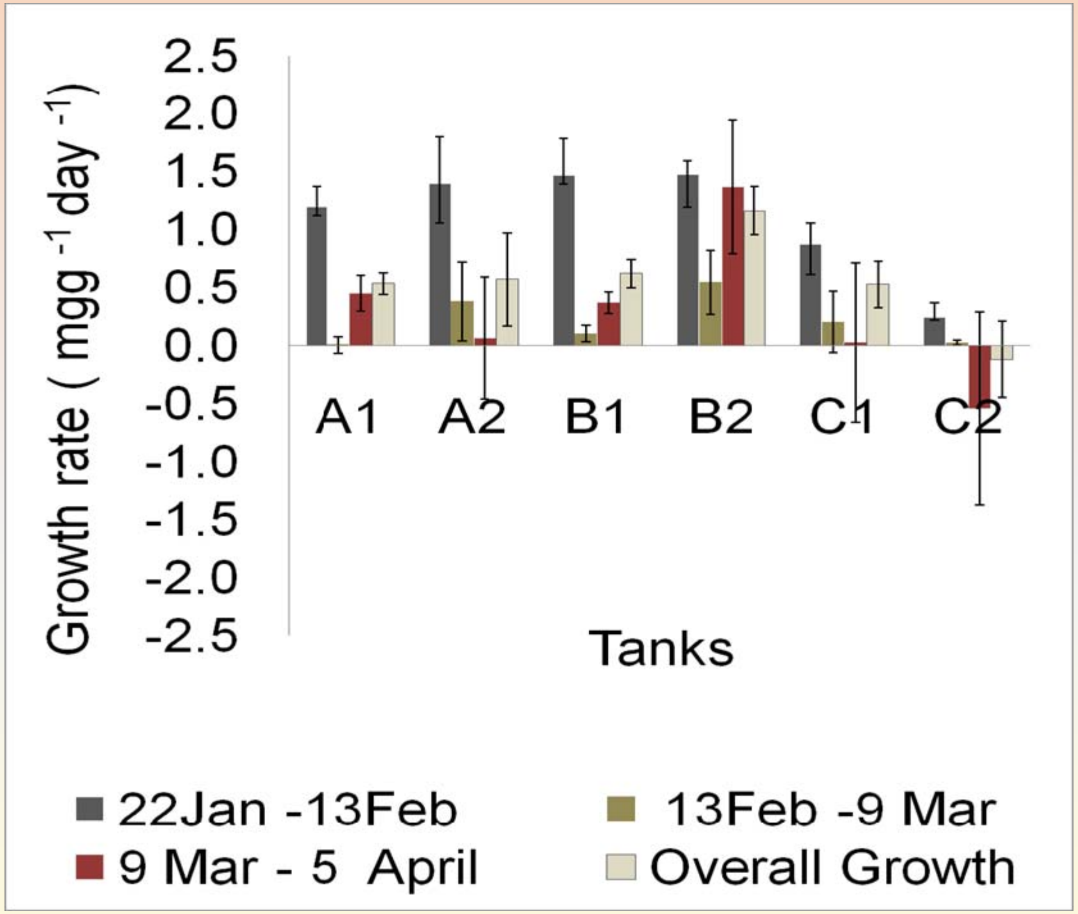


7th -28th March 2009
28th -21st April 2009
Overall:7th March-21st April 2009



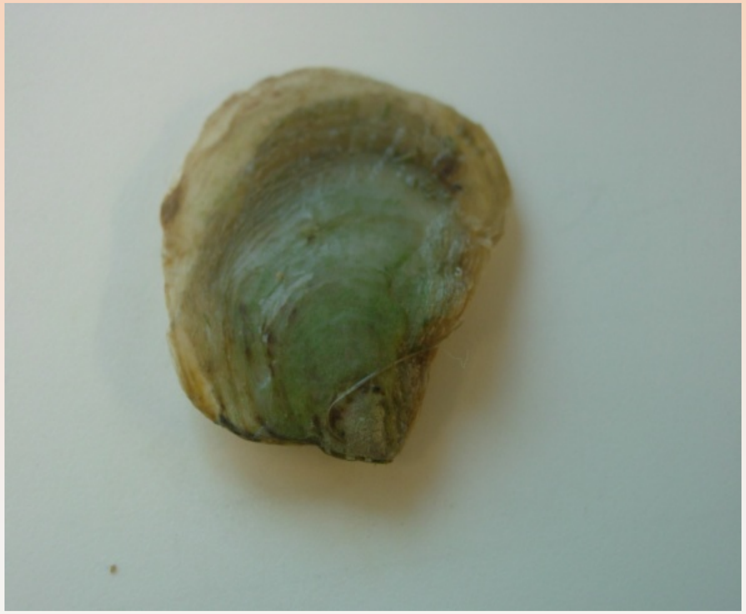


RESULTS FROM THE FIELD EXPERIMENT



Isognomon alatus

An example of ***Isognomon alatus*** exposed to natural seawater



An example of ***Isognomon alatus*** exposed to acidified seawater indicating changes in shell morphology

Conclusion

- *I. alatus* lost weight and experienced negative growth rates of –0.56 $\pm$ 0.36 mg $g^{-1}day^{-1}$ under average pH_{total} values of 7.8 compared to a loss of –0.26 $\pm$ 0.23 mg $g^{-1}day^{-1}$ under average ambient pH_{total} conditions of 8.1.

- *I. alatus* incubated in a natural environment showed gain in weight and positive growth despite exposure to pH levels (~7.4) during low tide.

- Ocean acidification could have drastic negative consequences on *I. alatus*, but that additional factors (e.g., food availability) need to be considered in evaluating the response of this marine calcifier to these ongoing perturbations.

ACKNOWLEDGMENT

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- Dr. Samantha de Putron
- Dr. Anthony H. Knap
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- BIOS staff
- Pogonians (2008/2009@BIOS**)**

Photo: Andreas

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Literature Cited

- Comeau S, Gorsky G, Jeffree R, Teyssi´e JL, Gattuso JP (2009) Key Arctic pelagic mollusc (*Limacina helicina*) threatened by ocean acidification Biogeosciences Discuss., 6: 2523–2537, www.biogeosciences-discuss.net/6/2523/2009

- Gazeau F, Quiblier C, Jansen JM, Gattuso JP, Middelburg JJ, Heip CHR (2007) Impact of elevated CO_2 on shellfish calcification. Geophys Res Lett 34, L07603. doi: 10.1029/2006GL028554

- Kurihara H, Kato S, Ishimatsu A (2007). Effects of increased seawater pCO_2 on early development of the oyster *Crassostrea gigas*. Aquat Biol1: 91–98, doi: 10.3354/ab0000

- Kurihara H, Asai T, Kato S, Ishimatsu A (2009) Effects of elevated pCO_2 on early development in the mussel *Mytilus galloprovincialis*, Aquat Biol 4: 225–233, doi:10.3354/ab00109

- Michaelidis B, Ouzounis C, Paleras A, Pörtner HO (2005) Effects of long-term moderate hypercapnia on acid–base balance and growth rate in marine mussels *Mytilus galloprovincialis*. Mar Ecol Prog Ser 293: 109–118.

- IPCC (2007) Climate Change 2007: The Physical Science Basis. Working group 1 Contribution to the Fourth Asessment Report of the Intergovernmental Panel on Climate Change.

THANK YOU

The Power of 10

In October 2008 the Bermuda Institute of Ocean Sciences (BIOS) welcomed ten students from around the globe, to complete a ten-month training course in observational oceanography. Because of the Institute's excellent teaching resources and capacity to provide students a very practical, hands-on experience of marine science, BIOS was chosen to be this Nippon-funded "Centre of Excellence" for the Partnership for the Observation of the Global Oceans (POGO).

POGO is an international consortium of oceanographic institutes, which has the aim of improving global cooperation and communication in ocean observations. Two thirds of the world's oceans are in the southern hemisphere, yet most of our well-resourced academic centres for this discipline are in the northern hemisphere. With oceanography at the centre of the pressing issue of global climate change, a global approach to the problem is the one likely to have any success.

The idea of the Centre of Excellence arose to address the related need for specialised training in observing the ocean. The 2008 programme that began at BIOS was the first Centre of Excellence for POGO, and so it was a learning experience for BIOS as well as for the POGO Scholars. As Dr. Gerry Plumley—the Director of the POGO programme—puts it: "Ten students, from ten developing countries, for ten months to take ten modules in observational oceanography. The power of ten. It sounded so easy ten months ago. And it has been. Largely. The time has passed quickly. Was the programme everything we hoped it would be? No. Was it more than we dreamed? Yes."

2009 POGOnian Scholars; Tiago Queiroz, Lailah Lartey-Antwi, Rene Campos, Catia Matias, Dr. Samina Kidwai, Houssem Smati, Toye Akinnigbagbe, Sebasitan Kreiger, Joseph Palermo and Nimit D.J.