9. DEEP-SEA BIOLOGY

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The aim of this project is to investigate depth related distribution patterns of benthic bacteria and meiofauna. Various biotic parameters are investigated on the background of interannual variability. Sediment samples were taken at a long term depth-transect (1000-5000 m) on the continental margin west off Spitsbergen, crossing the "AWI-Hausgarten" to the Arctic deepest point, the Molloy Deep (Fig. 13).

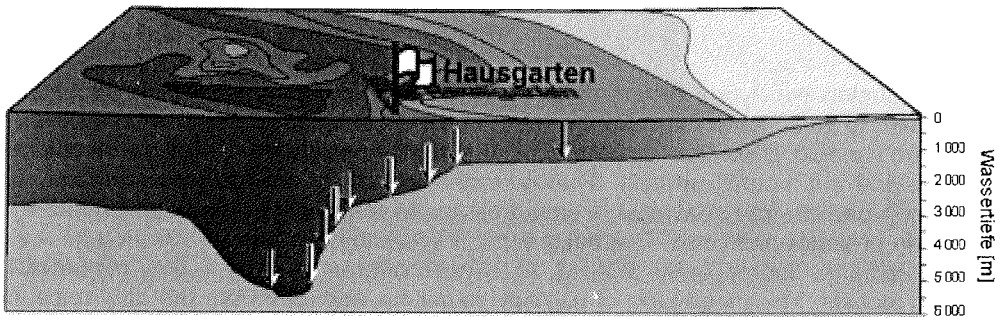

Fig. 13: Schematic representation Molloy Deep and the "Hausgarten" sampling distribution.
Abb. 13: Schematische Darstellung von Molloy Deep und die Verteilung der Probennahme im „Hausgarten".

Sampling was performed using a multicorer sampling system, allowing the investigation of an undisturbed sediment surface. A total of 10 stations were sampled along this transect. Subsamples for faunistic investigations and for biochemical analyses were taken using 1ml, 5 ml and 20 ml syringes with cut off anterior ends. Subsamples were sectioned horizontally in 1 cm-layers and analysed separately to investigate gradients within the sediment column.

9.1 Causes and effects of physical, chemical and biological gradients in the deep sea

The parameters which are suspected to follow a gradient are mainly abundance, diversity and activity of bacteria and meiofauna, as well as the biogenic sediment composition. To evaluate microbial exoenzymatic activities, esterase turn-over rates were determined with the fluorogenic substrates fluorescein-di-acetate (FDA). Sediment-bound chloroplastic pigment equivalents (CPE) also were determined to quantify organic matter input from primary production. Additional sediment samples were preserved for later investigations in the home laboratory - analysis of phospholipids and proteins will contribute to the assessment of the total microbial biomass and the proportion of sediment bound detrital organic matter.

Preliminary results show a distinct depth-gradient for sediment bound plant pigments (Fig. 14) and exoencymatic bacterial activities (Fig. 15). An exception of this gradient are the two stations sampled in the Molloy Deep. In relation to water depth the values for FDA and CPE are increased. A possible explanation for this result might be the special water mass regime above the deep (Fig. 16). A gyre circulation in the deep might keep the products of an increased primary production within the Molloy Deep area.

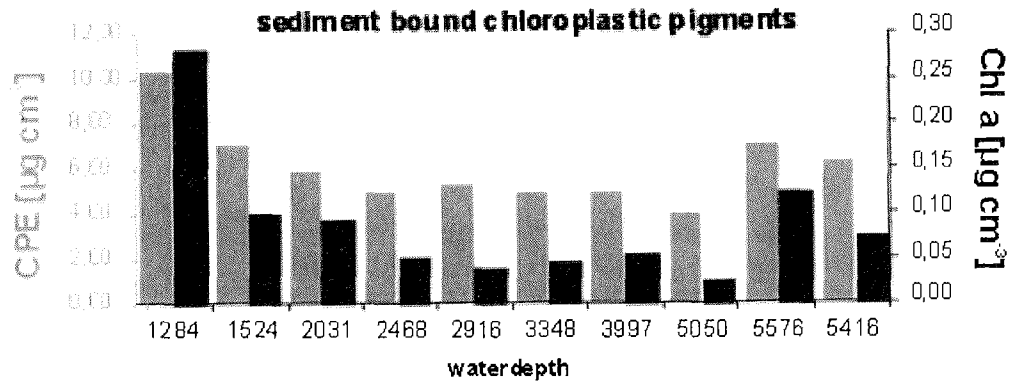

Fig. 14: Concentrations of plant pigments in the sediment-water-interface (0 - 1 cm) along the "Hausgarten" depth-transect.
Abb. 14: Konzentrationen der pflanzlichen Pigmente in der Sediment-Wasser-Übergangsschicht (0 - 1 cm) auf dem Schnitt durch den Hausgarten.

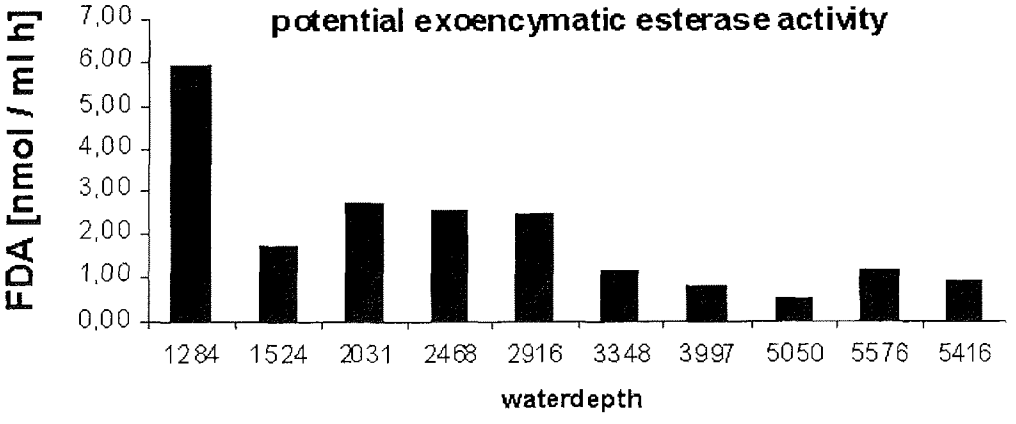

Fig. 15: Potential exoenzymatic activity of ester-cleaving bacteria in the sediment-water-interface (0-1cm) along the "Hausgarten" depth-transect.
Abb. 15: Potentielle exoenzymatische Aktivität von ester-aufspaltenden Bakterien Pigmente in der Sediment-Wasser-Übergangsschicht (0 - 1 cm) auf dem Schnitt durch den Hausgarten.

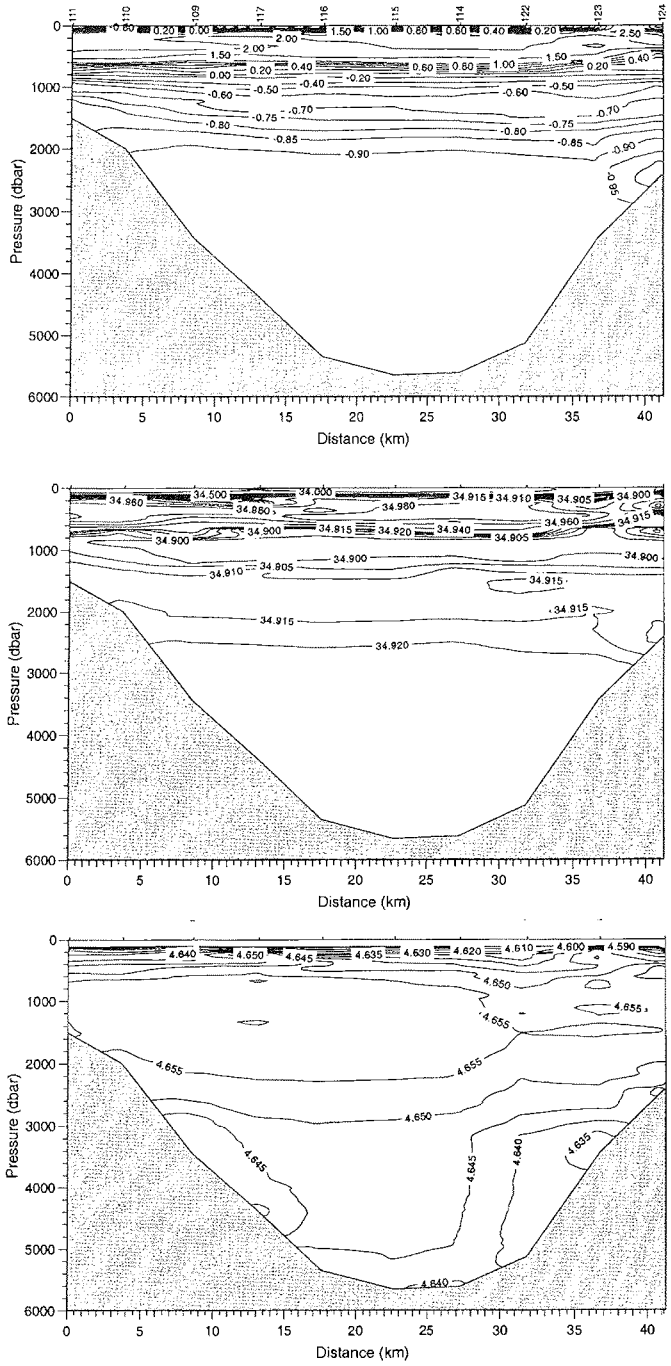

Fig. 16: Transect of potential temperature, salinity and attenuation across Molloy Deep.
Abb. 16: Vertikalschnitt der potentiellen Temperatur, des Salzgehalts und der Licht-Attenuation quer zu Molloy Deep.

9.2 Investigations on the dynamics of benthic bacterial communities and their impact on small-scale heterogeneity patterns of Arctic deep-sea sediments

Topographic-geochemical features are connected with the varying occurrence of megafaunal populations, which in turn play an important role for the distribution and for the activity of benthic bacteria. To get an idea about bacterial dynamics in deep-sea sediments, large-scale samples implying the decreasing effects with increasing water depth were compared with small-scale samples with regard to biologically produced habitat structures in terms of bacterial activity, diversity and abundance.

The benthos of the Molloy Deep is dominated by holothurians producing tracks, feeding traces and faeces. The sediment there is characterized by small grain sizes. In the sample aera of the "Hausgarten" we can find a wide range of bioturbating species creating tubes, burrows sea mounds and other biogenic structures.

Bacterial production was measured via dual labelling by means of ^{14}C leucine and ^{3}H thymidine incorporation. A direct counting, dual staining method was applied to evaluate the proportion of active and inactive bacteria. We found a trend of decreasing microbial activity in sediment surface layer in dependence of an increasing sediment depth as well as water depth. Samples for different molecular analysis were prepared on board for further processing at the institute.

9.3 "Food falls" – natural disturbances at the seafloor of the deep sea

The food supply hence energy flow to the benthic deep-sea ecosystem is partly driven by sinking carcasses (food falls). Although of natural origin food falls create small scaled disturbances because they are discrete events with significant implications for the influenced area. Scavenging demersal fishes and invertebrates are attracted in large numbers by food falls. The impact of any food fall is unpredictable both in space and time for benthic or bentho-pelagic scavengers.

However, preliminary results of baited time-lapse camera experiments and baited traps carried out in 2000 (ARK XVI/2) and 2001 (ARK XVII/1) indicate that thousands of individuals of the cosmopolitic necrophagous deep-sea amphipod *Eurythenes gryllus* appear shortly after bait deployment (Fig. 17).

A free-falling lander system was used equipped with a pre-programmed time-lapse camera, flow meter, autonomous scanning sonar system and traps. Five lander deployments each lasting for about 20 hours were scheduled for the centre and vicinity of the deep-sea long-term station (AWI-"Hausgarten"). The scanning sonar system recorded signals, which could in combination with the photos of the time laps camera use to find out a prefered direction in the appearance of the amphipods (Fig. 18).

The bait in the traps with a weight of about 4 kg (on average) was totally consumed in 20 hours by 800 amphipods per lander deployment. About 3900 amphipods were caught by the traps. 200 organisms were kept alive in a cooled laboratory container on board POLARSTERN and later at the institute for further experiments under controlled conditions. The other 3700 cached amphipods of all deployments will be used

for analysing lipid contents, estimate the genetic differences, and for information about the distribution of female and male amphipods.

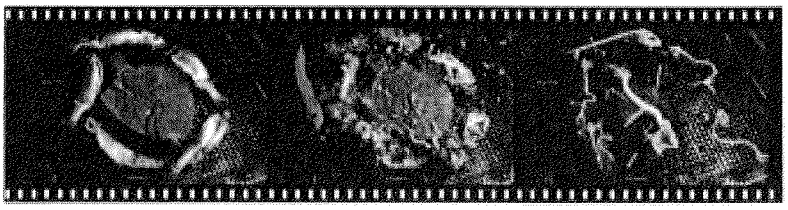

Fig. 17: Time-lapse photograph sequences of bait deployment at 2600 m water depth indicating the rapid consumption of about 3 kg (wet weight) of fish bait by a single amphipod species (*Eurythenes gryllus*).
Abb. 17: Fotosequenz während der Köderausbringung in 2600 m Wassertiefe, die den schnellen Verzehr von etwa 3 kg (Nassgewicht) Fischköder durch eine Amphipodenart (*Eurythenes gryllus*) zeigt.

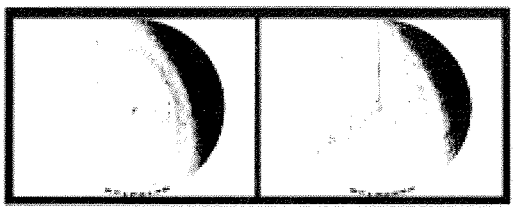

Fig. 18: Recorded signals of scanning sonar system on the lander, plotted in polar version (01:12 hours in between); the right picture show the incoming individuals to the bait.
Abb. 18: Mit dem scannenden Sonar auf dem Lander im Zeitabstand von 1:12 Stunden aufgezeichnete Signale in polarer Projektion. Auf der rechten Abbildung sind die sich dem Köder nähernden Tiere zu erkennen.