Bundesministerium
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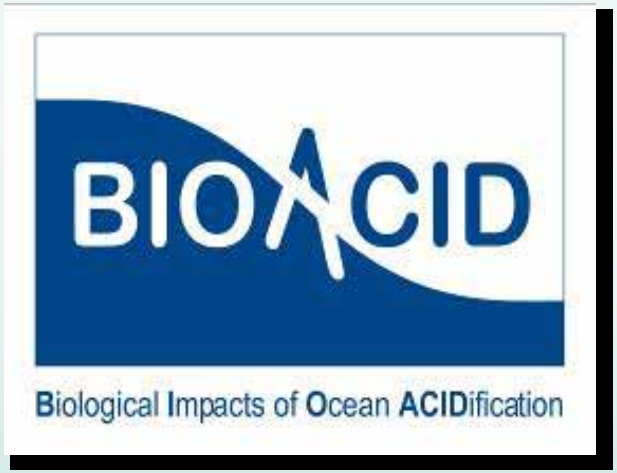
BIOACID

Projektträger Jülich
Forschungszentrum Jülich

BIOACID – **B**iological **I**mpacts of **O**cean **ACID**ification



Universität Hamburg

Universität Bremen

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BIOACID – **B**iological **I**mpacts of **O**cean **ACID**ification

- 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)

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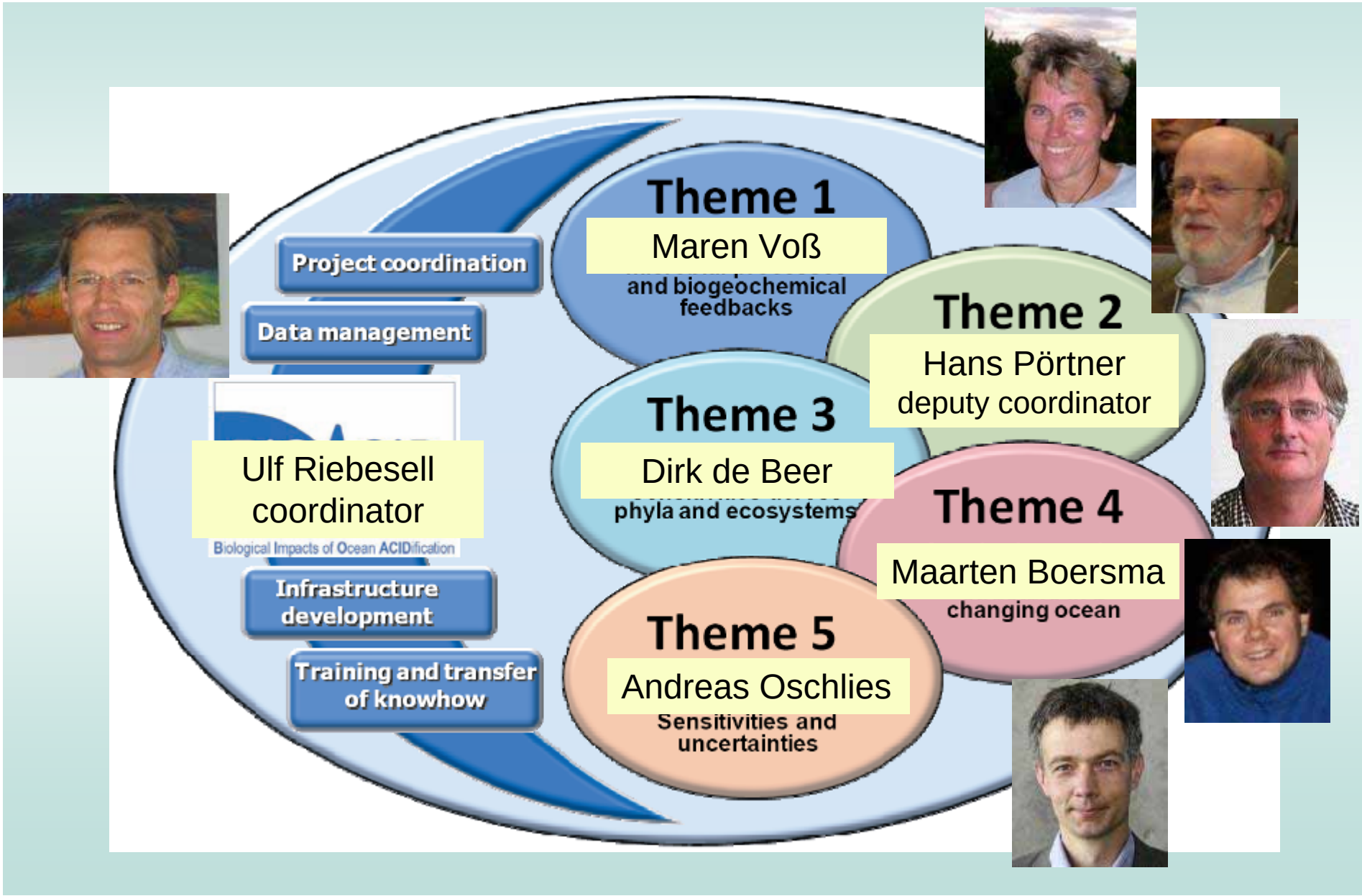
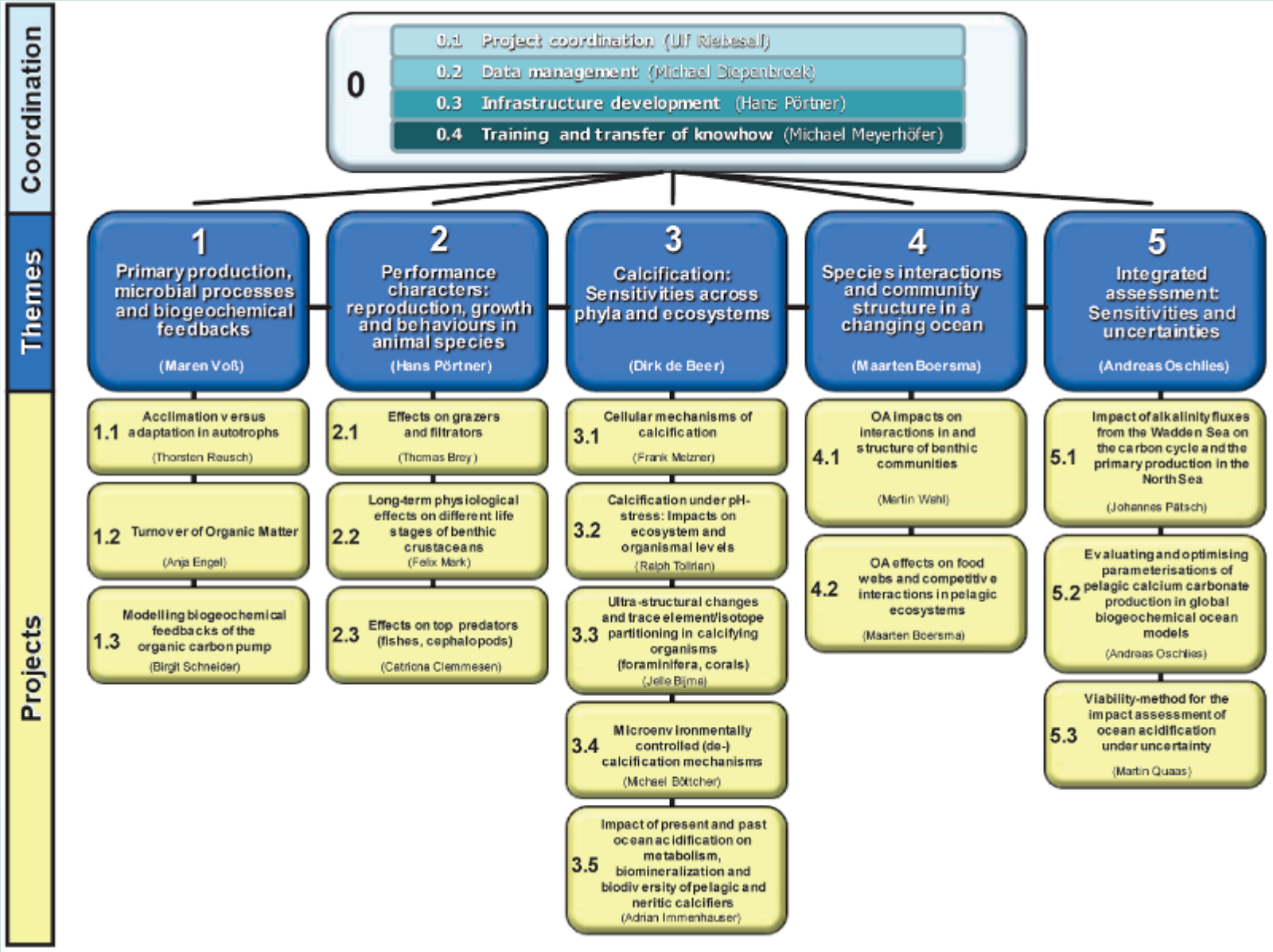
Project structure



Work in progress in 46 subprojects



General overview

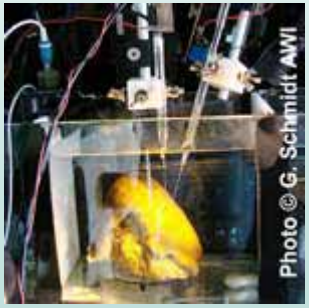
Wide range of disciplines:

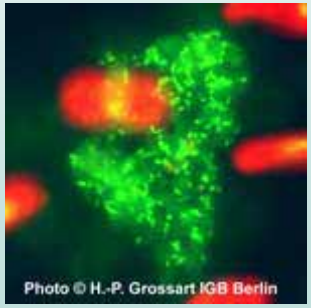
marine biologists, chemists, physicists, molecular biologists, paleontologists, medical researchers and mathematicians

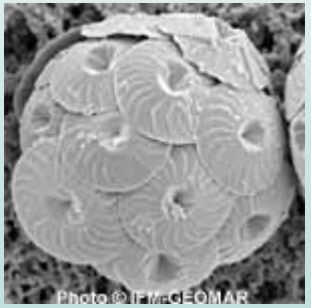
As well as marine engineers which are developing precise analytical techniques.

Wide range of organisms and communities:

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







General overview

Field work in various regions with complementary long-term experiments on-site or in home culture facilities:

Arctic:

•Spitsbergen: Pteropods (Kiel mesocosms in cooperation with EPOCA)

Antarctic:

•Experiments on RV Polarstern

Temperate:

•North Atlantic: e.g. cold water corals, sampled by manned submersible JAGO

•Baltic Sea (experiments with communities and single specimen)

•North Sea (Helgoland, Sylt; (experiments with communities and single specimen)

Tropics and Subtropics:

•Australia, Oman, Israel

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

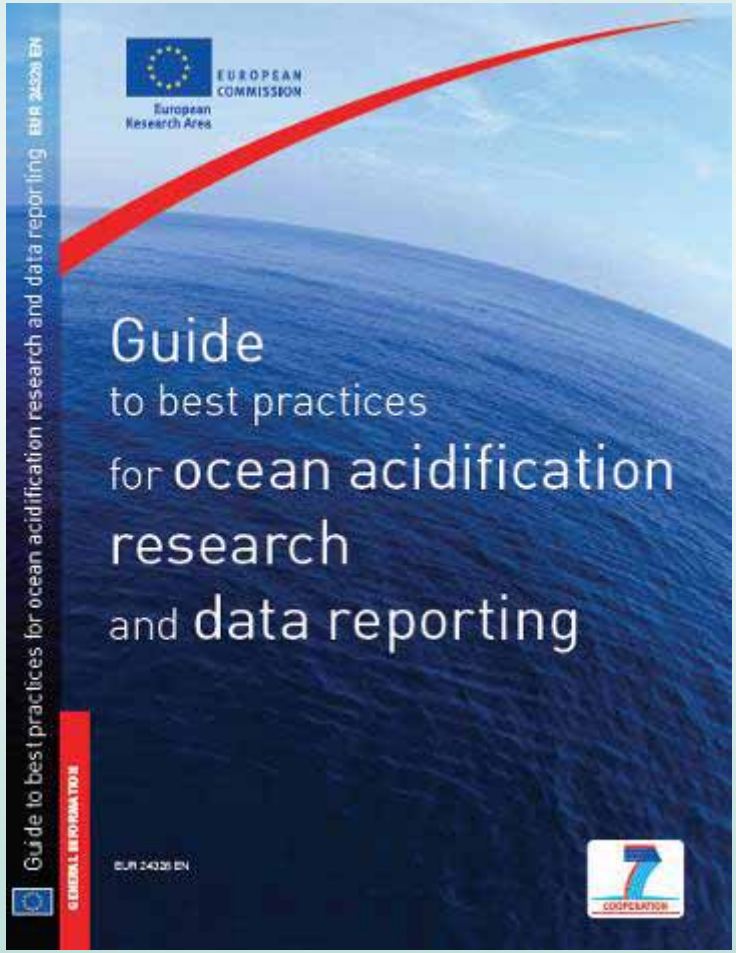
(Laboratoire d'Océanographie de Villefranche)

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)

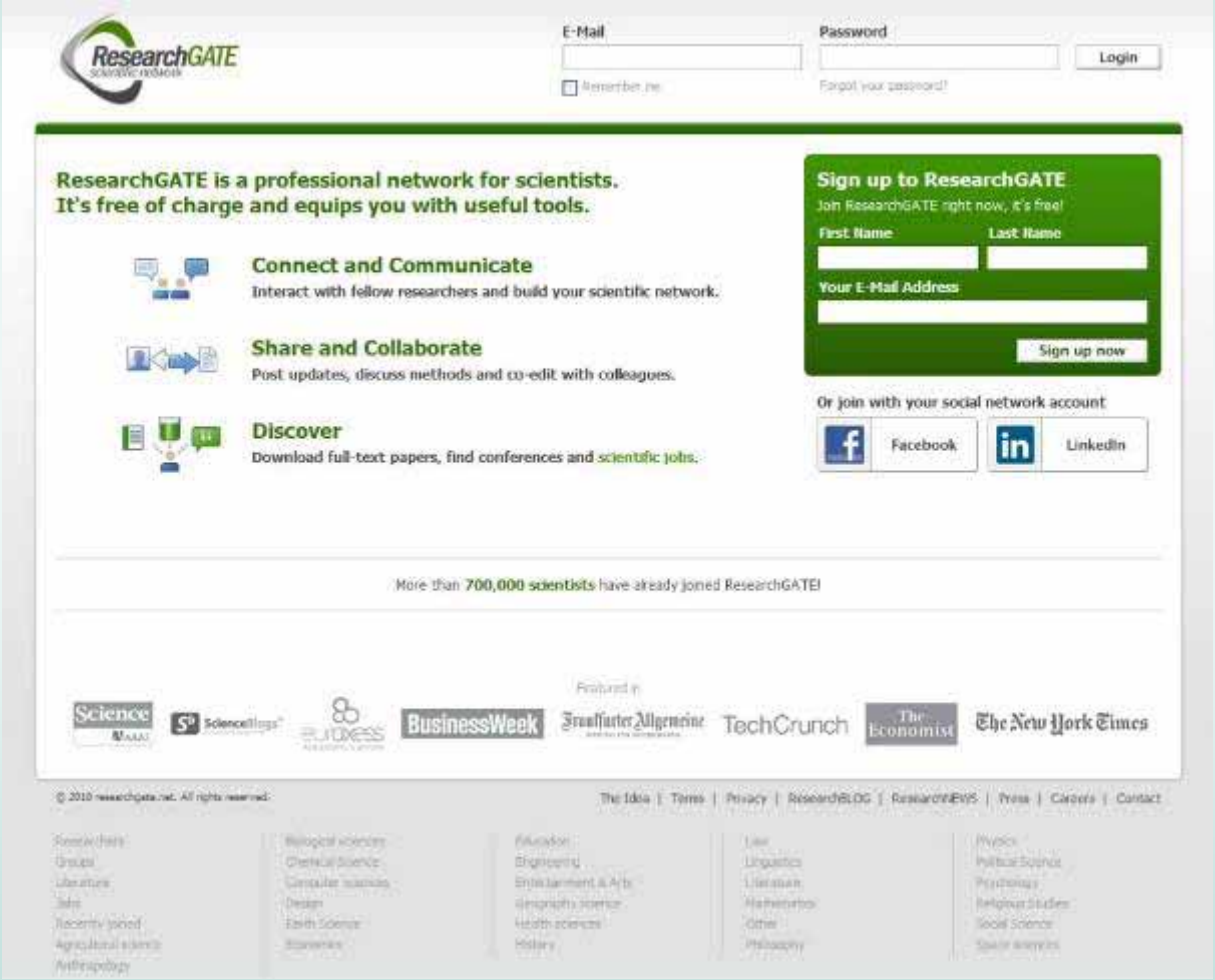
Outreach/communication

- New website

www.bioacid.de

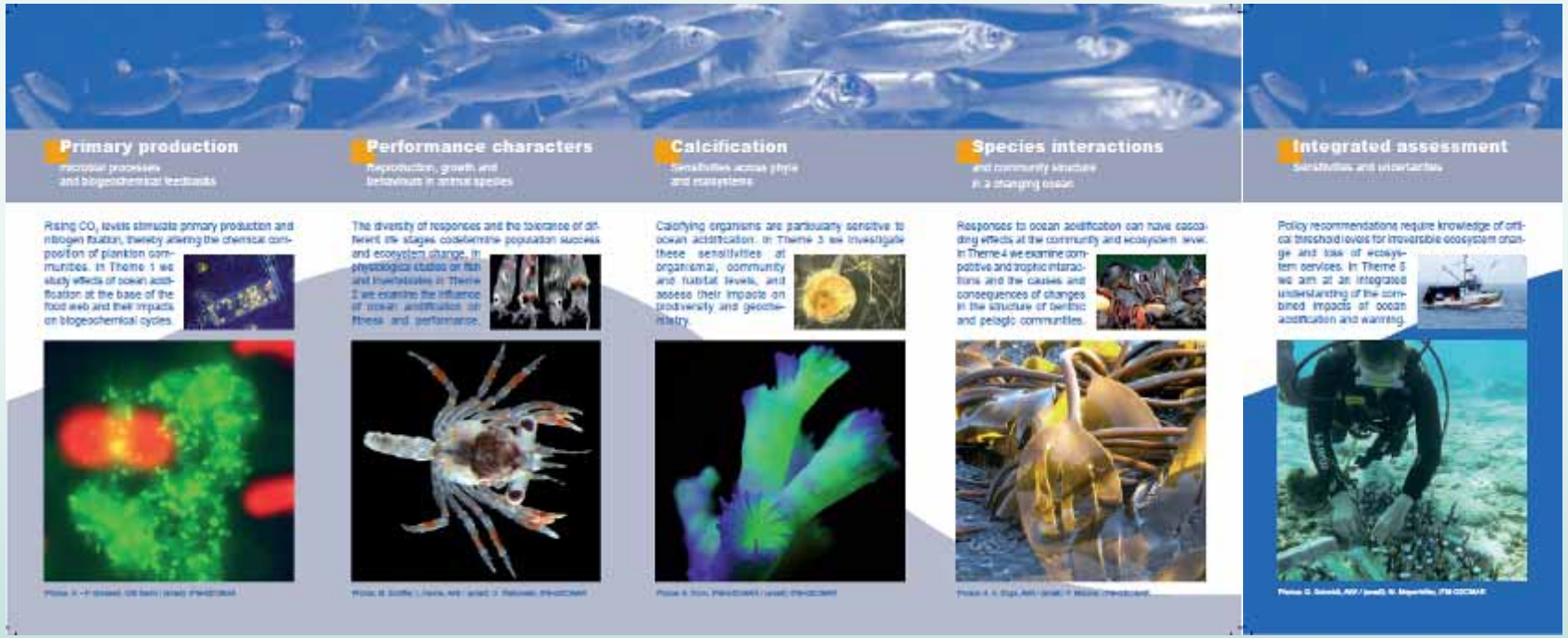
Outreach/communication

- New website
- Marketplace



Outreach/communication

- New website
- Marketplace
- Flyer



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 CO_2 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

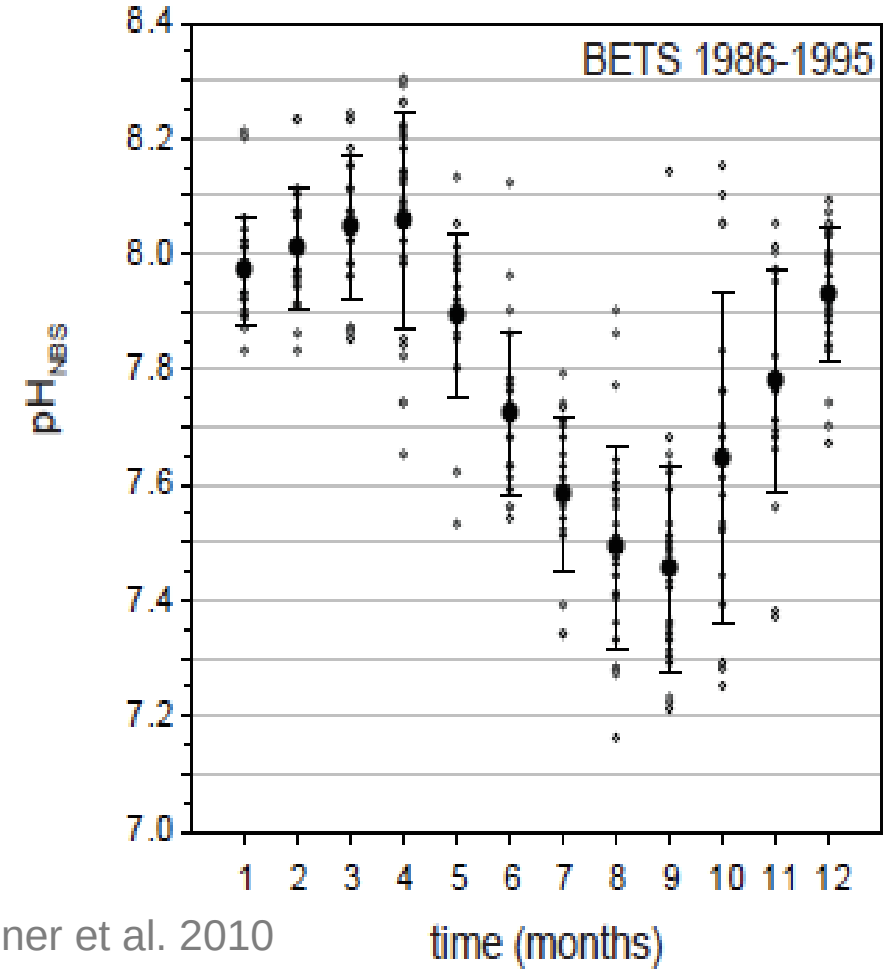
1st example

Acidified waters occur naturally

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

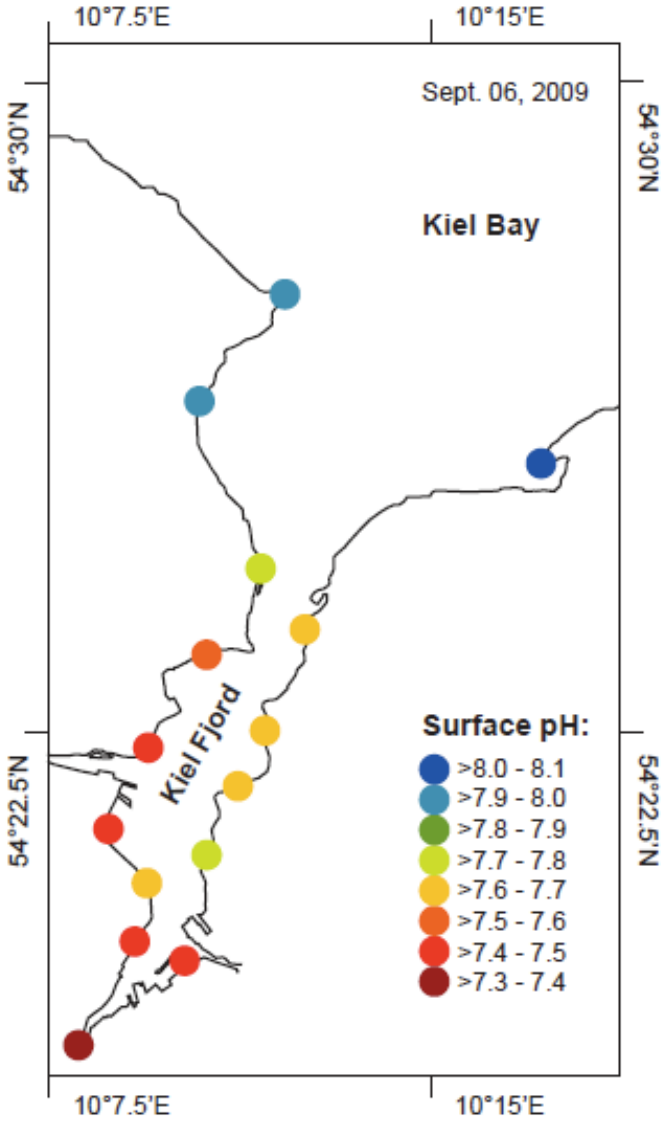
pH variability - Boknis Eck

- BETS = Boknis Eck Time Series in Kiel Bay

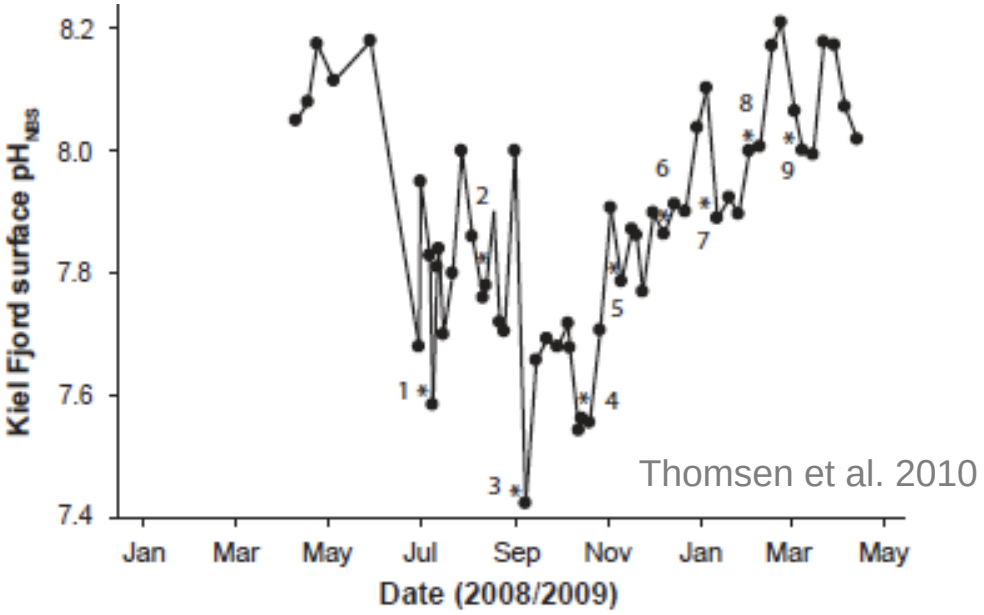


Melzner et al. 2010

pH variability - Kiel Bay



Melzner et al. 2010

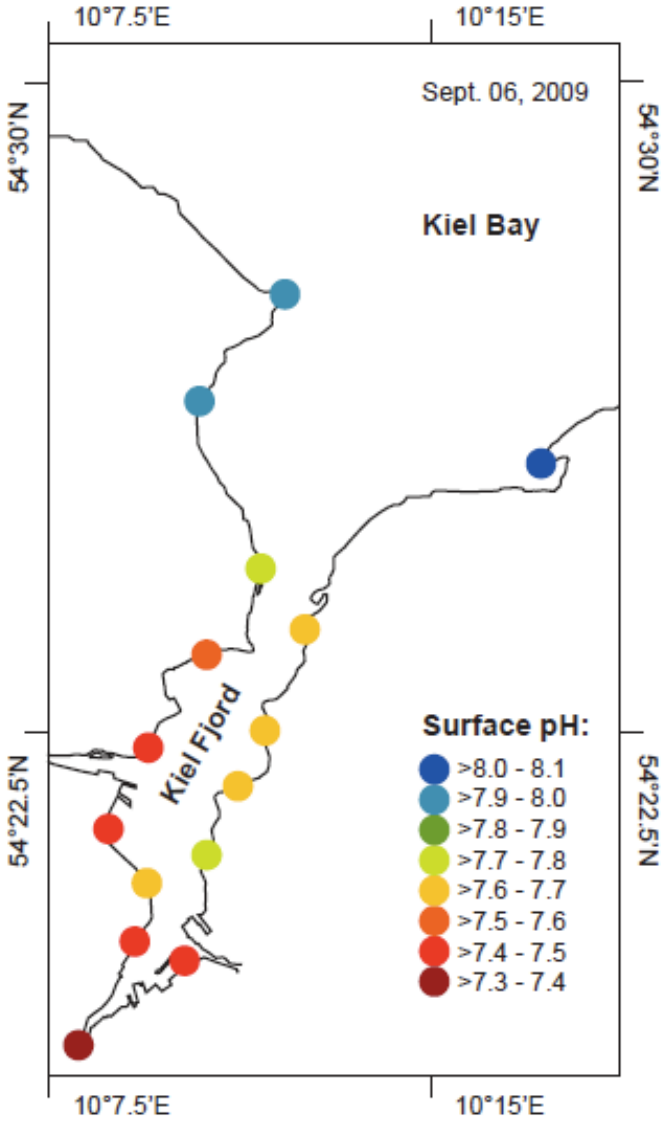


Thomsen et al. 2010

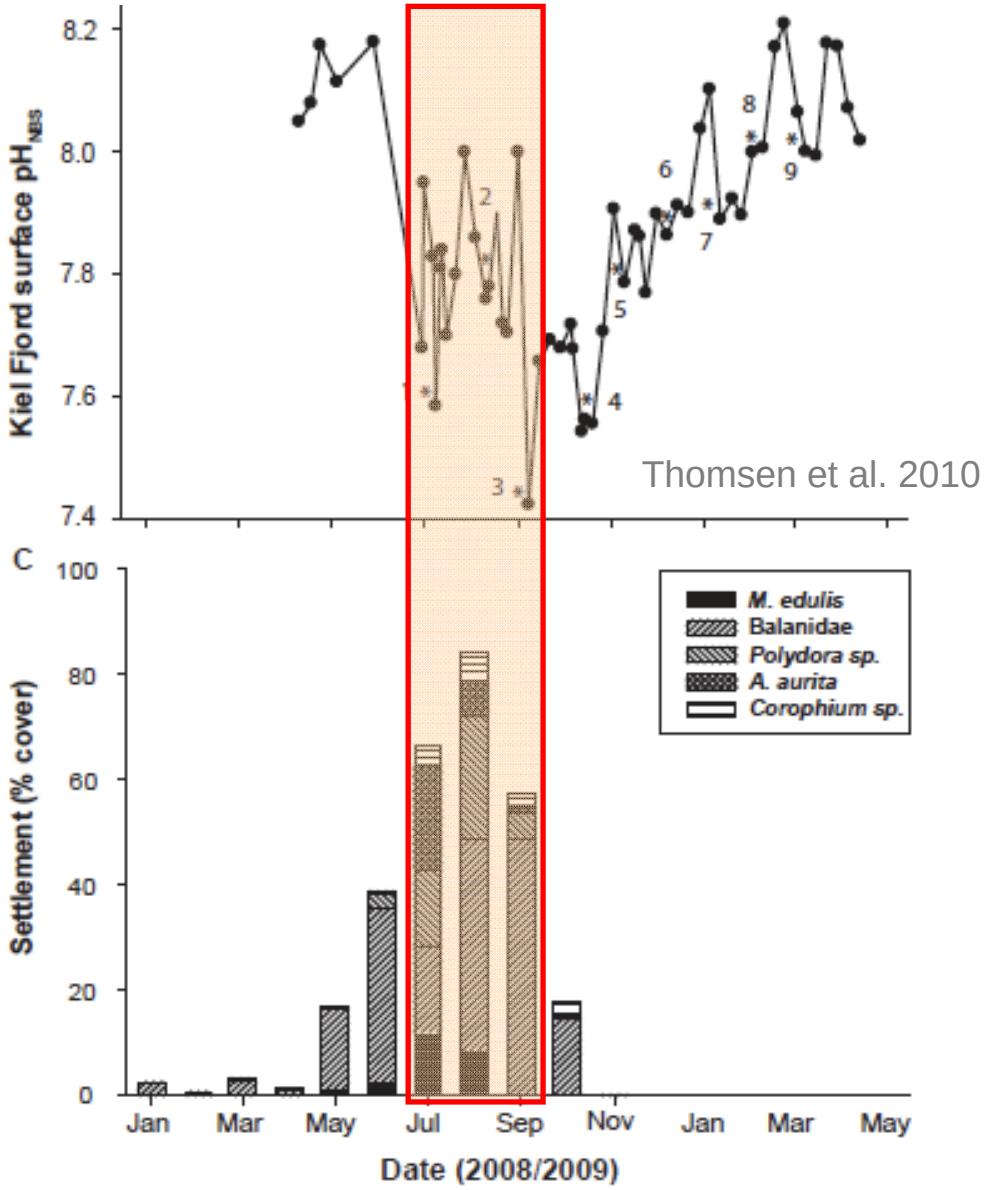
Upwelling of ‚deep' waters in summer and autumn

Average pCO_2 in 2008/2009 ~ 700 µatm
Average pCO_2 July-August ~ 1000 µatm
Maximum pCO_2 >2000 µatm

pH variability - Kiel Fjord



Melzner et al. 2010



Thomsen et al. 2010

Settlement - Kiel Fjord

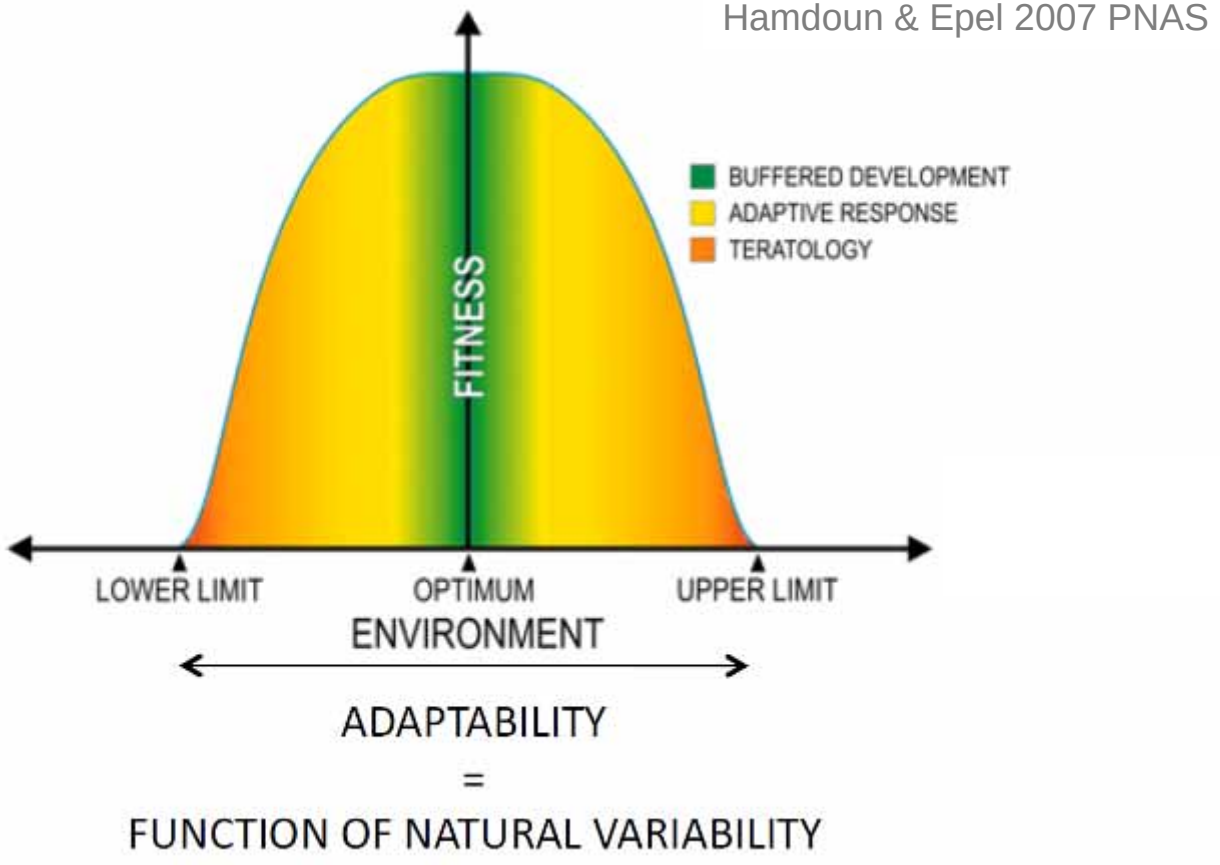
Calcifying communities dominate within 6 weeks after settlement (>99%)

Environmental variability hypothesis

Greater environmental variability

broader physiological limits
= higher resilience to future changes

Hamdoun & Epel 2007 PNAS

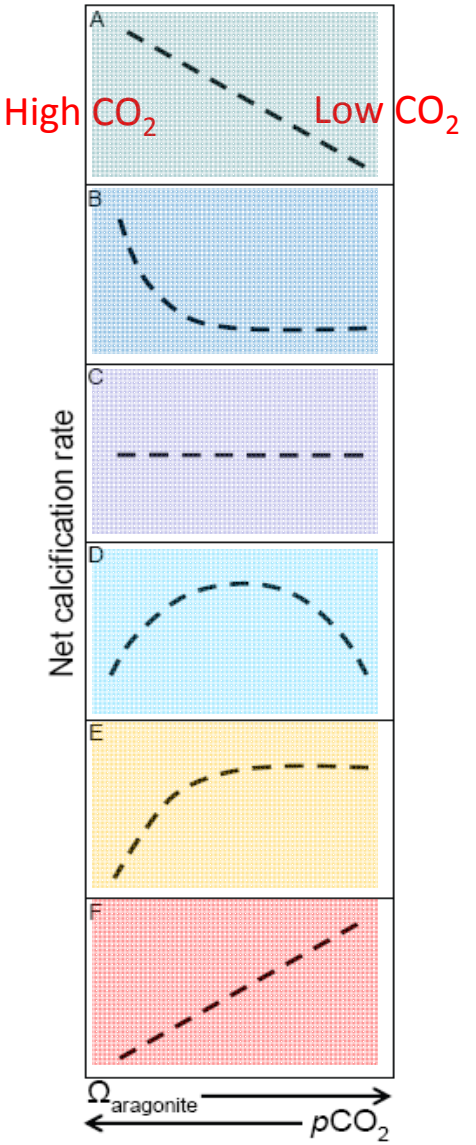


Unexpected responses

2nd example

Some organisms appear to be stimulated by ocean acidification.

Unexpected responses



2800 – 900 – 600 – 400 ppm CO_2

A - Crab	*Callinectes sapidus*
A - Shrimp	*Penaeus plebejus*
B – Lobster	*Homarus americanus*
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	*Stromubus alatus*
F - Periwinkle	*Littorina littorea*
F - Whelk	*Urosalpinx cinerea*
F - Bay scallop	*Agropecten irradians*
F - Oyster	*Crassostrea virginica*
F - Soft clam	*Mya arenaria*

Callinectes sapidus

Penaeus plebejus

Homarus americanus

Ries et al., 2009 Geology

Unexpected responses: fish

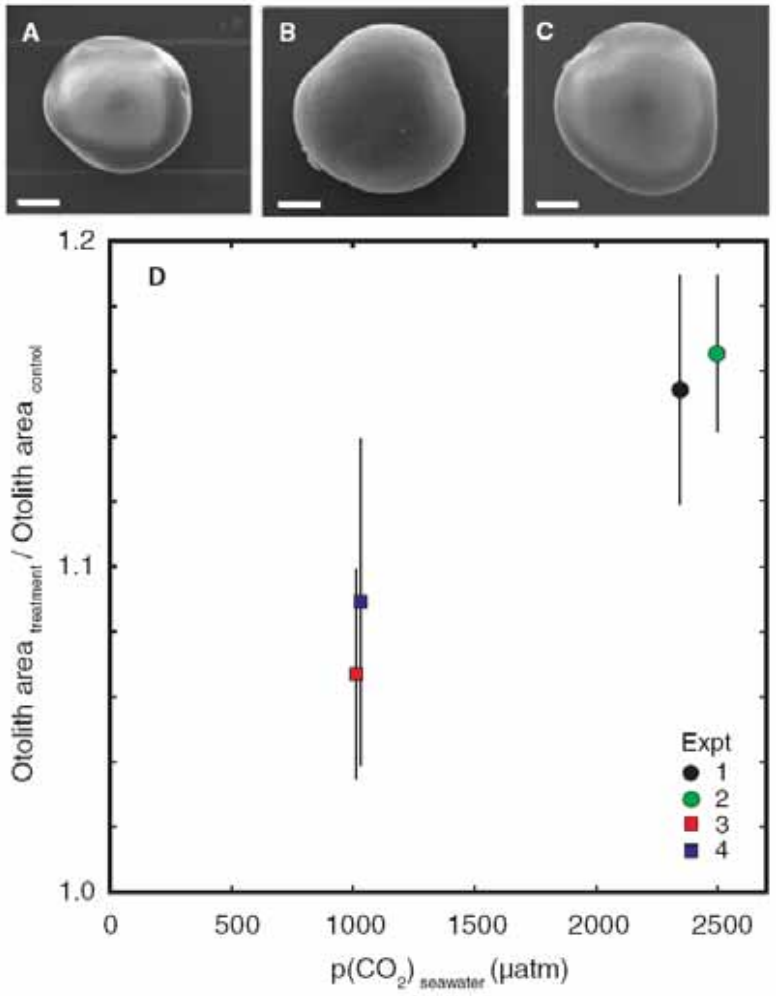
Elevated CO_2 Enhances Otolith Growth in Young Fish

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

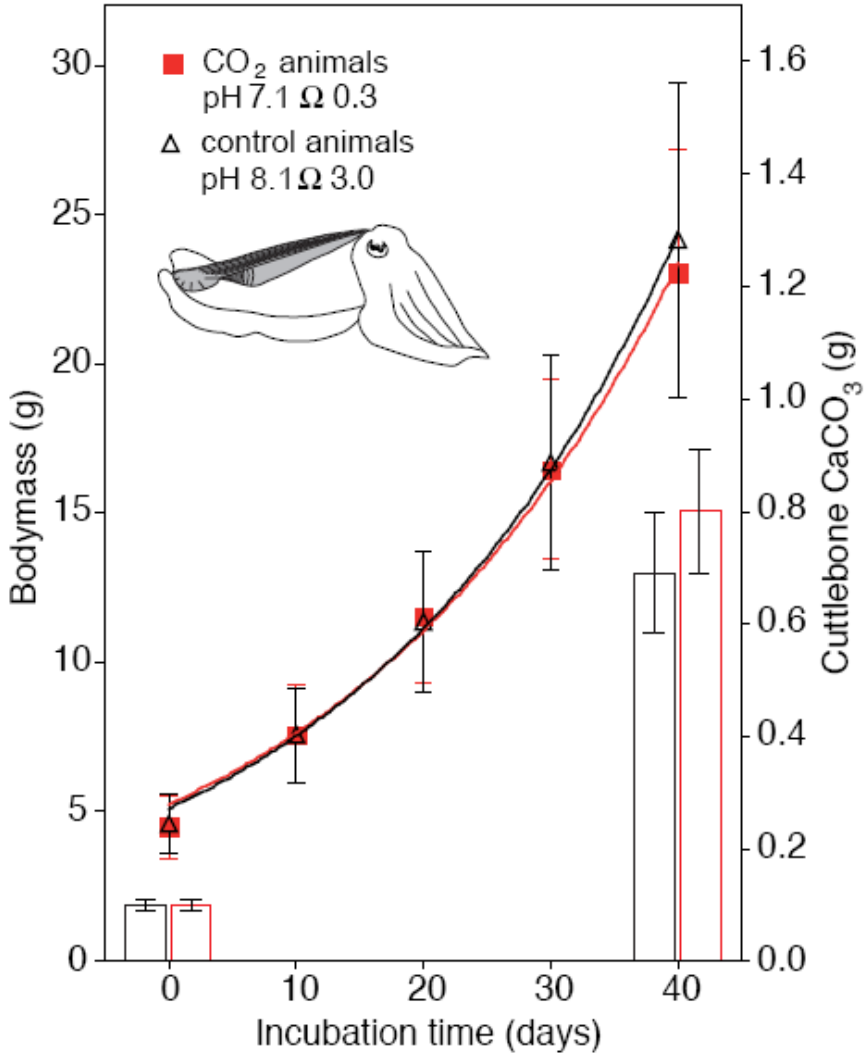
SCIENCE VOL 324 26 JUNE 2009

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

Otolith masses increased by 15% and 25% when exposed to 2000 and 2500 µatm pCO_2.



Unexpected responses: cuttlefish



During long-term exposure to elevated pCO_2 cuttlefish maintain:

- control growth rates
- food conversion efficencies

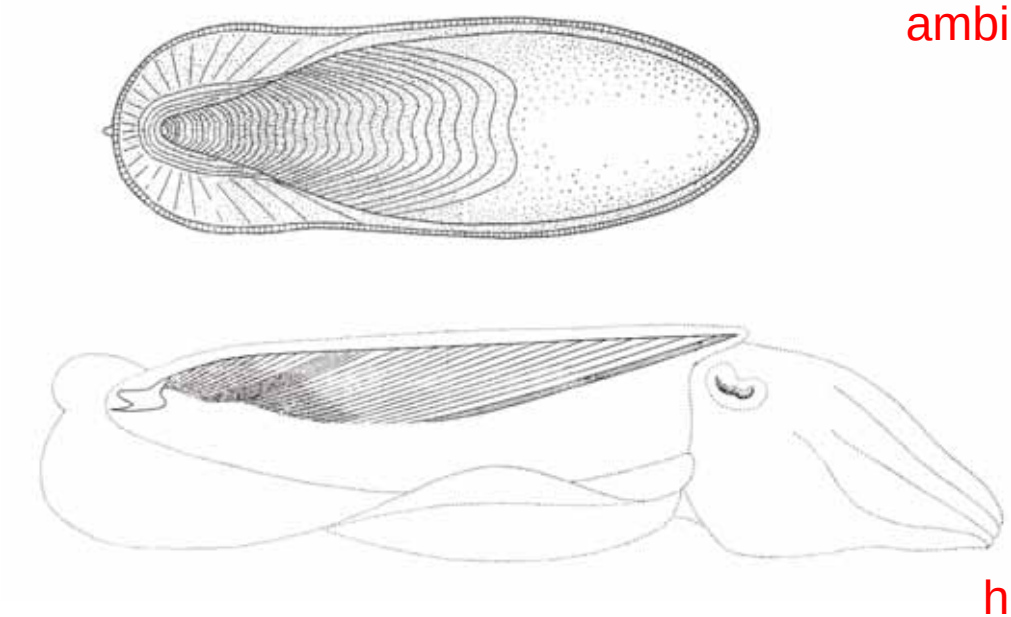
Contrary to all existing studies on molluscs...

calcification rate increases

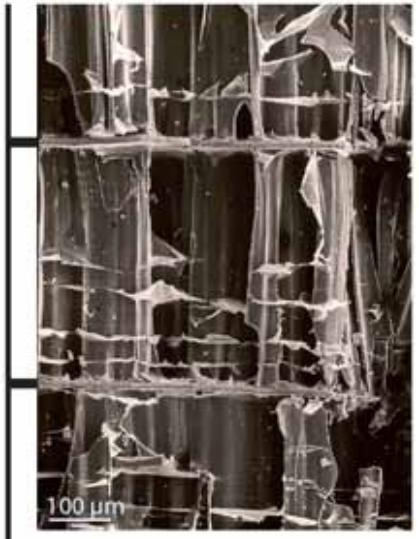
(Gutowska et al. 2008)

Unexpected responses: cuttlefish

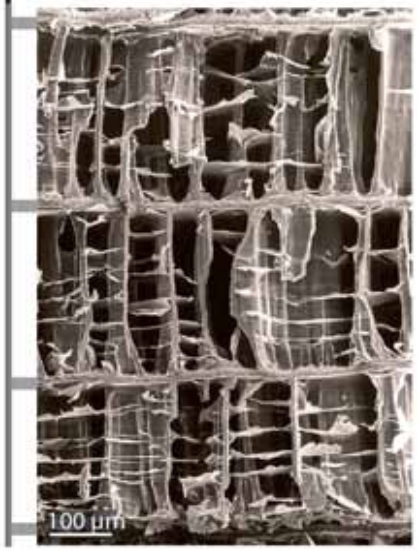
Cuttlebone Microstructure



ambient pCO_2



high pCO_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 pCO_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!
BIOACID
Biological Impacts of Ocean ACIDification