Preliminary results on the ecology of demersal fish from the 'Hausgarten' (79°N west off Svalbard)

M. Bergmann* & M. Klages

Alfred Wegener Institute for Polar & Marine Research, Bremerhaven, Germany

*Melanie.Bergmann@awi.de

Background

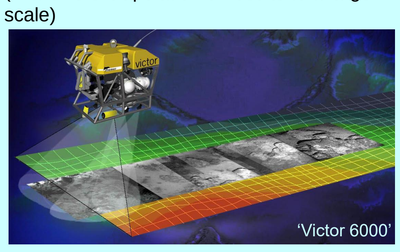
In 1999, the AWI Deep-Sea Research Group established the 1st long-term deep-sea observatory beyond the polar circle, the 'Hausgarten' (west off Svalbard) which consists of 9 stations along depths from 1200-5500m (see poster by Soltwedel *et al*.). Although video footage suggests that demersal fish constitute an important fraction of the local benthic megafauna little is known to date about their ecology. In this study, we aim to explore the fishes' biology, functional ecological role and adaptations to different depths.

Methods

30min-tows with an Agassiz trawl at 'Hausgarten' I and IV to gain specimen for 'ground truthing' of video transects, age & trophic analyses

2 x 48 h-deployment of fish traps attached to a benthic lander at HG IV (2400m) to catch further fish for 'ground-truthing and analyses

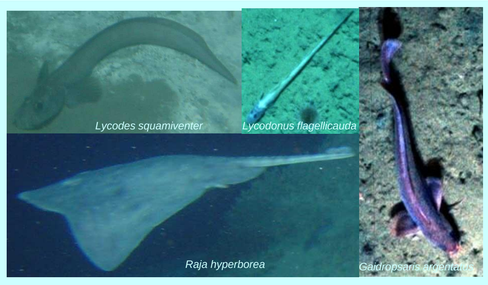
Photographic and video transects with an Ocean floor observation system (OFOS) and ROV (*Victor 6000*) to estimate fish abundance and size at different depths (→allows extrapolation of results to a larger scale)



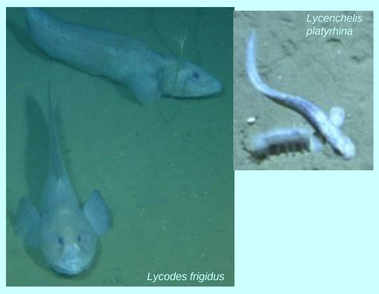
Results

1. Fish assemblages at Hausgarten

The fish caught in 2004 by trawl and baited traps deployed at 1200 and 2400m depth belonged mainly to the Zoarcidae (eelpout). *Lycodes squamiventer* dominated at the shallow station (1200m) whereas *Lycodonus flagellicauda, Gaidropsaris argentatus* and the ray *Raja hyperborea* occurred in low numbers. The larger congeneric *Lycodes frigidus* dominated at the central station (2400m), in addition to a few individuals of *Lycenchelys platyrhina*.



'Hausgarten' I, 1200m



'Hausgarten' IV, 2400m

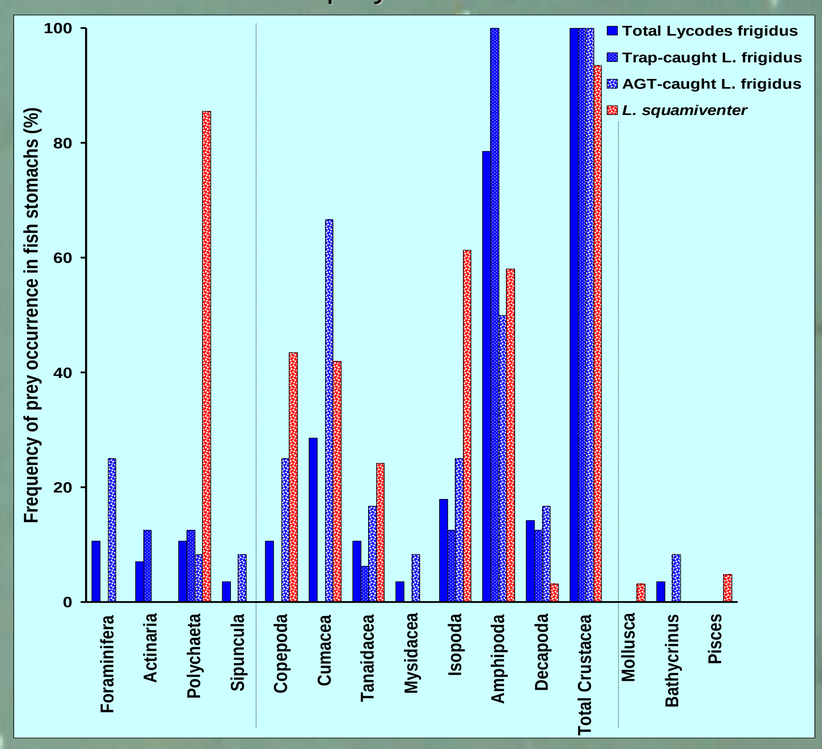
Characteristics of fish caught. Total number of fish (N), mean length (L: cm), mean wet weight (Wt: g), gonadosomatic index (GSI*), hepatosomatic index (HSI*), Fulton's condition (*K*), N_2 used for stable isotope analysis, stable nitrogen ($^{15}N/^{14}N$) and carbon ($^{13}C/^{12}C$) isotope ratios, not available (n.a.)

Species	Station	Depth	N	L	Wt	GSI	HSI	*K*	N_2	$\delta^{15}N$	$\delta^{13}C$
Gaidropsaris argentatus	HG I	1324	1	28	240	6.12	12.5	1.09	1	13.04	-19.97
Lycodes squamiventer	HG I	1324	63	15.6 ±0.38	15.2 ±1.06	0.32 ±0.11	1.49 ±0.15	0.37 ±0.01	17	13.91 ±0.12	-18.59 ±0.06
Lycodonus flagellicauda	HG I	1324	3	18 ±1.53	6 ±2.08	2.68 ±2.61	2.38 ±0.82	0.1 ±0.02	1	n.a.	n.a.
Raja hyperborea	HG I	1324	1	35	490	n.a.	n.a.	1.14	1	12.35	-20.36
Lycenchelys platyrhina	HG IV	2377	3	16 ±0.58	15.7 ±0.88	0.34 ±0.15	1.03 ±0.1	0.39 ±0.03	0	n.a.	n.a.
Lycodes frigidus	HG IV	2377	32	33.3 ±1.4	245 ±25.8	0.16 ±0.03	1.31 ±0.07	0.55 ±0.01	22	12.32 ±0.17	-20.62 ±0.19

- Analysis of OFOS-transects at 1200, 1600 and 2500m indicated that fish abundance decreases with increasing depth while the mean size of fish increases with water depth
- While fish condition and hepatosomatic index were significantly higher at the deeper station ($p < 0.05$) the reverse was true for the gonadosomatic index ($W = 3148$, $p = 0.032$)

2. Stomach contents analysis

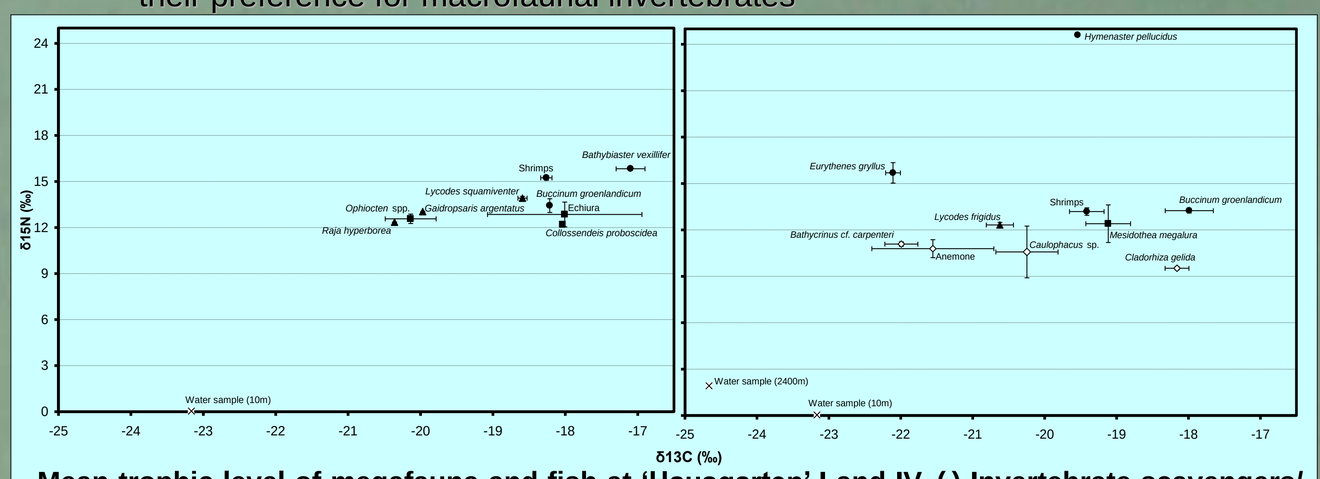
- The proportion of empty stomachs was higher in *L.frigidus* (20%) *cf. L. squamiventer* (1.6%) → more limited prey supply at greater depths
- Trap-caught *L. frigidus* fed chiefly on scavenging amphipods that were also attracted to traps (→experimental artefact)
- All trawled *L. frigidus* fed on small crustaceans (cumaceans, amphipods)
- In addition to crustaceans (isopods, amphipods), many *L. squamiventer* fed on polychaetes
- Prey (Shannon-Wiener) diversity was significantly higher for *L. squamiventer* even when trap-caught fish were excluded ($W = 165.5$, $p = 0.049$) → *L. frigidus* may be more food-limited or more prey-selective



3. Stable isotope analysis

While stomach contents analysis allows us to determine preferences for specific prey species in the short term, the composition of stable isotope in muscle tissues reflect the diet of consumers over longer time scales. The trophic level of fish was determined by stable isotope analyses of tissue samples. Megafauna (from trawls) and filtered water samples were used as a baseline. Stable nitrogen ($^{15}N/^{14}N$) and carbon ($^{13}C/^{12}C$) isotope ratios were determined by continuous flow mass spectrometry. $\delta^{15}N$ increases by 3.8‰ per trophic level (Hobson & Welch 1992). Although $\delta^{13}C$ indicates the distance to the primary carbon source it is less useful for food web analysis due to its bias by an organism's lipid content.

- Assuming a stepwise $\delta^{15}N$ enrichment of 3.8‰ per trophic level, the megafaunal food web at 'HG' I and IV consisted of 4 and 6 trophic levels
- *L. squamiventer* had a significantly higher trophic level *cf. L. frigidus* ($t_{1,26} = -6.35$, $p < 0.001$) although *L. squamiventer* were significantly smaller-sized ($t_{1,24} = 6.63$, $p < 0.001$) → this may be due to differences in local prey supply & quality
- *L. squamiventer* size was positively correlated with $\delta^{15}N$ values ($r = 0.702$, $p = 0.016$) → larger fish fed at a higher trophic level
- While starfish, shrimps and amphipods occupied the highest level of the megafaunal food web, eelpout had an intermediate trophic position, reflecting their preference for macrofaunal invertebrates



Mean trophic level of megafauna and fish at 'Hausgarten' I and IV. (▯) Invertebrate scavengers/ predators, (▯) deposit feeders, (▯) water samples, (▯) suspension feeders, (▯) fish predator/ scavenger. Error bars: standard error of replicate samples.

Outlook

- Sampling of remaining 'Hausgarten' depth transect to assess if differences in the ecology of fish are correlated with depth
- Determination of fish age (reading otoliths) to gain an estimate for fish productivity
- Analysis of further OFOS-transects to estimate fish abundance and thus enable extrapolation of results to the population level
- Assess predation pressure on benthic assemblage → functional ecological role

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