ECOPHYSIOLOGICAL CHANGES OF A SIMPLIFIED CORAL REEF COMMUNITY FACING OCEAN ACIDIFICATION: A ONE YEAR STUDY IN ARTIFICIAL REEF MINICOSMS

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Highlight

A simplified reef community has been able to face increased pCO_2 during one year: calcification of hermatypic scleractinians were unchanged, or even enhanced for the *Pocilloporidae* family. The main bioeroders from this reef, *Echinometra mathaei*, was also able to deal with pCO_2 : unchanged growth, respiration or coelomic fluid pH. **Nevertheless bio-erosion increased: this could shift the balance between a calcifying and an eroding reef.**

Background

Ocean acidification, which is one consequence of increasing pCO_2 partially dissolving in the seawater, is today an undisputed fact. The future of coral reef ecosystem depends on the balance between the accretion of $CaCO_3$ by **calcifiers** and the **bio-erosion by eroders**. In this study, we describe the effects of a progressive higher pCO_2 (during 6 months reaching predicted pH for 2100) followed by 6 months of stable pH on a simplified reef community using original minicosms developed at UMONS.

Material and methods

Figure 1: Minicosm devices available at UMONS. Picture by Ph. Grosjean.

Two twin minicosms were developed, each composed of a control and an experimental tanks. Accurate control of pH, temperature, salinity, alkalinity, light, nutrients, etc is performed. **Physico-chemical conditions found in La Saline Lagoon, Réunion Island, are simulated including their daily variations.**

Parameter	Min - max values in minicosms	Field
Salinity	33.1 - 35.1	33.5-35.5
Temp.	25.0 - 26.5 °C	25.5 - 27°C
A_T (µmol. kg^{-1})	2300 - 2500	2320 – 2500
N (µmol. kg^{-1})	< 0.1 – 1.0	0.1 – 1
P (µmol. kg^{-1})	< 0.1 – 0.5	0.1 – 0.3

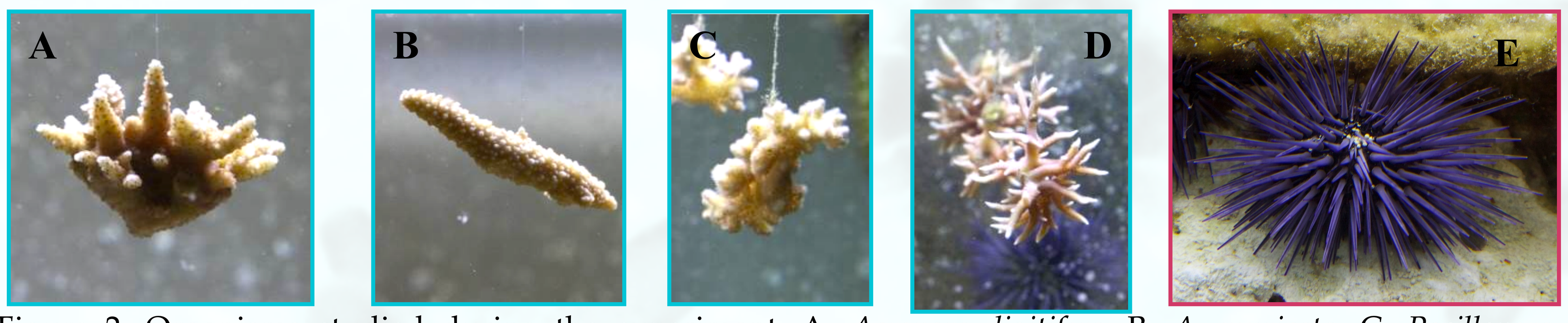

Figure 2: Organisms studied during the experiment. A: *Acropora digitifera*, B: *A. muricata*, C: *Pocillopora damicornis*, D: *Seriatopora hystrix* and E. *Echinometra mathaei*.

The **simplified reef community** was composed of **"reef building corals"** (hermatypic scleractinians; Fig. 2 A-D), important bio-eroders of the La Saline Reef, ***Echinometra mathaei*** (Fig.2 E) and also calcareous reef substrate containing algae, micro-organisms, gastropods, *etc*.

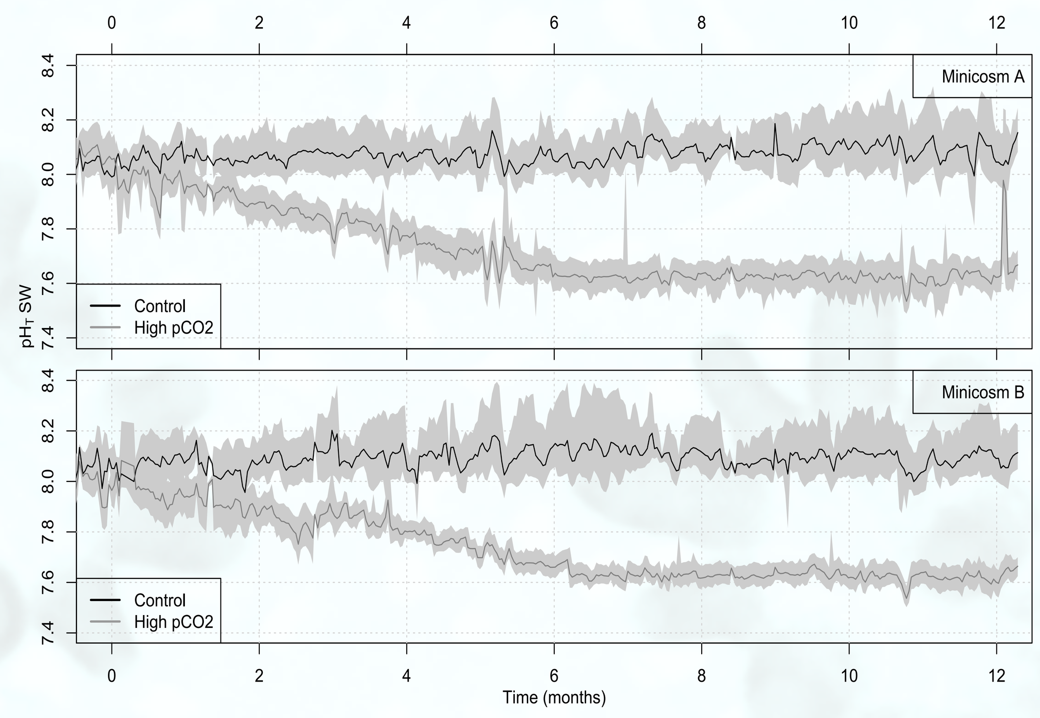

Figure 4: pH_T time course inside each experimental tank of both minicosms. Black lines represent the control tanks, grey lines represent the acidified tanks. Envelopes represent daily min and max values.

The **pH progressively decreased** in both acidified tanks during 6 months to reach mean pH_T of 7.65. The control tanks remained at a mean pH_T of 8.05.

Results

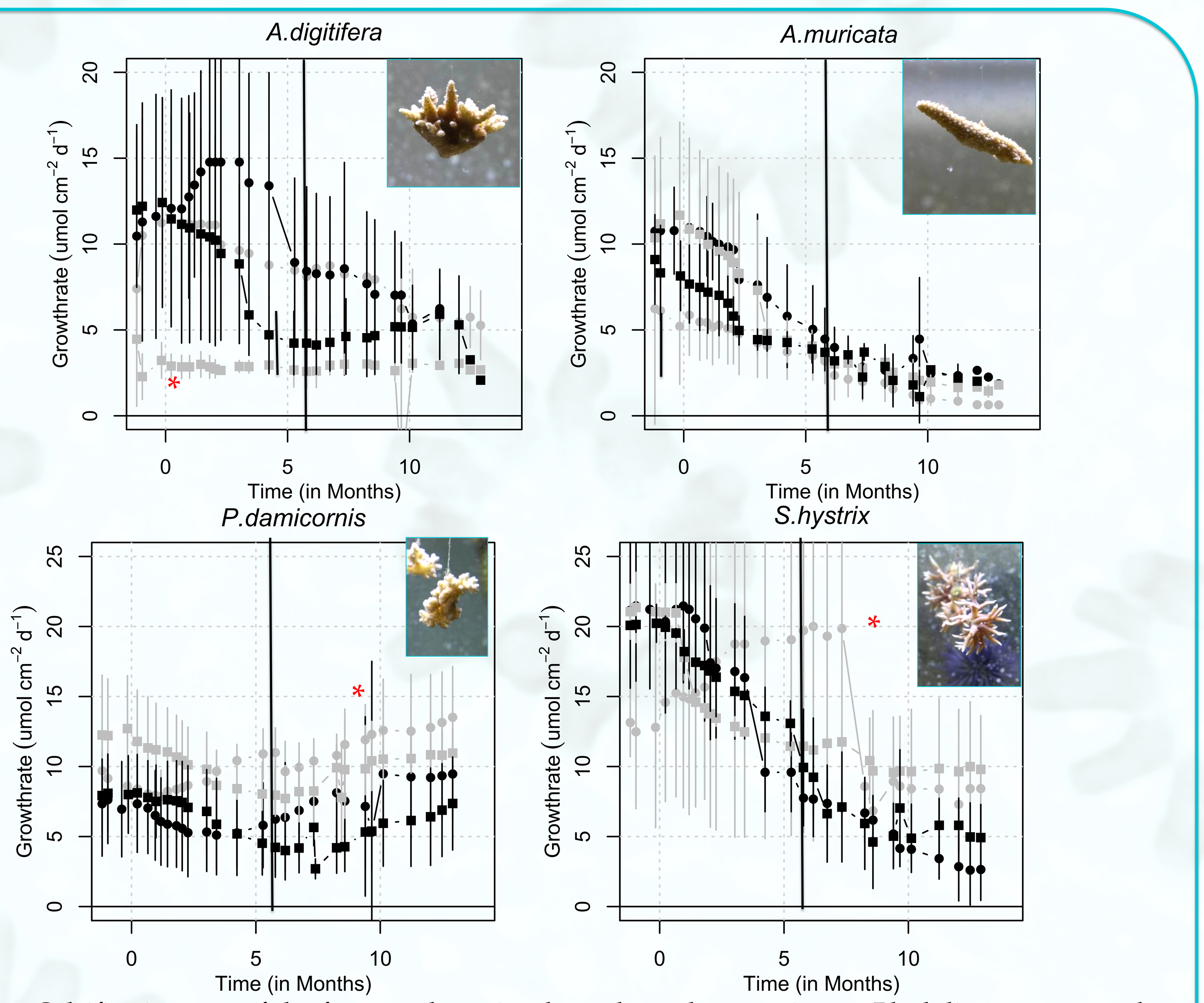

Figure 5: Calcification rate of the four coral species throughout the experiment. Black lines represent the control tanks, grey lines represent acidified tanks. Circles represent results from minicosm A, squares from minicosm B. Values are means ± sd. N=8.

Calcifiers of the simplified community had a family dependent response with higher pCO_2. ***Acroporidae* species** (Fig 5 A-B) **showed no significant difference of calcification rate except for *A. digitifera*** in one minicosm, while an **increase of calcification was observed for the *Pocilloporidae* family** (Fig 5 C-D) .

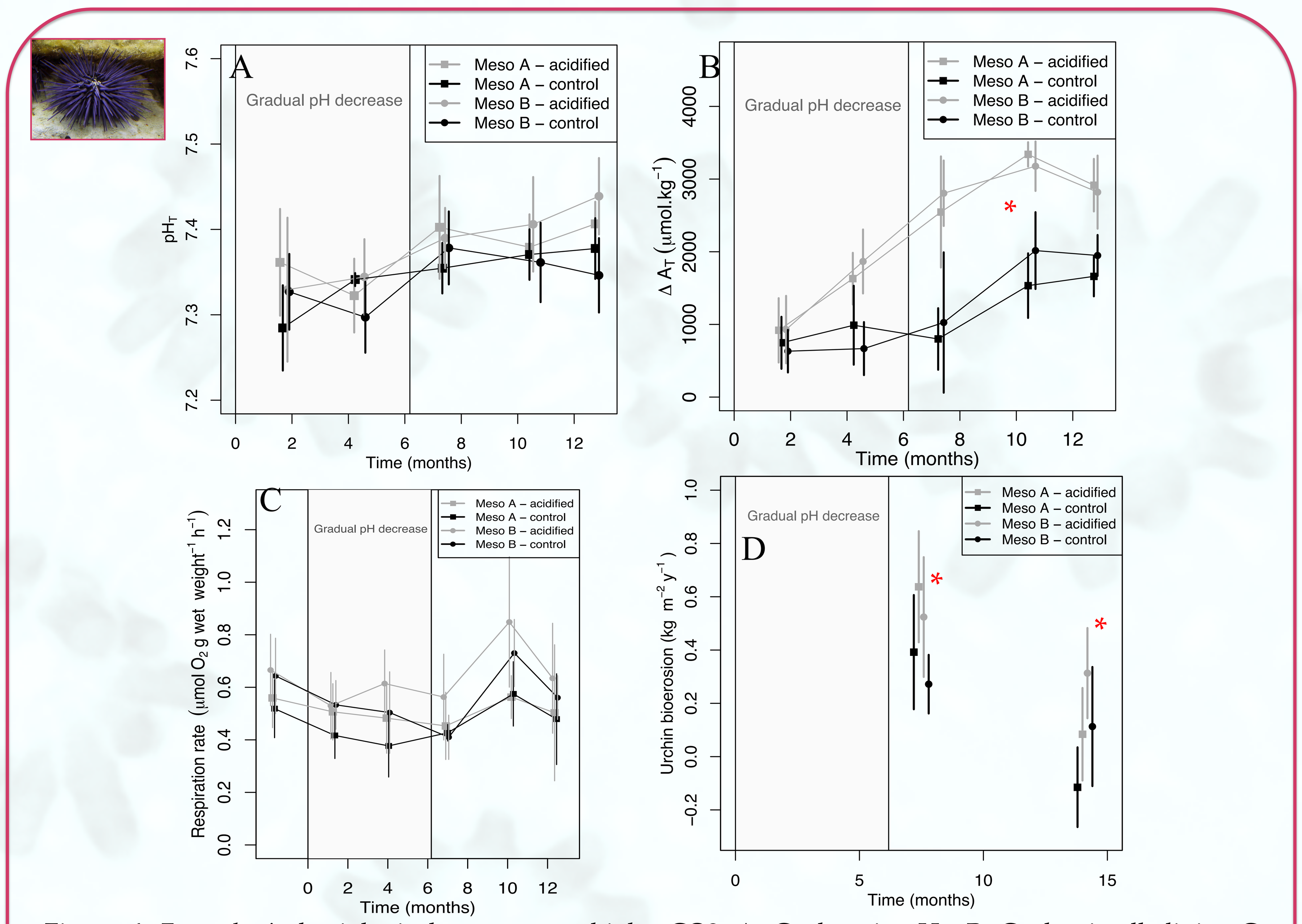

Figure 6: *E. mathaei* physiological response to high pCO2. A: Coelmocic pH_T, B: Coelomic alkalinity, C: respiration rate and D: bio-erosion rate. Black lines represent the control tanks, grey lines represent acidified tanks. Values are means ± sd. N=4

***E. Mathaei* was able to maintain its coelomic pH** (Fig. 6A) in acidified condition by increasing significantly its coelomic alkalinity (Fig. 6B). No difference of respiration was observed between control and treatment tanks (Fig 6C). Finally, **bio-erosion rate significantly increased with pCO_2** in both minicosms after 6 and 12 months.

Discussion and conclusions

The future of the coral reef ecosystems will depend on the balance between the reef accretion and erosion. Working at **ecosystem scale** was thus important to catch a global picture of the effects of a pCO_2 increase on the different organisms involved. **Minicosms devices were suitable for this kind of approach**. The present study highlighted that the **progressive pH decrease gave to organisms the possibility to acclimate to contrasted conditions.** In one hand, calcification of reef building corals was not impacted, and was even enhanced when confronted to acidified conditions.

On the other hand, *E. mathaei* physiology was also acclimated : no coelomic pH change and no respiration change neither. **Nevertheless an increase of the bio-erosion was observed: that could shift the balance of the reef even if the coral calcification is not impacted.** This balance depends on many other factors like temperature, eutrophication, *etc* that need to be further investigated, possibly in such kind of minicosms.