Experimental studies

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Inshore Resources Research

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Why experiments?

- To establish a mechanistic understanding of how climate change may impact global (marine) biota

- To establish cause-effect relationships

- To provide scientific evidence to inform management and mitigation of environmental impacts

- Some impacts are difficult to observe *in situ* (inaccessibility, complexity, long duration of processes, factors difficult to manipulate)

Limits:

- Don’t replicate complexity of natural communities and their environment
- Therefore not possible to directly translate results to natural events

What is done globally?

Worldwide:

- Mostly single-factor experiments (acidification or warming)
- Much less two or more factors
- Mostly animals studied (often only a single life stage)
- Majority investigated acidification (because “novel” impact)
- Exponential increase of publications since 2000
- Mainly lab- and mesocosm experiments (only 11% in the field)
- Many acute (short-term), few chronic (long-term)

Results so far:

- Patchy due to small number
- Mostly snapshots
- But provide some ideas of mechanisms

Wernberg et al. (2012) Global Change Biology

Some animal responses observed:

- **Corals:** calcium carbonate structure dissolves (“bio-erosion”)

- **Mussels:** reduction of somatic- and shell growth

- **Prawns:** reduced reproduction

- **Crabs:** reduced capacity to survive low oxygen events

- **Fish:** impact on sensory abilities

Own research at Branch Fisheries

Needed for Resources Research:

- **Somatic growth**
- **Reproduction**
- **Distribution**
- etc.

We want to provide “Bolts and Nuts” for the above:

- **Physiology/biochemistry**
- **behaviour**

Experimental approach:

- species/individual level
- long-term (chronic) experiments (what is the response? Sustainable?)
- short-term (acute) experiments (what mechanisms facilitate response?)

First:
- 1-factor experiments
- basic parameters (for example baseline properties of lobster haemocyanin)
- acute- and some chronic experiments

Next:
- 2-factor experiments (pH + temperature)
- Mostly chronic experiments

Later:
- multi-factor experiments (pH + temperature + oxygen)
- Mimic situations in the field

Experimental animals:

West Coast rock lobster *J. lalandii*

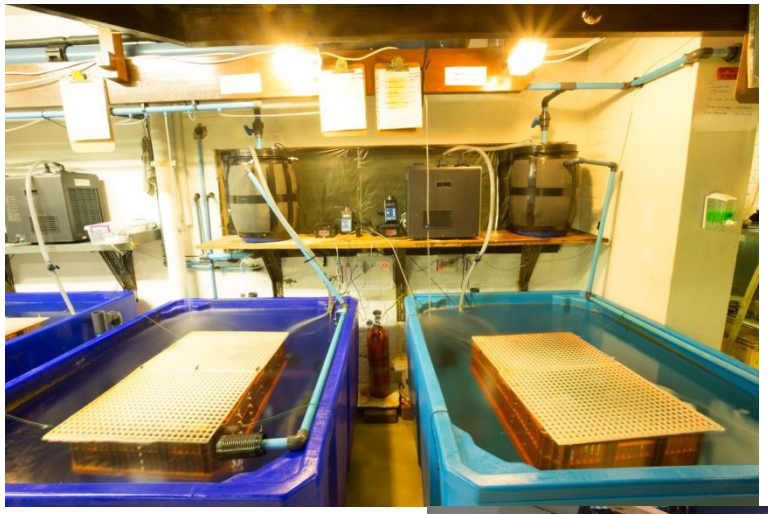
South African abalone *H. midae*

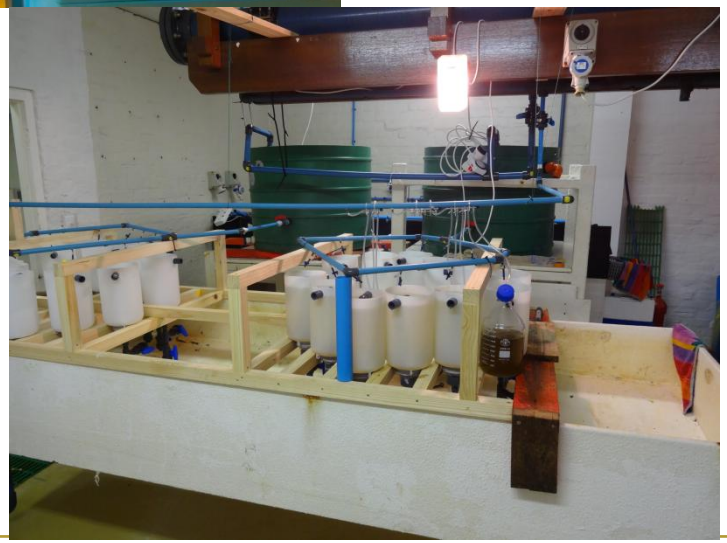
Puffadder shyshark *H. edwardsii*

Cape urchin *P. angulosus*

Experimental infrastructure:

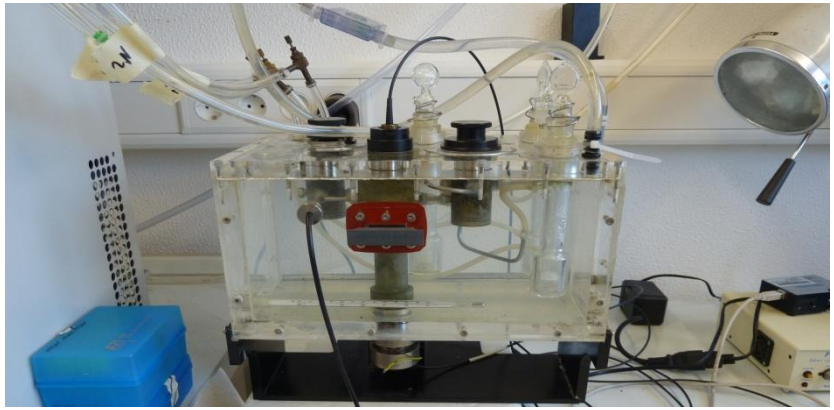
- Seapoint Research Aquarium
- Abalone farms

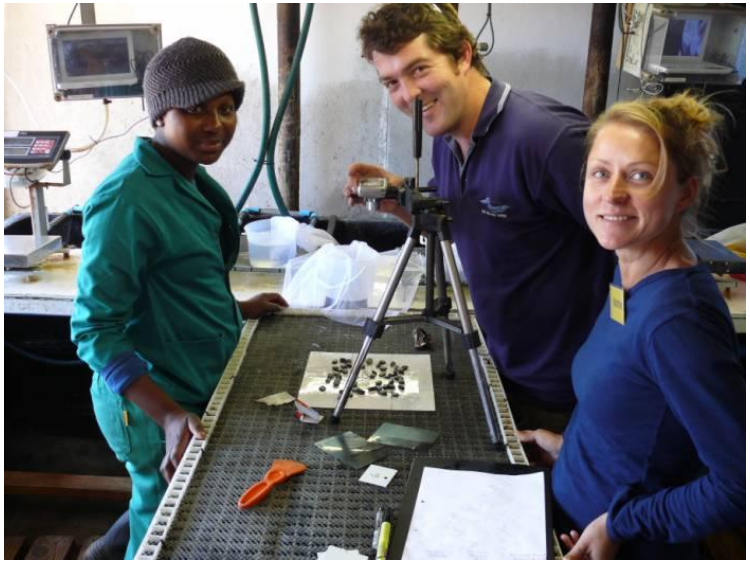




Parameters investigated:

- Acid-base balance
- Haemocyanin properties
- Growth
- Immune response
- Behaviour
- etc.



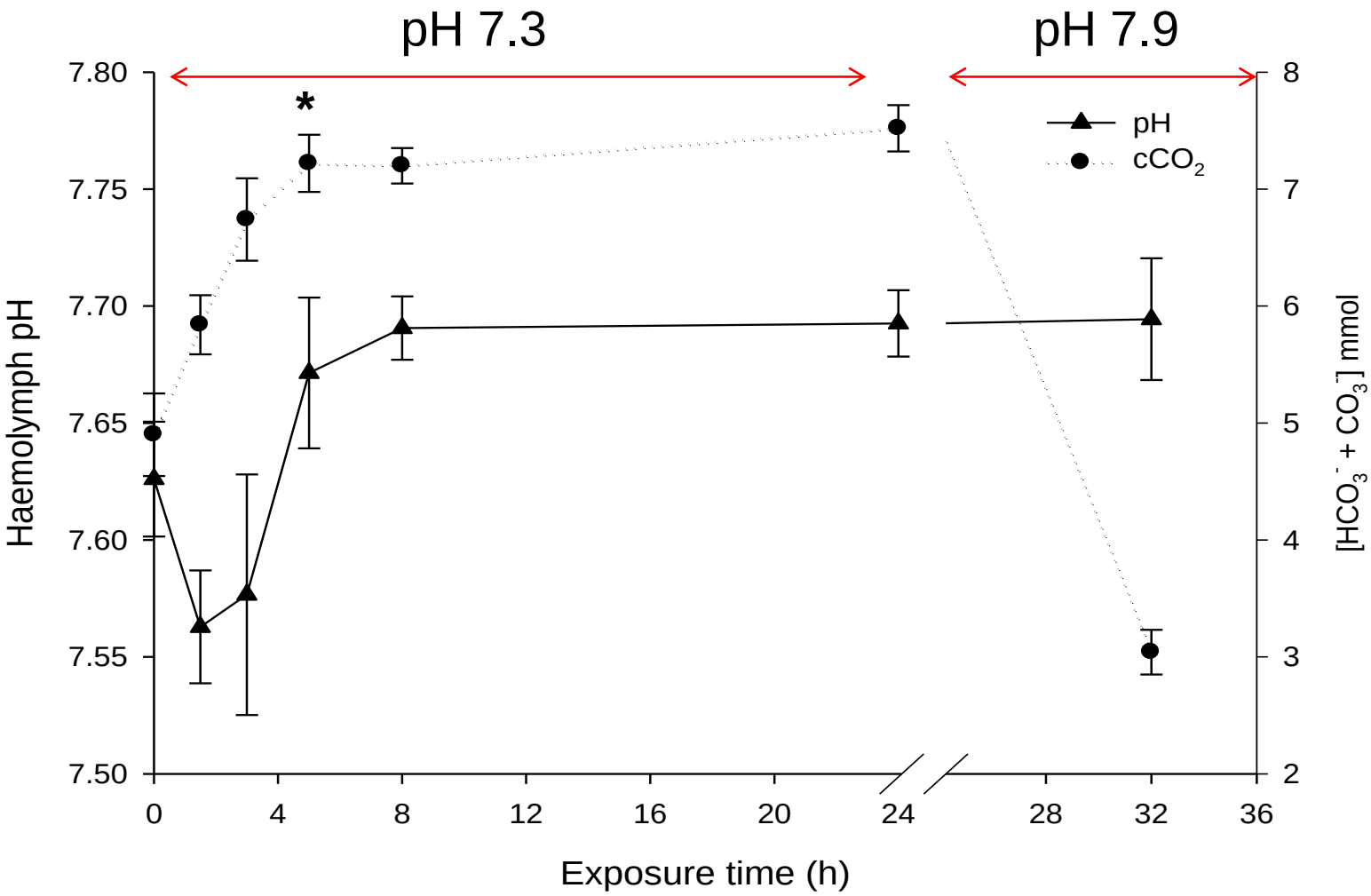


Some results:

Jasus lalandii

- Males and females regulate acid-base balance efficiently by bicarbonate (reversible)
- This regulation is sustainable (tested in juveniles after 11 months hypercapnia)
- Strong Bohr-effect of haemocyanin (low pH would negatively affect respiration)
- Haemocyanin oxygen affinity elevated after 7 month hypercapnia at molecular level
- Growth not impacted by hypercapnia alone or combined with high temperature
- Egg development on berried females not impacted by hypercapnia (11 months)
- Immune response not impacted by hypercapnia alone or combined with high temperature (11 months)
- Exoskeleton of females and egg surface not impacted by hypercapnia (SEM evaluation)

But: all experiments done with well-fed animals.


pH 7.3
pH 7.9
*
pH
cCO2
Haemolymph pH
[HCO3- + CO3] mmol
7.80
7.75
7.70
7.65
7.60
7.55
7.50
8
7
6
5
4
3
2
0
4
8
12
16
20
24
28
32
36
Exposure time (h)

Haliotis midae

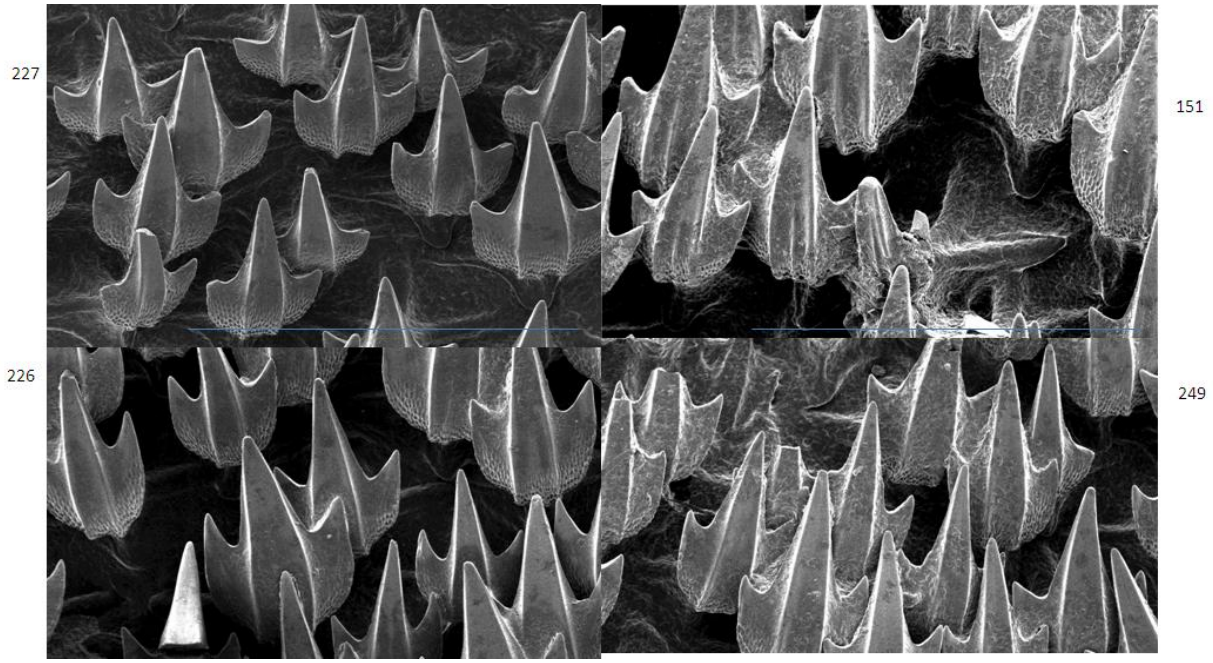
- Weak acute acid-base regulation
- Corrosion of shells (found in various experiments)
- Growth impacted by hypercapnia

Parechinus capensis

- No acid-base regulation
- No impact on eggs or sperm from parents incubated in hypercapnia (8 weeks)
- But: impact of hypercapnia on larval development (independent of treatment of parents)

Habloblepharus edwardsii

- Efficient acid-base regulation (reversible), acute and chronic (12 weeks)
- Denticles corrode in chronic hypercapnia



Normocapnia Hypercapnia

In collaboration with **Sarika Singh** (DEA)

Project partners and students:

9 student projects; students from 4 universities

Prof. Chris Bridges	University of Düsseldorf (Germany)
Project linked to German and EU programs:	BIOACID Biological Impacts of Ocean ACIDification; EPOCA European Project on OCean Acidification
Matt Naylor	HIK abalone farm (Hermanus)
Sarika Singh	DEA

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- NRF/ BMBF (German Dept. Education and Research)
- DAFF
- HIK

Future research:

Multifactorial experiments and mimick observed situations in the field:

- testing of physiological limits (mostly with pre-incubated animals)
- collaboration with **Dr. T. Haupt-Schuter** (DEA) to test temperature limits

- observed situations in the N and S Benguela
- collaboration with **Mr. M. Tsanwani** (DEA), **Dr. P. Monteiro** (CSIR), **Prof. J. Bolton** (UCT)

- Physiological investigation of *J. lalandii* in Elands Bay (field and lab)