Effects of ocean acidification on the physiological profiles in the Japanese pearl oyster *Pinctada fucata*

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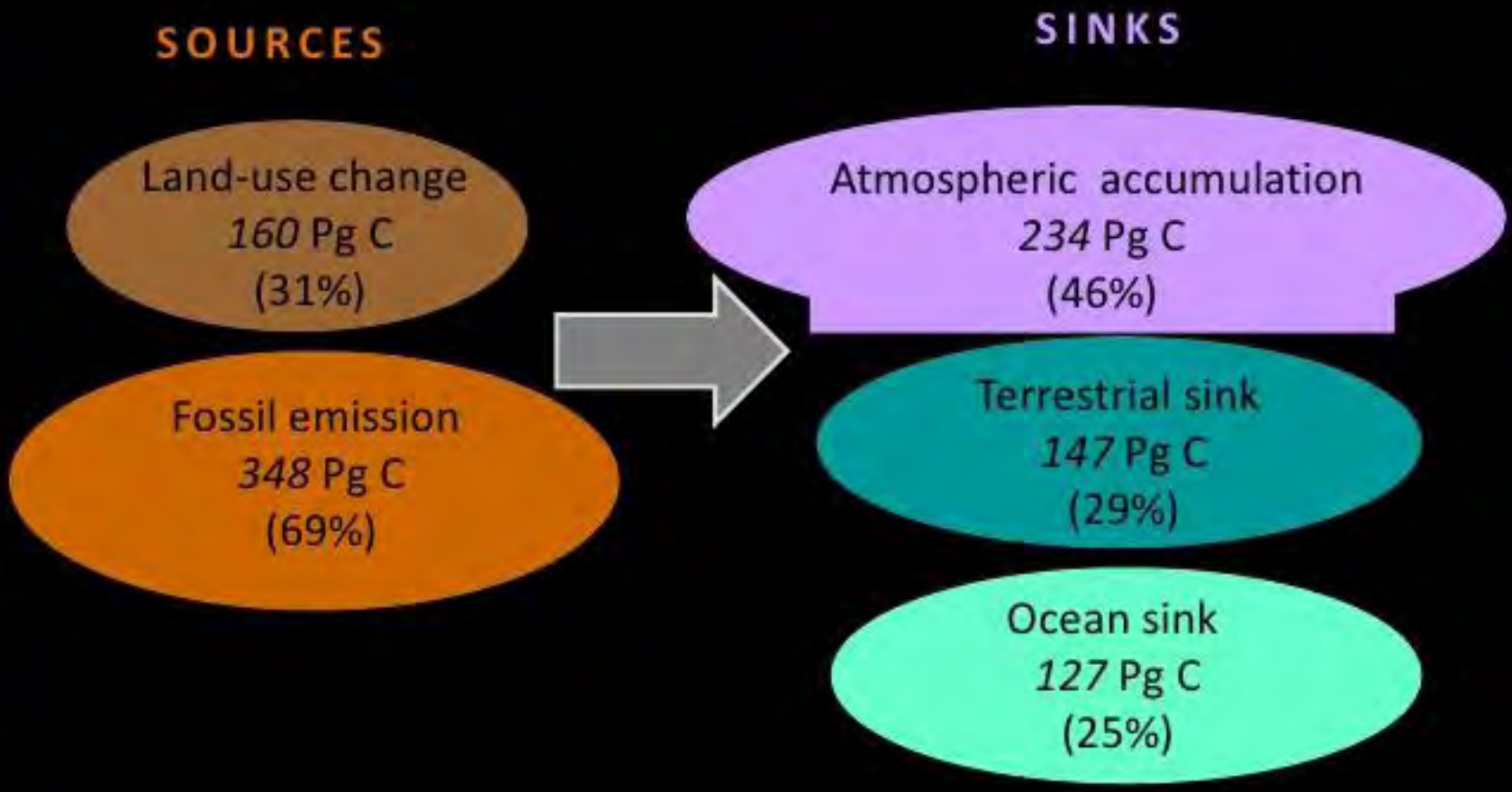
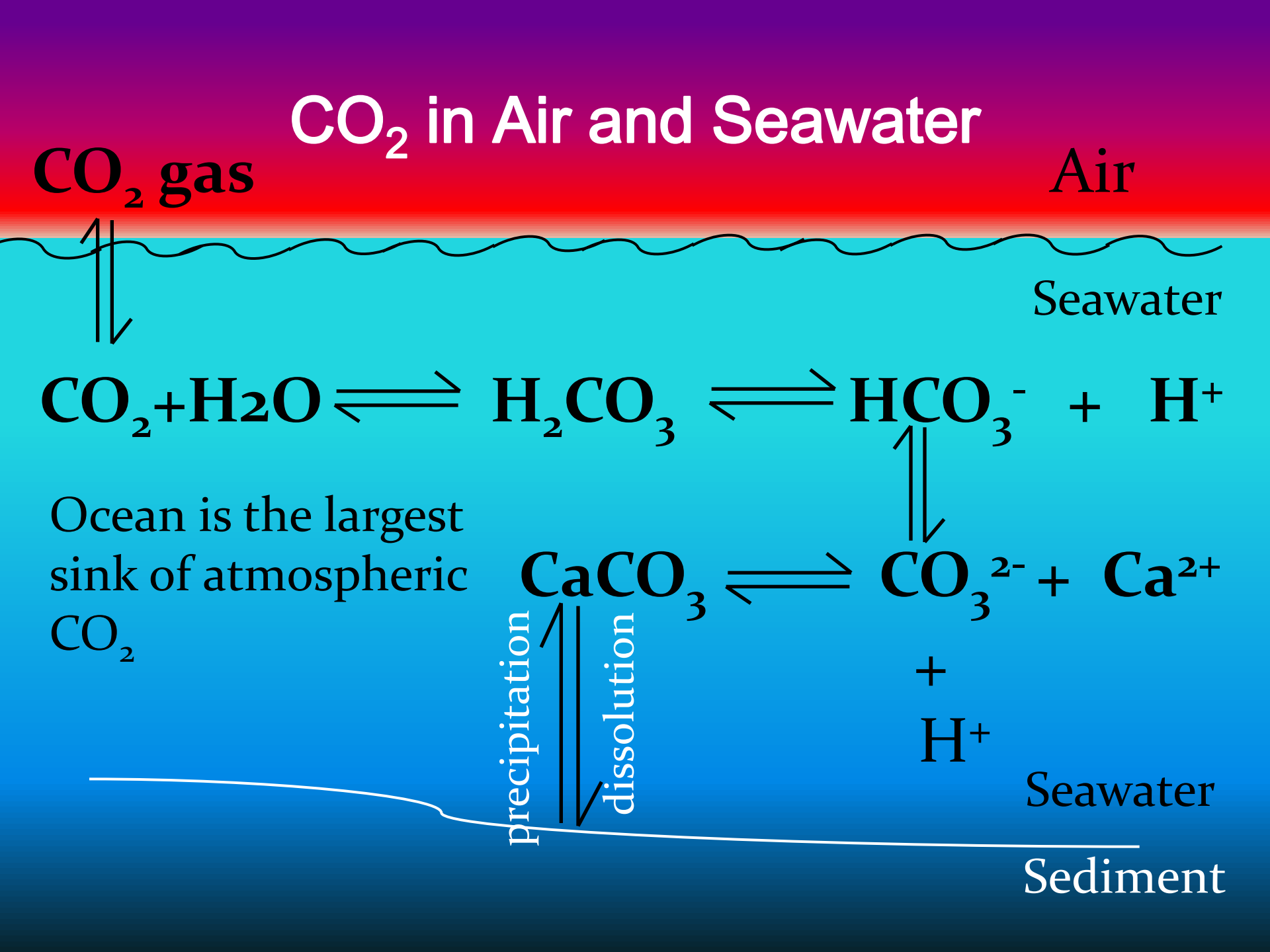
Cumulative carbon sources and sinks over the last two centuries



Global Carbon Project (2008) Carbon Budget and trends 2007, www.globalcarbonproject.org, 26 September 2008

CO_2 in Air and Seawater



These unprecedented changes…

- By the prediction of IPCC, under business-as-usual scenario, the pCO_2 will reach to 1,000 μatm by the end of this century.
- This will decrease pH by 0.3-0.4 unit, as well as decrease the $\Omega_{\text{calcium carbonate}}$, and shrink the marine regions for calcifiers deposition.
- These unprecedented changes potentially evoke dramatic challenges for marine organisms and ecosystems.

P. fucata

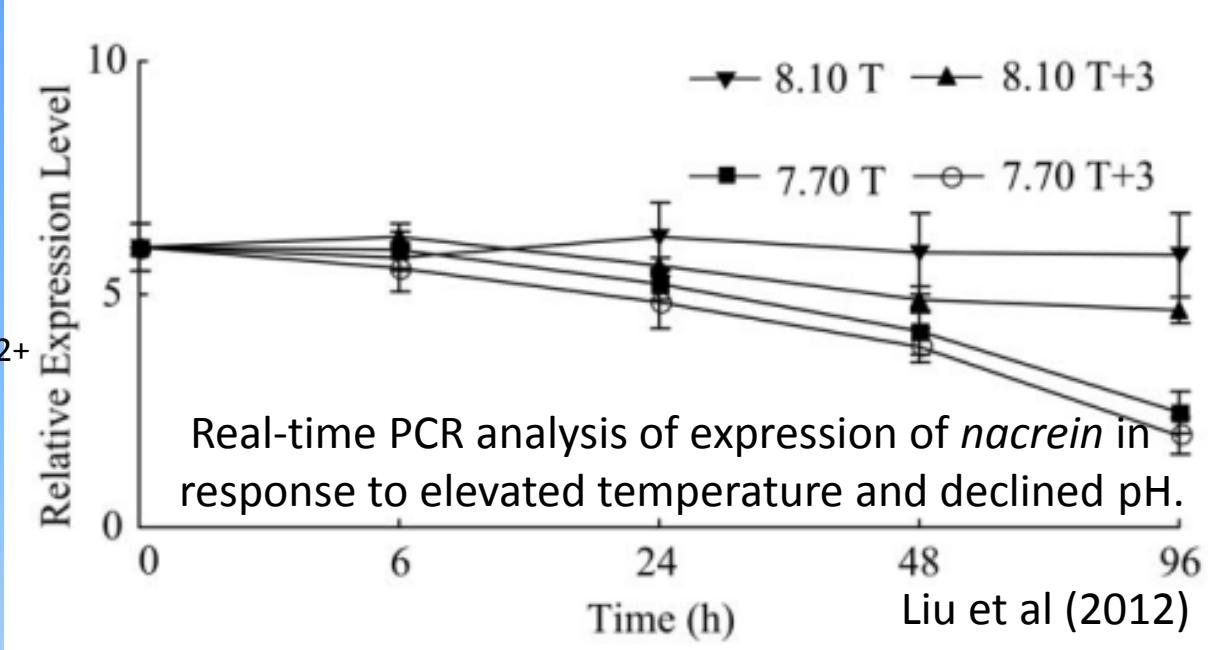
Pinctada fucata

P. fucata is the main species for yielding pearl, which is broadly distributed in the coastal area around Japan, Korea and China.
As a mollusks, *P. fucata* which lives on or in the sea bad,
by opening and closing their shells to filter seawater to pluck food .
Provide CaCO3, and play a role as engineer.

Previous work of OA on P. fucata

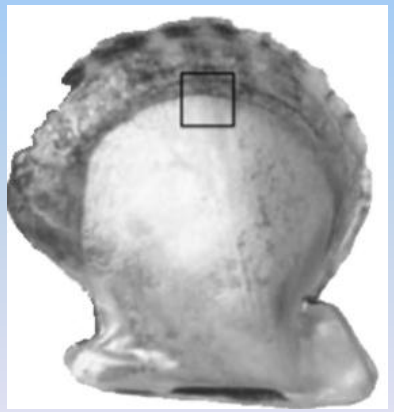
Gene expression of OA on calcification in larvae.

Nacrein was believed to mediate both HCO3-and Ca^{2+} and is deeply involved in CaCO 3 crystallization

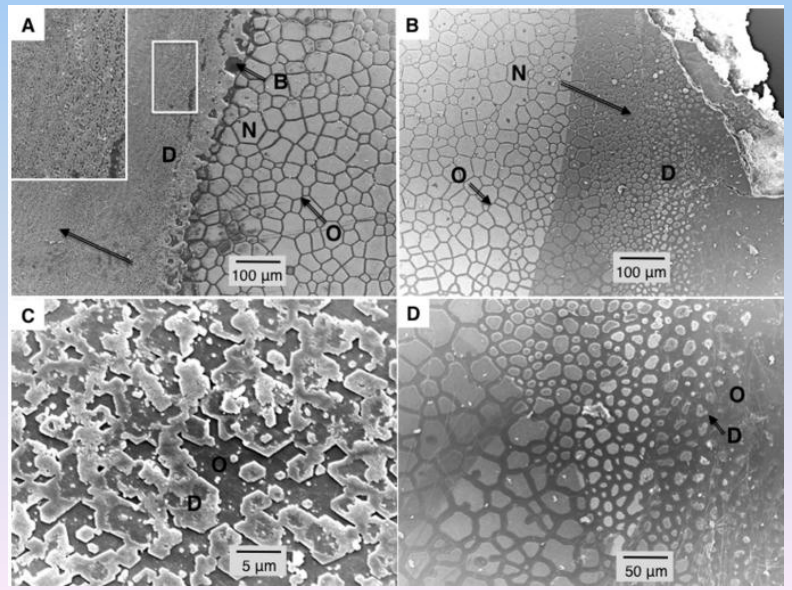


Real-time PCR analysis of expression of *nacrein* in response to elevated temperature and declined pH.

Liu et al (2012)



Welladsen et al. (2010)



Shells of *P. fucata* showed exposed to acidified seawater revealed malformation and dissolution by SEM.

However, the integration of physiological effect of CO_2-induced acidification on *P. fucata* has not yet been elucidated by experiments and analogies.

Physiological response of the Japanese pearl oyster *P. fucata* to ocean acidification by :

1. morphological characteristics,
2. food intake,
3. metabolic adjustments: $\dot{M}O_2$
4. protein synthesis: RNA / DNA ratios.

The process of Exp.

30 days acclimation

Two exp. Setups

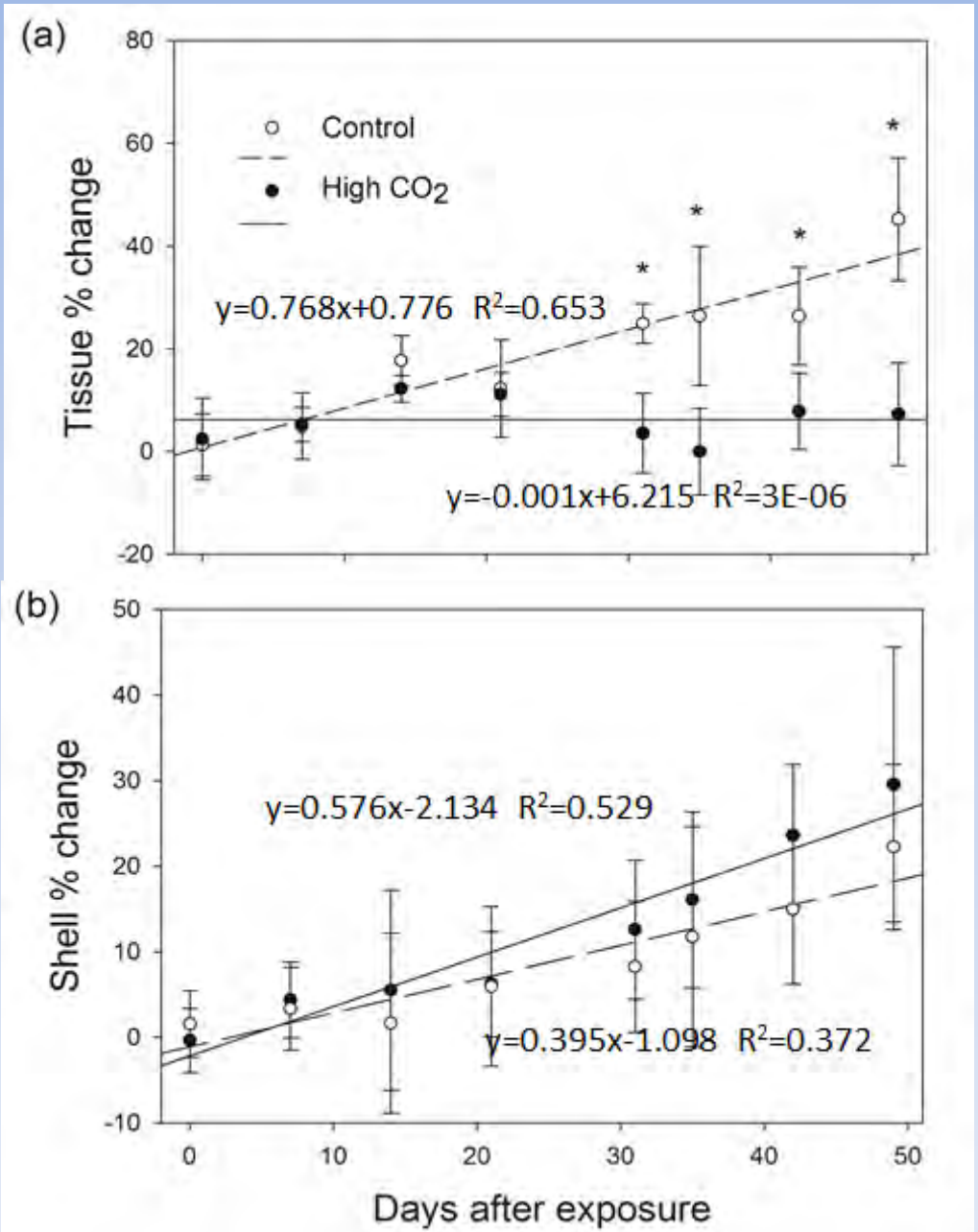
control (400 uatm) vs. high CO_2 (1,000 utam)

12individuals X 5 replicates X2 treatments

Exp. Period: 7weeks exposure

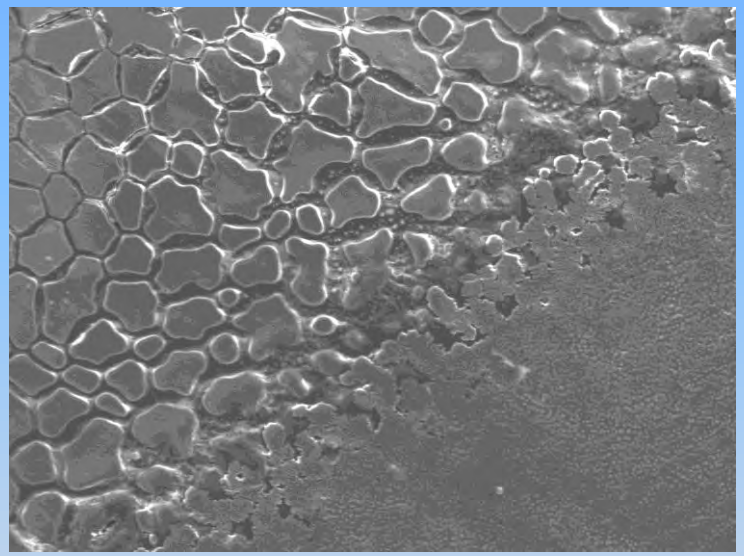
Sampling: every week sampled 1 individual from each aquarium.

- The growth

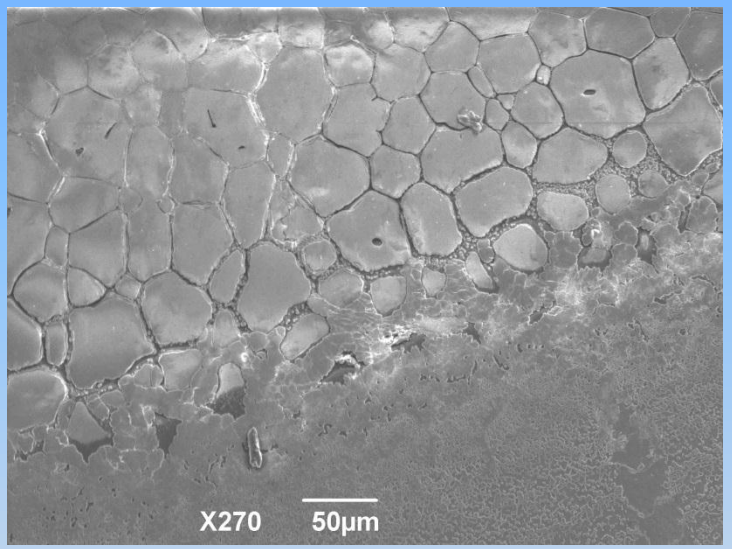


P. fucata cultured in high CO_2 gained tissue mass at a slower rate than did in control, (0 vs 0.77 % day^{-1}), while there are no more potential impacts on shell dry weight.

Scanning Electron Microscopy (SEM) analysis



Control



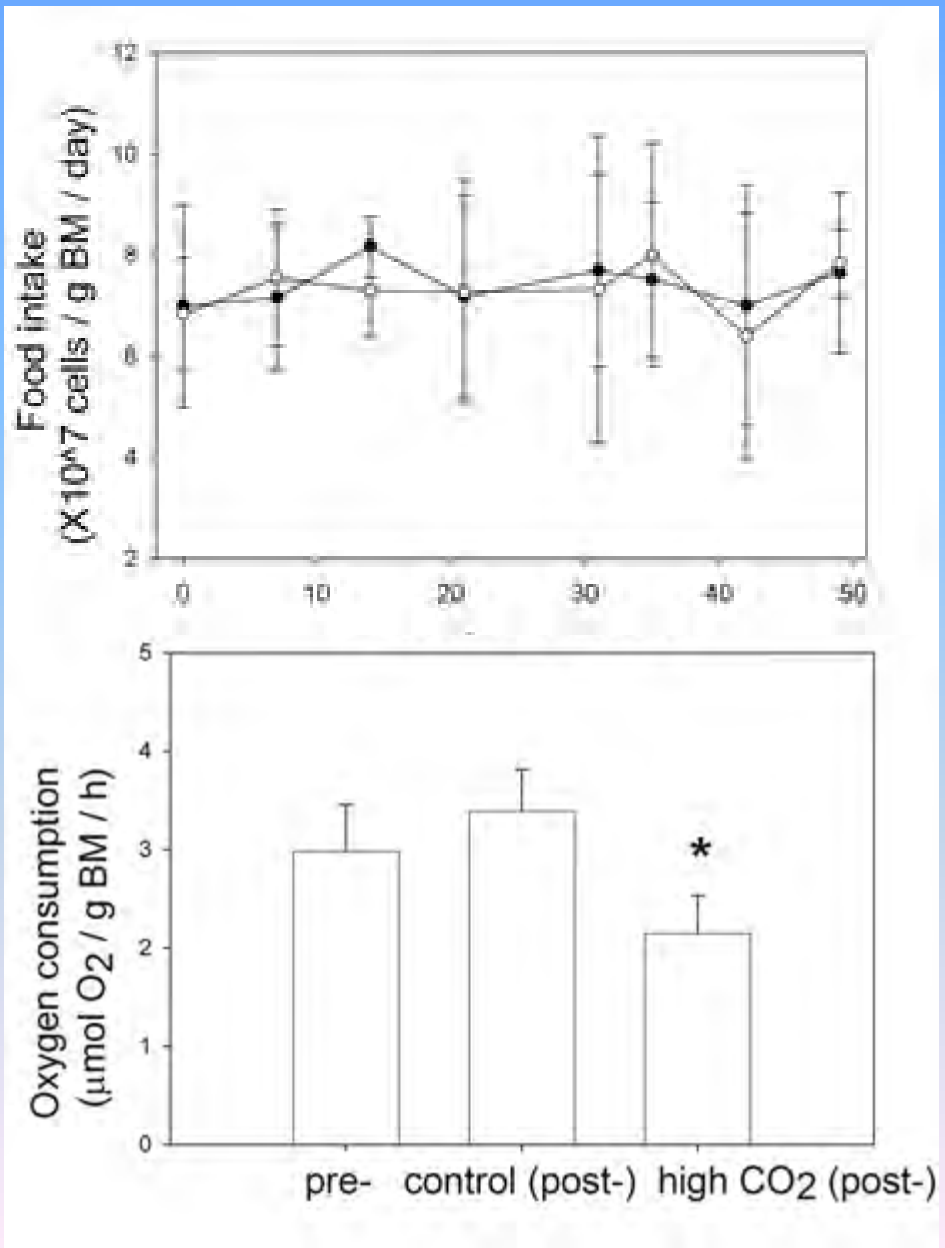
High pCO2

Elevated CO2 (1,000 uatm) did not affect the shell morphology during a 7-week exposure. The animals may sustain the high energetic cost to counteract the high dissolution rate which could happen in high pCO2 animals.

Mineralization = calcification – dissolution ↑

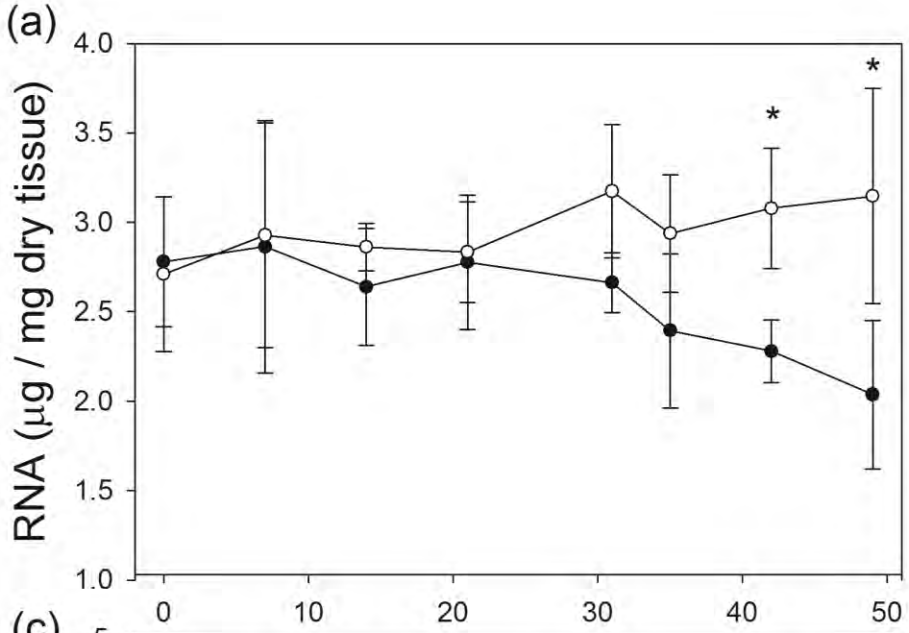
Calcification increased

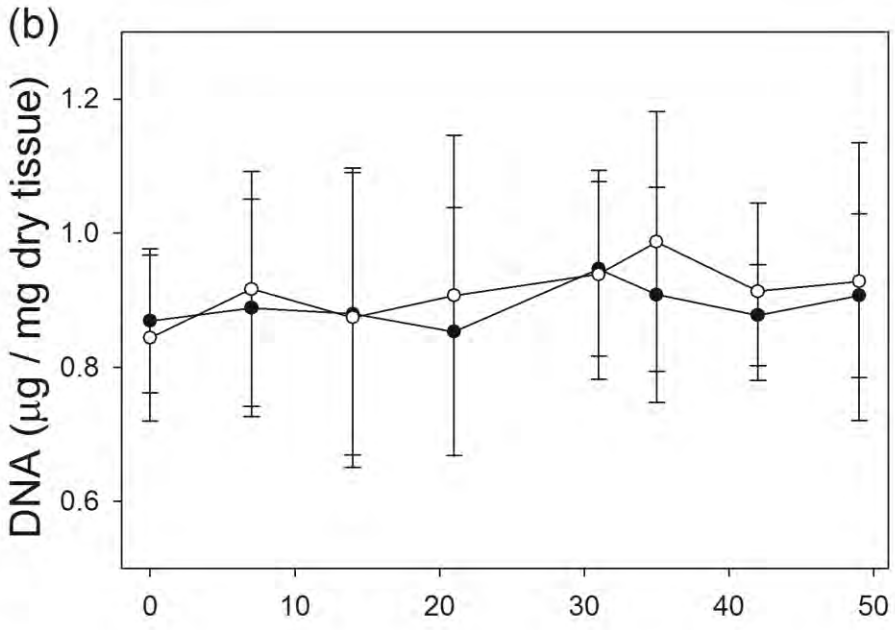
Food intake & oxygen consumption

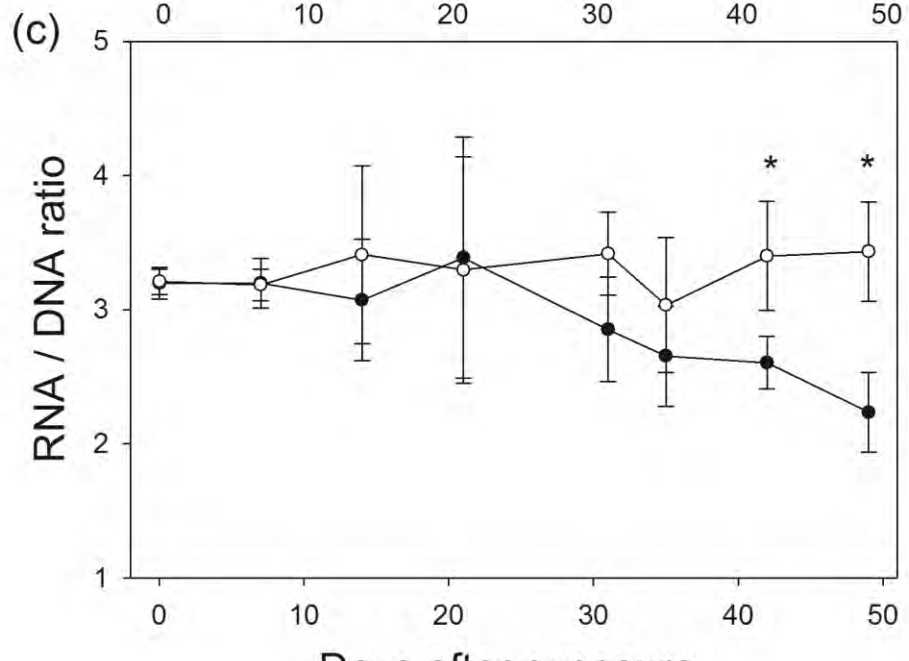


P. fucata showed a depressed metabolism under the realistic levels of ocean acidification, suggest that for pearl oysters there may be a lower cost of basal metabolism, which might be a strategy under unfavorable environment On energy conservation and allocation to fitness sustaining processes

Protein synthesis







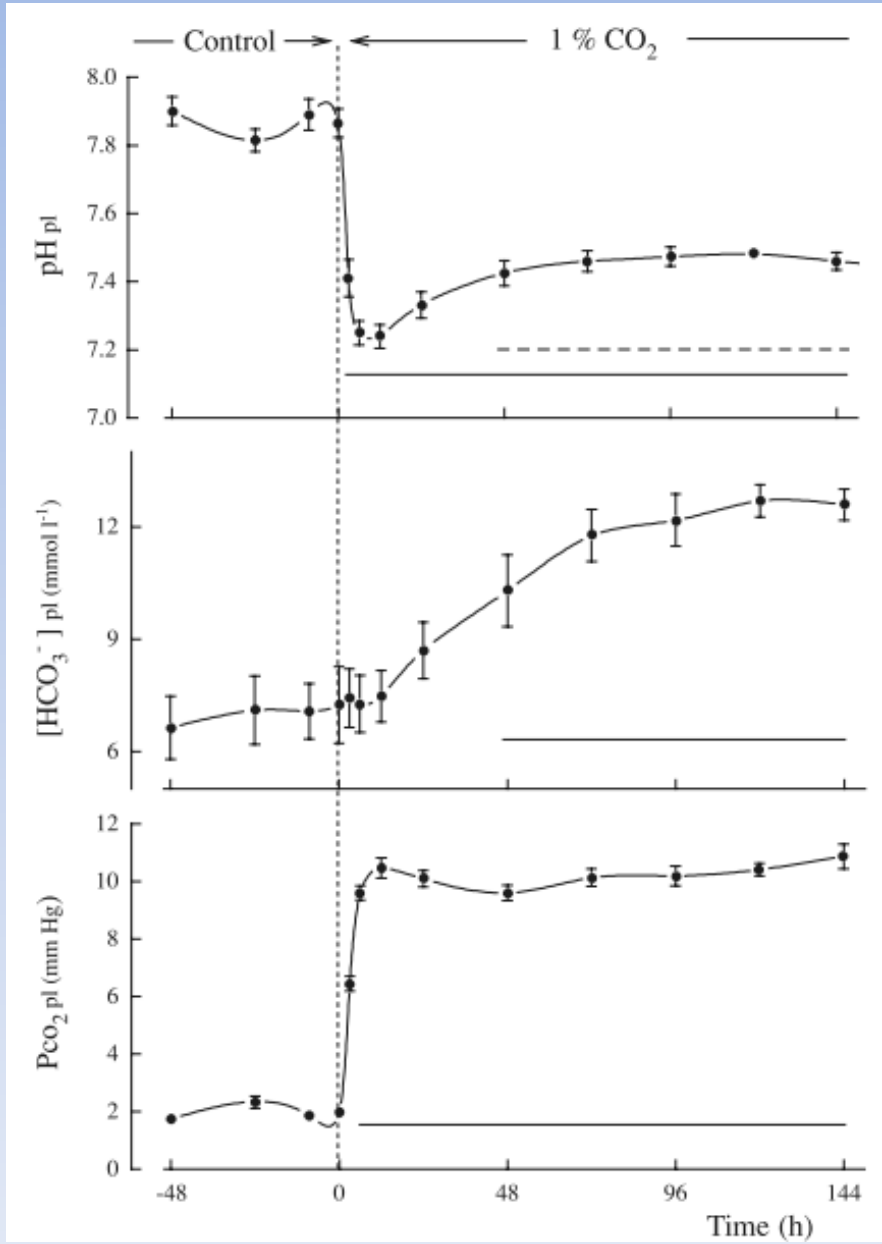
RNA/DNA ratios can be treated as environmental indices showing the eco-physiological responses and trophic interactions of environmental changes on marine organisms.

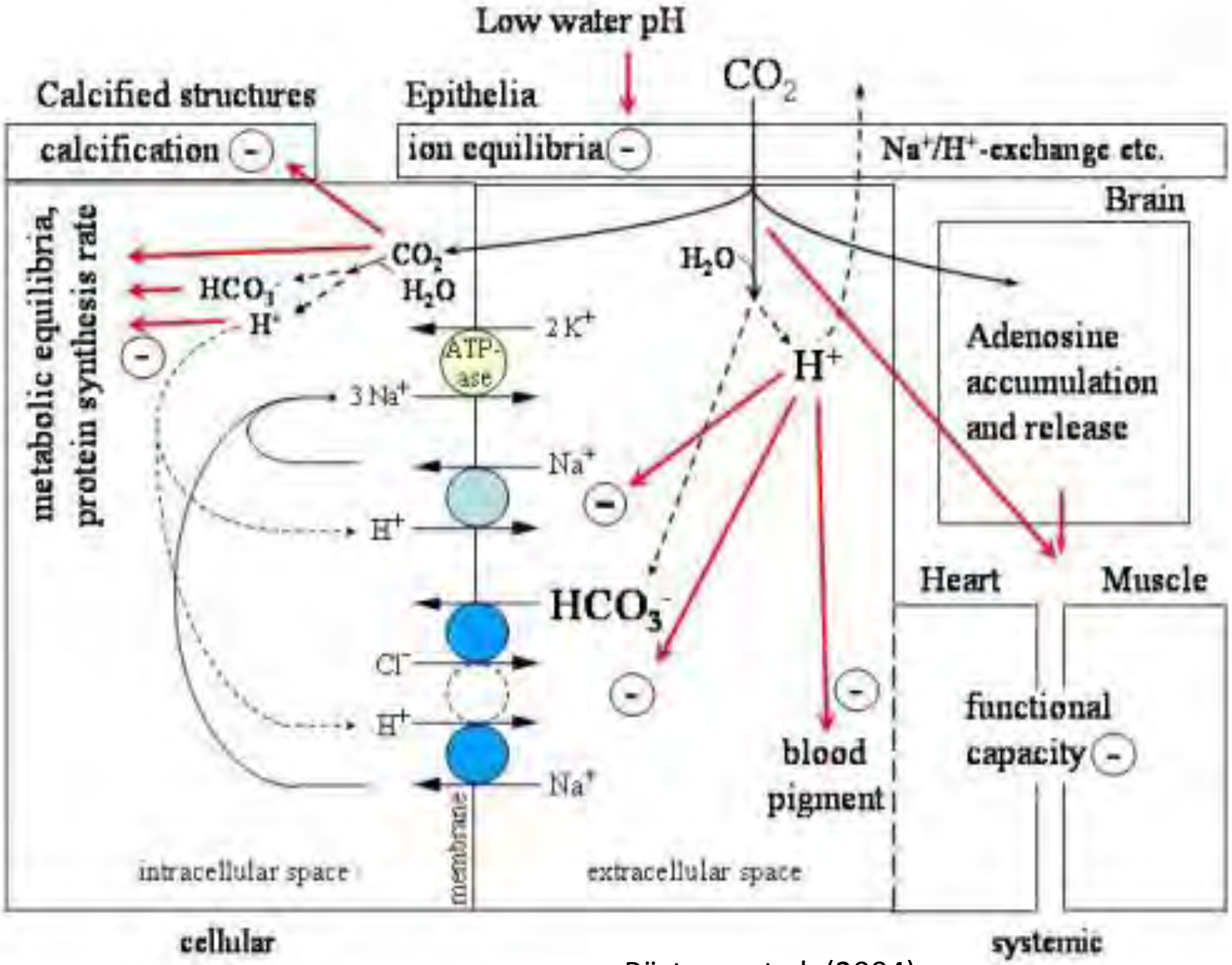
Extracellular

Acid-base variables (pH, [HCO3–], PCO2) in the coelomic plasma (extracellular fluid) of Sipunculus nudus under control conditions and subsequent hypercapnia

Note the incomplete compensation of the acidosis in the extracellular space.

When exposed to CO_2-induces acidification, marine organisms are proposed to excrete the redundant protons from the intra- and extracellular fluids, and these processes are usually considered to be the trigger for metabolism depression, which is usually by down-regulation of protein synthesis as well as by decrease in ATP consumption





Pörtner, et al. (2004)

summary

1. The observed reduction in growth rate of somatic tissue may have been caused either

by energy competition for calcification when they were not able to increase the energy input

or by acclimation to elevated pCO_2 (measured as depressed metabolic rates and reduced RNA / DNA ratios).

2. The net outcome of these competing processes has substantiated the postulation that the elevation of pCO_2 to 1,000µtam may disrupt the population of *P. fucata*.

3. The high accretion of the mineralization which is occurred in the calcification site is potentially not able to sustain permanently.

Further studies

- Further studies are needed to evaluate the combined effects of elevated pCO_2 and its corresponding phenomenon, such as elevated temperature, hypoxia or low salinity on the growth and energy homeostasis of mollusks.