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Pelagic-benthic coupling on the Faroe shelf: A pilot study

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Innihald

Introduction

The main objectives in this study were to investigate how tight the benthic community below the tidally mixed waters inside the persistent front on the Faroe shelf is linked to the pelagic ecosystem. The composition of the stable isotopes $\delta^{13}C$ and $\delta^{15}N$ in mussel tissue of benthic fauna indicates that the benthic community inside the front on the Faroe shelf prey on organic carbon produced in phytoplankton, and on organic carbon produced elsewhere. Further, there are indications of a tighter pelagic-benthic coupling in the tidally mixed waters on the Faroe shelf, than in the oceanic environment outside the front. However, further and more regular studies are required before any conclusions can be made on the pelagic-benthic coupling on the Faroe shelf. In this report we describe the results obtained during this project, and evaluate the sampling approach used here and for possible future studies in the same topic on the Faroe shelf.

Biological production in a given trophic level within an ecosystem is controlled by production or other input into the lower trophic, starting with the primary production. Several marine ecosystem studies have shown relationships between primary production and production in higher trophic levels. However, the benthic part of the ecosystem is often neglected. Until present, all ecological research on the Faroe Shelf has been focused on the pelagic environment. When considering the role of the seabed in the Faroe shelf ecosystem, there is virtually no knowledge. Considering that several fish species, including two of the most important demersal species on the Faroe shelf, cod and haddock, find the majority of their food in the benthic environment, this is a highly understudied area.

On the Faroe shelf, strong tidal currents lead to intense mixing, resulting in vertically homogeneous water masses in the shallow shelf areas (Hansen, 1992, 2000, Larsen et al. 2008). The well-mixed shelf water is relatively well separated from the surrounding oceanic water mass by a persistent front, surrounding the shelf at about the 100–130 m bottom depth contour (Larsen et al. 2009).

The hydrographical features allow the inner-shelf area to support a relative isolated shelf ecosystem, which in many ways is distinct from the surrounding oceanic environment. The shelf water largely maintains its own neritic ecosystem regarding both phyto- and zooplankton (Gaard 1996, Gaard et al. 1998, Gaard 1999, Debes and Eliasen 2006) as well as benthic fauna, and several local fish stocks (e.g. Fosaa et al. 2006, Gaard et al. 2006, ICES 2008).

Research has revealed that the phytoplankton abundance in most years increases in May and decreases in August. There are, however, large interannual variations in seasonal timing, productivity and biomass of the phytoplankton (Gaard 2003, Hansen et al. 2005, Debes et al. 2008), which have a large affect on higher trophic levels in the ecosystem.

These ecological settings at the Faroe Shelf make a base for tight pelagic-benthic coupling, and due to its small size and well defined hydrography and plankton ecology, the Faroe Shelf ecosystem is very well suited for detailed investigations into pelagic-benthic coupling.

The objectives of this project were to investigate various parameters in order to elucidate the coupling between the pelagic- and the benthic ecosystem on the Faroe shelf, and thus increase our understanding of the functioning of the system.

Materials and Methods

The investigations were carried out on the research vessel Magnus Heinason during 5 cruises. Spring (27. April to 4. Maj 2011), summer11 (22. June to 4. July 2011), autumn (28. August 2011), winter (28. February 2012) and summer12 (20. June to 4. July 2012).

The spatial variability of sediment properties, sediment water exchange rates, and carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes in benthic fauna was investigated at a transect extending from the central Faroe-shelf into the oceanic environment southwest of the shelf (V1 to V9 in figure 1).

The temporal variability in the stable isotope signature of the benthic fauna was investigated east of the Faroe Islands at a site with shell bottom and vivid fauna assemblage (E10 on figure 1, bottom depth 56m).

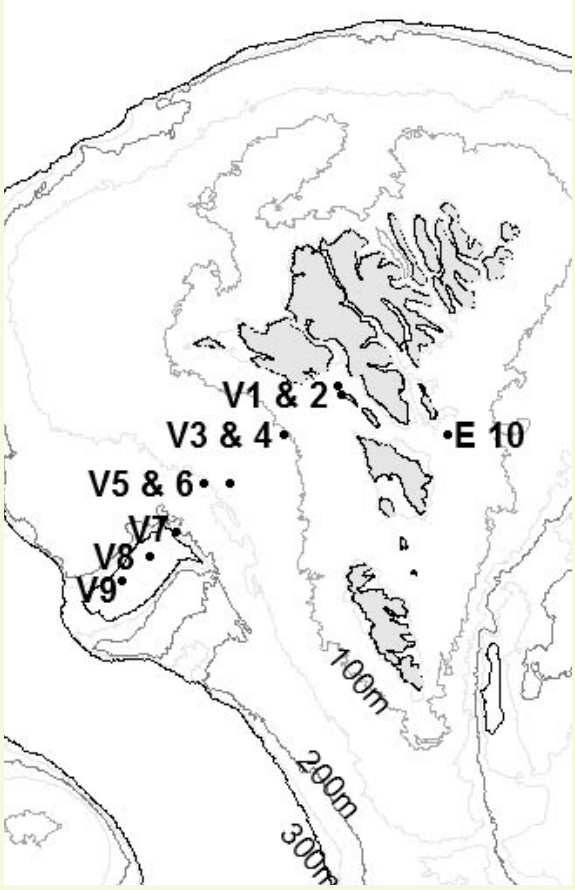

Figure 1 The Faroe shelf. Sampling positions are shown as black dots.

Water samples

Depth profiles of temperature, salinity and fluorescence were obtained with a CTD, where salinity was calibrated against discrete samples on a salinometer. Calibration of the fluorescence profiles was done using a calibration constant based on discrete chlorophyll *a* samples from various positions in Faroese waters during the period 2002-2010 (chl *a* (µg l^{-1}) =1.2 x fluorescence, n=1204, r^2=0.74).

Primary production was measured at some stations during the spring, summer and autumn cruise in 2011. Measurements were made using the standard radiocarbon technique (Steemann Nielsen, 1952). Water was collected at 10m depth using Niskin bottles attached to the CTD rosette and transferred to 40ml plastic bottles. After adding 5228000 µC ^{14}C to each bottle, they were immediately placed on a rotating wheel and incubated at *in situ* temperature for approximately 2 hours.

After incubation the content of each bottle was filtered through Whatmann GF/F filters for later analysis at DHI Water and Environmend in Denmark.

Depth integrated primary production was calculated from:

$$PP = P_{max}*(\exp(-\alpha *Ic/P_{max})-\exp(-\alpha *I/P_{max}))$$

where P_{max} is the light saturated primary production, is the slope of the initial part of the PI-curve, I_c is the compensation light intensity, and I_z is the light intensity at depth z.

Primary production at depths where the light intensity was less that I_c was set to zero.

Sediment properties

Sediment was investigated during the spring cruise 2011.

It was highly difficult to obtain sediment samples with the HAPS bottom corer (KC denmark), which was only successful at station V4, V7 and V8, at the respective bottom depths of 122, 232 and 346m. Thus sediment water exchange rates of oxygen and nutrients, and the depth distribution of porosity, organic carbon and nitrogen were investigated at those three stations only. At the remaining stations sediment was sampled with a Van Veen grab (KC denmark) and only grain size was measured.

For grain size determination, sediment was sieved through a sequence of sieves on a shaker (mesh sizes 8000, 2000, 1000, 710, 250 and 63µm).

Porosity, total organic carbon (TOC) and total nitrogen (TN), was determined on two cores from stations V4, V7 and V8. The cores were sectioned into 1cm intervals in the top 4cm and two cm intervals from 4 to 12cm into the sediment. Water content was determined as the weight loss after drying at 55°C until constant weight. Sediment density was determined as the weight of a 4ml sample, obtained with a cut of syringe. TOC and TN were measured on a CE 440 Elemental analyzer after the sediment had been homogenized with a Retch Mortar Grinder RM 200, acidified with 5% H_2SO_4 and dried.

Sediment water exchange rates

For flux measurements, sub cores were collected from the HAPS bottom corer in Plexiglass tubes (i. d. =5.6cm). 2 cores from each of the stations V4, V7 and V8 were submerged in an incubation tank, holding bottom water at in situ temperature, and flushed with air. In order to ensure well mixed conditions in the cores, small Teflon coated magnets were attached to the inner wall of the cores. The magnets received momentum from an externally rotating magnet (Rasmussen and Jørgensen 1992).

After two days pre incubation on board the research vessel, the sediment water exchange rates of oxygen, nitrate, ammonium, phosphate and silicate were investigated in two replicate cores from each station. The sediment cores were capped, leaving an internal water height of approximately 10cm. The oxygen concentration in the cores was monitored with a Clark-type oxygen minielectrode, with a tip diameter of 500µm (Revsbech and Jørgensen 1989). Water samples were taken at the onset of the incubation, 14 hours into the incubation, and again when the oxygen concentration hand decreased 15-20%. The water taken out after 14 hours, was replaced with air flushed *in situ* water.

The sediment water exchange rates were calculated according to the linear change in solute concentration in the enclosed water, accounting for the incubation time and enclosed plus replaced water volume. Sediment uptake is defined as a negative flux while release is defined as a positive flux.

Oxygen microprofiles

The day after the flux measurements were terminated by cap removal. Oxygen depth profiles were obtained with a Clark-type microelectrode (Revsbech 1989). As the measurements were conducted onboard the research vessel a large tip diameter of ~100µm was used. Three profiles were measured in each core with a depth resolution of 250µm. The microelectrode was calibrated by a two point calibration from the signal in the fully oxygenated water and the constant signal of the anoxic sediment.

The setup onboard the research vessel only made it possible to measure under stagnant overlying water. Thus the Diffusive Boundary Layer (DBL) most probably was larger than in situ, but as the total oxygen uptake was so small, it is not expected that the DBL thickness influenced the oxygen profiles (Jørgensen and Des Marias 1990).

The O_2 flux was estimated from the profile as the depth integrated oxygen consumption of the sediment calculated by the profile interpretation procedure PROFILE (Berg et al. 1998), using the average porosity of the sediment (0.51) and assuming that molecular diffusion was the dominant transport process.

The oxygen penetration depth was determined as the distance from the sediment surface, located by visual inspection of the oxygen profiles, to the constant anoxic signal.

Stable isotopes

Particulate organic matter was collected by filtrating water sampled at 5m depth through a Whatmann GF/F filter until the filter was saturated.

Benthic fauna was collected with a triangular dredge (1 x 1 x 1m) towed for ~20 min.

Up to five individuals of the following epifauna were prepared for stable isotope (SI) analysis. Astarte sp., Hermit Crabs, Whelks, Sea Urchin , Horse mussel, and brittle stars.

Samples were collected from fresh animal tissue, with exception of brittle stars which were frozen prior to sampling. The following tissues were used for SI analysis. Adductor muscles from bivalves, stomach tissue of echinoderms, the foot of the whelks and tissue from the larger claw of the hermit

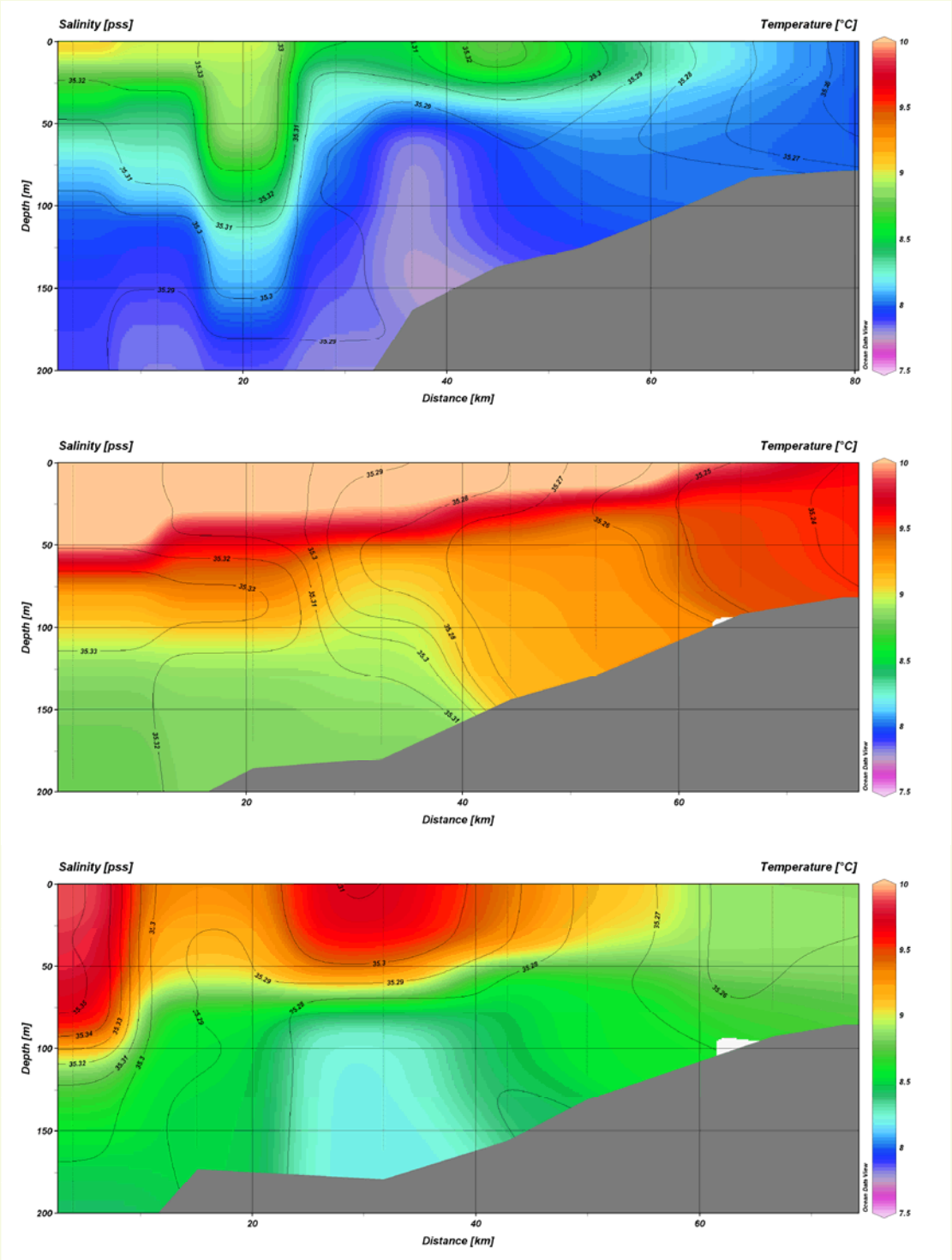

Figure 2a Three snapshots of temperature (colour scale) and salinity (lines) at transect exceeding from station V9 (Distance 0 on x axis) to V1 (distance 80km). The top and middle panels show the spring, and summer cruise in 2011, respectively, while the bottom panel shows the summer cruise 2012

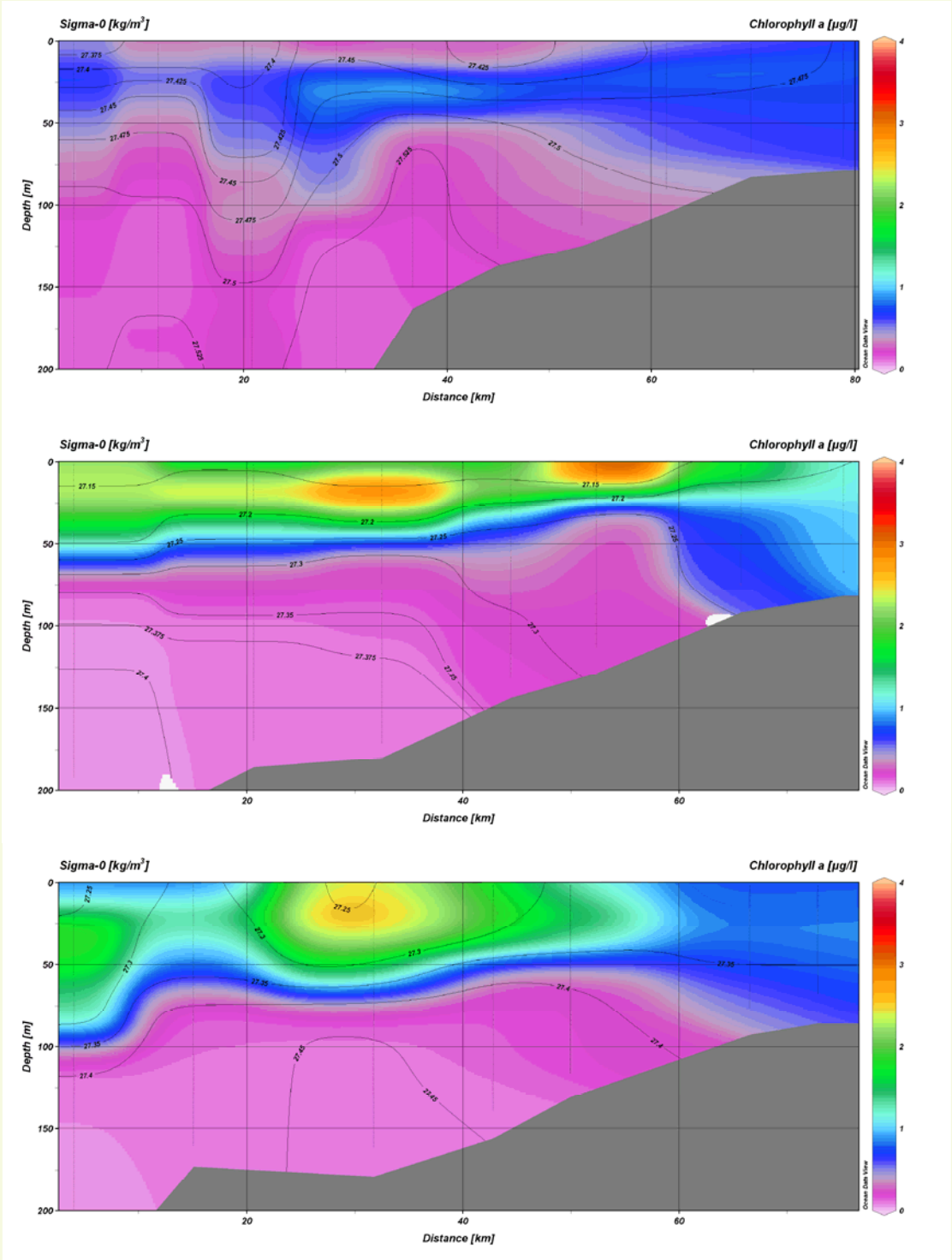

Figure 2b Three snapshots of Chlorophyll a, from fluorescence profiles (colour scale) and density (lines) at transect exceeding from station V9 (Distance 0 on x axis) to V1 (distance 80km). The top and middle panels show the spring, and summer cruise in 2011, respectively. While the bottom panel shows the summer cruise 2012.

crabs. Samples were dried at 55°C, homogenized, and approximately 1mg sample was weighed into pre-weighed tin capsules.

Stable carbon and nitrogen isotope analysis was preformed at Mylnefield Research Services, Invergowire, Dundee, using an automated nitrogen-carbon analyser (ANCA) coupled to a 20/20 isotope ratio mass spectrometer (SerCon Ltd, Crewe, UK). Measured $^{13}C/^{12}C$ isotope ratios were processed using the instrument manufacturer's proprietary software Calisto (SerCon Ltd, Crewe, UK) and anchored to the VPDB scale by contemporaneous analysis of international reference materials IAEA-600 ($\delta^{13}C$ VPDB = 27.77 ‰; IAEA, Vienna, Austria) and IAEA-CH6 ($\delta^{13}C$ VPDB = 10.45 ‰. IAEA, Vienna, Austria). The working standard for N analysis was 1 mg leucine prepared by freeze drying 50 µl of a 20 mg ml^{-1} stock solution into tin cups, and calibrated against 'Europa flour' and IAEA standards N1 and N2. Data are reported as $\delta^{13}C$ relative to PDB and $\delta^{15}N$ relative to air according to the formula:

$\delta I = [(R_{sample}/R_{standard}) - 1] \cdot 1000$, where I is ^{13}C or ^{15}N and R is the ratio of the heavy to the light isotope ($^{13}C/^{12}C$ or $^{15}N/^{14}N$)).

Table 1 Primary production mg C m^{-2}.

Station	Spring 2011	Summer 2011	Autumn 2011
V2	1.33		
V4	0.80	8.99	
V6	0.65		
V8	0.65	4.74	
V9	0.61		
E10			1.03

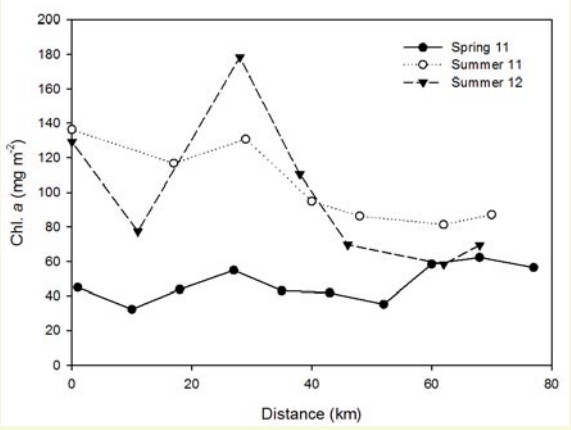

Figure 3 Depth integrated (0-70 m) chlorophyll *a* at transects extending from station V9 (distance 0 on x axis) to V1 (distance ~ 80 km). The chl *a* values are obtained from calibrated florescence profiles during the spring and summer 2011 (filled and open dots, respectively) and in summer 2012 (filled triangles).

Results

Water column characteristics

All transects (Fig. 2) show vertically homogenous water masses at the central Faroe shelf at bottom depths < 80m. At the spring cruise (27. April to 4. Maj 2011) the temperature at the central shelf ranged from 7.91 to 7.98 while the salinity was within 35.24-35.26. At the greater depths the water column was stratified, mainly due to temperature differences, and the sea surface was warmer than at the shallower stations, ranging from 8.4 to 9.1°C. The depth of the warmer surface layer was highly variable with distance to the central shelf.

At the summer cruise 2011 the sea surface had been heated further and the sea surface temperature (SST) ranged from 9.6 to 10.5°C, at the shallowest and deepest station, respectively. The water masses on the central shelf were still vertically homogenous, while the depth of the heated surface layer was 10m at 93m bottom depth, and increased to 50m at the outermost station.

During the summer cruise 2012 the water both on the shelf and off the shelf was considerably colder than the year before. This was especially the case for the (SST) which ranged from 8.9 on the central shelf to 9.9 ° C at the outermost station.

The transect taken during the summer 2012 also showed more dynamic settings than the previous summer, with variable surface heating and chl. *a* concentration.

As for the density, the chlorophyll *a* concentration was vertically homogenous (0.8µg l^{-1}) at the shallow stations, while the chl. *a* was concentrated in the upper water masses at the deeper stations. (Fig. 2).

During spring 2011 the depth integrated chlorophyll *a* concentration, was somewhat higher in the vertically homogenous central shelf water than in the off shelf water while the picture was reversed during summer 2011, when the chl. *a* content in the off shelf water was higher (Fig. 3).

The same pattern with higher chl. *a* in the off shelf water was observed during summer 2012, albeit the difference between central and off shelf water was more pronounced.

The primary production measurements from the spring cruise showed a gradual decline in primary production going from the shallow station V2 on the shelf, towards the deep station V9 in the oceanic water mass (Table 1).

Only two stations were investigated in June 2011 - V4 within the shelf front and V8 in the oceanic water mass. Far the highest primary production during the whole period investigated were measured on this cruise, with the highest production at V4 and somewhat lower at station V8 (Table 1).

Primary production was only measured once at station E10 on the eastern shelf. This was in late August 2011 and the primary production was 1.03 mgC m^{-2}.

Sediment properties

At the most shallow station the sediment was coarse, consisting of more than 50% gravel while the rest was composed of medium to coarse sand (Fig. 4). With increasing bottom depth the grain size decreased, and at V4 the vast majority of the sediment consisted of fine sand. This was also the

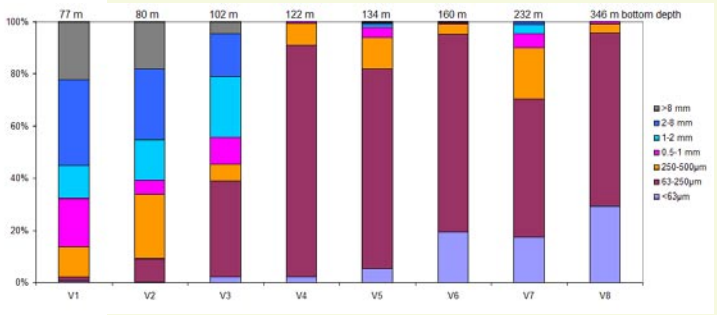

Figure 4 Sediment grain size distribution at a transect extending from the central Faroe islands in a southwest direction of the shelf. The bottom depth is shown above the bars. The various grain sizes are classified as followed: mud ‹63 µm, fine sand 63-250 µm, medium sand 250-500 µm, coarse sand 0.5 – 1 mm, fine gravel 2 – 8 mm and large gravel ‹ 8 mm.

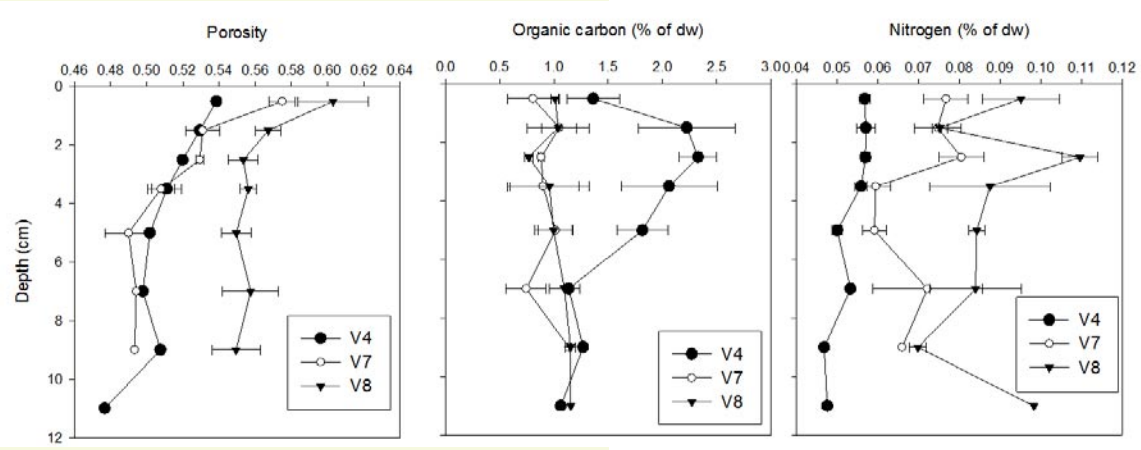

Figure 5 Sediment poriosity, organic carbon and nitrogen content at 0 – 12 cm depth in the sediment at station V4, V7 and V8. Error bars show the standard deviation of replicate cores.

Table 2 Total oxygen uptake (TOU), diffusive oxygen uptake (DOU) and the oxygen penetration depth (OPD) in the sediment, ± SE, n = 2 in TOU and 6 in DOU and OPD.

Station	TOU ($mmol\ m^{-2}\ d^{-1}$)	DOU ($mmol\ m^{-2}\ d^{-1}$)	OPD (mm)
V4	6.8 ± 0.18	3.8 ± 0.36	3.7 ± 0.44
V7	6.6 ± 2.64	3.1 ± 0.61	3.9 ± 0.93
V8	3.7 ± 0.71	2.4 ± 0.18	5.8 ± 0.38

Table 3 Sediment water exchange rates of nitrate, ammonium, phosphate and silicate. Fluxes are given in $mmol\ m^{-2}\ d^{-1}$. Positive numbers represent release from the sediment, ± SD, n = 2

Station	NO_3^-	NH_4^+	PO_4^{3-}	SiO_4^{4-}
V4	0.05 ± 0.09	0.03 ± 0.03	0.02 ± 0.01	1.01 ± 0.49
V7	0.10 ± 0.09	0.27 ± 0.13	0.03 ± 0.01	1.47 ± 0.15
V8	-0.04 ± 0.01	0.07 ± 0.04	0.03 ± 0.00	1.01 ± 0.06

innermost station where the HAPS bottom corer was successful. With increasing bottom depth the mud content of the sediment increased, and at the outermost station the mud content was 29%.

Station V4, which is the innermost station where OC inventory and mineralization rates were examined, is located at the transition zone between the on shelf and off shelf waters. Thus we have no samples of sediment which is continuously inside the shelf front.

The density of the sediment at station V4 did not change much with depth and was somewhat lower than at the off shelf stations (1.6 compared to 1.7 – 1.8 at the two other stations). The water content at the three stations was quite low ranging from 27 – 37% (data not shown). However the porosity at station V4 and V7 was highly similar and decreasing somewhat with depth (Fig 5). The porosity at station V8 likewise decreased with depth in the sediment although it was a little higher than at the other stations.

The organic carbon content of the sediment was low and did not change with depth, with exception of station V4 where the measured carbon content was considerably higher at 2 to 8cm depth in the sediment (Fig. 5), and the molar C:N ratios were extremely high (>40). Thus we suspect that we did not succeed in removing all the inorganic carbon at V4, and this data will not be used in further discussions.

The nitrogen content did not change much with depth in the sediment. However the content increased somewhat with distance from the shore, as the mud content of the sediment increased (Fig. 5).

The oxygen uptake and oxygen penetration depth was similar at the innermost stations, while the oxygen uptake at the deepest station was somewhat smaller, and oxygen penetrated deeper into the sediment than at the other stations. The difference between TOU and DOU was also larger at the innermost stations (Table 2). The sediment water exchange rates of nutrients were quite low at all stations. The nitrate, silicate and ammonium fluxes indicated higher mineralization rates at V7 which is located at the shelf slope than at the other stations (Table 3). The silicate release from the sediment was considerably higher than the release of the other nutrients.

Stable isotopes

The results from the stable isotopes show that the different benthic organisms have different trophic position. The sea urchin and the brittle stars are continuously on a lower trophic level compared to *Asarte* and horse mussel (Fig. 6). Also there seems to be a difference in the trophic level of sea urchins between the shallow station E10 and the deep station V7. This pattern is also seen in *Asarte* for the same stations (Fig. 7).

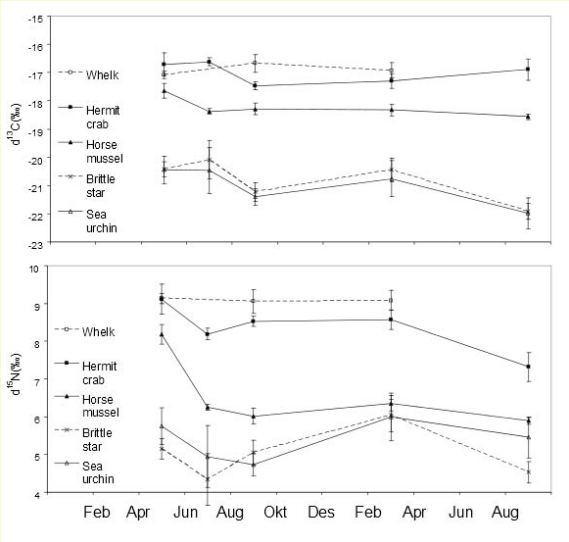

Figure 6 Temporal variation in stable carbon (upper panel) and nitrogen (lower panel) isotope composition in mussel tissue of benthic fauna at the Faroe shelf (station E 10).

Discussion

Water column

The measurements conducted in the water column in this study, only give snapshots of the pelagic settings, and thus have to be taken with great cautions when comparing with the sediment and stable isotope ratios in the benthic fauna. Never the less, the snapshots illustrate the settings when comparing pelagic benthic coupling on the shallow Faroe shelf and the oceanic water. The shallow waters (bottom depth ‹ 80 m) were vertically homogenic, while the deeper waters were stratified. The front between the stratified and mixed water on the Faroe shelf is generally positioned at bottom depths between 100 and 130 m although some variation may occur locally (Larsen et al. 2009). The stratified versus mixed settings of the water column, may have great implications for the pelagic – benthic coupling. In mixed waters, the current speed often is so high, that the particulate material will be held in the water column, rather than being deposited on the seabed. This is also reflected in the seabed which generally is coarse in turbulent

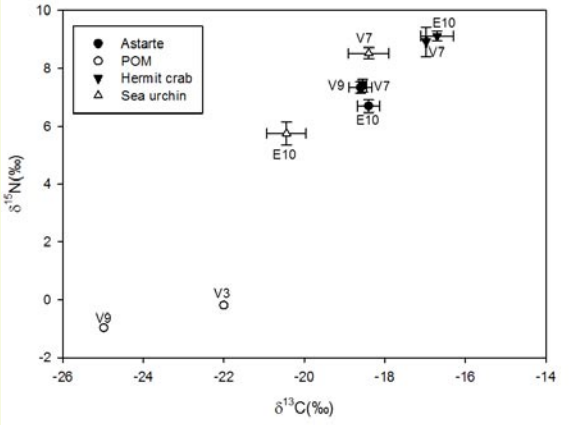

Figure 7 $\delta^{15}N$ and $\delta^{13}C$ of suspended particulate organic matter (POM) and various benthic fauna at the inner (Stations E10 and V3) and outer Faroe shelf (Stations V7 and V9) in spring 2011.

areas. In stratified waters the seabed often consists of depositional sediments, with higher content of organic matter than sandy sediments (Trimmer et al. 2003), and it is commonly observed that the spring bloom boosts the mineralization rates in such sediment, often without any time laps (Rysgaard et al. 1998, Eyre and Ferguson 2005), indicating tight pelagic benthic coupling.

In contrast to the silt sediments, the low organic carbon content of sandy sediments typically found below mixed waters, might be viewed upon as low pelagic benthic coupling (Trimmer et al. 2003). On the other hand, the absence of a pycnocline might imply, that the benthic fauna has just as good access to freshly produced organic carbon as the pelagic species.

The primary production measurements indicate that production in spring and summer is higher closer to the shelf than further off-shore. This would imply a higher flux of autotrophic material to the benhtic community on the shelf or in the shelf-front, compared to the open ocean. However, we have to consider that our results are only a snap-shot in a highly dynamic system. In order to be able to evaluate the amount of autotrophic material reaching the bentic community, we need to have a much better resolution of the progression in the primary production during the season.

Sediment

None of the stations where the sediment water exchange rates of oxygen and nutrients were measured (bottom depth 121, 232 and 346m) are from the mixed shallow Faroe shelf waters, as the seabed at the more shallow stations was too coarse to sample with the HAPS bottom corer (Fig. 4).

The oxygen consumption of the sediment in this study was at the lower end of the reported oxygen consumptions at continental shelves (e.g. Rysgaard et al. 1998, Trimmer et al. 2003, Giles et al. 2007). This might be due to the timing of the study, which was conducted before the spring bloom took off. All though there was some primary production and also chl. *a* present in the water column at the time when sediment was sampled, the concentration was quite low (< 1 µg l^{-1}), both in the shallow mixed Faroe shelf water, and outside the front. The spring bloom on the shallow part of the Faroe shelf commenced during the spring cruise and peaked two weeks later, when the Chl a concentration reached 2.5 µg l^{-1} (http://hav.fo/index.php?option=com_content&view=article&id=18&Itemid=123).

The oxygen consumption of the sediment changed with depth, as it was highest in the most shallow part of the sediment (data not shown) at all stations. This indicates, that the oxygen consumption, although small, is mostly based on organic material reaching the sediment, rather than reoxidation of reduced metabolites diffusing upwards from depth in the sediment (Rysgaard et al. 1998).

In general the nutrient fluxes from the sediment were highest at station V7, which is located at the slope of the Faroe shelf (Fig. 1). The release of silicate from the sediment was more than one order of magnitude higher than the net nitrogen release (NO_3^- + NH_4^+ flux). Considering the molar ratio of C:Si:N:P in suspended matter, the redfield ratio of 106:15:16:1, it might be expected that the release of Si and N from the sediment due to mineralization would be much more similar than observed. However, denitrification might play a role here releasing the nitrogen as N_2 gas rather than ammonium and nitrate.

The silicate efflux is also high compared to the ratio between silicon and phosphorus in suspended matter. The silicate release from the sediment is two to three times higher than might be expected from the redfield ratio between silicon and phosphorus. This might also be expected since the phosphate retention in oxidized sediments is high, and that phosphate is preferentially buried relative to C (Canfield et al. 2005), while less than 3% of the biogenic silica reaching the sediment is buried (Holstein and Hensen 2010). Similar findings of high silicate release relative to the other nutrients have been observed elsewhere (Rysgaard et al. 1998).

All in all, the sediment sampling in this study does not give much insight on the pelagic-benthic coupling of the Faroe shelf, due to insufficient equipment. In order to find out the metabolic activity in the sediment on the Faroe shelf, in situ tools most probably are needed. Furthermore the tools must be able to include advection and not merely diffusion as is the case in our measurements, since advection often plays a major role in solute transport between the sediment and water in sandy sediments (Huettel et al. 2003).

Stable isotopes

The analysis of stable carbon and nitrogen isotopes is a well established and widely used tool for the description of food web structures in ecosystems, including marine environments (e.g. Peterson and Fry 1987, Post 2002, Layman et al. 2012). The method is based on the fact that heavy isotopes (^{13}C and ^{15}N) accumulate from food to consumer (diet-tissue enrichment). The isotope ratio of carbon ($d^{13}C$)and nitrogen ($\delta^{15}N$) provides a time-integrated signal over weeks to months for an organism's potential trophic relationships and its trophic level, thereby supplementing the much more labor-intensive stomach analyzes. Although stomach analyzes provide more detailed information on diet, the results are more like a snapshot of the system functioning. Isotope signatures therefore have the potential to better describe the energy flows in food webs (Hobson and Welch 1992, Hobson et al. 1995, 2002, Post 2002).

Particles sinking through the water column are exposed to microbial degradation. These mineralization processes favors compounds of low C:N ratio and the light isotopic compounds, resulting in an increase in the C:N ratio, and $\delta^{13}C$ and $\delta^{15}N$ of the sinking material (Saino and Hattori 1980, Rau et al. 1991, Mintenbeck et al. 2007). These effects may, however, be limited to the euphotic zone, with only small changes in the nitrogen signature at depths greater than 300 m (Holmes et al. 1999, Bergmann et al. 2009). Larger, rapidly sinking detritus particles are less susceptible to degradation and thus do not exhibit the same relative increase in the heavy isotope with depth (Altabet 1988, Mintbeck et al, 2007).

As a consequence of these processes, benthic organisms feeding on suspended material exhibit enrichment in heavy isotopes of carbon and nitrogen with depth, whereas organisms that are more directly coupled to primary production in the euphotic zone will not exhibit such an effect. Organisms in the benthic detritus-food chain, which primarily rely on rapidly sinking particles will not to the same degree show depth dependence of the isotope signature (Mintbeck et al. 2007, Bergmann et al. 2009), but will have an enriched signature compared to organisms in the pelagic food webs (Altabet 1988).

This pilot study of the isotopic signature of benthic organisms from the Faroese shelf shows significant differences between stations as well as temporal changes. A more complete analysis would, however, require a more consistent temporal and spatial coverage.

There is a distinct trophic enrichment in both $\delta^{13}C$ and $\delta^{15}N$ and a clear trophic segregation, with the predators (whelks and hermit crabs) as the most enriched. It is interesting that sea urchins and brittle stars have lower isotopic values than the pure suspension feeders *Astarte* and horse mussel. Thus, the latter two feed on other organic material in addition to autotrophic phytoplankton.

The sea urchins at the deep station (V7) have significantly higher isotope values than at the shallow station (E10), corresponding to approximately one trophic level. It may be an indication that the food source at the shallower station (E10) are benthic microalgae, while detritus is the food source in deeper water below the euphotic zone. *Astarte* also has higher isotope values in deep water (V7, V9) compared to the shallow station (E10), which might reflect a stronger benthic-pelagic coupling at station E10.

The POM samples are somewhat variable and therefore do not provide any indication for differences in baseline levels between stations. Problems with filter-samples of POM is that it is not possible to collect pure autotrophic particles because at certain times there may occur significant amounts of heterotrophic and mixotrofic organisms of the same size fractions as the micro-autotrophs. In potential future studies a more precise determination of the base-level and its seasonal variations is needed. This may be done by *in situ* incubations of autotrophs (e.g. *Ulva*) at certain depths at the selected stations, with regular analysis of new growth, as well as regular collection of invertebrates from the lower trophic levels.

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