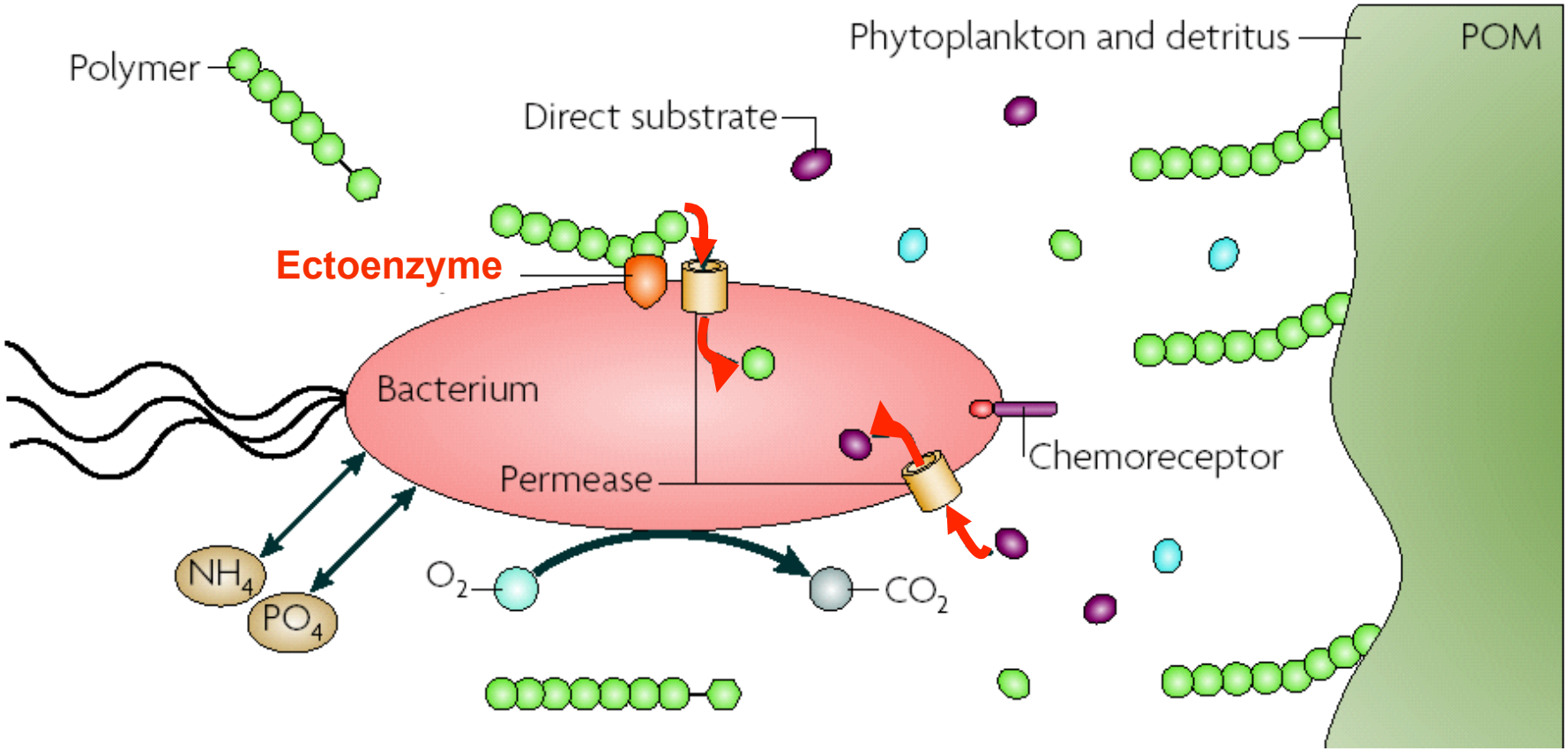
Effects of rising seawater pCO_2 on the bacterial turnover of organic matter in temperate marine systems

Judith Piontek, Nicole Händel, Martin Sperling, Ulf Riebesell, Anja Engel

AWI

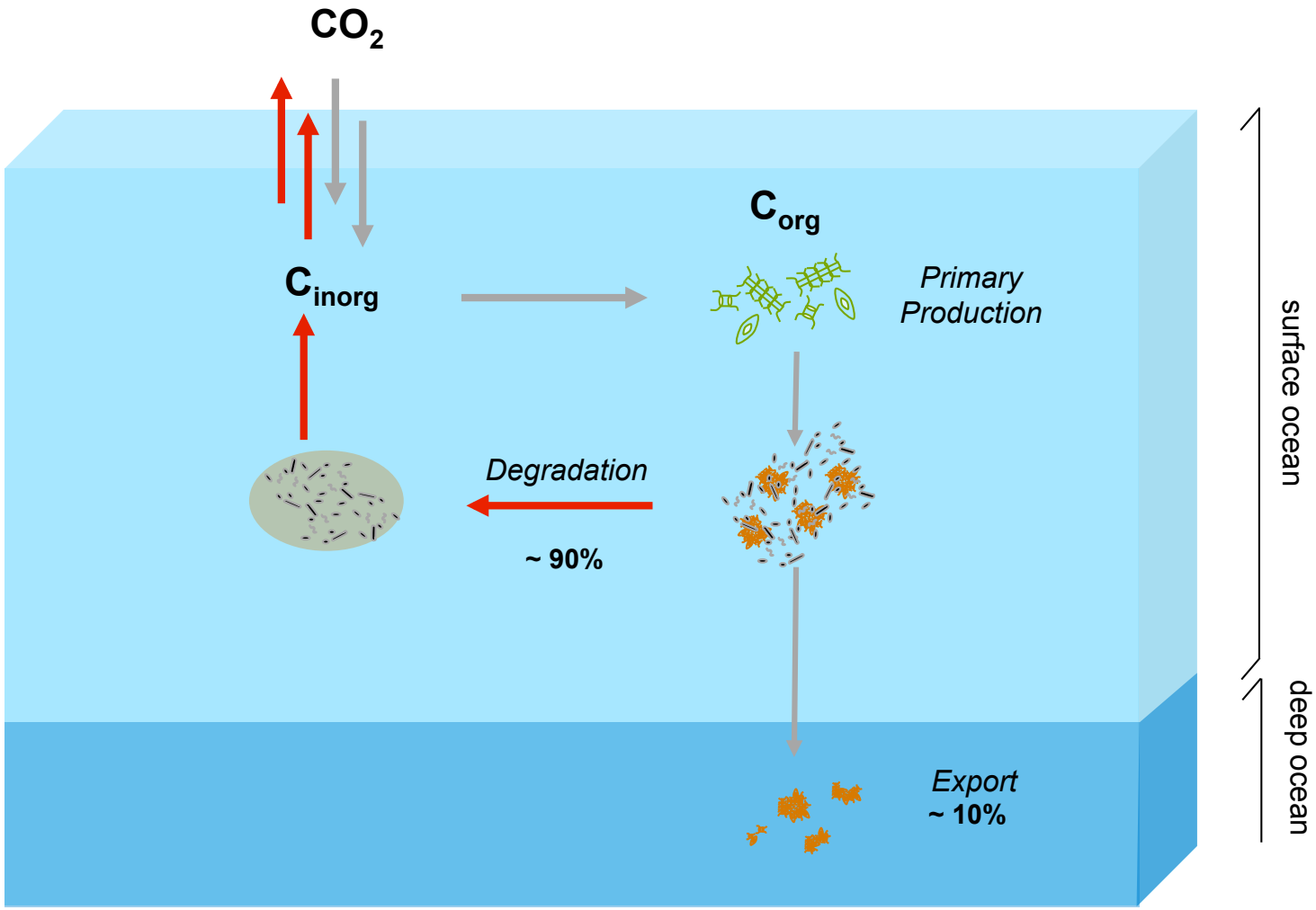
IFM-GEOMAR

The function of extracellular enzymes in organic matter turnover

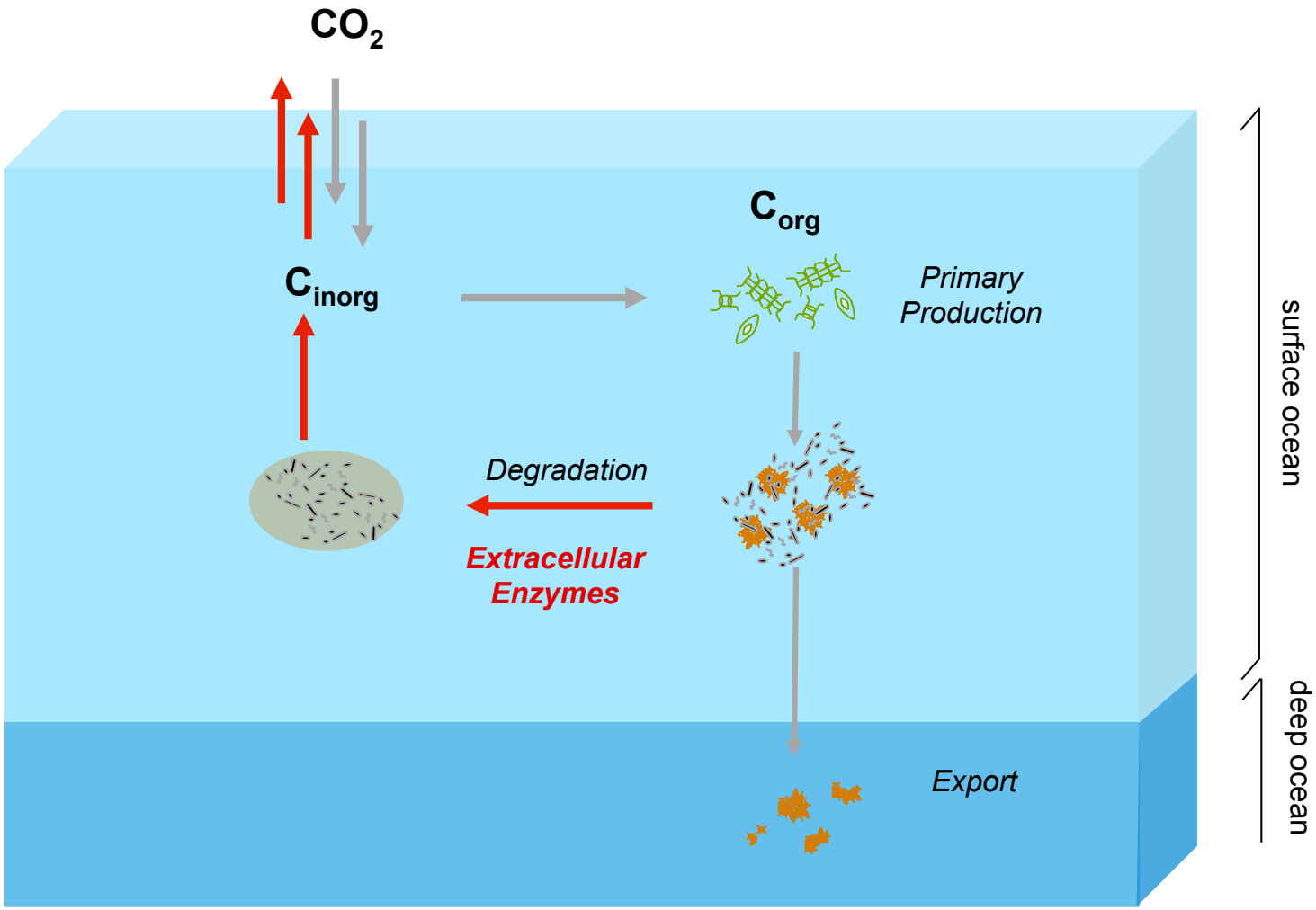


Azam & Malfatti (2007)

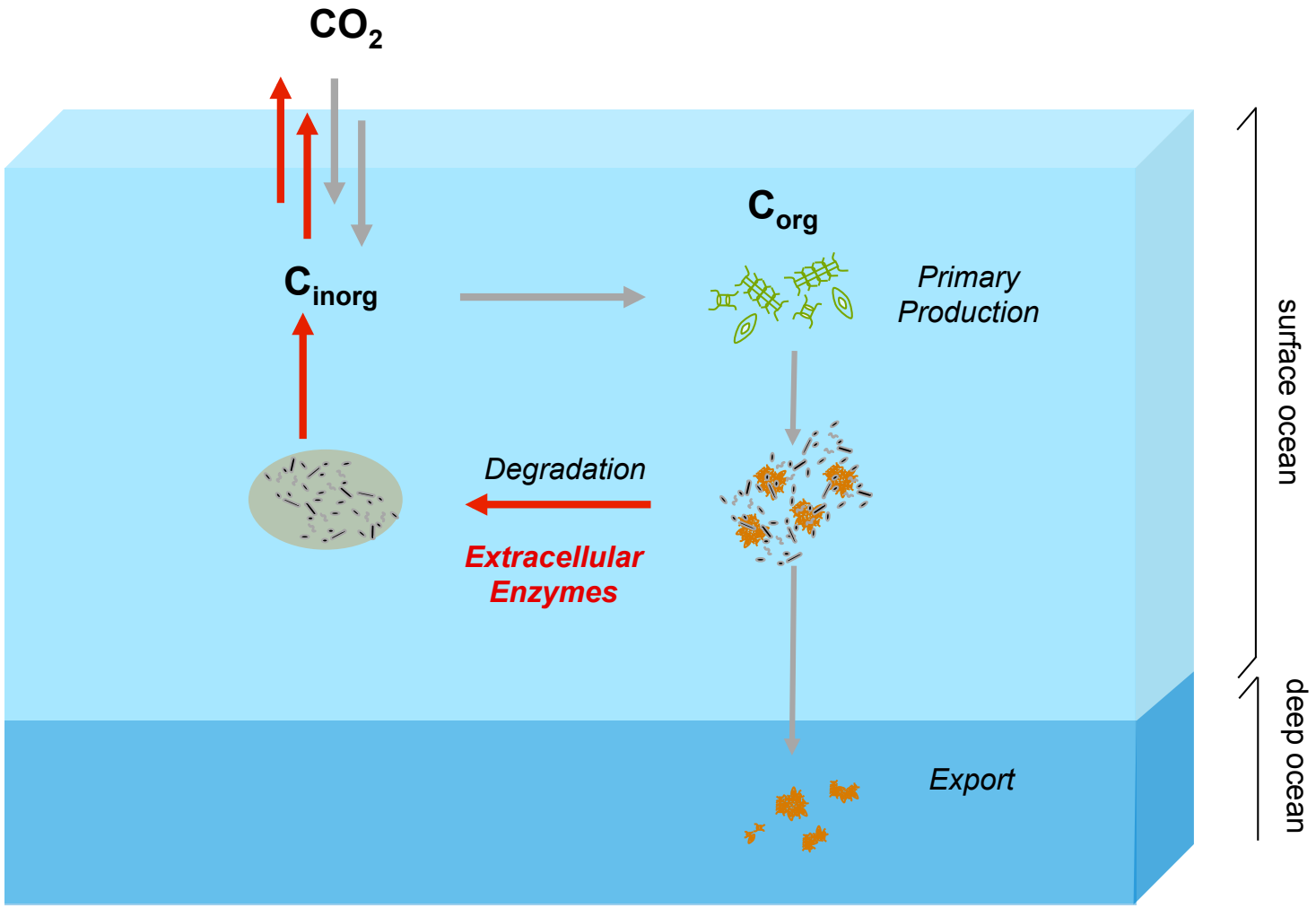
The function of extracellular enzymes in organic matter turnover



The function of extracellular enzymes in organic matter turnover



The function of extracellular enzymes in organic matter turnover



How does the activity of bacterial extracellular enzymes respond to Ocean Acidification?

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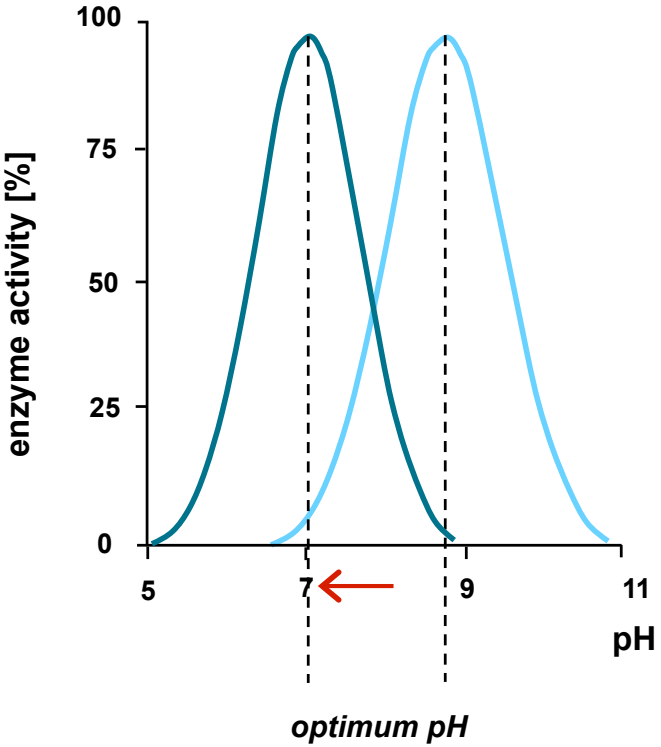


Is there a direct biochemical effect of ocean acidification on rates of extracellular enzymes?

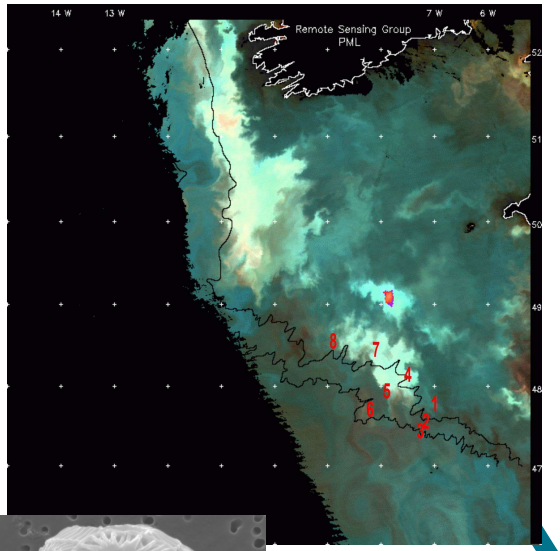
Can acidification impact bacterial organic matter degradation in the ocean?

➔ Experimental results on glucosidase and leucine-aminopeptidase activity

Method: fluorescent substrate analogues, Hoppe (1983)

CO_2 Perturbation Studies

Gulf of Biscay, North Atlantic



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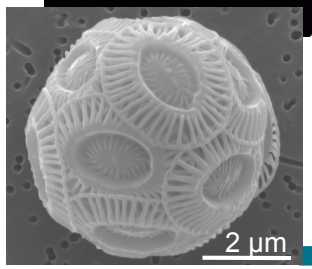
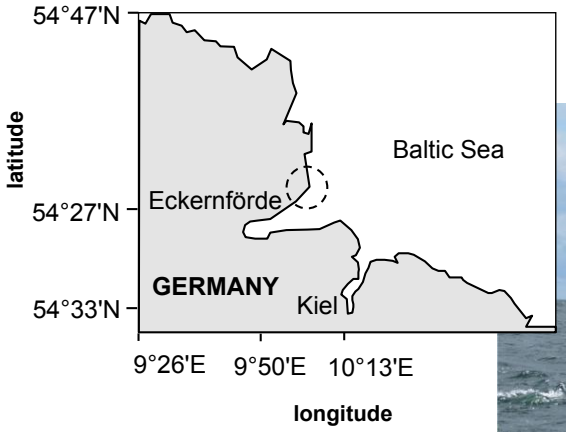


Emiliania huxleyi



Baltic Sea

Degradation Experiments

incubation in the dark

at *in situ* pH and after acidification

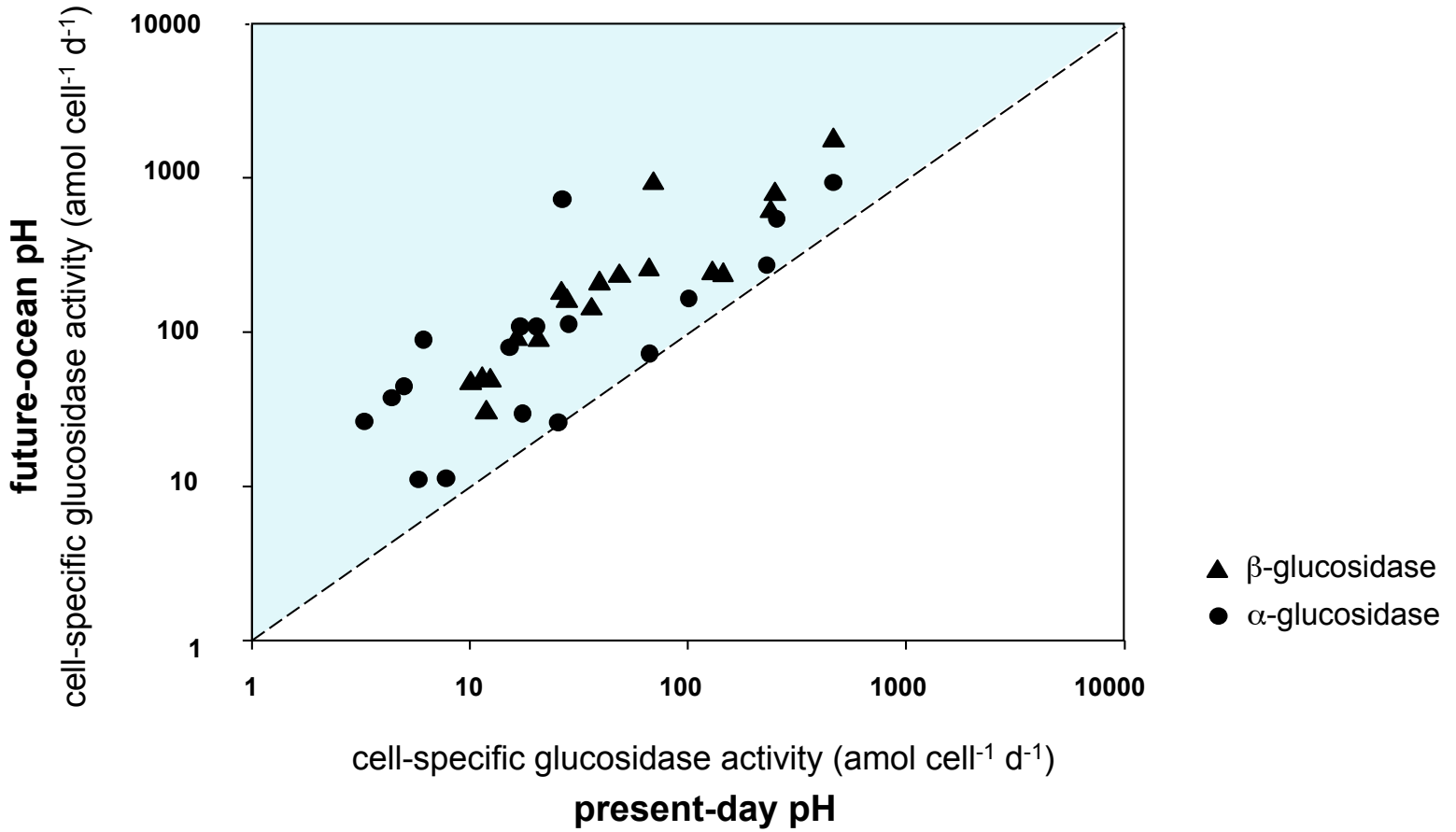
(Δ pH 0.2 – 0.3 units)

Mesocosm Experiments

Bloom development, pH Gradient

(Δ pH 0.1 – 0.3 units)

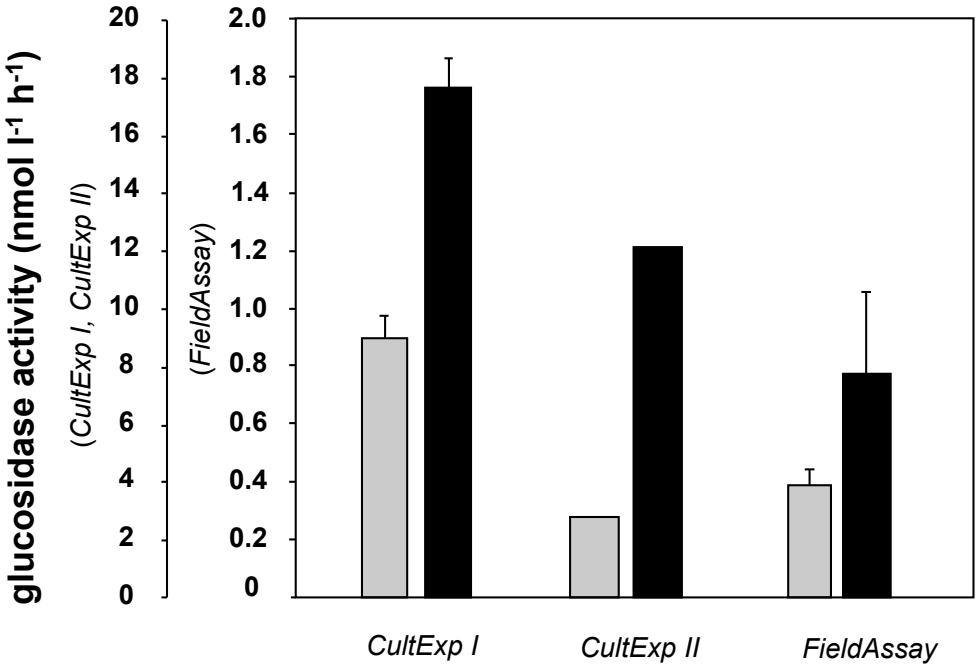
Effect of lowered pH on extracellular GLUCOSIDASE

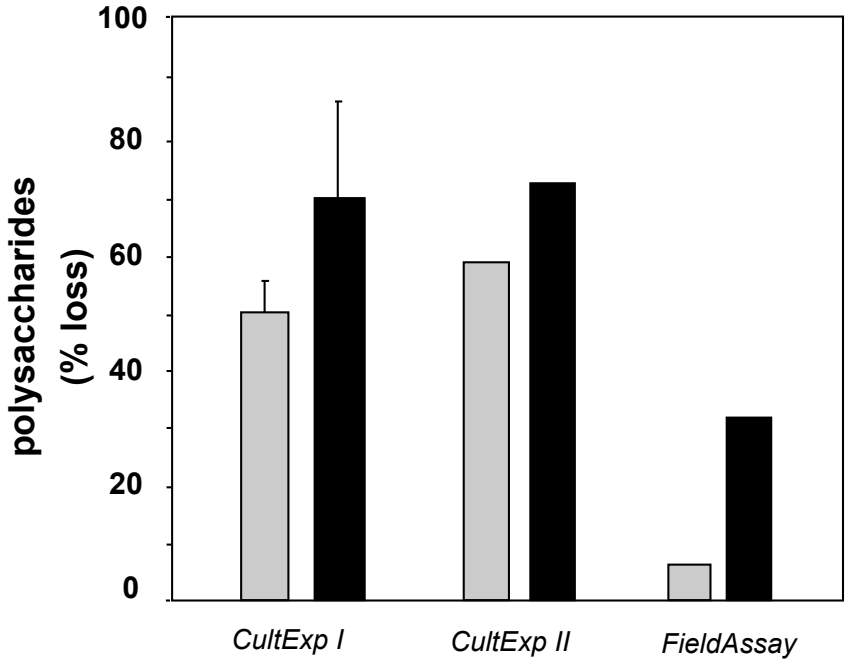


Piontek et al. (2010)

➔ cell-specific glucosidase rates at future-ocean pH exeed rates at present-day pH

Effect of lowered pH on extracellular GLUCOSIDASE





present-day pH

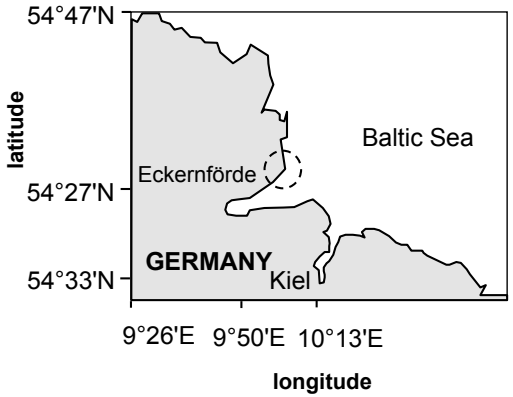
future-ocean pH

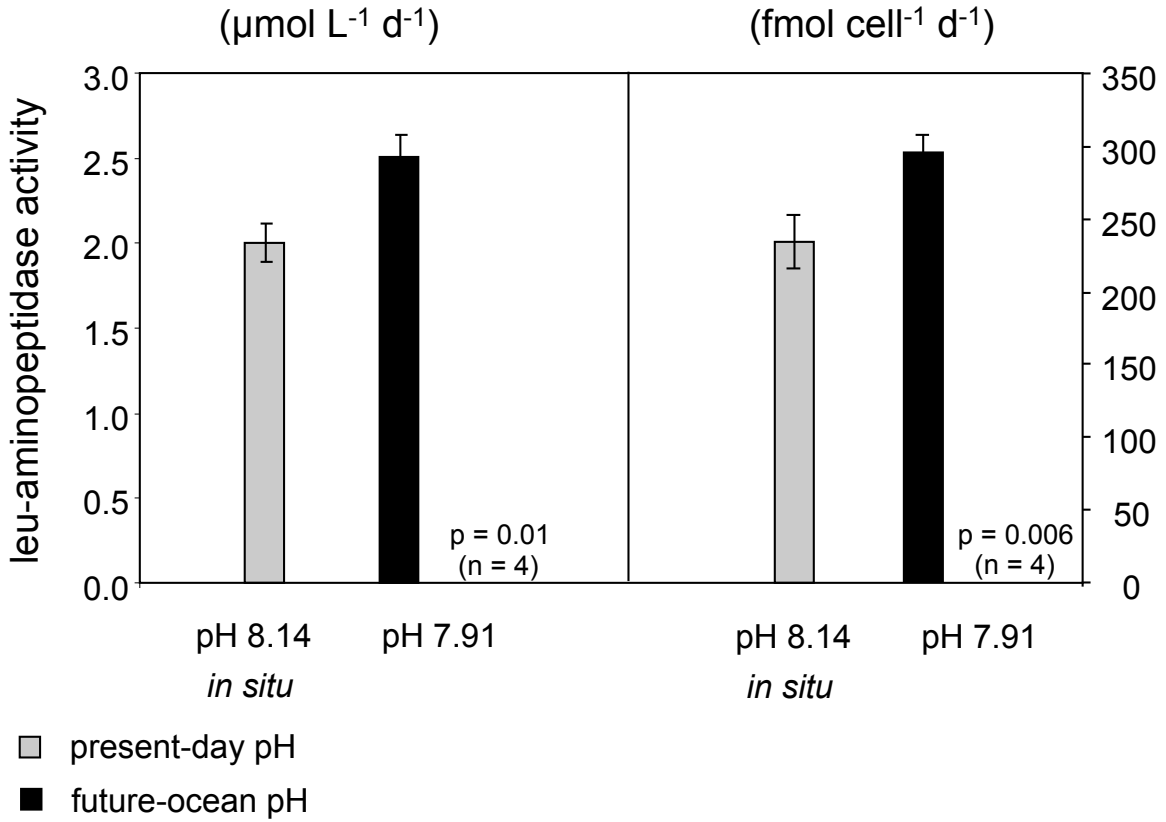
Piontek et al. (2010)

➔ higher glucosidase activity at future-ocean pH leads to a higher loss of polysaccharides

Effect of lowered pH on extracellular LEUCINE-AMINOPEPTIDASE

Baltic Sea (field sample)





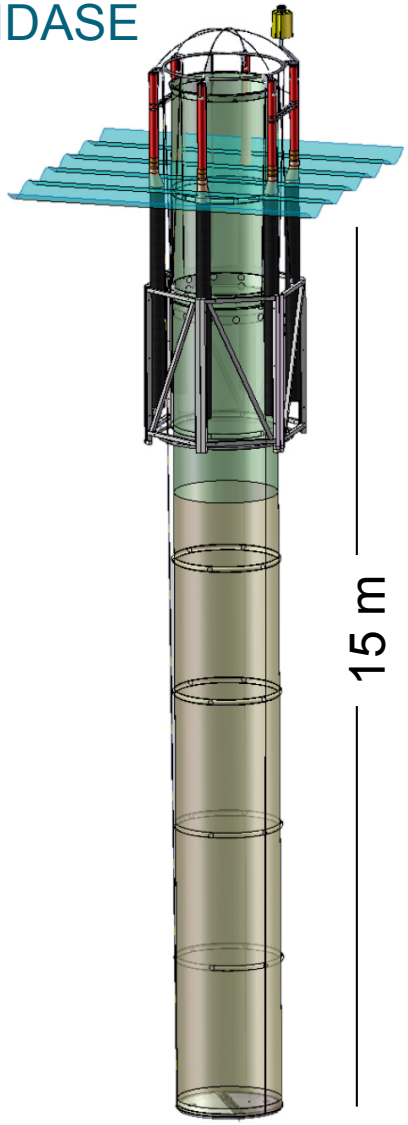
➔ higher leu-aminopeptidase activity in response to moderate acidification

Effect of lowered pH on extracellular LEUCINE-AMINOPEPTIDASE

Eckernförde Bight, Baltic Sea

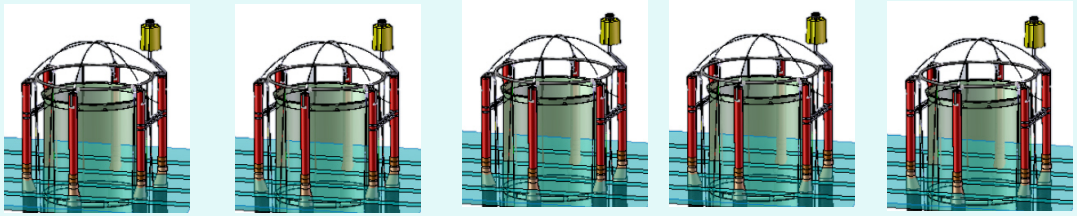
KOSMOS: Kiel Off-Shore Mesocosms for future Ocean Simulations

photos: U. Riebesell, M. Sperling, Greenpeace



Effect of lowered pH on extracellular LEUCINE-AMINOPEPTIDASE

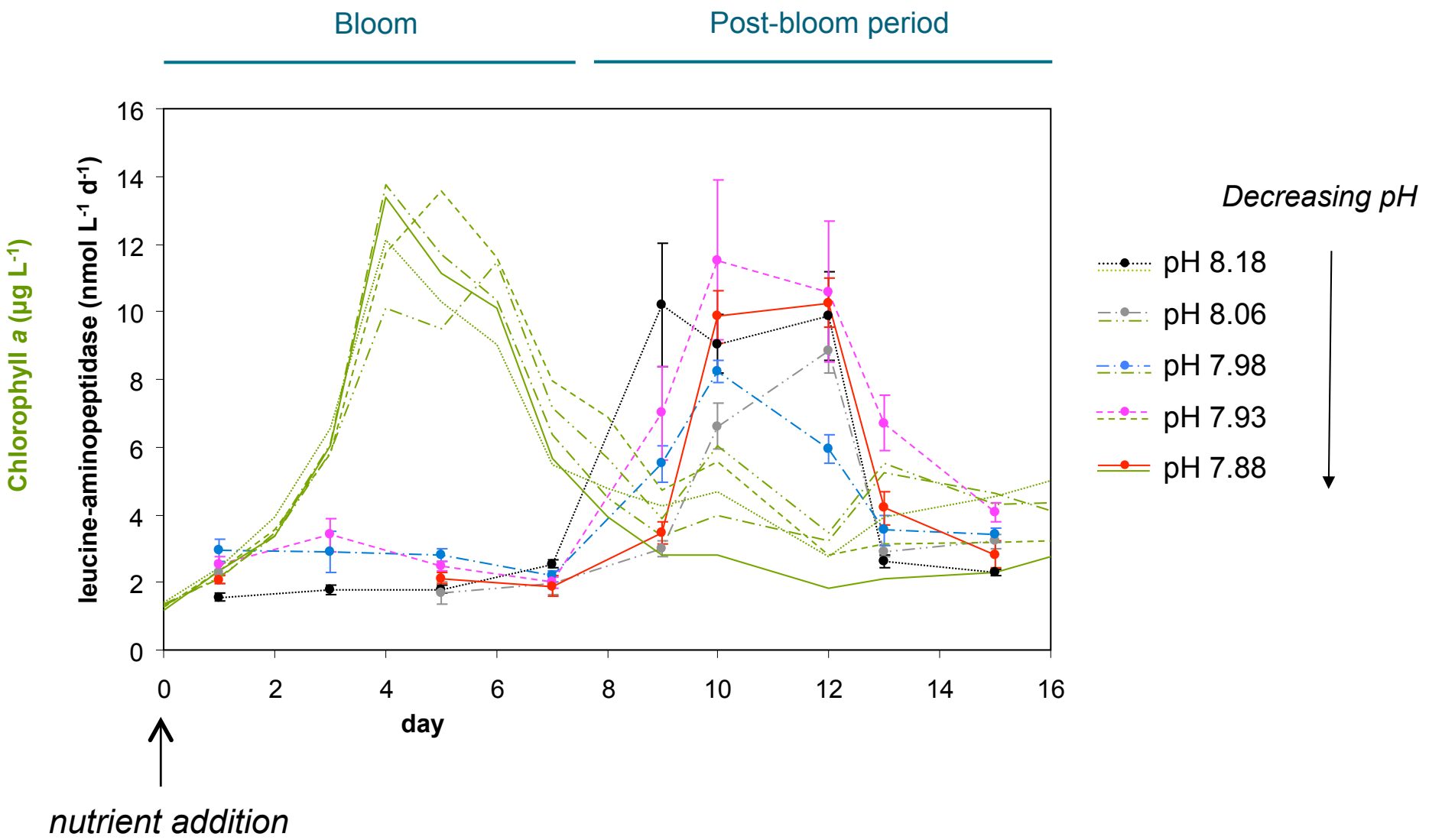
Mesocosms



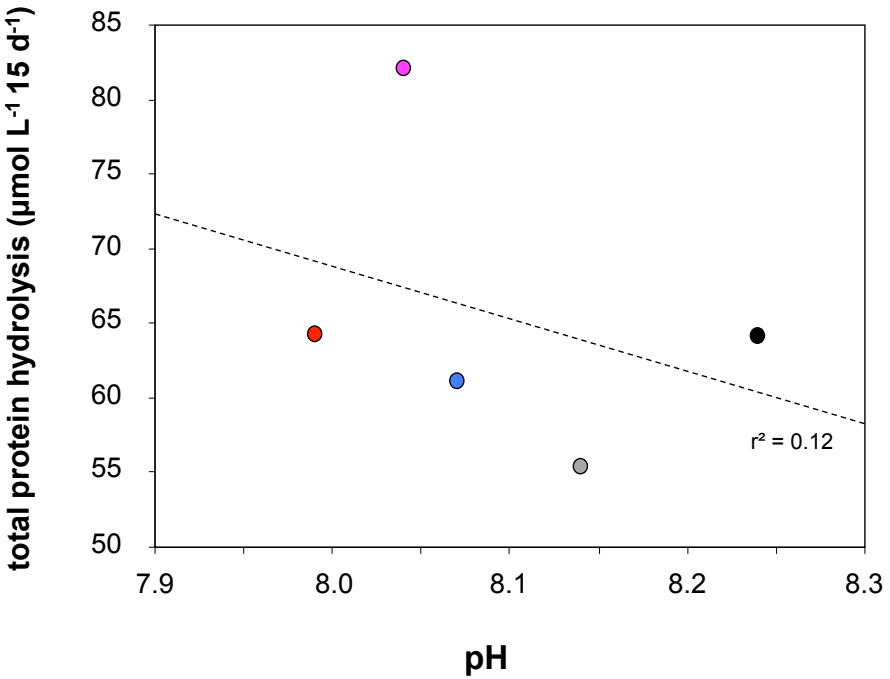
CO_2 (µatm)	300	404	499	559	643
pH (initial values)	8.18	8.06	7.98	7.93	7.88

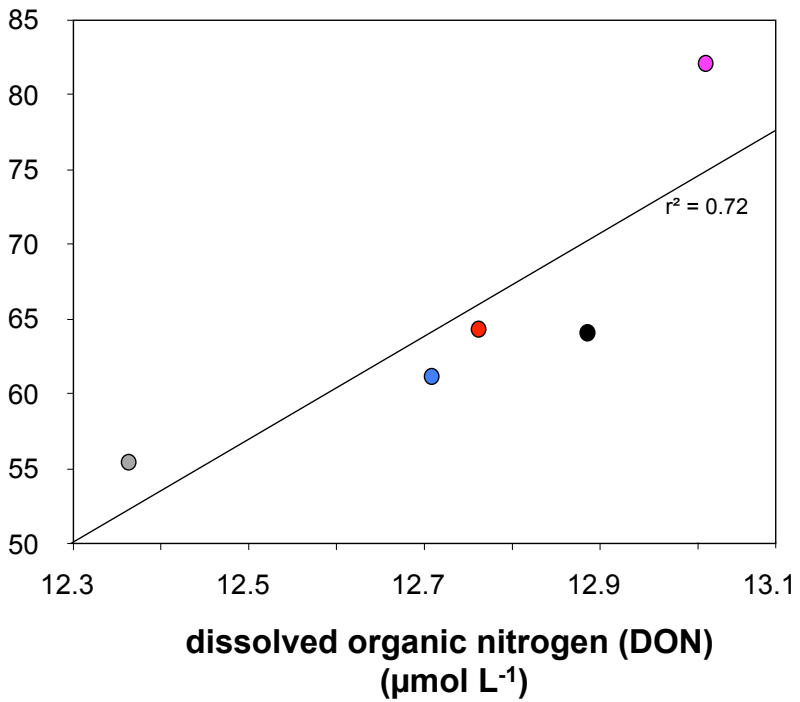
- Nutrient addition to induce a phytoplankton bloom (8 µM nitrate, 0.5 µM phosphate)
- Acidification by CO_2 (supersaturated seawater)
- Sampling over 16 days, integrated sampling over 10 m depth

Effect of lowered pH on extracellular LEUCINE-AMINOPEPTIDASE



Effect of lowered pH on extracellular LEUCINE-AMINOPEPTIDASE



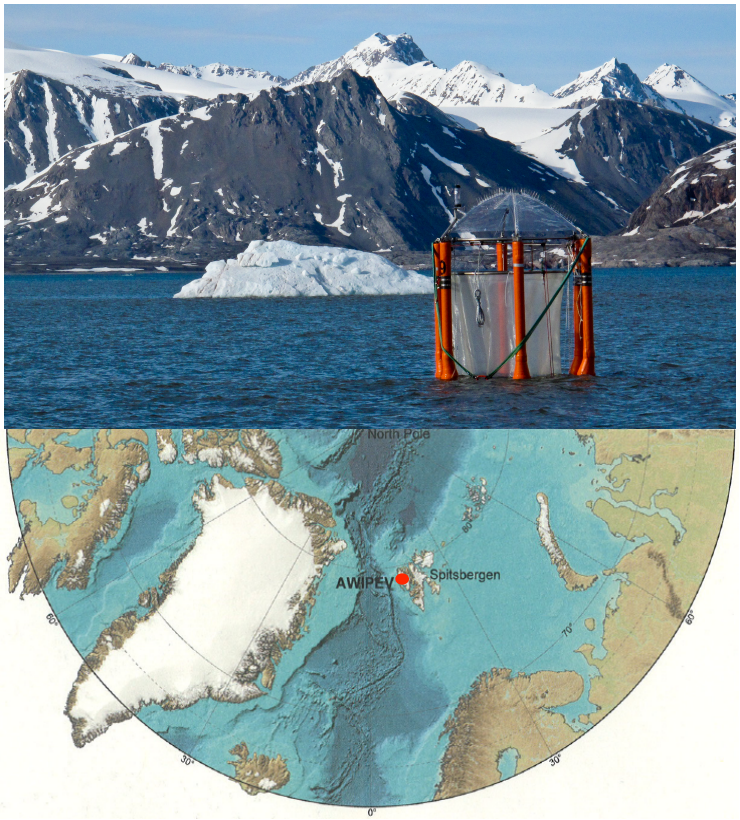


➔ no significant correlation between integrated aminopepitdase activity and pH

➔ direct relationship between integrated aminopepitdase activity and the mean concentration of DON

EPOCA Mesocosm Study, Spitsbergen 2010

Kongsfjord (field sample)



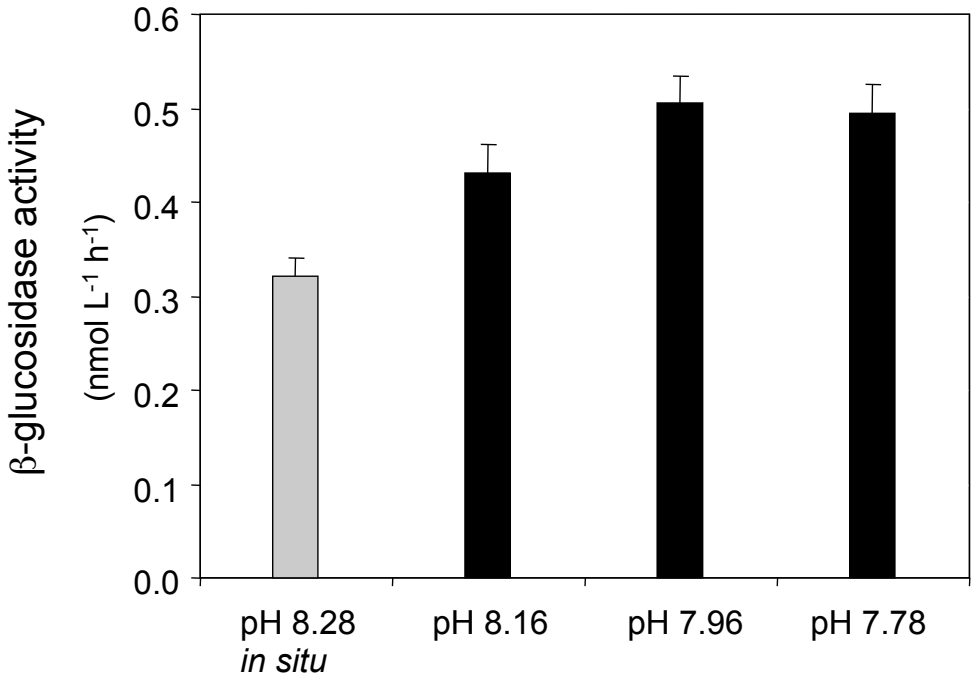
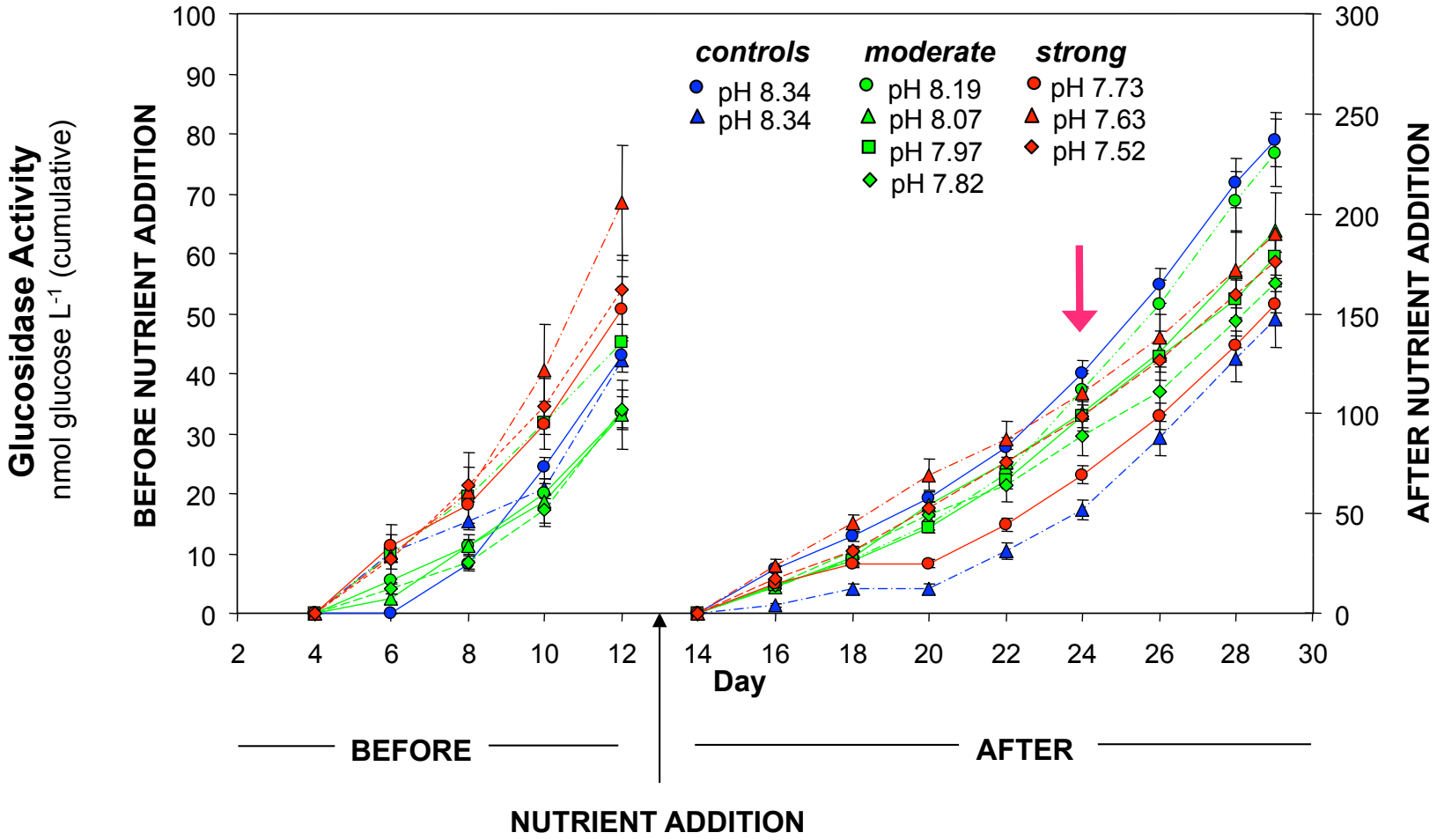
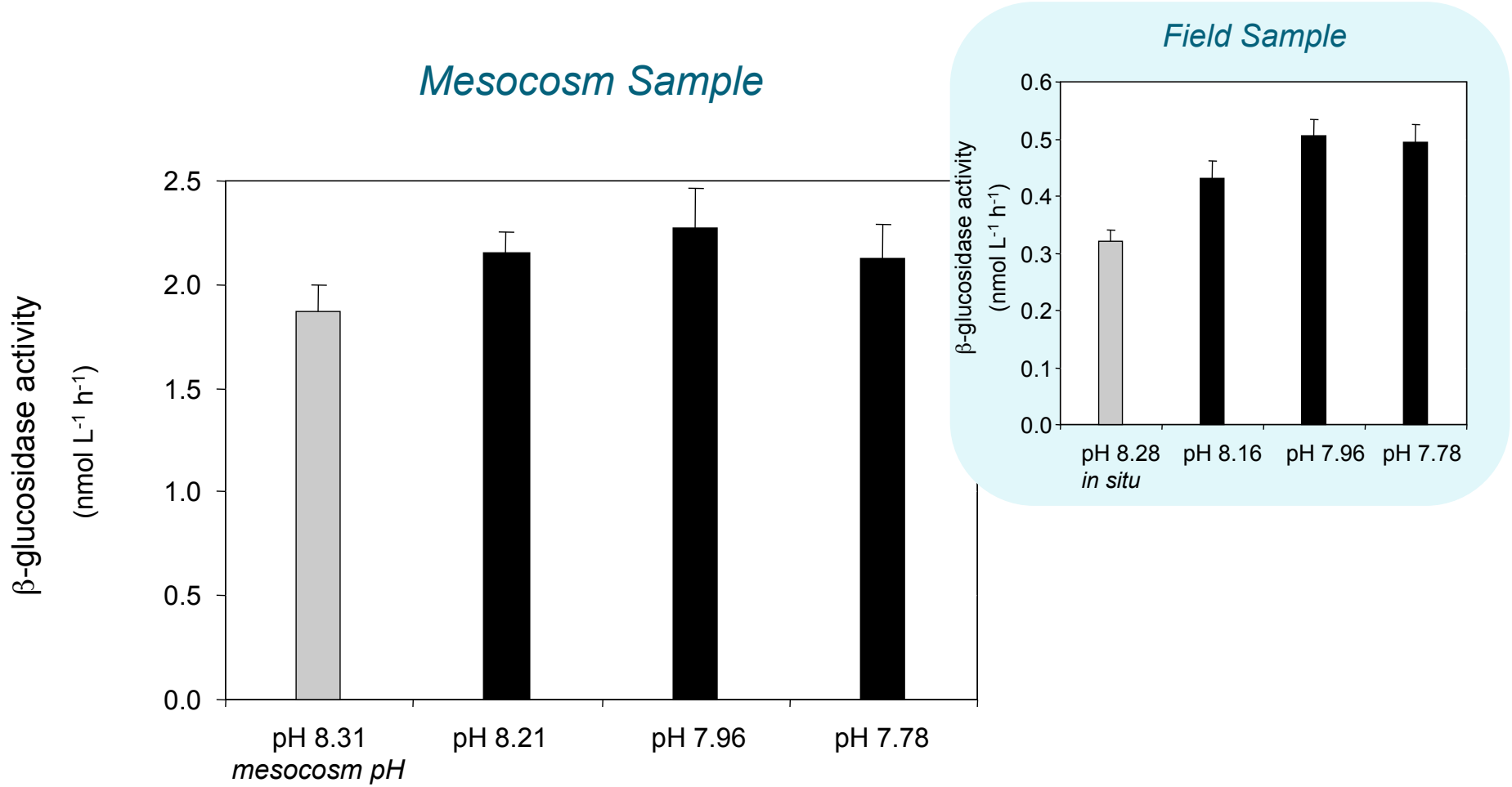


Photo: M. Sperling/ Map: AWI

EPOCA Mesocosm Study, Spitsbergen 2010

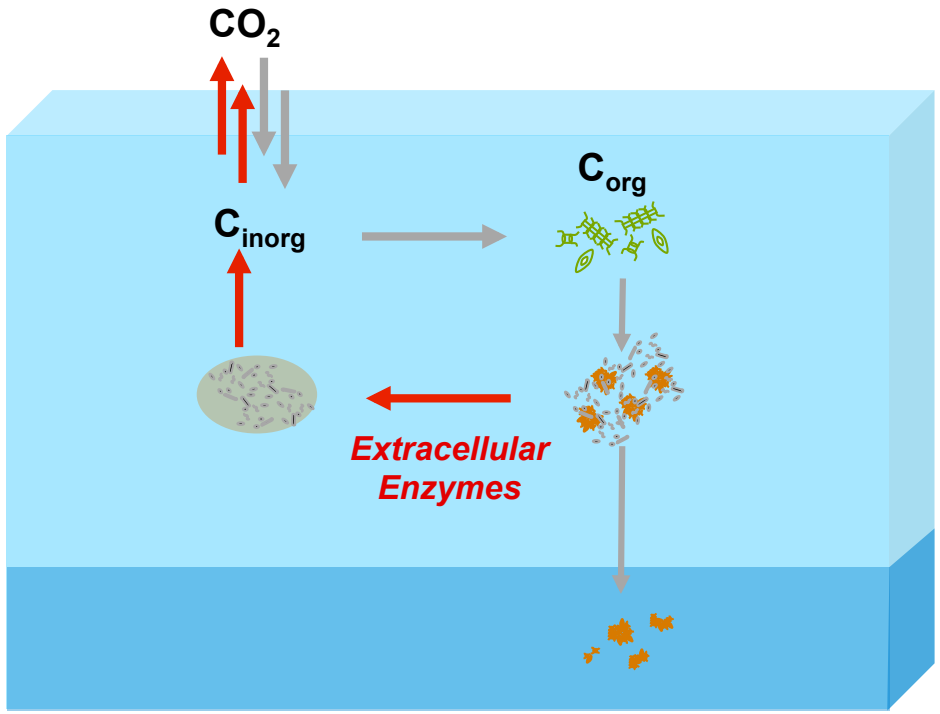


EPOCA Mesocosm Study, Spitsbergen 2010



Conclusions

Anthropogenic impacts on ocean pH are strong enough to affect the activity of extracellular enzymes in general.



Positive effects of moderate acidification on extracellular enzymes suggest higher bacterial degradation activity in the future ocean.

The regulation of enzyme activity by substrate concentration can superimpose pH effects induced by acidification.

Acknowledgments

Special thanks to
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HELMHOLTZ ASSOCIATION

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European Project on OCean Acidification

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Surface Ocean Processes in the Anthropocene

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