



Bundesministerium
für Bildung
und Forschung

BIOACID



BIOACID – Biological Impacts of Ocean ACIDification



JACOBS
UNIVERSITY



Universität Hamburg



Universität Bremen



Max-Planck-Institut
für Marine Mikrobiologie





BIOACID

BIOACID – Biological Impacts of Ocean ACIDification

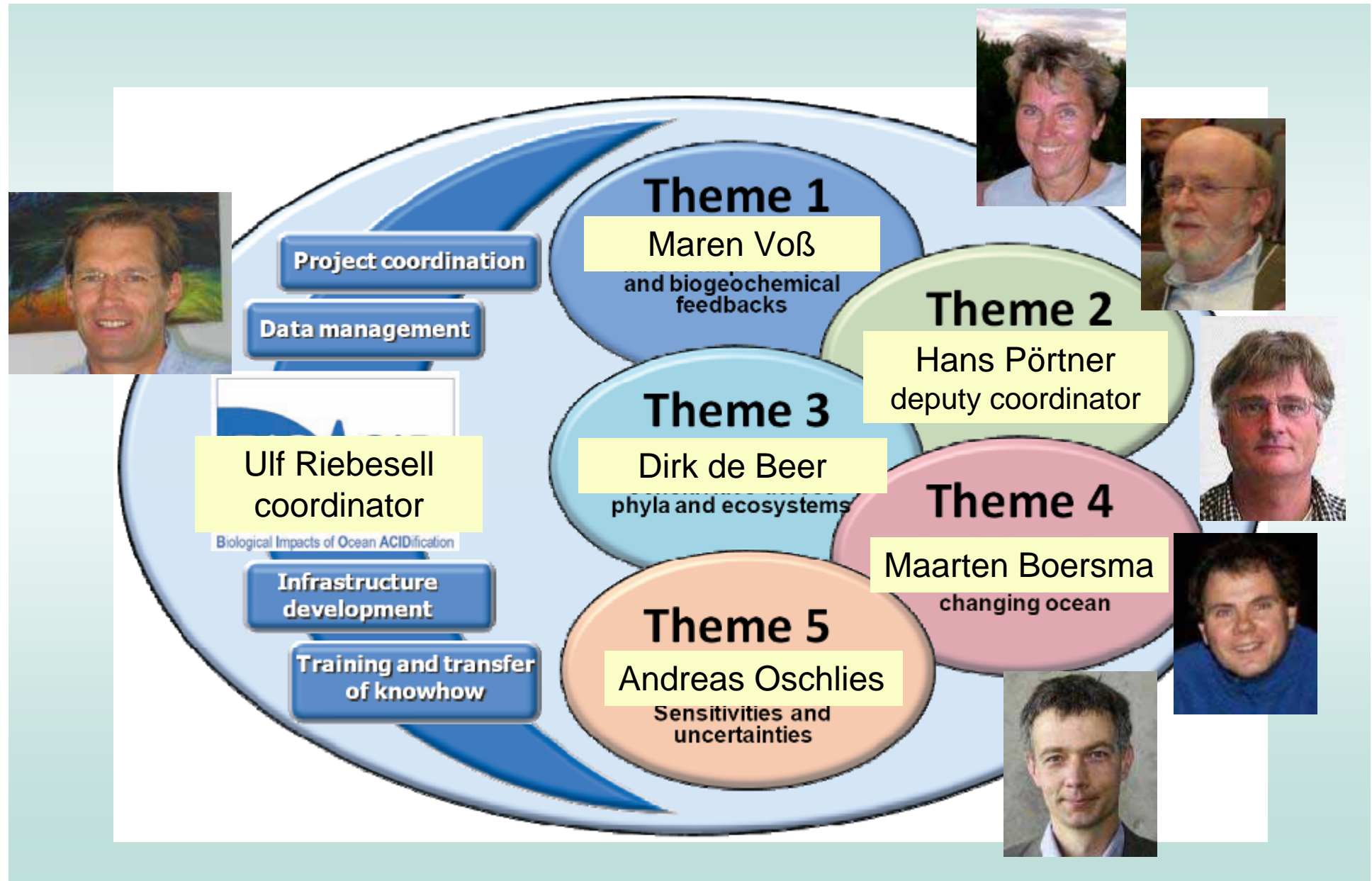
- Coordinated project, 16 partner institutes, 1 SME, 62 PIs
- Funded by German Ministry for Education and Science (BMBF)
- Start: September 1, 2009
- Funding: 8.9 M€
for first phase (2009-2012)



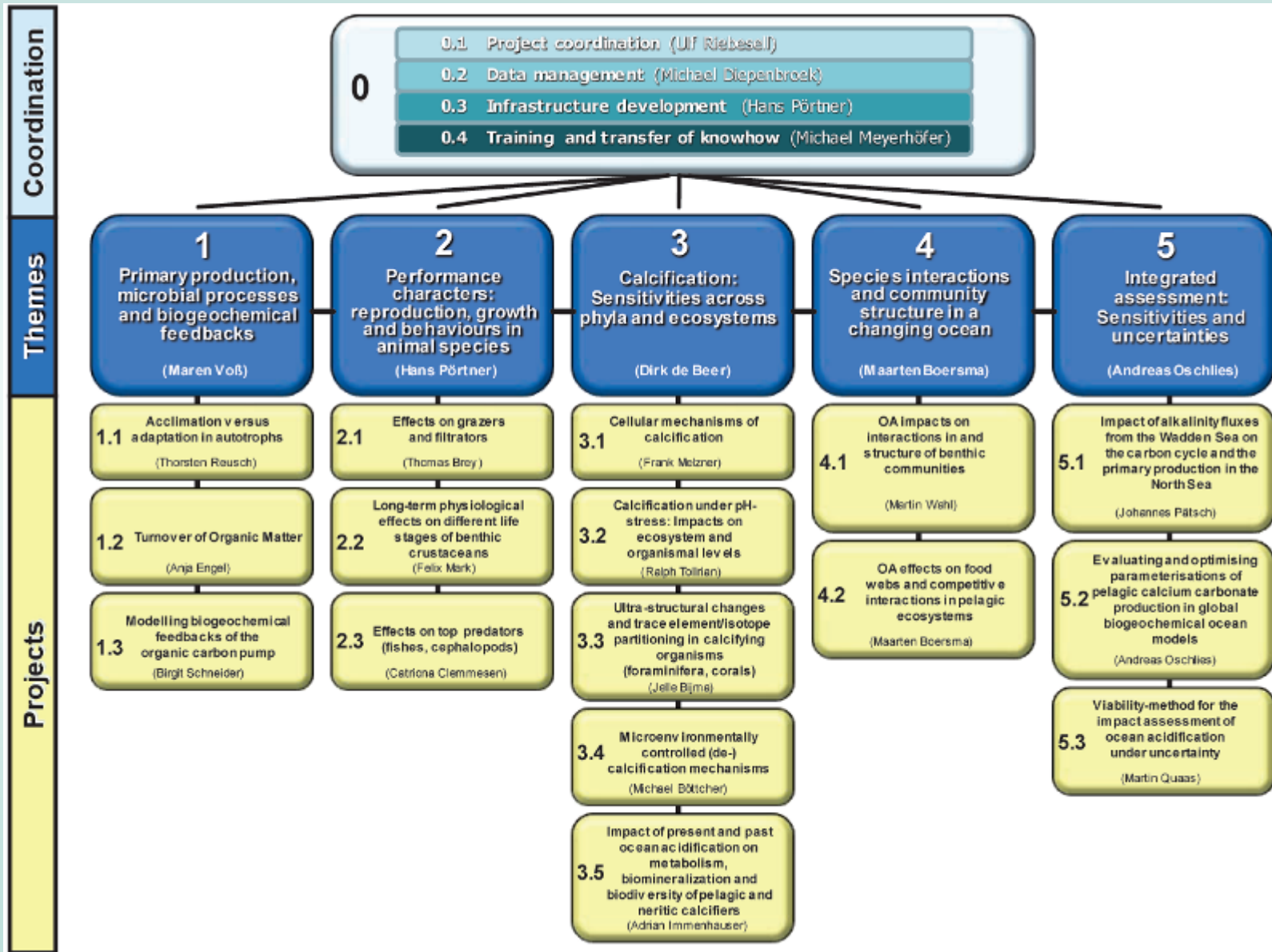
BIOACID



Project structure



Work in progress in 46 subprojects



General overview

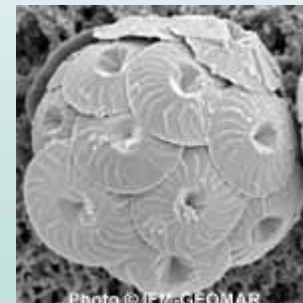
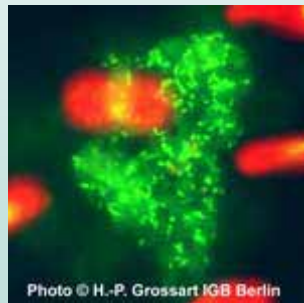
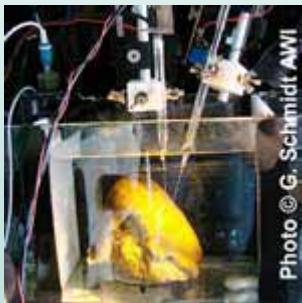
Wide range of disciplines:

marine biologists, chemists, physicists, molecular biologists, paleontologists, medical researchers and mathematicians

As well as marine engineers which are developing precise analytical techniques.

Wide range of organisms and communities:

From isolated tissues to bacteria and phyto- and zooplankton and -benthos up to predators and their larvae)



Project office



Project secretariat



Silvana Gagliardi



Monika Peschke

Scientific Advisory Board (SAB)



Carol Turley

(Plymouth Marine Laboratories)



James Barry

(Monterey Bay Aquarium and Research Institute)



Jean-Pierre Gattuso

(Laboratoire d'Océanographie de Villefranche)



Michael Thorndyke

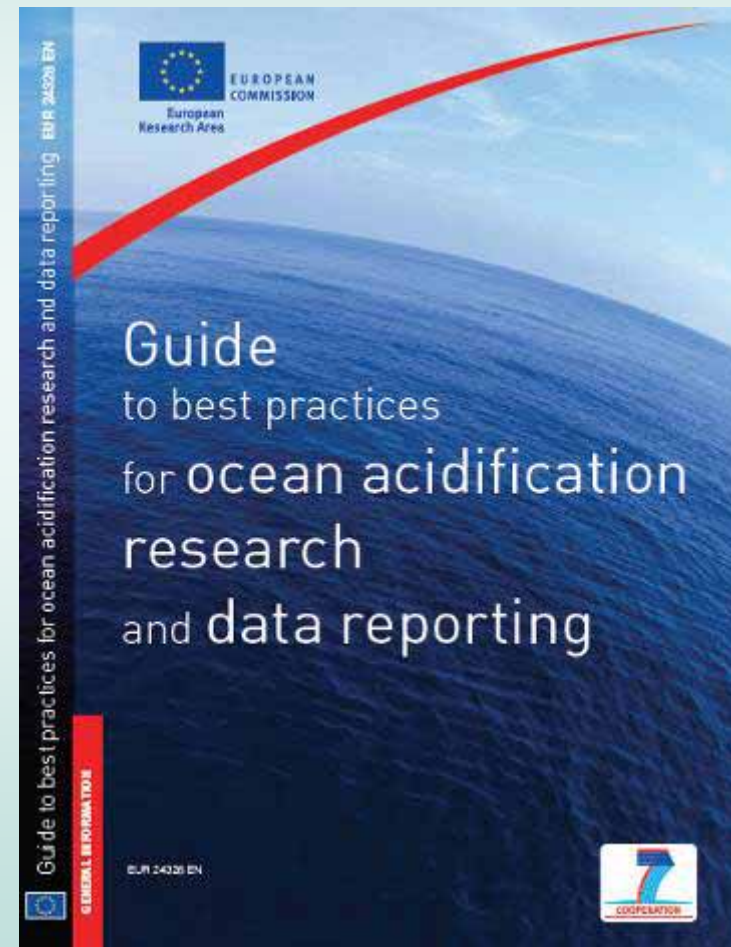
(University of Gothenburg)



Training



- Guide to Best Practices for Ocean Acidification Research and Data Reporting



Training



- Guide to Best Practices for Ocean Acidification Research and Data Reporting
- Training workshops

Best practices in ocean acidification research

IFM-GEOMAR, Kiel, March 8-12, 2010

jointly with EPOCA, CalMarO and US-OCB (U. Riebesell)

Lecturers: J. Barry, R. Bellerby, C. Brownlee, C. Clemmesen, J.-P. Gattuso, J. Havenhand, D. Hutchins, M. Lenz, A. Körtzinger, F. Melzner, A.-M. Nisumaa, J. Orr, B. Pfeil, R. Schlitzer, K. Schulz, M. Wahl

Physiological approaches to body fluid physicochemistry & acid-base regulation

AWI Bremerhaven, March 15-19, 2010 (F. Sartoris, AWI)

Microsensor applications

MPI Bremen, April 26 – May 9, 2010 (D. de Beer, MPI)

Outreach/communication



- New website



www.bioacid.de

Outreach/communication




- New website
- Marketplace

The screenshot shows the ResearchGATE website homepage. At the top left is the ResearchGATE logo. To the right are login fields for E-Mail and Password, with a 'Login' button and links for 'Remember me' and 'Forgot your password?'. The main content area features a green header with the text: 'ResearchGATE is a professional network for scientists. It's free of charge and equips you with useful tools.' Below this are three main sections: 'Connect and Communicate' (Interact with fellow researchers and build your scientific network.), 'Share and Collaborate' (Post updates, discuss methods and co-edit with colleagues.), and 'Discover' (Download full-text papers, find conferences and scientific jobs.). To the right of these sections is a green 'Sign up to ResearchGATE' box with fields for First Name, Last Name, and Your E-Mail Address, and a 'Sign up now' button. Below the sign-up box are social media links for Facebook and LinkedIn. At the bottom of the main content area, it states 'More than 700,000 scientists have already joined ResearchGATE!'. The footer contains logos for Science, ScienceDirect, Eureka, BusinessWeek, Frankfurt Allgemeine, TechCrunch, The Economist, and The New York Times. Below the logos is the copyright notice '© 2010 researchgate.net. All rights reserved.' and a list of links: The Idea, Terms, Privacy, ResearchBLOG, ResearchNEWS, Press, Careers, Contact. At the very bottom, there are several columns of subject categories: Science fields (Groups, Literature, Jobs, Recently joined, Agricultural sciences, Anthropology), Biological sciences (Chemical Science, Computer sciences, Design, Earth Science, Statistics), Education (Engineering, Entertainment & Arts, Geography science, Health sciences, History), Law (Linguistics, Literature, Mathematics, Other, Philosophy), and Physics (Political Science, Psychology, Religious Studies, Social Science, Space sciences).

Outreach/communication



- New website
- Marketplace
- Flyer

Primary production	Performance characters	Calcification	Species interactions	Integrated assessment
microbial processes and biogeochemical feedbacks	reproduction, growth and behaviour in animal species	sensitivities across phyta and ecosystems	and community structure in a changing ocean	sensitivities and uncertainties
<p>Rising CO₂ levels stimulate primary production and nitrogen fixation, thereby altering the chemical composition of plankton communities. In Theme 1 we study effects of ocean acidification at the base of the food web and their impacts on biogeochemical cycles.</p> 	<p>The diversity of responses and the tolerance of different life stages co-determine population success and ecosystem change. In physiological studies on fish and invertebrates in Theme 2 we examine the influence of ocean acidification on fitness and performance.</p> 	<p>Calcifying organisms are particularly sensitive to ocean acidification. In Theme 3 we investigate these sensitivities at organismal, community and habitat levels, and assess their impacts on biodiversity and geochemistry.</p> 	<p>Responses to ocean acidification can have cascading effects at the community and ecosystem level. In Theme 4 we examine competitive and trophic interactions and the causes and consequences of changes in the structure of benthic and pelagic communities.</p> 	<p>Policy recommendations require knowledge of critical threshold levels for irreversible ecosystem change and loss of ecosystem services. In Theme 5 we aim at an integrated understanding of the combined impacts of ocean acidification and warming.</p> 
				
Photo: K. J. Flynn, USFWS / (left) P. M. Edwards	Photo: M. Soffin / (left) AP / (right) J. Thomson, Shutterstock	Photo: S. Fox, Shutterstock / (right) Shutterstock	Photo: A. K. Dugdale / (left) P. M. Edwards	Photo: D. Serrão, AP / (right) M. Stepienillo, P. M. Edwards



Outreach/communication

- New website
- Marketplace
- Flyer
- PhD and PostDoc Meeting at MPI Bremen
Dec. 3-4, 2009, 41 participants
organized by Gertraud Schmidt (AWI) and Martin Glas (MPI)

planned:

- Ocean acidification video(s) for YouTube
- School project(s)

International integration



- BIOACID endorsed by

- **SOLAS** Surface Ocean – Lower Atmosphere Study



- **IMBER** Integrated Marine Biogeochemistry and Ecosystem Research



International integration/coordination



- BIOACID endorsed by SOLAS and IMBER
- BIOACID represented in SOLAS-IMBER OA working group

Mission:

- Coordinate international research efforts in ocean acidification
- Undertake synthesis activities at the international level

Members

- Jean-Pierre Gattuso (chair) (France)
- Jim Barry (USA)
- Jelle Bijma (Germany)
- Minhan Dai (China)
- Dick Feely (USA)
- Richard Matear (Australia)
- Yukihiro Nojiri (Japan)
- James Orr (France)
- Ulf Riebesell (Germany)
- Lisa Robbins (USA)
- Carol Turley (UK)

International integration/coordination



- BIOACID endorsed by SOLAS and IMBER
- BIOACID represented in SOLAS-IMBER OA working group
- BIOACID joined OA Reference User Group (RUG)

Mission:

- synthesize and disseminate information on OA most useful to managers, policy advisors, decision makers
- feedback key science developments into their own sector/organisation
- support OA projects in outreach activities

New German RUG representatives:

- Mojib Latif (climate scientist, PR expert)
- Stefan Rahmstorf (oceanographer, WGBU)
- NN (Deutsche See/Frosta)



International integration/coordination



- BIOACID endorsed by SOLAS and IMBER
- BIOACID represented in SOLAS-IMBER OA working group
- BIOACID joined OA Reference User Group (RUG)
- IPCC 5th Assessment Report
 - IPCC Ocean Acidification Expert Meeting
 - Okinawa, Japan, 16-19 January 2011
- 3rd symposium „The Ocean in a High CO₂ World“
 - Monterey, USA, fall 2012

EPOCA / BIOACID / UKOARP collaboration



- Education joint training workshops, student exchange
- Coordination coordinators of each project in EB/SAB of the two others
- Information flow joint annual meetings, ocean acidification blog, shared reference user group of key stakeholders
- Data managem./ storage EPOCA and BIOACID use same portal at WDC-MARE / PANGEA
- Research exchange of samples, joint cruises/mesocosm experiments



Unexpected responses

1st example

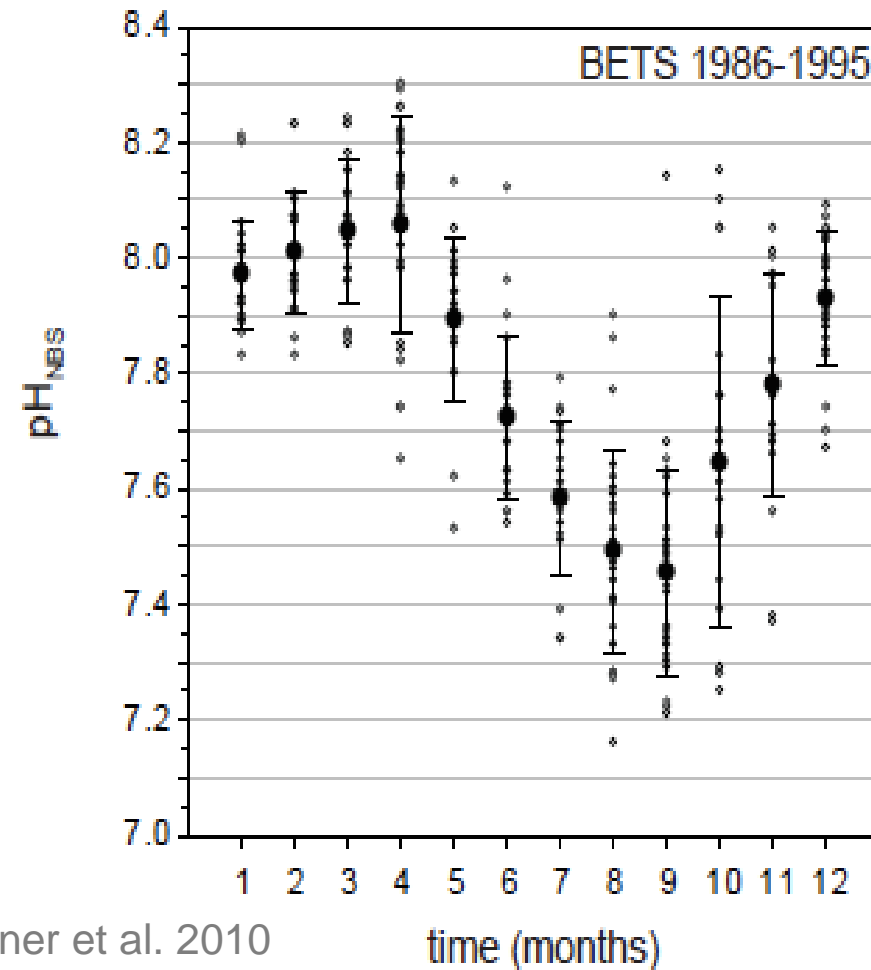
Acidified waters occur naturally

- large chemical gradients in seawater pH
 - vertically
 - horizontally
 - temporally (seasonally, diurnally)

pH variability - Boknis Eck

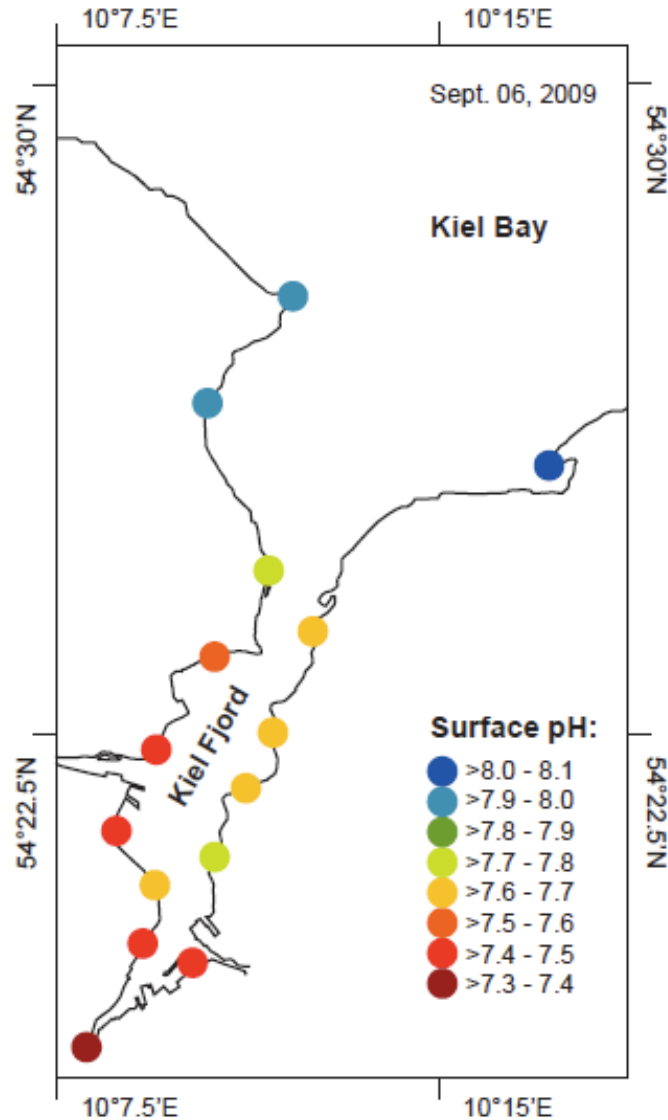


● BETS = Boknis Eck Time Series in Kiel Bay

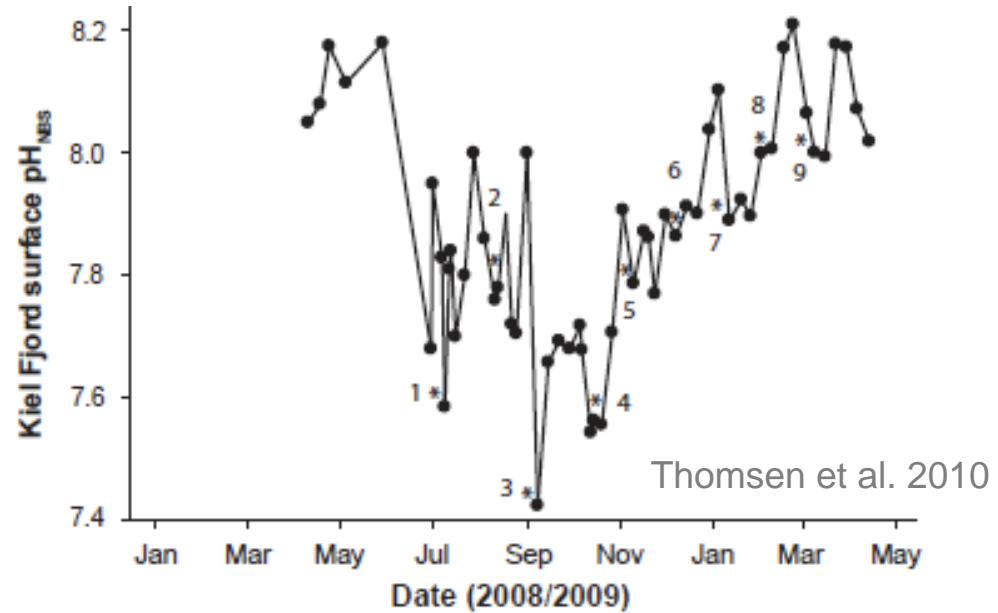


Melzner et al. 2010

pH variability - Kiel Bay



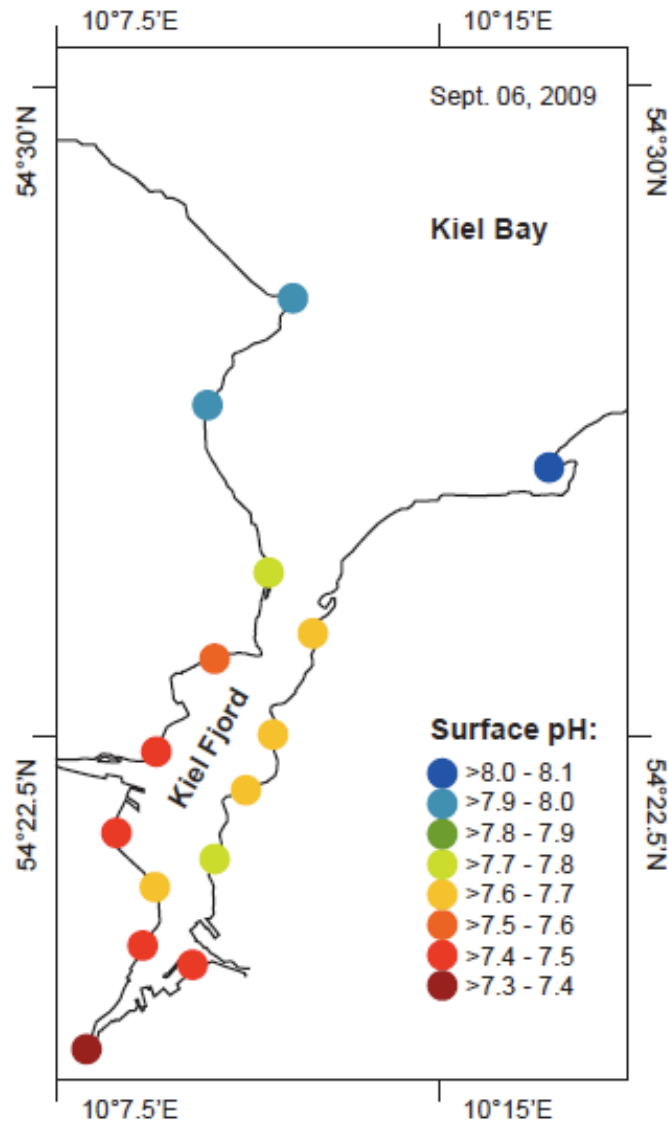
Melzner et al. 2010



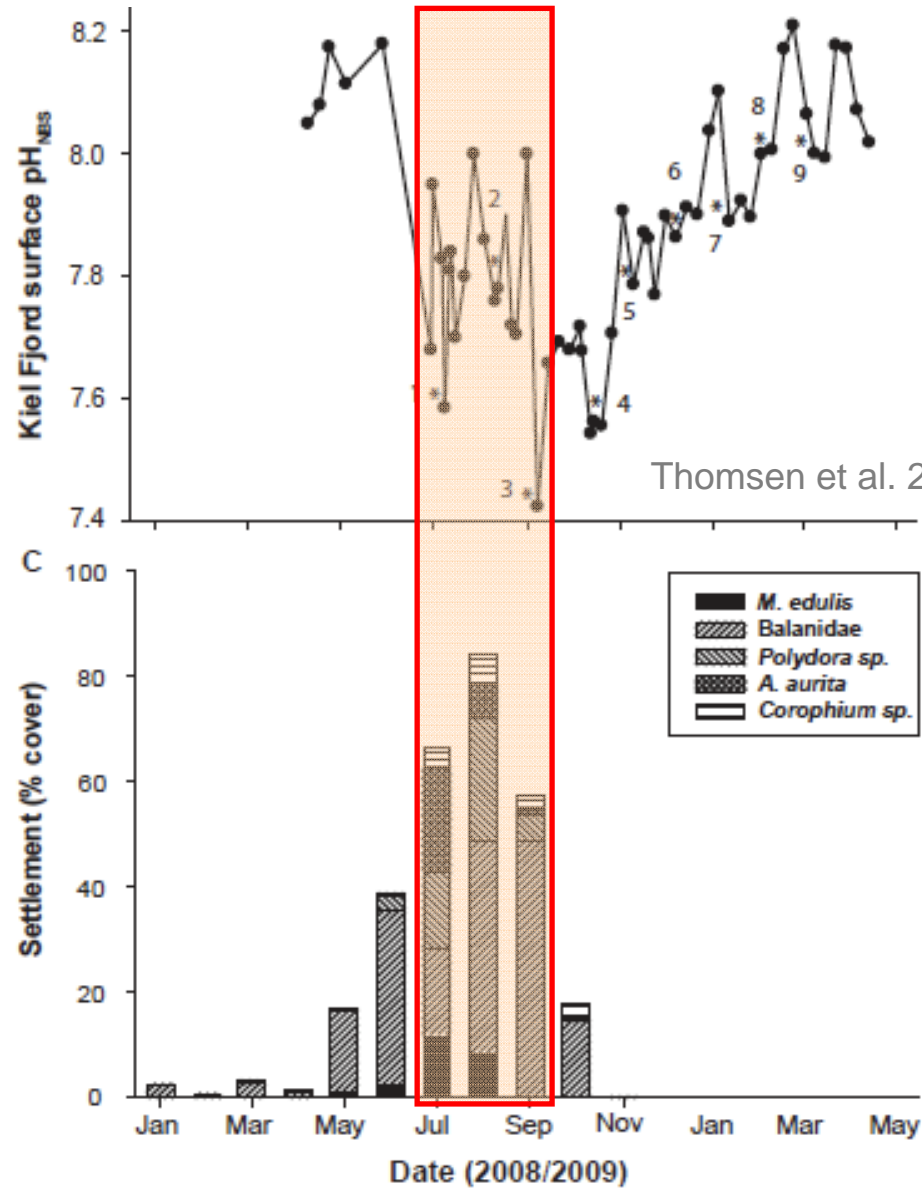
Upwelling of ,deep' waters in summer and autumn

Average $p\text{CO}_2$ in 2008/2009 ~ 700 μatm
 Average $p\text{CO}_2$ July-August ~ 1000 μatm
 Maximum $p\text{CO}_2$ >2000 μatm

pH variability - Kiel Fjord



Melzner et al. 2010

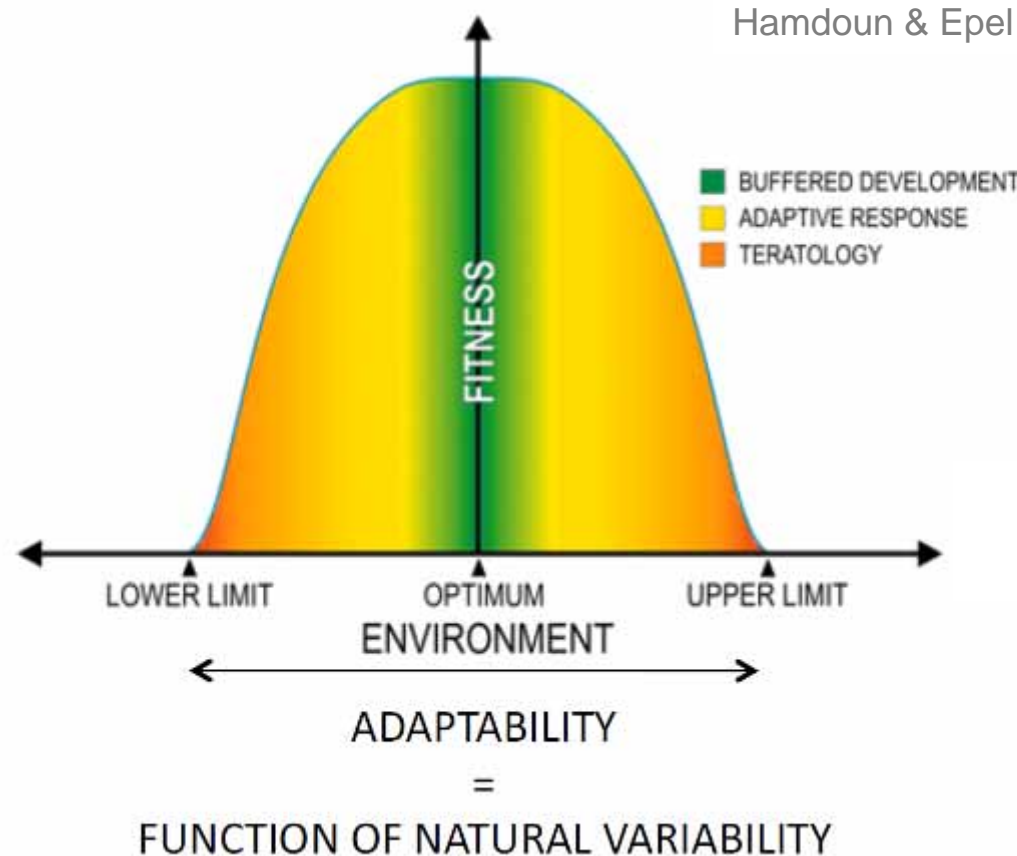


Calcifying communities dominate within 6 weeks after settlement (>99%)



Environmental variability hypothesis

- Greater environmental variability
- broader physiological limits
- = higher resilience to future changes

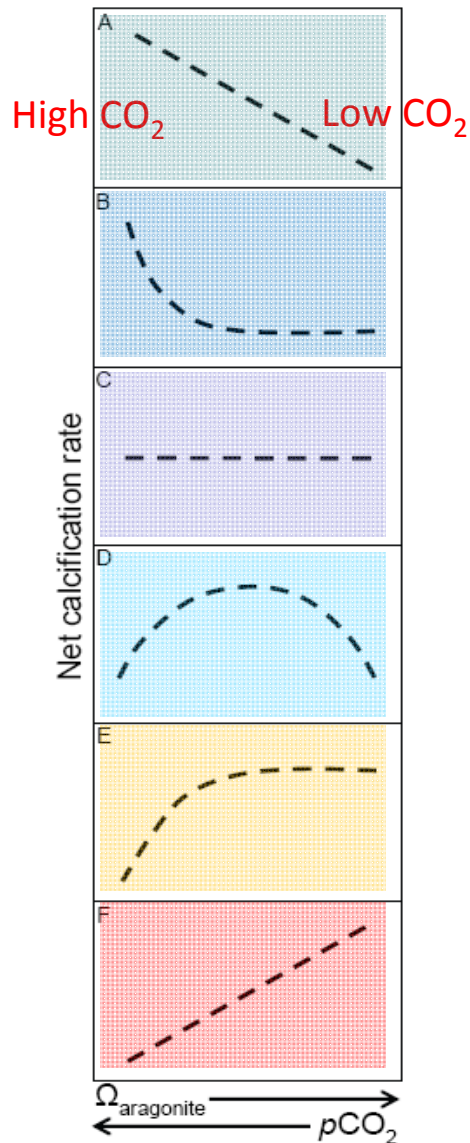




2nd example

Some organisms appear to be stimulated by ocean acidification.

Unexpected responses



2800 – 900 – 600 – 400 ppm CO₂

A - Crab
A - Shrimp

Callinectes sapidus
Penaeus plebejus



Callinectes sapidus

B – Lobster

Homarus americanus



Penaeus plebejus

C - Serpulid worm *Hydroides crucigera*

D - Halimeda *Halimeda incrassata*
D - Coralline red alga *Neogoniolithon sp.*
D - Pencil urchin *Eucidaris tribuloides*
D - Limpet *Crepidula fornicata*

E - Temperate coral *Oculina arbuscula*
E - Conch *Strombus alatus*

F - Periwinkle *Littorina littorea*
F - Whelk *Urosalpinx cinerea*
F - Bay scallop *Argopecten irradians*
F - Oyster *Crassostrea virginica*
F - Soft clam *Mya arenaria*



Homarus americanus

Unexpected responses: fish

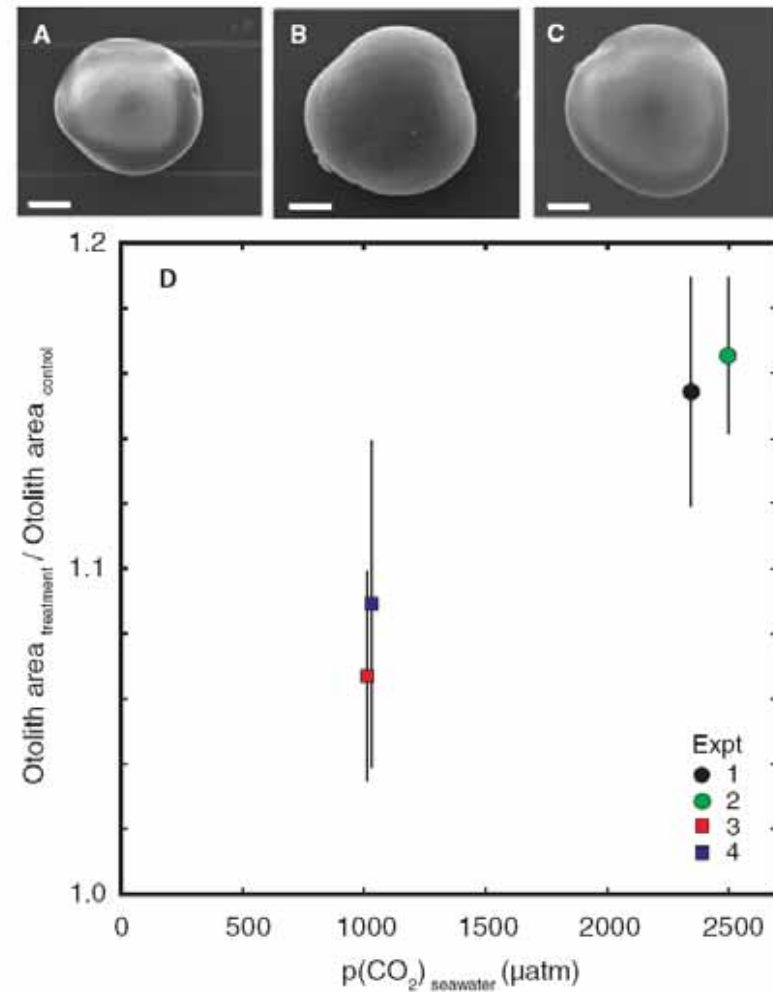
Elevated CO₂ Enhances Otolith Growth in Young Fish

David M. Checkley Jr.,* Andrew G. Dickson, Motomitsu Takahashi,† J. Adam Radich, Nadine Eisenkolb,‡ Rebecca Asch

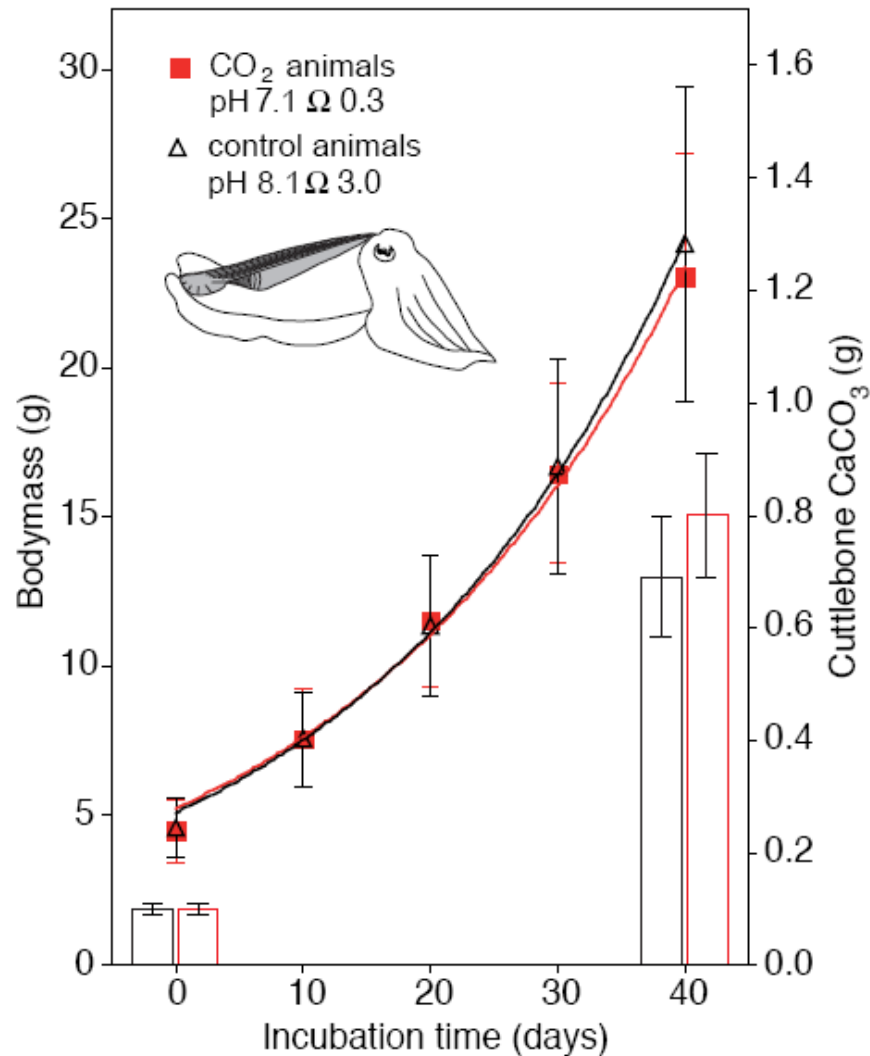
SCIENCE VOL 324 26 JUNE 2009

Otolith = earstones, important in balance system, made of calcium carbonate

Otolith masses increased by 15% and 25% when exposed to 2000 and 2500 μatm pCO₂.



Unexpected responses: cuttlefish



During long-term exposure to elevated $p\text{CO}_2$ cuttlefish maintain:

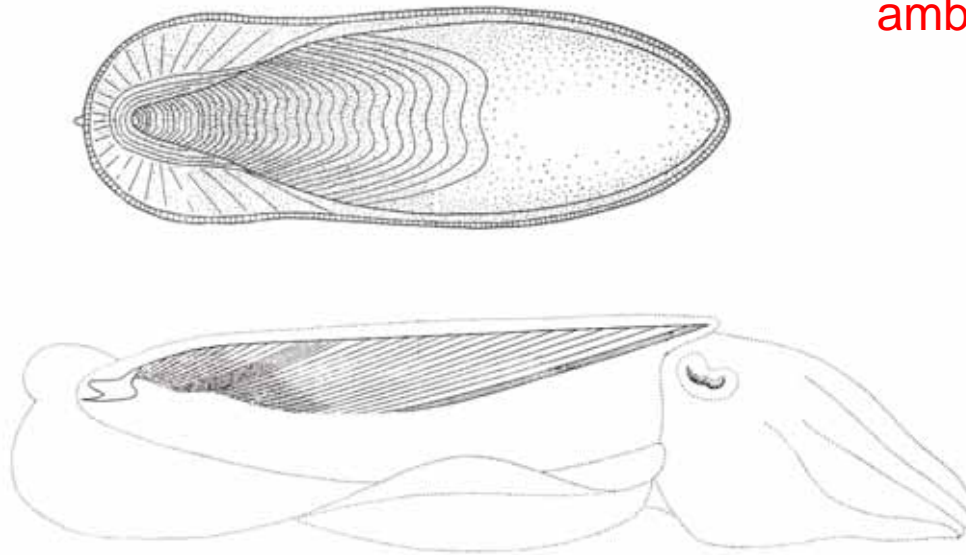
- control growth rates
- food conversion efficiencies

Contrary to all existing studies on molluscs...

calcification rate increases

(Gutowska et al. 2008)

Cuttlebone Microstructure

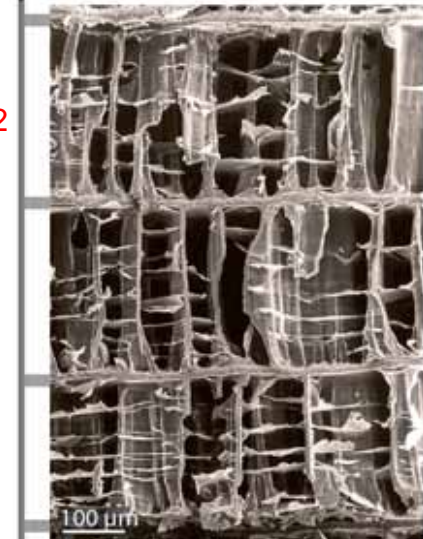
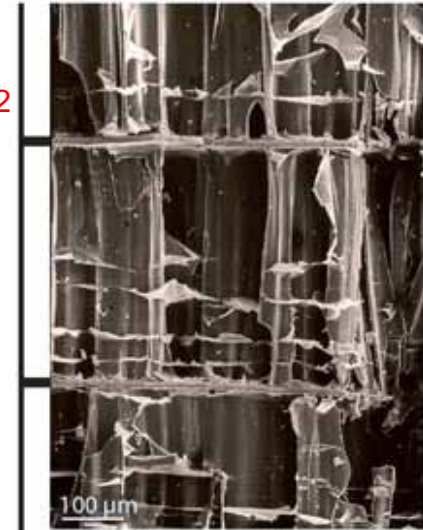


ambient $p\text{CO}_2$

high $p\text{CO}_2$

~ 50% reduction in lamellar spacing.

increase in lamellar & pillar wall thickness
lead to greater cuttlebone mass



(Gutowska et al. 2010)

Unexpected responses

Increased calcification in response to elevated $p\text{CO}_2$ in

- crustaceans (Ries et al. 2009)
- fish (Checkley et al. 2009)
- cephalopods (Gutowska et al. 2010)

What distinguishes these species / taxa from those that display reduced rates of calcification (bivalves, sea urchins, sea stars)?

Thank you!

