# BENTHIC MACROFAUNA COMMUNITIES ON THE NORTHEAST GREENLAND SHELF

## Results and data from the NEG Dana cruise 2017

Scientific Report from DCE – Danish Centre for Environment and Energy No. 361 2019

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# Data sheet

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Abstract: Benthic macrofauna was sampled from the Northeast Greenland Shelf between the 74° N and 78° N latitude during the NEG R/V Dana cruise August-September 2017. At all stations on the shelf and eastern shelf slopes down to 1,400 m depth, the sediment consisted of fine mud with a layer of stones on the sediment surface suggesting erosion of the sediment. Quantitative sampling of the fauna showed low densities of 400 individuals $m^{-2}$ as an average for the area and biomass was also low with an average of 10 g wet weight $m^{-2}$. Compared with the West Greenland shelfs, the biomass of the infauna is about 30 times lower at the NEG shelf compared to the WG shelfs and the abundance is about seven times lower than on the WG shelfs. The differences between the west and the east Greenlandic shelfs reflect the differences in productivity of the two shelf ecosystems. Small-scale species richness was about 2/3 of that of corresponding samples and communities of the WG shelfs. However, the diversity in a larger scale was about the same and species accumulation curves suggest that the total species pools of the NEG shelf could be even higher. Underwater video of epibenthic megafauna documented populations of giant sea pens > 2 m high, *Umbellula encrinus*, forming populations with ages of > 40 years. Furthermore, dense gardens of the cold-water "bamboo coral" *Keratoisis sp.* were observed on the shelf slopes at 1,000 m depth. These epifauna communities document the pristine conditions on the Northeast Greenland shelf and emphasise the extreme vulnerability of these ecosystems to disturbance.

Keywords: Northeast Greenland shelf, soft-bottom macrofauna, cold-water corals, diversity

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Front page photo: Soft-bottom cold-water coral garden of *Keratoisis sp.* and associated epifauna at 1,100 m depth from a position on the eastern continental slopes filmed during the NEG 2017 R/V Dana cruise. Photo Jørgen L.S. Hansen.

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# Preface

As part of the overall "Joint Northeast Greenland Strategic Environmental Study Programme 2016-2019", this project "5.2 Offshore benthos" studied the benthic fauna on the outer shelf and the eastern continental shelf slopes. The shelf and continental slopes between 74° N and 78° N were sampled during the NEG 2017 R/V Dana cruise. The hydrography of the area is dominated by the cold East Greenland Current and is therefore coved by sea ice and drifting icebergs for most of the year, and the seafloor underneath is among the least studied areas in the world. The area may in future be more accessible due to climate warming and possibly be opened for, and exposed to, offshore oil explorations. This study, together with contemporary studies of the other ecosystems and environmental elements in the Northeast Greenland Shelf area, will set baselines for this remote ecosystem. The study has, like the other studies of the Joint Northeast Greenland Strategic Environmental Study Programme, been funded by: The Mineral License and Safety Authority (MLSA) and the Environmental Agency for Mineral Resource Activities (EAMRA) of Greenland as part of the Joint Northeast Greenland Strategic Environmental Study Programme. This report focuses on the results from sampling of the benthic fauna in and on the sediment as well as measurement of some physical and chemical sediment properties. However, the role of the benthic fauna in the overall ecosystem processes of the NEG shelf considers also knowledge acquired from the other projects reported in separate reports. We are very grateful to Ole Secher Tendal, National History Museum of Denmark, for taxonomic help specifying epifauna from our underwater video recordings.

# Summary

Benthic macrofauna was sampled from 21 stations on the Northeast Greenland shelf between the 74° N and 78° N latitude during the NEG R/V Dana cruise in August-September 2017. At all stations on the shelf and on the eastern shelf slopes down to 1,400 m depth, the sediment consisted of fine mud. On most of the stations on the shelf, the sediment surface was furthermore covered with a layer of stones suggesting erosion of the sediment. Quantitative sampling of infauna communities with 0.1 $m^2$ Van Veen grabs and a 0.0143 $m^2$ Haps-corer generally showed low densities of arthropods and annelids with about 400 individuals $m^{-2}$ as an average for the area, and the corresponding biomass was even lower with an average biomass of 10 g $m^{-2}$. Compared to the West Greenland shelfs, from where corresponding and comparable data exist, the biomass of the infauna was about 30 times lower at the NEG shelf and the abundance was about 7 times lower than on the WG shelfs. The differences in the benthic fauna communities between the western and eastern shelfs are in agreement with the differences in productivity of the two shelf ecosystems. Species densities in the samples (0.1 $m^2$ sample) were also lower, about two thirds of comparable species densities on the WG shelfs. However, the Shannon diversity showed about the same values for the two shelfs and species accumulation plots of the two phyla suggest that the total species pools of the systems could be of the same sizes or larger on the NEG shelf. Qualitative sampling of epibenthic megafauna included observations of an iconic giant > 2 m high sea pen *Umbellula encrinus* retrieved from bottom trawling and observed on the underwater video. Furthermore, dense gardens of cold-water corals *Keratoisis sp*. were observed on the continental slopes. From counting of year rings, the population of *Umbellula encrinus* was determined to be more than 30 years old and literature values of growth rates of *Keratoisis* suggest that these populations were considerably older. These epifauna communities document the pristine conditions of the NEG shelf and emphasise the extreme vulnerability of these communities to disturbance.

# Sammenfatning

Som en del af "*Joint Northeast Greenland Strategic Study Programme 2016-2019*" blev bundfaunaen og overfladesedimentet undersøgt på den nordøstgrønlandske kontinentalsokkel (shelf) i forbindelse med Danatogtet (NEG 2017) i august 2017. På alle stationerne på selve kontinentalsoklen (shelfen) samt stationer på kontinentalskrænten ned til dybder på 1.400 m bestod bunden af finkornet mudder. På de fleste stationer var overfladesedimentet dækket af småsten og skærver, hvilket er tolket som et udtryk for vedvarende erosion af sedimentoverfladen. Den kvantitative prøvetagning af bundfaunaen, som blev foretaget med henholdsvis 0,1 $m^2$ Van Veen grabs og 0,0143 $m^2$ hapskerner, viste generelt meget lave individtætheder på ca. 400 individer $m^{-2}$ som gennemsnit for hele området. Den gennemsnitlige biomasse var endnu lavere på kun 10 g vådvægt $m^{-2}$. Til sammenligning viser undersøgelser fra den vestgrønlandske shelf, som tidligere er foretaget med samme metode, at biomassen her er ca. 30 gange højere og individtætheden tilsvarende 7 gange højere. Disse store forskelle kan forklares med den lave produktivitet i planktonsamfundene i vandsøjlen over den nordøstgrønlandske shelf. I modsætning til bundfaunaens tæthed og biomasse, så viste Shannon diversitetsindekset næsten sammen niveau på de to shelfer og akkumuleringen af arter med stigende prøvetal antyder, at der formodentligt er flere arter af leddyr og ledorme, totalt set, på den nordøstgrønlandske shelf end på den vestgrønlandske shelf. Undersøgelser af den epibentiske fauna med video viste forekomster af den store søpen, *Umbellula encrinus,* der bliver mere end 2 meter høj, og videooptagelser på kontinentalskrænten viste forekomst af tætte haver af koldvandskorallen "bambuskoral" (*Keratoisis sp*.). Tælling af årringe på *Umbellula encrinus* indikerede en alder på mere end 30 år, og litteraturstudier af vækstrater for *Keratoisis* viste, at disse samfund var betydeligt ældre end 100 år. Disse epibentiske dyresamfund understreger, at området er uforstyrret med en meget høj bevaringsværdighed og kan klassificeres som meget følsomme for forstyrrelse.

# Eqikkaaneq

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# 1 Introduction

The benthic macrofauna communities play a key role in the functioning of the marine ecosystem and contribute with the majority of species adding to the overall marine biodiversity. In shallow waters, where the productive surface layer is in direct contact with the sea bottom, the macrofauna may in fact control the pelagic ecosystem production by filtering of the phytoplankton. In deeper waters with disphotic or aphotic bottoms where there are no primary production, the fauna communities are fuelled almost entirely by the so-called allochthonous organic material, which defines organic matter transported to the ecosystem from outside (as opposed to autochthonous material originating from within the ecosystem). This input of organic material originates from primary production in the illuminated surface layers of the ocean and is subsequently transported to the bottom by sinking. Here the material is taken up by the benthic fauna community and it may eventually sustain higher trophic levels such as fish, mammals and even birds if water depths allow them to dive to the bottom. The overall biomass and richness of the fauna community are related to the input of organic matter and therefore to the distribution of primary production in the above surface layers of the water column. This linkage, between pelagic primary production and benthic secondary production, may be so close, that even small-scale hydrographic features such as productive frontal areas may be evident in the benthos community in terms of enhanced standing biomasses (Josefson & Conley 1997; Josefson & Hansen 2003). However, water depth also play an important role for the size of the sedimentary input to the benthos because there is a respiratory loss during the descent of the organic matter through the water column (Bendtsen et al. 2015). This means that the deeper the water column is, the less is the size of the organic matter input and the less is its degradability. Therefore, due to a combination of high productivity and relative shallowness, bottoms of continental shelfs generally receive high sedimentary input which sustain a rich benthic fauna community. The close coupling between pelagic primary production and the benthos furthermore sustains the rich fisheries known from many of the world's shelf areas. However, the Northeast Greenland Shelf might be an exception from this rule because of low primary production, low sedimentary input to the seafloor and a relatively poor developed benthic fauna community due to these constraints (Carmack & Wassmann 2006; Wassmann 2015).

The water masses overlying the Northeast Greenland shelf are dominated by the cold East Greenland Current and a layer of polar surface water on top which also carries the largest export of sea ice out of the Polar Sea (Aagaard & Coachman 1968; Carmack & Wassmann 2006; Codispoti et al. 2013; Michel et al. 2015). Extensive ice cover during most of the productive season limits primary production, and possibly the relatively little primary production of the system may be traceable in pelagic-benthic coupling in terms of low sedimentation rates to the bottom (Hobson et al. 1995). This could furthermore affect the biomass and community composition of the benthic macrofauna and have associated effects on the higher trophic levels of the area.

The sea ice also limits accessibility of the area for scientific exploration of the shelf bottom and so far few studies have documented the benthos of the Northeast Greenland shelf in the literature. A number of R/V Polarstern cruises (ARK VII, VIII, IX, and X) have covered parts of the area with benthic sampling. Mayer & Piepenburg (1996) and Schnack (1998) conducted a study across the shelf break at about 75° N; otherwise, most other studies have covered the area north of 78° N (Brandt 1995; Piepenburg & Schmid 1996a & 1996b; Schnack 1998). It has not been possible so far to find any studies of benthos covering the shelf area between 75° and 78°N.

The objective of this study is to establish a baseline for the NE Greenland shelf area for benthos, its overall role in the ecosystem and to provide data that may further be used to assess the sensitivity of the benthic ecosystem to disturbance from human activities and environmental changes. The study is part of a holistic ecosystem study covering a suite of ecosystems and environmental elements and processes and based on the field work conducted from the R/V Dana cruise in August 2017. In this report, we present the results from the investigation of the offshore benthic fauna community and its relation to the seafloor habitat.

# 2 Material and methods

## 2.1 Sampling

21 stations on the Northeast Greenland (NEG) shelf were sampled for soft-bottom macrofauna during the NEG-cruise with R/V Dana in August-September 2017. Sampling used a combination of 0.1 $m^2$ Van Veen grabs, 0.0143 $m^2$ Haps-corer (Kanneworff & Nicolaisen 1973) and underwater photography and video recordings of the seafloor. The total quantitative sampling counted 76 Van Veen grabs and 3 Haps-corer samples corresponding to a total seafloor area of 7.6 $m^2$ (about 1 $m^3$ sediment) and 19 of these stations had corresponding video recordings of the seafloor (5 to 15 minutes per station) which were recorded while the ship was drifting. Furthermore, sediment samples were retrieved from most of the Van Veen grabs and additionally 11 stations were sampled with a Haps-corer for profiling of the sediment (0-20 cm) for analysis of sediment chemistry. The sampled stations ranged from 66 to 1,460 m depth (*Table 2.1*). All 21 stations were located between the latitudes 74° N and 79° N and hereof 14 stations were on the shelf and 7 were located on the eastern marginal slopes of the shelf (*Figure 2.1*). In addition to the sediment samples from 2017, we also analysed water content and ignition loss on sediment samples from August 2016 collected by Volcanic Basin Petroleum Research AS which kindly made these samples available for analysis and use for this project.

Sediment samples were analysed for water content by drying the samples at 105 °C for 24 h and then ignition loss was measured by further burning of the dried sediment at 470 °C. Dried and burned sediment was stored in a desiccator until weighting.

Quantitative fauna samples were sieved on board and preserved with 4 % formaldehyde. In case of the qualitative samples or in cases where only qualitative grab samples with too little sediment were retrieved, these samples were preserved with 70 % alcohol (final volume). All quantitative samples were subsequently analysed in the laboratory which imply that the sieved material was sorted under the microscope (10-40 × magnification). Then, all animals were determined to lowest possible taxa, counted and weighted. All field and laboratory procedures followed the guidelines described in Hansen & Josefson (2014) and are in principle similar to corresponding OSPAR-guidelines (OSPAR 1997). Final data format is species specific abundance and wet weight and quantitative data will eventually, upon final quality assurance, be stored at the Arctic database hosted by DCE, Aarhus University.

Qualitative sampling included video recordings obtained with a GoPro© camera mounted on the frame of the Haps-corer while the ship was drifting. The Haps-corer was slowly lowered until it reached the bottom, then lifted about 1 m to allow drift. In order to keep the distance to the bottom as constant as possible, the procedure with lowering-lifting the Haps to the bottom was repeated every 1-5 minutes. This meant that it was possible to obtain quantitative counts on still photos while the Haps-frame was standing on the bottom, whereas drifting only resulted in qualitative observations. Subsequent analysis of the video recordings included observation of epifauna, bottom dwelling fish and characterisation of sediment surfaces. Methods for collection of environmental data and hydrography and sediment are described in separate reports.

**Table 2.1.** Benthic stations sampled with trawl, Haps bottom corer, Van Veen grab, video and sediment. Numbers indicate number of replicates.* Trawl samples were used for taxonomic verification and not reported here.

| Station ID | Depth | Latitude N | Longitude W | Trawl* | Haps | Van Veen | Video | Sediment |
|---|---|---|---|---|---|---|---|---|
| NEG12 | 336 | 78.40.966N | 5.5.184W | | 3 | 5 | 1 | 1 |
| NEG15 | 1460 | 77.53.855N | 4.4.489W | | | 3 | 1 | 1 |
| NEG20 | 743 | 76.39.085N | 7.30.114W | | | 3 | 1 | 1 |
| NEG27 | 297 | 75.24.184N | 11.53.168W | | 1 | 5 | 1 | 1 |
| NEG29 | 402 | 75.46.308N | 12.52.631W | | | 5 | 1 | 1 |
| NEG3 | 1148 | 78.2.680N | 5.58851W | 1 | | 1 | | |
| NEG36 | 191 | 76.39.035N | 15.35.993W | | | 5 | 1 | 1 |
| NEG36B | 189 | 76.43.809N | 15.37.428W | | | 5 | 1 | |
| NEG41 | 266 | 77.13.382N | 14.17.441W | | | 5 | 1 | 1 |
| NEG45 | 438 | 77.30.185N | 12.25.41W | | | 3 | 1 | |
| NEG49 | 117 | 77.40.401N | 16.29.502W | | | 5 | 1 | 1 |
| NEG57 | 320 | 76.28.823N | 19.31.48W | | | 3 | 1 | 1 |
| NEG6 | 286 | 78.28.929N | 6.50.603W | 1 | | 4 | | |
| NEG61 | 66 | 75.55.872N | 17.51.528W | | | 5 | 1 | |
| NEG63 | 104 | 75.15.679N | 16.52.524W | | | 5 | 1 | |
| NEG70 | 459 | 74.9.335N | 13.55.619W | | | 5 | 1 | 1 |
| NEG74 | 1117 | 74.26.568N | 13.40.389W | | | 3 | 1 | |
| NEG76B | 844 | 74.31.849N | 13.40.574W | | | 3 | 1 | 1 |
| NEG76C | 927 | 74.30.92N | 13.40.083W | | | | 1 | |
| NEG76D | 937 | 74.21.691N | 13.43.011W | | | 3 | 1 | |
| NEG81B | 995 | 75.24.4021N | 11.26.679W | | | | 1 | |
| Totals | | | | 2 | 4 | 76 | 19 | 11 |

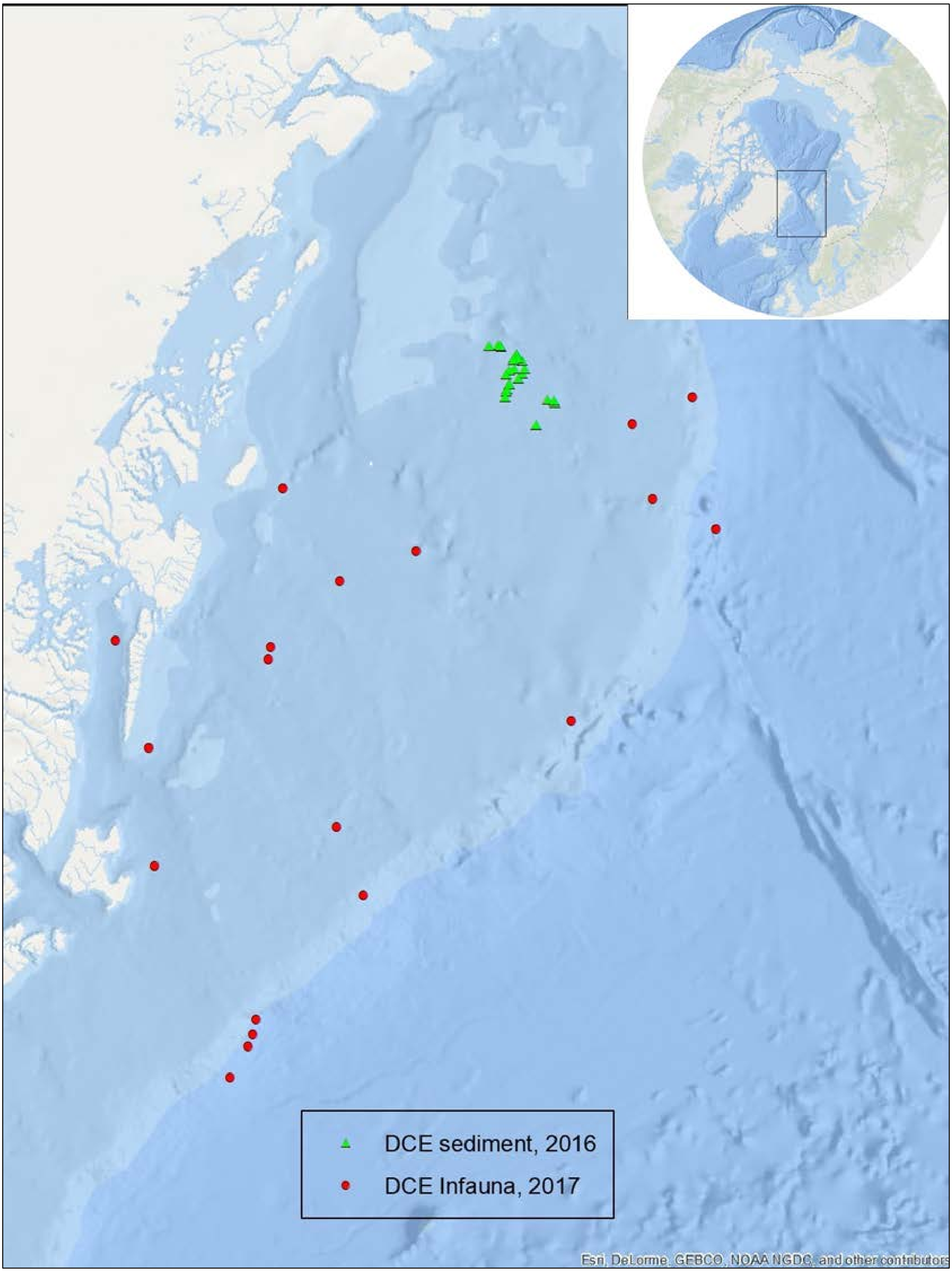



**Figure 2.1.** Survey area of soft-bottom macrofauna 2017 (red symbols) and sediment survey area 2016 (green triangles).

# 3 Results

## 3.1 Sediment observations

All stations sampled for fauna consisted of soft sediments composed of fine mud with little differences among stations. The average water content was 25 % and the organic matter content (ignition loss) was about 2.5 % (*Table 3.1*). Almost similar water content was found in the samples from 2016 with an average of 26.6 ± 7 % and a corresponding average ignition loss of 2.8 % ± 0.5 % (data not shown).

**Table 3.1.** Sediment profiles of NEG 2017 stations with values of water content and ignition loss average over the 8 depth levels 0-1, 1-2, 2-3, 3-5, 5-8, 8-12, 12-16 and 16-20 cm. ± standard deviation for stations and for total average.

| Station | Station depth | Core depth | Water content | Ignition loss |
|---|---|---|---|---|
| | m | cm | % | % |
| NEG12 | 334 | 0 - 16 | 30 ± 2.8 | 3.0 ± 0.24 |
| NEG15 | 1441 | 0 - 20 | 25 ± 3.0 | 3.0 ± 0.52 |
| NEG20 | 765 | 0 - 20 | 21 ± 5.2 | 2.3 ± 0.48 |
| NEG27 | 299 | 0 - 16 | 19 ± 2.2 | 1.7 ± 0.39 |
| NEG29 | 401 | 0 - 20 | 28 ± 2.5 | 2.4 ± 0.48 |
| NEG36 | 191 | 0 - 16 | 27 ± 6.7 | 2.4 ± 0.79 |
| NEG41 | 271 | 0 - 16 | 22 ± 4.3 | 2.1 ± 0.59 |
| NEG49 | 117 | 0 - 16 | 23 ± 3.7 | 2.7 ± 0.58 |
| NEG57 | 318 | 0 - 16 | 30 ± 2.0 | 2.4 ± 0.35 |
| NEG70 | 453 | 0 - 16 | 20 ± 4.1 | 1.8 ± 0.25 |
| NEG76B | 856 | 0 - 20 | 34 ± 2.4 | 3.8 ± 0.27 |
| Average | - | - | 25 ± 5.8 | 2.5 ± 0.72 |

The sediment profiles also did not show any clear distribution of water content or ignition loss with the sediment depth at any of the stations (*Figure 3.1*).

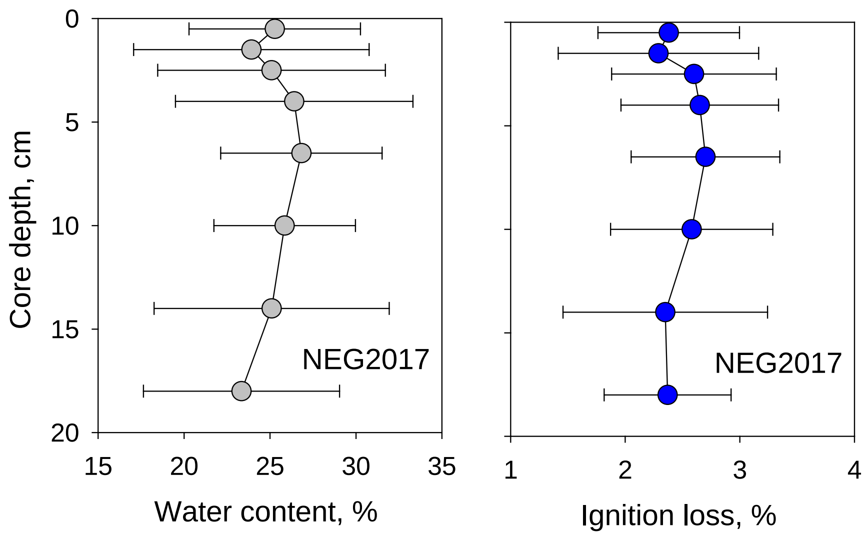



**Figure 3.1.** Sediment profiles of water content (left) and ignition loss (right) shown as average for the 11 stations with samples of sediment chemistry (*Table 3.1*). Error bars show standard deviation.

In most areas, the video recordings showed striking featureless clay bottoms which, however, were covered almost completely with small stones and gravel. However, these video recordings were contrasted to the sampled sediment in the Van Veen grabs where there were relatively few stones in the sieved material (*Figure 3.2*). This clearly indicates sorting of the sediment with stones on top. These observations are here interpreted as a result of erosion of the sediment surface so that fine sediment is removed leaving back the stones on the sediment surface.

**Figure 3.2.** Mud bottom at station 27 covered by 2-7 cm stones (gravel) as observed from video recordings of the sediment surface. Grab samples, however, showed that very few stones were found deeper in the sediment.

At station 49, where the water depth was 117 m, video recordings showed scour marks or craters of several meters in depth. These were identified as a result of scouring from icebergs. Another observation was that station 49 differed from the other shelf stations as there was no stones on top of the sediment and no clear sign of erosion or bioturbation. This was evident from the edges of the iceberg scour marks which were standing sharp in the mud (*Figure 3.3*). Thus, erosion must have been very limited, at least during the time elapsed after the iceberg scouring event. Sediments from depth below 800 m were more brownish and with large amounts of foraminifera shells. From stations 74 and 76B, where the largest gardens of bamboo corals *Kertoisis sp*. were observed, the sediment contained large quantities of the skeletons of this coral species. The buried skeletons in the sediment seemed to be inter-connected to the living branches of the coral above the sediment. The old and dead parts of the skeletons in the sediment probably function as an anchor of the colonies. At the same stations, the sediment was also filled with needle-like silica spines down to a depth of 20 cm. They were also attached to the sponge *Stelletta rhaphidiophora* which was visible on video recordings of the sediment surface.

**Figure 3.3.** An undisturbed ophiuroid and crinoid community at station 49 (upper) and the same community developed in a trench formed by iceberg at the same station (lower).

## 3.2 Macrofaunal communities observed in quantitative samples

The two dominating phyla in the samples were annelids and arthropods followed by echinoderms and molluscs. Biomasses ranged between < 0.1 and 63 g wet weight m$^{-2}$ on the shelf. However, two stations located on the continental slopes (St. 76B and 76D) had biomasses up to 2,000 g wet weight m$^{-2}$ due to epifauna associated to dense stands of bamboo corals. Abundances ranged between 40 and 1,240 individuals m$^{-2}$ (*Table 3.2*). Totally, 298 different species or species groups (specimens identified to higher taxonomic level than species) were identified (*Table 3.3*, *Appendix 1*). The most species-rich phyla were annelids (88 taxa), arthropods (71 taxa), bryozoans (35 taxa), molluscs (30 taxa), echinoderms (23), cnidarians (20 taxa), sponges (15 taxa) and 8 other phyla contributing with 16 taxa. On average, each 0.1 Van Veen sample contained 19 species varying between 6 and 30 species. Calculation of the Shannon diversity index showed an average value of 3.54 and rarefaction estimates showed that an ensemble of 20 individuals on average contained 11.4 species (range 5-14). Species richness and species diversity showed no clear relation to water depth or sampling location (*Figure 3.4*). The contribution of beta-diversity was assessed comparing the average number of species per sample with the average accumulated number of species by pooling the five samples taken from the same station (total sampling area of 0.5 m$^2$). The total station species richness was 49 species per station and the Shannon diversity calculated for the five samples pooled together was correspondingly 4.61 (*Table 3.2*, *Figure 4.2*).

**Table 3.2.** Station averages of benthic fauna communities from NEG 2017. Biomass and abundance per square meter. Species richness (S) as total number of species recorded per station (0.5 $m^2$, 3-5 samples). ES20 represents expected number of species per 20 individuals. Shannon diversity is calculated per sample and averaged over stations. *Two samples from stations 76B and 76D were considered outliers and omitted in the global average.

| Station | Species total | Abundance $m^{-2}$ | Biomass $m^{-2}$ | Species per sample | ES20 | Shannon diversity H´ |
|---|---|---|---|---|---|---|
| 12 | 66 | 314 | 7.1 | 19.8 | 7.8 | 2.73 |
| 15 | 29 | 437 | 4.6 | 12.7 | 7.8 | 2.66 |
| 20 | 63 | 610 | 2.8 | 24.3 | 12.3 | 3.96 |
| 27 | 69 | 777 | 18.6 | 24.7 | 11.4 | 3.90 |
| 29 | 64 | 284 | 4.4 | 17.8 | 13.2 | 3.75 |
| 3 | 25 | 250 | 4.1 | 9.0 | 8.1 | 2.74 |
| 36 | 61 | 308 | 9.0 | 18.6 | 11.8 | 3.58 |
| 36B | 57 | 314 | 10.4 | 18.6 | 13.5 | 3.87 |
| 41 | 50 | 274 | 2.1 | 18.0 | 14.4 | 3.88 |
| 45 | 26 | 220 | 16.1 | 11.3 | 10.1 | 3.05 |
| 49 | 64 | 440 | 9.8 | 20.8 | 11.8 | 3.83 |
| 57 | 24 | 203 | 8.3 | 12.7 | 11.9 | 3.38 |
| 6 | 48 | 260 | 18.1 | 15.5 | 12.7 | 3.43 |
| 61 | 57 | 400 | 16.2 | 19.4 | 12.0 | 3.69 |
| 63 | 78 | 636 | 17.4 | 29.8 | 14.1 | 4.44 |
| 70 | 57 | 702 | 4.5 | 24.0 | 11.6 | 3.87 |
| 74 | 51 | 460 | 15.0 | 19.0 | 10.6 | 3.39 |
| 76B | 30 | 275 | 840.0 | 15.0 | 10.4 | 3.46 |
| 76D | 12 | 185 | 116.0 | 5.5 | 4.6 | 1.86 |
| Average | 49 | 410 | 10.3* | 18.5 | 11.4 | 3.54 |

Species accumulation curves showing species accumulation against random numbers of sampled stations showed that by increasing the number of stations by one from 19 to 20 would have increased the total species list by 8 species and hereof annelids and crustaceans would contribute with 7 species (*Figure 4.3*).

**Table 3.3.** Distribution of species richness, total abundance and total biomass among major taxonomic groups (phyla and classes) for all quantitative infauna samples from NEG 2017. * Not specified below phylum level.

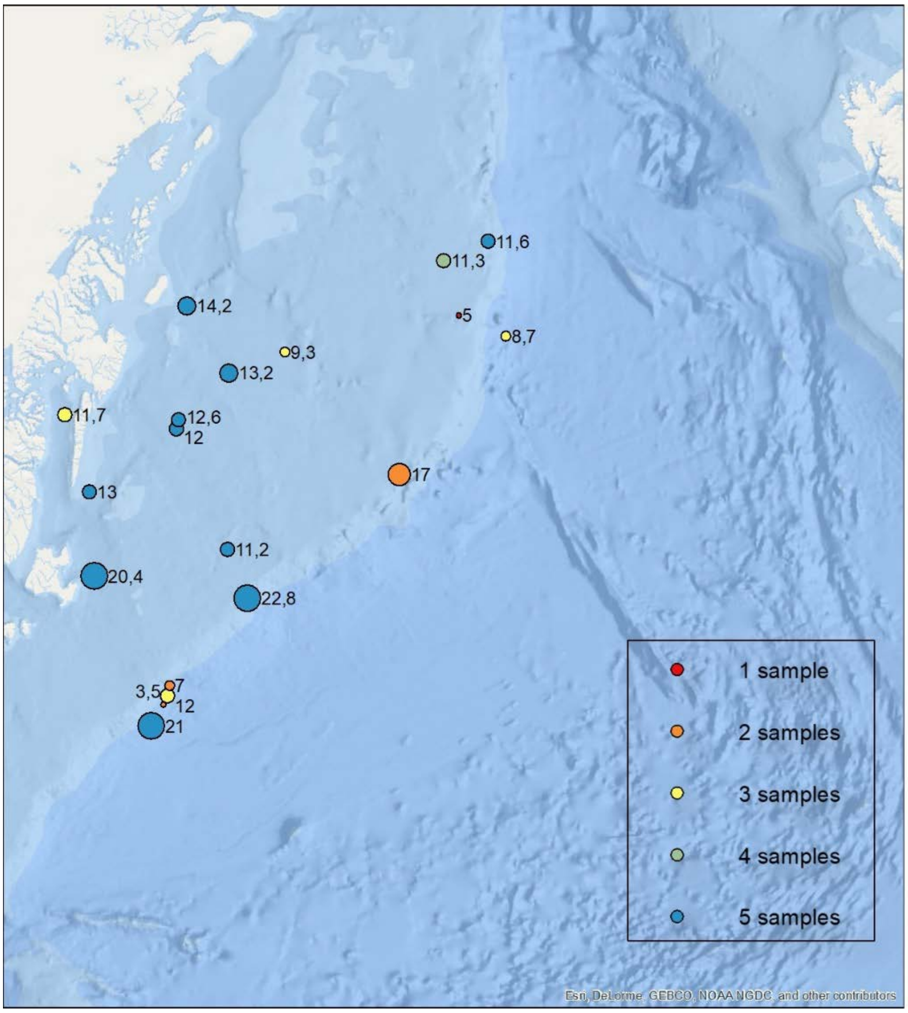
| Phylum | Classes | Number of species | Abundance % | Biomass % |
|---|---|---|---|---|
| Annelida | Polychaeta | 88 | 49 | 2 |
| Arthropoda | Hexanauplia, Malacostraca, Ostracoda Pycnogonida | 71 | 10 | 10 |
| Brachiopoda | Rhynchonellata | 1 | 0 | 0 |
| Bryozoa | Gymnolaemata, Stenolaemata | 35 | 5 | 0 |
| Cephalorhyncha | Priapulida | 1 | 0 | 1 |
| Chaetognatha | Sagittoidea | 1 | 0 | 0 |
| Chordata | Actinopterygii, Ascidiacea | 8 | 1 | 0 |
| Cnidaria | Anthozoa, Hydrozoa | 20 | 1 | 0 |
| Echinodermata | Asteroidea, Crinoidea, Echinoidea, Holothuroidea, Ophiuroidea | 23 | 4 | 9 |
| Foraminifera | | 0 | 3 | 0 |
| Mollusca | Bivalvia, Gastropoda | 30 | 10 | 13 |
| Nematoda | | 1 | 4 | 0 |
| Nemertea | | 1 | 1 | 0 |
| Porifera | Calcarea, Demospongiae, Hexactinellida, Sipunculidea | 15 | 3 | 63 |
| Sipuncula | Sipunculidea | 2 | 9 | 0 |

## 3.3 Quantitative observations

From trawl track, species of the giant sea pen *Umbellula encrinus* were collected and also observed from the video recordings. Qualitative registrations of epifauna from video recordings on the shelf and shelf slopes revealed 8 different phyla with 32 different taxa determined to the taxonomic level of family (*Appendix 2*). For two specimens the central stalks were cut and growth rings were counted under the binocular microscope assuming that the rings represented yearly growth rings. More than 30 rings were clearly distinguishable thus the age (maximum) of the population was assumed to be > 30 years.

At station 74 and 76B dense stands or gardens of the Bamboo corals (*Keratoisis sp.*) were observed at between 800 and 1,200 m depths. Videos showed actively filtering polyps of *Keratoisis*. From video recordings where the Haps frame was drifting over the top of the *Keratoisis* populations, it seemed like the densest stands were standing on "dune-like" elevated areas of the bottom although this was difficult to decide as the camera direction was perpendicular to the bottom. These coral gardens were associated with a diverse community of epifauna as described above (*Appendix 2*).

**Figure 3.4.** Distribution of alpha diversity on the NEG shelf expressed as average number of annelids and arthropod species per 0.1 m samples. Colours indicate number of Van Veen samples per station.



# 4 Discussion

## 4.1 NEG 2017 and other expeditions

Benthos sampling of the 21 stations on the NE Greenland shelf from the NEG 2017 cruise supplements the existing benthic sampling programmes and data collections in the literature (Degerbel et al. 1941; Bluhm et al. 2011). Previous studies have focused in the area further to the north within the polynya area (the Northeast Polynya) where a series of R/V Polarstern expeditions (*Figure 4.1*) have collected benthic data during the 1990s (Piepenburg 1988; Hirche & Kattner 1994; Brandt 1995; Mayer & Piepenburg 1996; Piepenburg & Schmid 1996a; Piepenburg & Schmith 1996b; Piepenburg et al. 2017; Piepenburg et al. 2010; Schnack 1998). It is assumed that due to the higher primary production of the open water of the NE polynya as hypothesised by Hobson et al. (1995), the benthos data from these studies may represent more productive benthic ecosystems. Thus, there is probably little correspondence in species composition. However, a direct comparison is not possible as the methods were slightly different and most of the studies have published the benthos data at a high taxonomic level than species. There are two studies of Mayer & Piepenburg (1996) and Schnack (1998), which have some spatial overlap with the NEG 2017-cruise, but this only concerns the slopes of the continental shelf and not the shelf itself.

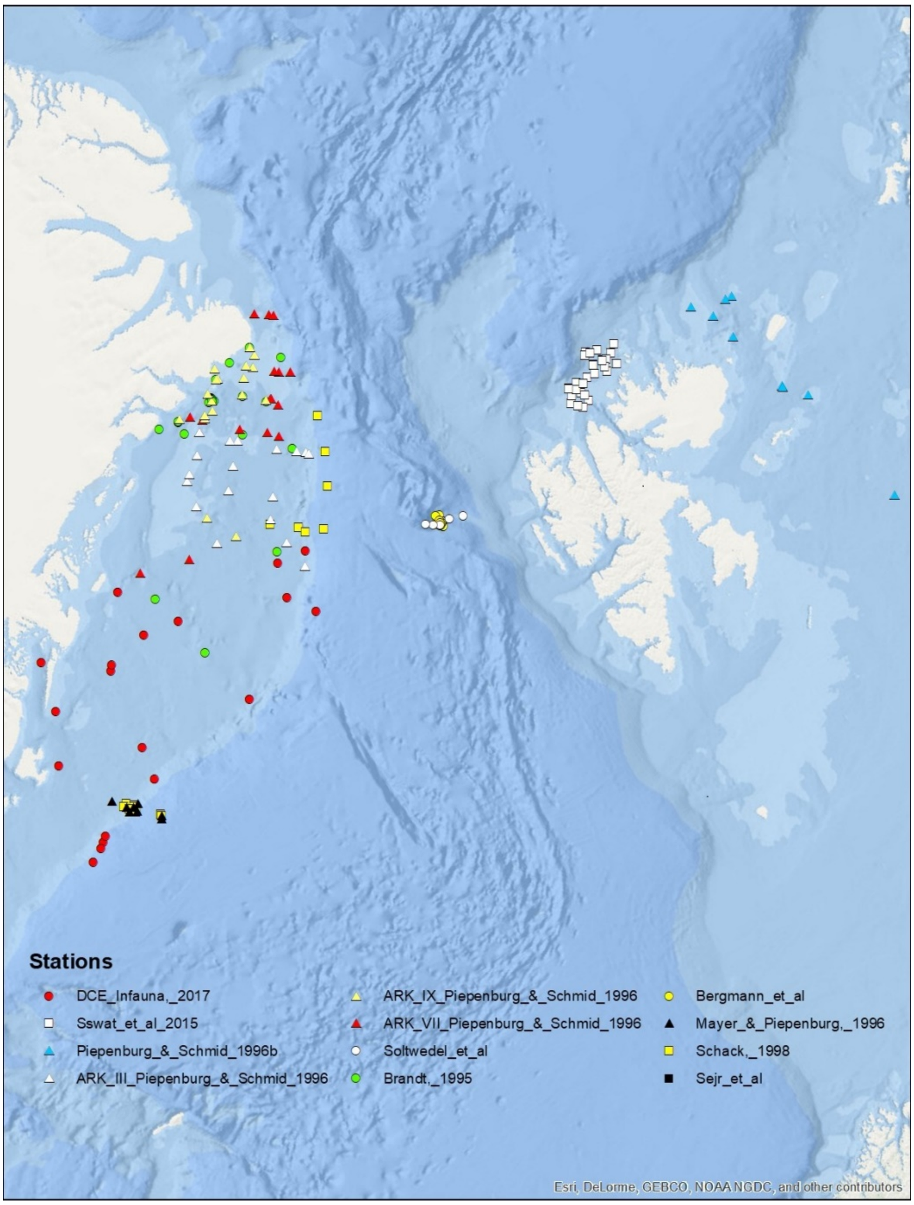



**Figure 4.1.** Locations of NEG 2017 sampling stations (red filled circles) together with sampling stations visited by previous expeditions on the Northeast Greenland shelf. Sampling locations of Sejr et al. (2000) located more westerly in Young Sound and outside the map. Symbols arranged by scientific publications and cruise reports.

## 4.2 The fauna community

Our stations on the central part of the NEG shelf showed low abundances of about 400 $m^{-2}$ individuals of annelids and arthropods and strikingly low biomasses of only 10 g wet weight $m^{-2}$, and where the bivalves, which often dominate the biomass on shelfs, only contributed with 2 g wet weight $m^{-2}$. The biomass of the epifauna was not quantified and echinoid megafauna such as *Gorgonocephalus sp*. or the giant pennatulids, *Umbellula encrinus,* could be important for the total biomass of the community. However, the video surveys covered several square metres of the seafloor on each station and only few specimens of large epifauna were observed with the exception of station 49 (*Figure 3.3*) where there were high abundances of ophiuroid and crinoid epifauna. The distribution of biomass could also be patchy as exemplified by the scattered gardens of bamboo corals where the biomass was considerably higher and this would also lead to an underestimation of the biomass. In general, the composition of functional groups in the community indicated that deposit feeders and bioturbating animals appeared to be low compared to temperate shelfs in general and to the West Greenland shelfs (see below). Another characteristic finding was that the filtrating animals seemed to be dominated by erect life forms such as sponges and not by infauna such as bivalves as seen in many other productive shelf areas. This could be due to the absence of physical disturbance from trawling which is particularly critical to erect epifauna. The dominance of erect filter feeding fauna could also be due to the competitive superiority of erect fauna when the food availability is low because it reaches higher up in the water column where the food comes from. In contrast to the low densities and very low biomass, species richness seems to be high with representation of 16 phyla, and more than 298 species in only 73 0.1 $m^2$ samples. On average, there were about 18.5 species in one sample and 49 species when the 3-5 samples from the same station were pooled. Thus, even though the bottom at most stations appeared featureless, the fauna community was highly heterogeneous and diverse which was also reflected in the average value of the Shannon diversity of 3.5.

## 4.3 Comparison of fauna communities on West and East Greenland shelfs

The present study can be compared with a number of previous studies on the West Greenland shelfs (shelf plains, banks, fjords and shelf slopes). These studies have used exactly the same sampling design and analytical methods and there is even overlap in the taxonomists who identified the species. The comparison shows that biomass of the fauna community of the NEG shelf was only about 3-4 % of the corresponding biomass observed on the WG shelfs, and the abundance was only about 15 % of that on the WG shelfs (*Figure 4.2*). The species diversity of annelids and arthropods are the most comparable phyla of the two shelfs because they are the most species-rich phyla on both shelfs and because these phyla have the largest proportion of species which could be specified on both the WG and the NEG shelf. Species richness, expressed as average number of species of the two phyla in one sample, showed that values of the NEG shelf were about 2/3 of that of the WG shelfs, whereas the Shannon diversity was almost the same for the two shelf systems. The diversity at the station level (including the contribution of beta-diversity among replicate samples) showed that the two phyla have the same diversity as the WG shelfs. In fact, the expected species number for 100 individuals (rarefaction-ES100) for the NEG shelf was higher than observed for any of the WG investigations (*Figure 4.2*).

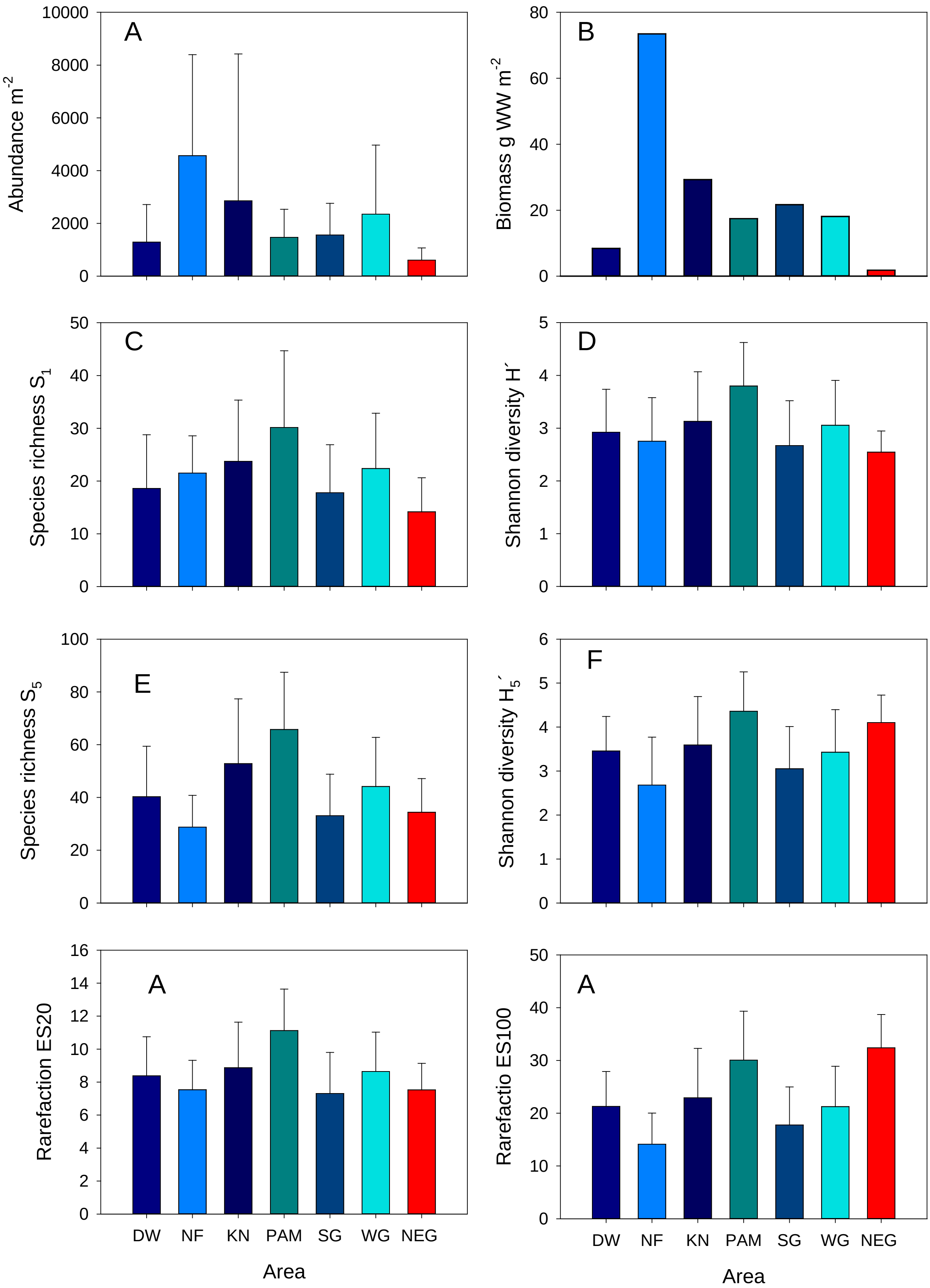
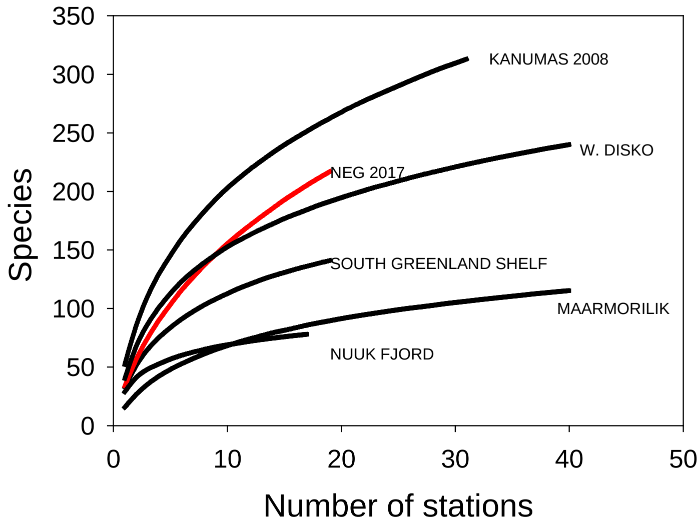



**Figure 4.2.** Comparison of fauna communities from West Greenland benthos surveys on shelf plains, banks and fjords with corresponding data from Northeast Greenland (DW = Disko West 2009; NF = Nuuk Fjord 2008; KN= Kanumas 2008; PAM = South Greenland 2011; SG = South Greenland 2010; WG = all west Greenland investigations) and red column denotes present data from 2017 (NEG). A) Total number of individuals per $m^2$. B) Total average biomass per $m^2$. C) Species richness ($S_1$ = number of species per 0.1 $m^2$ sample) of arthropods and annelids only ($S_1$) Average number of species per sample (arthropods and annelids only). D) Shannon diversity estimated for one sample (arthropods and annelids only). E) Species richness of arthropods and annelids as average number of species per station (five samples). F) Shannon diversity estimated for five accumulated samples (arthropods and annelids only). G) Rarefaction expressed as average number of species of arthropods and annelids per 20 individuals. G) Rarefaction number of arthropod and annelid species per 100 individuals.

Traditionally, diversity is assessed in different scales where alpha diversity represents the diversity in the smallest spatial scale and beta and gamma diversity the larger scales. In this case we define α-diversity as representing the diversity of the individual sample, β-diversity the diversity of the sampled station and γ-diversity correspondingly the total diversity of the survey. Starman & Gutt (2002) compared the biodiversity of epibenthic megafauna on the Northeast Greenland shelf with that of the Weddell and Bellinghausen Seas (Antarctica) and found contrasting results depending on the assessment scale. While the total diversity was larger in the Antarctic seas, the alpha and beta diversities were more or less similar to the Northeast Greenland shelf. The present NEG survey showed that the total density of individuals was very low and α-diversity was slightly lower than observed in corresponding WG shelf studies. In contrast, estimates of β- and γ-diversity showed the same or even higher diversity levels (*Figure 4.2*). This is also evident from species-accumulation curves (*Figure 4.3*). The slopes of the curves indicate differences among stations in species composition. The steeper the slope, the more differ the fauna communities among stations, and the higher is the large-scale (β and γ) contribution to the biodiversity. For sampling of 19 random stations, the Kanumas-investigation located in fjords, banks and shelf plains along the West Greenland shelf gave the highest number of records of arthropods and annelids (262), followed by the NEG 2017 investigation (217 records). However, the rate of increase going from 18 to 19 stations was highest for the NEG 2017 survey (addition of 5.61 species) and was followed by Kanumas survey (5.26), Disko survey (3.25) South Greenland survey (2.35) and with the two fjords Maamorilik Fjord and Nuuk Fjord showing the lowest increment rates (1.80 and 1.01, respectively). This suggests that the species accumulation curve for the NEG survey may in fact cross the curve from the Kanumas survey if more stations were sampled. This is also suggested from the "$Chao_2$"-estimate (Chao 1984) for sampling of 19 random stations which suggests a total species pool of annelids and arthropods of 385 for NEG 2017 data and 376 for Kanumas 2008. However, the "Chao"-species accumulation curves do not show saturation and therefore both of these numbers are clearly underestimated and should be seen only as an indication, that the total species pool of the NEG shelf, due to the contribution of beta and gamma diversity, may in fact exceed the species pool of the WG shelf. Furthermore, high gamma diversity is typically associated with high habitat heterogeneity. The WG shelf investigations have sampled much more heterogenic habitats and have covered a much larger latitudinal gradient than NEG 2017 which should lead to higher diversity on the WG shelfs. Furthermore, the WG investigations included high productive banks which are habitats we did not encounter on the NEG shelf. Altogether, this suggests that despite of low biomass and density of animals, the diversity is higher on the NEG shelf than the WG shelfs when taking sampling effort and habitat characteristics into account.

**Figur 4.3.** Species accumulation curves against number of sampled stations from West Greenland shelfs grouped by surveys and corresponding species accumulation curves from NEG 2017 cruise (red lines). Only arthropods and annelids are included in these species accumulation plots. West Greenland habitats include fjords, banks, and shelf plains. The NEG 2017 cruise included fjords, shelf plains and shelf slopes.




## 4.4 Megafauna on the NEG shelf and shelf slopes

Of special interest was the finding of a giant sea pen *Umbellula encrinus* (Linné) in the trawl tracks (*Figure 4.4*). Some specimens were also observed on the video. The species is well known from the deeper (> 800 m) mud bottom of the Baffin Bay area (Neves et al. 2015; 2018) and is also well known to the Northeast Atlantic. Danielssen & Koren (1884) described the species from the Norwegian shelf margins, from where morphological descriptions exist including measurements of lengths of the central stem (Danielssen & Koren 1884 and references herein) which agree with the findings in this study where many individuals exceeded 200 cm in height. However, as most specimens were broken apart by the trawl, it was impossible to evaluate length distribution and maximum height. Among the 16 specimens described by Danielssen & Koren (1884), the largest one was 253 cm. We cut the hard, internal skeleton/stem of a > 200 cm high individual at about 70 cm from basis and counted > 30 growth rings, presumably year rings. A similar attempt to measure the age of *U. encrinus* from counting year rings of the central stem (Neves et al. 2018) showed that ages ranged between 2 years (the smallest individuals) and up to 75 years as the maximum in that study. Neves et al. (2018) also reported annual apical growth rates of 4-5 cm in the Baffin Bay area. Thus, based on these studies, we therefore conclude that the sampled population from the NEG shelf included individuals of about 45 years or more when we add 15 years to the number of year rings since we cut the stem 70 cm above the basis (30 year rings plus 70 cm/4.5 cm $yr^{-1}$).

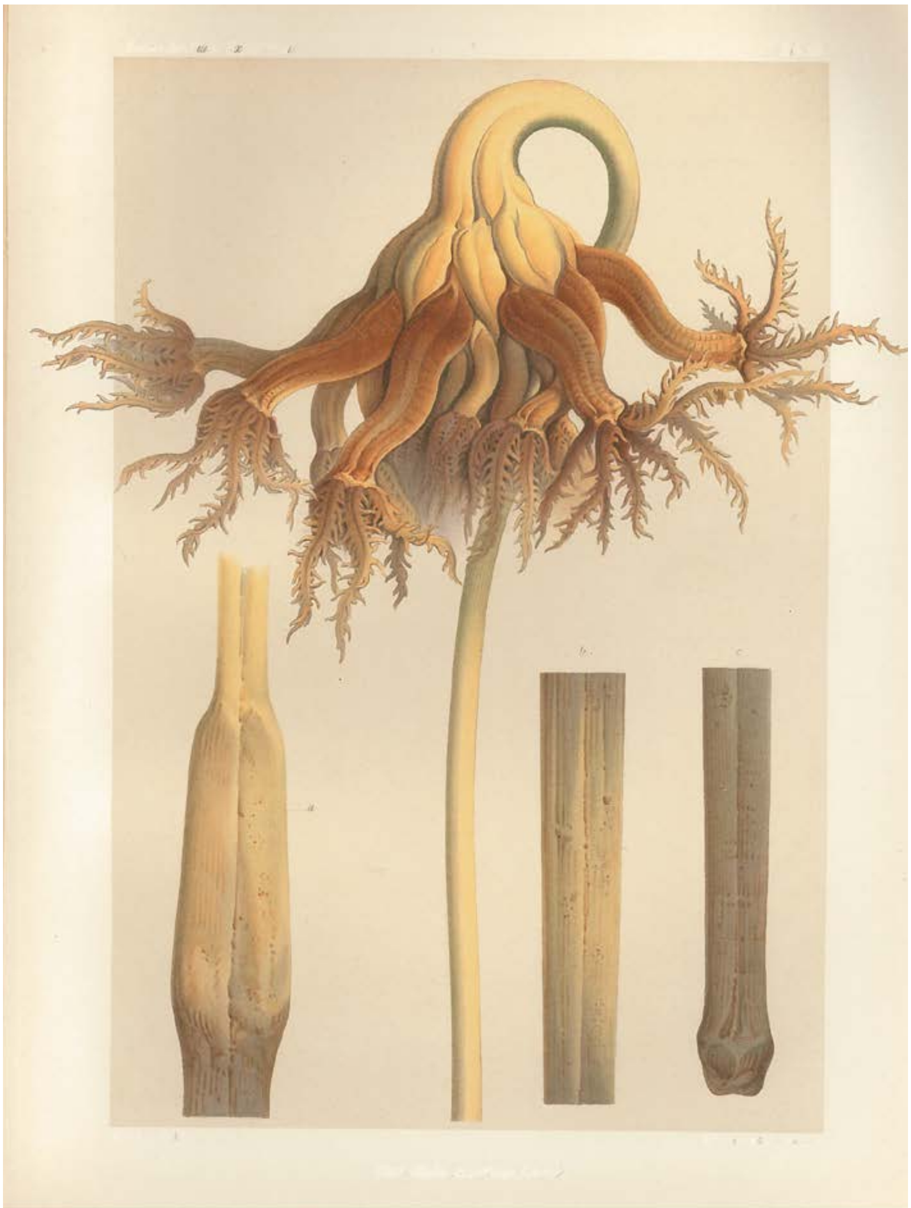


**Figure 4.4.** Drawing of the sea pen *Umbellulla encrinus* (Linné 1753) (Pennatulida) specimens from the Norwegian Polar expedition 1876-1878 by Danielsen & Koren (1884). Many specimens found during the NEG 2017 cruise exceeded 200 cm in height. Inserted drawings show the central hard stalk which was cut to count year rings.

## 4.5 Discovery of gardens of the cold-water coral *Keratoisis* *sp.*

During the NEG 2017 survey we encountered scattered gardens of the cold-water coral *Keratoisis* sp. (common name bamboo coral) (*Figure 4.5*). This is probably the first finding of this species on the east Greenland shelf, as it has not been possible for us to find previous records of the genus *Keratoisis* from east Greenland in the literature. The gardens of *Keratoisis* were found on 800-1400 m depth on the continental slope and the appearance on the video indicated that it had a very dynamic epifauna community associated. The polyps were actively filtering and the corals were associated with a diverse community of fish and invertebrate fauna with much higher biomasses than seen on the shelf. The corals were growing in the depth range of the shelf slopes dominated by the Atlantic water masses and high advection (Møller et al. 2019). High biomasses of the corals and associated epi-faunal communities suggest high input of food and energy and the locations could represent hot spots of benthic pelagic coupling (Vernet et al. 2019) or high allochthonous input from advection of material across the shelf. However, there are no environmental data to test this hypothesis.

The *Umbellula encrinus* populations and the gardens of *Keratoisis sp.* are in particular vulnerable to all kinds of the disturbance. For the cold-water coral *Keratoisis* which is a habitat-forming coral, this vulnerability applies to both the population itself and the habitat formed by the coral. As described above, a very rough age determination suggests that the *U. encrinus* population was > 50 years old. We did not measure the age of *Keratoisis*. However, the longest piece of unbroken skeletons was about 50-60 cm when caught in the Van Veen grab and according to Andrews et al. (2009), apical growth rates of *Keratoisis* is about 7 mm per year and this would correspond to about 90 years of growth. Furthermore, the gardens of the *Keratoisis* on the video had longer skeletons and the observation that skeletons were inter-connected with older parts below the sediment surface indicates that these communities are considerably older. These very rough age estimates emphasise the pristine conditions of the NEG shelf.

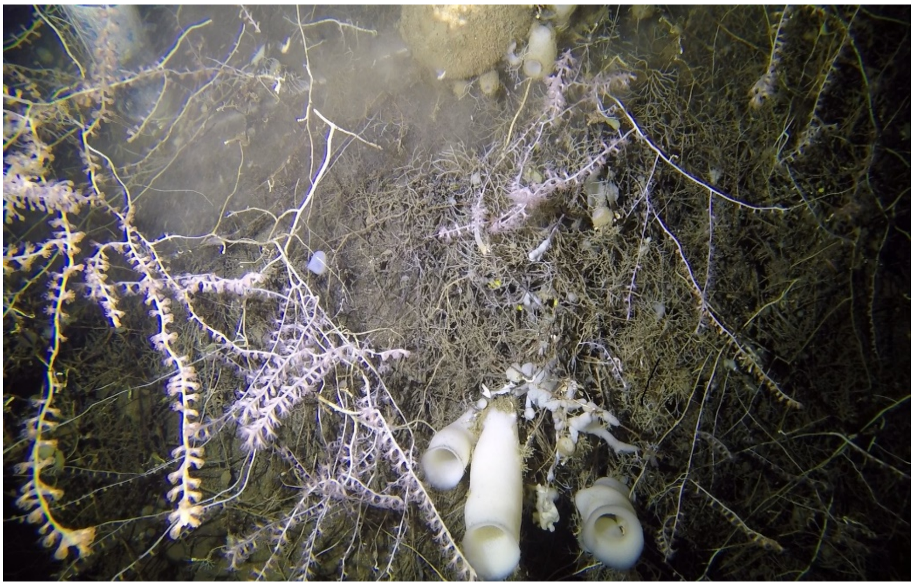


**Figure 4.5.** Gardens of cold-water corals *Keratoisis sp*. at 1,100 m depth on the eastern margins of the NEG shelf. Note tentacles on the polyps are open and actively filtering.

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# Appendix 1 - Species list, quantitative samples

## Annelida, Polychaeta

Abyssoninoe abyssorum
Aglaophamus malmgreni
Amage auricula
Ampharete acutifrons
Ampharete finmarchica
Ampharete octocirrata
Amphicteis gunneri
Anobothrus gracilis
Anobothrus laubieri
Aphelochaeta marioni
Apomatus globifer
Aricidea abranchiata
Bushiella (Jugaria) quadrangularis
Bylgides
Capitella capitata
Chaetozone setosa
Chirimia biceps biceps
Chone duneri
Cirratulidae
Dasybranchus caducus
Diplocirrus hirsutus
Diplocirrus longisetosus
Euchone analis
Euchone incolor
Eucranta villosa
Eunoe barbata
Eunoe nodosa
Euphrosine
Eusyllis blomstrandi
Galathowenia fragilis
Galathowenia oculata
Glyphanostomum pallescens
Harmothoe impar
Heteromastus filiformis
Lanassa nordenskioldi
Laonice bahusiensis
Leaena ebranchiata
Lipobranchius jeffreysii
Lumbrineridae
Maldane arctica
Maldane sarsi
Melinna cristata
Melinna elisabethae
Melinnopsis arctica
Melinnopsis rostrata
Melinnopsis somovi
Myrianida
Myriochele olgae
Nephtys ciliata
Nereis gracilis
Nereis pelagica
Nereis zonata
Nicomache lumbricalis
Nicomache personata
Nothria conchylega
Notomastus latericeus
Notoproctus oculatus
Odontosyllis fulgurans
Ophelina cylindricaudata
Owenia
Petaloproctus tenuis
Pholoe assimilis
Pholoe inornata
Pholoe longa
Phyllochaetopterus gracilis
Phyllodoce groenlandica
Pista maculata
Placostegus tridentatus
Polycirrus norvegicus
Praxillella praetermissa
Praxillura longissima
Prionospio cirrifera
Pseudoscalibregma parvum
Sabella pavonina
Samythella neglecta
Scalibregma inflatum
Schistomeringos rudolphi
Scoletoma fragilis
Sphaerodorum
Spiochaetopterus typicus
Spiophanes kroyeri

Spirorbis (Spirorbis) corallinae
Spirorbis (Spirorbis) tridentatus
Streblosoma intestinale
Syllis armillaris
Terebellides stroemii
Terebellomorpha
Thelepus cincinnatus

## Arthropoda, Hexanauplia

Balanoidea
Arthropoda, Malacostraca
Ampelisca anomala
Anarthrura
Anarthrura simplex
Aora typica
Astacilla longicornis
Brachydiastylis resima
Byblis crassicornis
Byblis gaimardii
Bythocaris
Caecognathia abyssorum
Caecognathia hirsuta
Caecognathia stygia
Calathura brachiata
Campylaspis glabra
Caridea
Cleippides quadricuspis
Cumacea
Diastylis lucifera
Diastylis rathkei
Diastylis spinulosa
Epimeria (Epimeria) loricata
Eudorella hirsuta
Euphausiacea
Eusirus longipes
Gammarus
Gnathia
Haplomesus quadrispinosus
Haploops setosa
Haploops tenuis
Haploops tubicola
Harpinia abyssi
Harpinia antennaria
Hippomedon propinqvus
Hymenodora
Ilyarachna
Ischnomesus bispinosus
Jaera
Lebbeus polaris
Leptognathia manca
Leucon
Liljeborgia fissicornis
Liljeborgia macronyx
Macrostylis longiremis
Meganyctiphanes norvegica
Metopa
Munna
Nannastacidae
Neohela monstrosa
Nyctiphanes couchii
Paragnathia formica
Parapleustes monocuspis
Pasiphaea multidentata
Penaeidae
Pleurogonium
Pseudosphyrapus anomalus
Sclerocrangon ferox
Socarnes vahlii
Stegocephalus inflatus
Stenopleustes
Syrrhoites serrata
Tanaidacea
Themisto libellula
Tmetonyx similis
Unciola crenatipalma
Westwoodilla

## Arthropoda, Ostracoda

Philomedes globosus
Arthropoda, Pycnogonida
Eurycyde hispida
Nymphon longimanum
Nymphon macronyx
Pycnogonida
Brachiopoda, Rhynchonellata
Terebratulina
Bryozoa, Gymnolaemata
Alcyonidium
Bicellariella ciliata
Callopora craticula

Celleporina
Cribrilina
Electra pilosa
Escharella abyssicola
Escharoides coccinea
Escharoides mamillata
Eucratea loricata
Hemicyclopora multispinata
Hemicyclopora polita
Micropora normani
Microporella
Paludicella
Porella
Puellina
Sarsiflustra abyssicola
Scrupocellaria
Setosella vulnerata
Smittina
Smittoidea reticulata
Stomacrustula cruenta
Terminoflustra barleei
Tricellaria
Umbonula ovicellata
Walkeria

## Bryozoa, Gymnolaemata

Crisia
Disporella hispida
Exidmonea atlantica
Hornera lichenoides
Lichenopora
Stigmatoechos violacea
Stomatopora
Tervia irregularis
CephalorhynchaPriapulida
Priapulus caudatus
ChaetognathaSagittoidea
Parasagitta

## Chordata, Actinopterygii

Cottidae
Gadidae
Gobiidae
Gymnelus
Lycodes luetkenii
Psychrolutes subspinosus
Psychrolutidae

## Cnidaria, Ascidiacea

Cnemidocarpa mollispina

## Cnidaria, Anthozoa

Actiniaria
Alcyonacea
Anthozoa
Ceriantharia
Cerianthidae
Cerianthus lloydii
Gersemia
Keratoisis
Nephtheidae
Pennatulacea
Umbellula
Virgularia
Zoantharia

## Cnidaria, Hydrozoa

Hydrozoa
Lafoea dumosa
Laomedea
Lytocarpia myriophyllum
Ptychogastria polaris
Sertularella
Symplectoscyphus tricuspidatus

## Echinodermata, Asteroidea

Asteroidea
Crossaster papposus
Ctenodiscus crispatus
Henricia sanguinolenta
Hymenaster
Luidia sarsii
Porania
Psilaster andromeda
Pterasteridae
Echinodermata, Crinoidea
Bathycrinus carpenterii
Heliometra glacialis
Echinodermata, Echinoidea
Strongylocentrotus pallidus

## Echinodermata, Holothuroidea

Molpadia arctica
Myriotrochus rinkii

Psolidae
Echinodermata, Ophiuroidea
Amphiura filiformis
Gorgonocephalus
Ophiacantha bidentata
Ophiacantha spectabilis
Ophiocten sericeum
Ophiopleura borealis
Ophioscolex glacialis
Ophiura sarsii
Foraminifera
Foraminifera

## Mollusca, Bivalvia

Astarte crenata
Axinopsida orbiculata
Bathyarca frielei
Cuspidaria arctica
Cyclopecten hoskynsi
Dacrydium vitreum
Hiatella arctica
Limatula hyperborea
Mysella
Mytilus edulis
Nuculana pernula
Policordia jeffreysi
Similipecten greenlandicus
Yoldia hyperborea
Yoldiella intermedia

## Mollusca, Gastropoda

Aclis walleri
Admete viridula
Bittium reticulatum
Buccinidae
Cylichna alba
Lepeta caeca
Margarites
Neptunea despecta
Nudibranchia
Onoba aculeus
Philine aperta
Rissoa
Skenea
Solariella amabilis
Volutopsius norwegicus

## Nematoda

**Nematoda**

## Nemertea

Nemertea

## Porifera, Calcarea

Grantia capillosa
Grantia phillipsi
Sycon

## Porifera, Demospongiae

Asbestopluma (Asbestopluma) furcata
Cladorhizidae
Demospongiae
Hymedesmia (Hymedesmia) curvichela
Polymastia
Radiella sol
Stelletta rhaphidiophora
Tentorium semisuberites
Thenea abyssorum

## Porifera, Hexactinellida

Anoxycalyx (Anoxycalyx) laceratus
Asconema foliatum
Scyphidium septentrionale

## Sipuncula, Sipunculidea

Nephasoma (Nephasoma) lilljeborgi
Phascolion (Phascolion) strombus strombus

# Appendix 2 - Species list, underwater video

## Annelida

Polynoidae

Sabellidae

Serpulidae

## Arthropoda

Arcturidae

Calliopiidae

Chordata

Cottidae

Gadidae

Psychrolutidae

Zoarcidae

## Cnidaria

Cerianthidae

Isididae

Nephtheidae

Ptychogastriidae

Umbellulidae

## Echinodermata

Bathycrinidae

Echinasteridae

Gorgonocephalidae

Ophiacanthidae

Ophiopholidae

Ophiopyrgidae

Ophioscolecidae

Ophiuridae

Psolidae

Pterasteridae

Solasteridae

## Mollusca

Buccinidae

## Porifera

Ancorinidae

Cladorhizidae

Hymedesmiidae

Polymastiidae

Rossellidae

Tracheophyta

Compositae

# BENTHIC MACROFAUNA COMMUNITIES ON THE NORTHEAST GREENLAND SHELF

Results and data from the NEG Dana cruise 2017

Benthic macrofauna was sampled from the Northeast Greenland Shelf between the 74° N and 78° N latitude during the NEG R/V Dana cruise August-September 2017. At all stations on the shelf and eastern shelf slopes down to 1,400 m depth, the sediment consisted of fine mud with a layer of stones on the sediment surface suggesting erosion of the sediment. Quantitative sampling of the fauna showed low densities of 400 individuals $m^{-2}$ as an average for the area and biomass was also low with an average of 10 g wet weight $m^{-2}$. Compared with the West Greenland shelfs, the biomass of the infauna is about 30 times lower at the NEG shelf compared to the WG shelfs and the abundance is about seven times lower than on the WG shelfs. The differences between the west and the east Greenlandic shelfs reflect the differences in productivity of the two shelf ecosystems. Small-scale species richness was about 2/3 of that of corresponding samples and communities of the WG shelfs. However, the diversity in a larger scale was about the same and species accumulation curves suggest that the total species pools of the NEG shelf could be even higher. Underwater video of epibenthic megafauna documented populations of giant sea pens > 2 m high, *Umbellula encrinus*, forming populations with ages of > 40 years. Furthermore, dense gardens of the cold-water "bamboo coral" *Keratoisis sp.* were observed on the shelf slopes at 1,000 m depth. These epifauna communities document the pristine conditions on the Northeast Greenland shelf and emphasise the extreme vulnerability of these ecosystems to disturbance.

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