Biological long-term experiments in 2500 m water depth at the LTER observatory HAUSGARTEN

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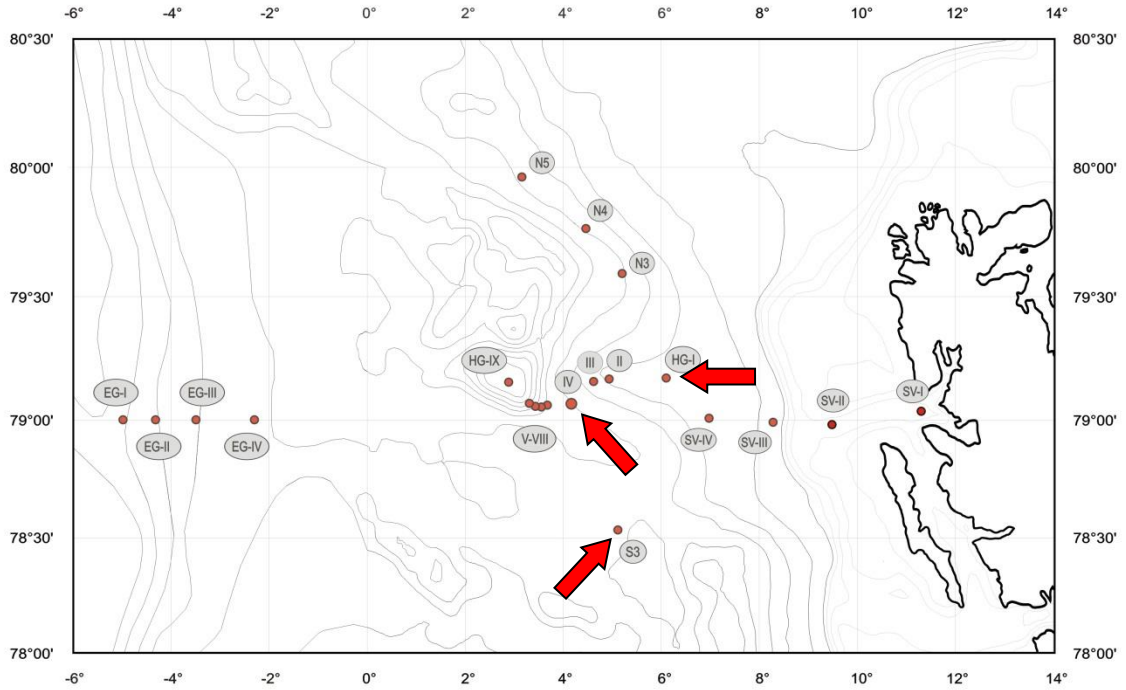
EXPERIMENTAL SITES AT HAUSGARTEN



- since 1999
- central site (~2.500 m),
  southern site (~2.300 m)
  shallow site (~1.280 m)
- short-term (days / weeks),
  long-term (months / years)
- different approaches:
  colonisation
  feeding / starvation
  disturbance / exclusion
  ...

Research on interactions between marine organisms, and between organisms and their environment is urgently needed to enhance our knowledge on ecosystem resilience in a period of rapid climate change. The most promising approach to enhance our understanding is experimental manipulation in the field.

PREREQUISITES

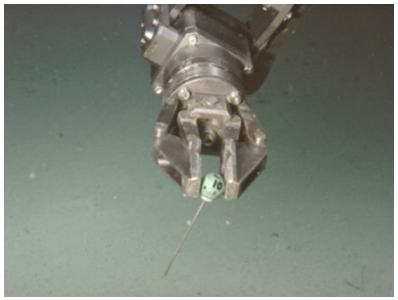
Controlled field experimentation in marine ecology is well established for shallow water habitats; due to technical and logistical difficulties, experimental work in deep waters is still in its infancy. Prerequisite for most experimental approaches at the deep seafloor is the availability of free-falling devices (Bottom-Lander) and Remotely Operated Vehicles (ROV).

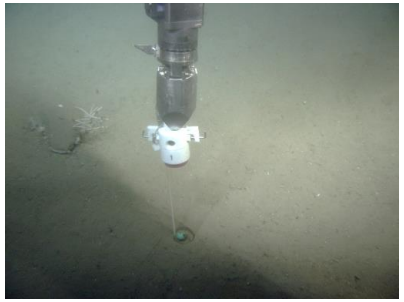
BIOGENIC STRUCTURES

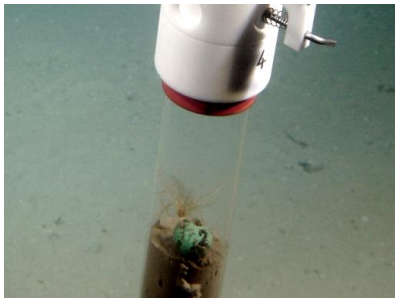
Small epibenthic sponges are known to influence the small benthic biota in their vicinity. Sponge mimics were brought out to determine whether the driving force is the living organism (i.e. the sponge), or simply the obstacle at the sediment surface, creating distinct areas of resuspension and sedimentation for particulate organic matter.

deployed in 2001;
sampled in 2003

Hasemann & Soltwedel (2012) PLoS One 6(12), e29152





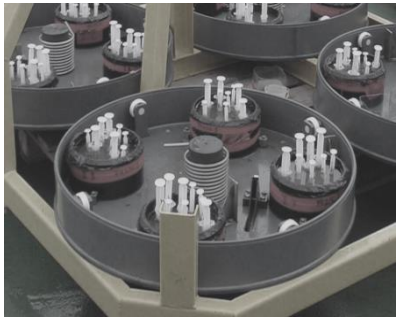


COLONISATION I

The reaction of the small benthic biota
(size range: bacteria to meiofauna)
to sporadic food supply was studied
by the deployment of colonisation trays,
containing natural and artificial sediments
enriched by various organic matter.

deployed in 2004,
recovered in 2005

Kanzog et al. (2009) Polar Biol. 32,105-112;
Kanzog et al. (2009) Mar. Ecol. 30, 391-404;

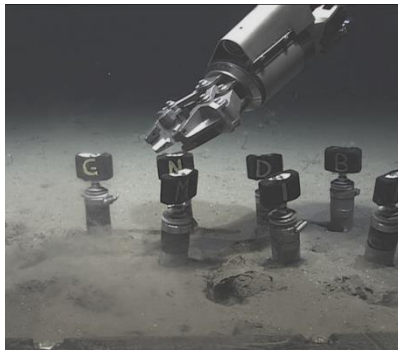


COLONISATION II

Bottom-lander based and ROV operated push-corer filled with azoic but food enriched sediments were inserted into the seafloor to study the colonisation by meiofauna organisms with special focus on deep-sea nematodes.

short-term deployment in 2007 (10 days),
medium-term deployment in 2015 (4 months),
long-term lander deployment 2009 (1 year)

Guilini et al. (2011) PLoS One 6(4), e18912;
Hasemann et al. (in prep.)

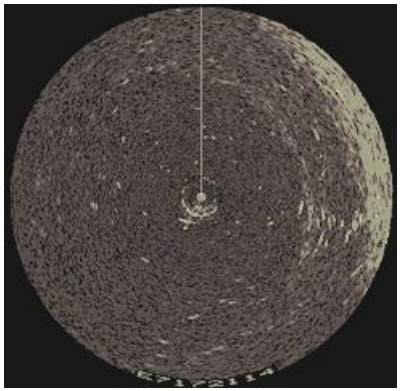


FOOD INPUT I

The attraction of deep-sea scavengers to “large food-falls” (large carcasses of invertebrate and vertebrate species), representing an episodic but locally significant supply of organic matter for benthic deep-sea organisms, was studied with camera systems and an acoustic scanning sonar.

deployed in 2000, 2001 and 2002

Premke et al. (2003) JEMBE 285/286, 283-294;
Premke et al. (2006) MEPS 325, 121-135

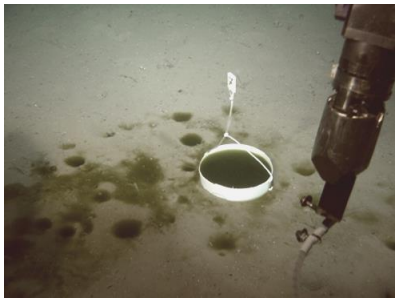


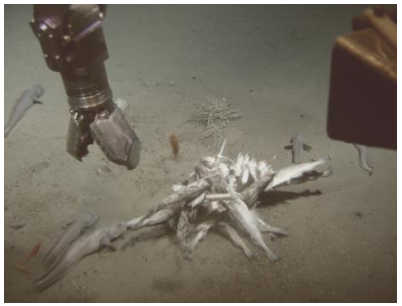
FOOD INPUT II

The reaction of the small benthic biota
to sporadic food supply was studied
by spreading algae suspensions
over isolated areas of the sediments.
Bundles of dead fish as well as
a small whale carcass were deployed
at the seafloor using a ROV
to simulate “large food-falls”.

deployed in 2003 and 2005;
sampled in 2003 and 2005

Freese et al. (2012) Polar Biol. 35, 1801-1813
Soltwedel et al. (in prep.)



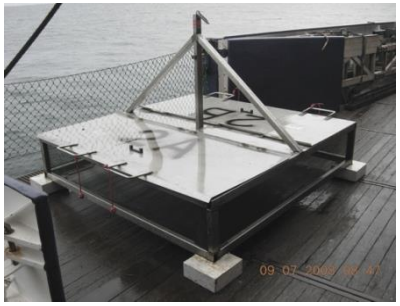


STARVATION

Large cages with solid top lids covering surfaces of approximately 4 m² were installed at the seafloor, to prevent the settling of particulate organic matter (food/energy source) over distinct areas. By reducing food availability at the seafloor, this experiments will allow to study the reaction of the small benthic biota to starvation periods or generally reduced organic matter input.

deployed in 2008;
first sampling in 2009;
second sampling in 2011;
third sampling in 2015

Jacob et al. (subm.)

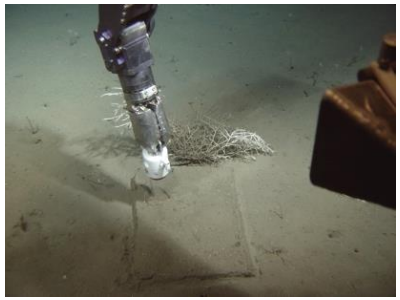


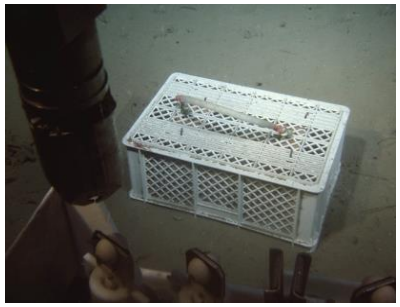
EXCLUSION

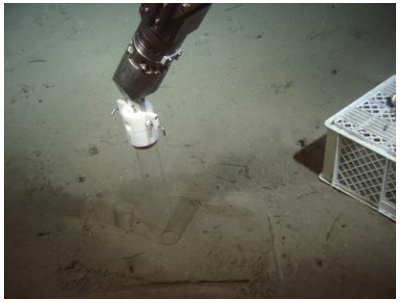
Smaller, “open” cages of approx. 0.25 m² were deployed at the deep seafloor to exclude different kinds of disturbances created by macro- and megabenthic organism (e.g. sediment perturbations, predation pressure), to study their impact on the small benthic biota.

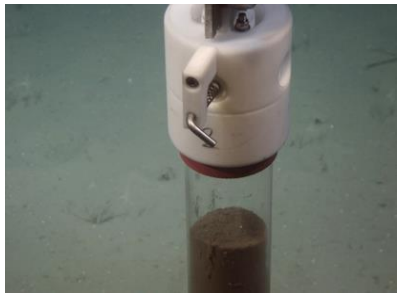
deployed in 1999;
sampled in 2003 and 2005

Gallucci et al. (2008a) JEMBE 354, 39-55;
Gallucci et al. (2008b) Deep-Sea Res. I 55, 332-349









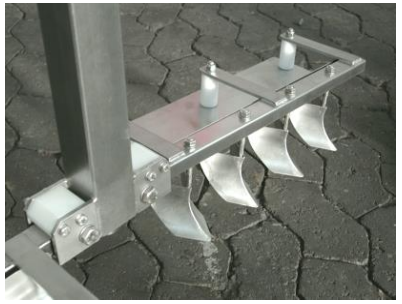
DISTURBANCE

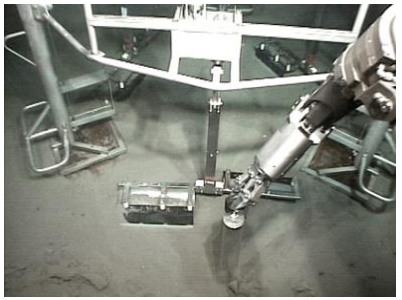
Following an inverse approach, plough-like disturber units were brought out in a bottom-lander frame* to repeatedly perturbate the upper sediment layers at different frequencies and over different time periods, in that way simulating enhanced macro- and megafauna bioturbation.

short-term deployment in 2008 (12 days);
long-term deployment 2008-2009 (12 months)

Hasemann et al. (in prep.)

* Soltwedel et al. (2007) L&O Methods 6, 307-318



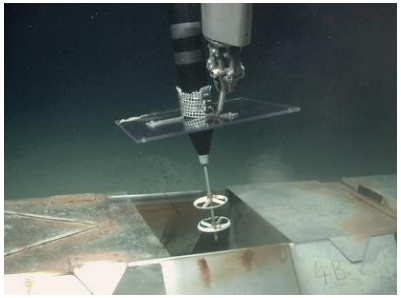


INCREASED BOTTOM-CURRENTS

A flume, 8.5 m in length
And 50 x 50 cm in cross-section,
has been installed at the seafloor
to increase current velocities
at the seabed, thereby also reducing
POC sedimentation inside the channel.
The reaction of the small benthic biota
to ~6-times elevated bottom currents
and reduced food availability inside
the channel is in focus of our studies.

deployed in 2003; sampled in 2007

Soltwedel et al. (2013) Deep-Sea Res. I, 73 (3), 31-45

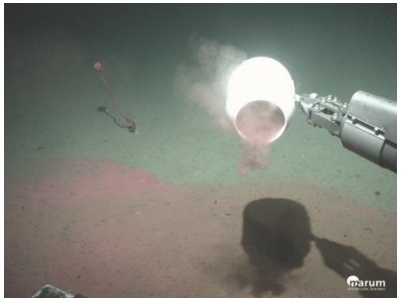


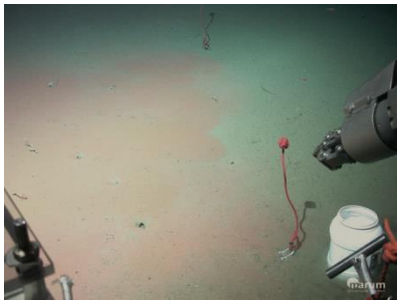
BIOTURBATION EXPERIMENT

Small inert fluorescing microspheres, so-called luminophores (~60 µm [pink] and 80-125 µm [green] in diameter), were spread out on defined areas at the seafloor to assess the mixing efficiency of larger benthic organisms at the stations HG-I (1250 m), S3 (2300 m) and HG-IV (2500 m)

deployed in 2011 and 2013;
sampled in 2015

Florian Krauss (Bachelor-Thesis 2016)





REFERENCES

Gallucci, F., Sauter, E., Sachs, O., Klages, M., Soltwedel, T. (2008). Caging experiment in the deep sea: efficiency and artefacts from a case study at the Arctic long-term observatory HAUSGARTEN. Journal of Experimental Marine Biology and Ecology. 354(1), 39-55. doi:10.1016/j.jembe.2007.10.006

Gallucci, F., Fonseca, G., Soltwedel, T. (2008). Effects of megafauna exclusion on nematode assemblages at a deep-sea site. Deep-Sea Research I, 55(3), 332-349

Kanzog, C., Ramette, A., Quéric, N.V., Klages, M. (2009). Response of benthic microbial communities to chitin enrichment: an in situ study in the deep Arctic Ocean. Polar Biology, 32(1), 105-112

Kanzog, C., Ramette, A. (2009). Microbial colonisation of artificial and deep-sea sediments in the Arctic Ocean. Marine Ecology, doi:10.1111/j.1439-0485.2009.00290.x

Premke, K., Muyakshin, S., Klages, M., Wegner, J. (2003). Evidence for long range chemoreceptive tracking of food odour in deep sea scavengers by scanning sonar data. Journal of Experimental Marine Biology and Ecology, 285-286, 283-294

Premke, K., Klages, M., Arntz, WE (2006). Aggregations of Arctic deep-sea scavengers at large food falls: temporal distribution, consumption rates and population structure. Marine Ecology Progress Series, 325: 121-135

Guilini, K., Soltwedel, T., van Oevelen, D., Vanreusel, A. (2011). Deep-sea Nematodes Actively Colonise Sediments, Irrespective of the Presence of a Pulse of Organic Matter: Results from an In Situ Experiment. PLoS One 6(4), e18912

Freese, D., Schewe, I., Kanzog, C., Soltwedel, T., Klages, M. (2012): Recolonisation of new habitats by meiobenthic organisms in the deep Arctic Ocean: an experimental approach. Polar Biology, 35, 1801-1813. doi:10.1007/s00300-012-1223-2

Hasemann, C., Soltwedel, T. (2012). Small-scale heterogeneity in deep sea nematode communities around biogenic structures. PLoS One, 6(12), 1-13. doi:10.1371/journal.pone.0029152

Soltwedel, T., Volkenandt, M., Mokievsky, V., Hasemann, C., Sauter, E., Rabouille, C. (2013). Effects of experimentally increased near-bottom flow on meiofauna diversity in the deep Arctic Ocean. Deep-Sea Res. I, 73 (3), 31-45

Jacob, M., Boetius, A., Soltwedel, T. (subm.). Response of a benthic bacterial community to decreasing food availability: an in-situ experimental approach at the Arctic deep-sea observatory HAUSGARTEN. ISME.

Schewe I., Guilini K., Klages M., Sauter E., Soltwedel T. (in prep.). The fate of large nekton carcasses at two Arctic deep sea ecosystems: a comparative study of the impact on benthic infauna, Journal of Experimental Marine Biology and Ecology.

THANK YOU !