Cruise Report

DANA 6/21

ECOTIP West Greenland **2021**

Part of the Ecotip Horizon 2020 project

Investigations from off Nuuk to north of Disko Island

July 13 (17) to July 30 2021

Contents

Summary

A multidisciplinary cruise was carried out off west Greenland during the period 17/7 to 29/7 (incl. transit 13/7 to 30/7) 2021, covering the area from north of Nuuk to north of Disko island by a set of latitudinal sampling transects. The plans for the cruise was challenged by corona restrictions necessitating changes to initial cruise track, and by generally windy working conditions, but overall, planned sampling activities were successfully carried out.

This field work is an important element of the HORIZON-2020 supported project ECOTIP which is carried out from 2020 to 2024. ECOTIP aims at improving our understanding of anthropogenic changes in the biological production and diversity in the Arctic marine regions, and their effects on the ecosystem services. The work has special emphasis on the evaluation of whether a change in the lower trophic levels, due to the increased temperature and freshwater outflow, can trigger an ecosystem tipping cascade that ultimately will change the important benthic-pelagic coupling and carbon sequestration processes as well as the fisheries production.

During the cruise several of ECOTIP's scientific sub-topics were emphasized. Sampling and investigations were set up for assessment of hydrographic and ecosystem variability both from the coastal to offshore areas and from boreal areas off Nuuk to the artic areas north of Disko Bay, and sampling and measurements was to a large extent carried out at sites from which historical information is available. We measured biodiversity at trophic levels from bacteria to fish larvae, and carried out a wide range of process studies investigating e.g. microbial activity, benthic processes and the biological pump. Further, chemistry and pollution of the marine area were considered.

Many fundamental elements of the arctic marine ecosystem have already changed, and many observations and samples from the cruise contributes valuable new information to support the assessment and modeling of biological changes under the future climate scenarios.

Cruise objectives

The cruise focused on: 1) the link between environmental (climatic) conditions and the biodiversity and productivity of pelagic and benthic ecosystems, 2) the processes of biological pump, pelagic-benthic coupling, sediment and land-ocean fluxes, microbial processes and lipid accumulation under different community composition (biodiversity) and environmental conditions and 3) long-term changes in biodiversity, through the comparison to existing historical data-sets and through new paleo-oceanographic sampling.

The main objectives are to:

- Investigate the climate-induced changes in biodiversity and the resulting changes in the major biological processes in the Arctic marine ecosystem.
- Use new measurements and process understanding for estimating the sensitivity of functional traits at different trophic levels to environmental conditions, and to link the observed traits of the natural communities to ecosystem functions and services.

The overall working hypotheses are the following:

- West Greenland plankton community composition and production, as well as geographic distribution patterns, have changed during the last decades due to climate-change related changes in hydrography
- Increased freshwater input will strengthen the stratification, which will result in a changed trait distribution of the plankton community, such as smaller primary producers, dominance of small particle-feeding zooplankton and high microbial abundance and activity.
- Changes in the community composition of the lower trophic levels will result in a lower sedimentation and carbon sequestration, decreased benthic biomass, and changed pelagic vs. benthic production.

Basic plan

The sampling stations were positioned along transects across the shelf, from close to the coast to the shelf slope. Station distance was about 10-20 nm, and four sampling transects were carried out, while 2 stations were sampled at Sukkertop Bank (see Fig. 2).
Station procedures were the following (Fig. 2):

1) Stations were positioned in vicinity of historical sampling transects and basically included the following measurements:
   - CTD casts including water sampling
     - for nutrients, chl-*a*, water chemistry, phytoplankton abundance and pigments (HPLC), prokaryotic and fungal abundance, biomass, production and respiration, community composition (metagenomics, metatranscriptomics and -proteomics)
     - $\Delta\ ^{13}C$ of CO_2 and CH_4 using a Picarro gas analyser
     - eDNA
   - Benthic samples collected by Box Corer for benthic biomass and community composition analysis
   - Zooplankton nets for collection of live zooplankton
   - Vertical sampling for zooplankton with 45 and – to a lesser extent – with 300 µm nets
   - Oblique haul for large macroplankton and fish larvae using a MIK, 2 meter ring with 1600 µm nets (with added mini net of 300 µm mesh)

2) At three KEYstations positioned at central positions in the transects a buoy for sediment traps were launced, and retrieved after 24 h (one station only 16 h). Specific intensive measurements were made at these stations (see details below)
3) At some om the basic stations, and at specific stations outside the general transect scheme, a series of marine sediment cores (Rumohr) were sampled.

Measurements included metabolic rates (both bacterial and zooplankton), secondary production (including both zooplankton and larval fish), quality and quantity of vertical flux (sediment traps), sediment surface-water column fluxes, changes in microbial abundance ratios and rates (prokaryotic and fungal abundance, biomass, production and respiration, community composition), biomass of benthic organisms, and the zooplankton colonization of aggregates. The marine sediment cores was collected to analyse the past abundance and composition of planktonic and benthic foraminifera, as well as diatoms, organic biomarkers, and other proxies commonly used in paleoceanography. The eDNA sampling aims at detecting the invasive target species (particularly invasive crabs with planktonic larval stages). Further the ship-mounted echo-sounders was set up for collecting data throughout the cruise.

Gear	Handling	Launch	Procedure
CTD (first)	hind-deck side, plankton wire	2 m above bottom	Measurements down the column, bottles closed on retrieval
CTD (extras at station)	hind-deck side, plankton wire	to lowest sampling depth	bottles closed at depths selected from first CTD
Multinet 45	hind-deck side, plankton wire	5 m above bottom	5 nets opened during retrieval
Multinet 300	hind-deck side, plankton wire	5 m above bottom	5 nets opened during retrieval
MIK ring net	hind-deck central, central wire	5 m above bottom (max 100 m)	oblique haul (approx 40 min duration)
Box corer	hind-deck side, central wire	bottom surface	fast to bottom and fast retrieval until surface layer
Rumohr corer	hind-deck side, central wire	into bottom	fast to bottom and fast retrieval until surface layer
WP2 net	hydrography deck	selected depth	opended at depth for given period
30 L water bottle	hydrography deck	selected depth	closed at selected depth
Sediment traps	hind-deck, launch	anchored (traps at selected d)	Launched for optimally 24 h

Table 1 Overview of basic procedures

Cruise route and progress

The cruise was planned to leave and return to Nuuk on the 17/7 and 30/7, respectively, but due to the corona restrictions in Greenland and long quarantine periods, it was decided that participants should embark in Reykjavik. Thus, the cruise started with a long transit leaving Reykjavik on the 13/7 crossing towards Greenland, and arrival at the first station north of Nuuk late 17/7. The plan was to start sampling at the Transect 1, positioned across the southern Sukkertop Bank, but due to bad weather forecast, the Transect 1 was postponed, and the first sampling took place at the two planned Rumohr stations (4 and 5, the original numbering of stations was withheld throughout the cruise).

After these stations, the Transect 2, crossing the Lille Hellefisk Bank was sampled from inshore to offshore on the 18-19/7. Hereafter we sailed north to the Transect 3, using the station (st.)14 as key station, launching the buoy with sediment traps here. It appeared that this station was close to the border of sea-ice from Canada, thus we could not as planned extend sampling further west, and we moved the planned position of st.15 to another depth position further south. After the termination of procedures at st.15, we sailed to st.14 to retrieve the buoy and sediment traps.

The Transect 3 was finished 20-21/7, and we sailed to the Disko Bay to start the sampling along Transect 4 from here, sampling was successful until st.19 where we, after the first successful cast of the CTD ran into problems with the electronics of the CTD. We used the 30 L water bottle to sample the water that we could not sample by the CTD here. However the repair of the CTD appeared to be long-lasting, and we decided to use the “waiting” time for a transit and Rumohr cores. Thus we postponed the remaining stations along Transect 4, and sailed towards Transect 5. This transect was sampled 23-24/7, using st.28 as a key station where the buoy was launced on our way to st.30 and retrieved after a return to st.28.

From st.28 we sailed back to Transect 4, using st.22 as a key station. Thus the buoy was launched at st.22 whereafter we sailed to the outermost station, st.24. The weather was quite windy during the remaining period of the cruise, but we succeeded in sampling all stations along Transect 4 (25-26/7), and in sampling two Rumohr stations and a single extra MIK (st.13) on our transit south towards Transect 1. Time and weather did, however, not allow for a full Transect 1 as planned, and only two stations at different depths were used to describe conditions at Sukkertop Bank. The last procedure during the cruise (a MIK) was finalized 28/7 15:10 GMT, and we hereafter sailed towards Narsarsuaq, arriving here 30/7 at 6:00.

The duration of cruise activities was thus 11 days. Our areal coverage extended 6 degree latitude, and at the longest transect also 6 degrees longitude. We used 31 sampling stations, and carried out 287 separate procedures.

Thus, in spite of shortening of cruise days and quite bad weather during much of the time, the cruise was very successful, this due to efficient and skilful work by all participants and the crew of Dana.

Stations

Map of station positions

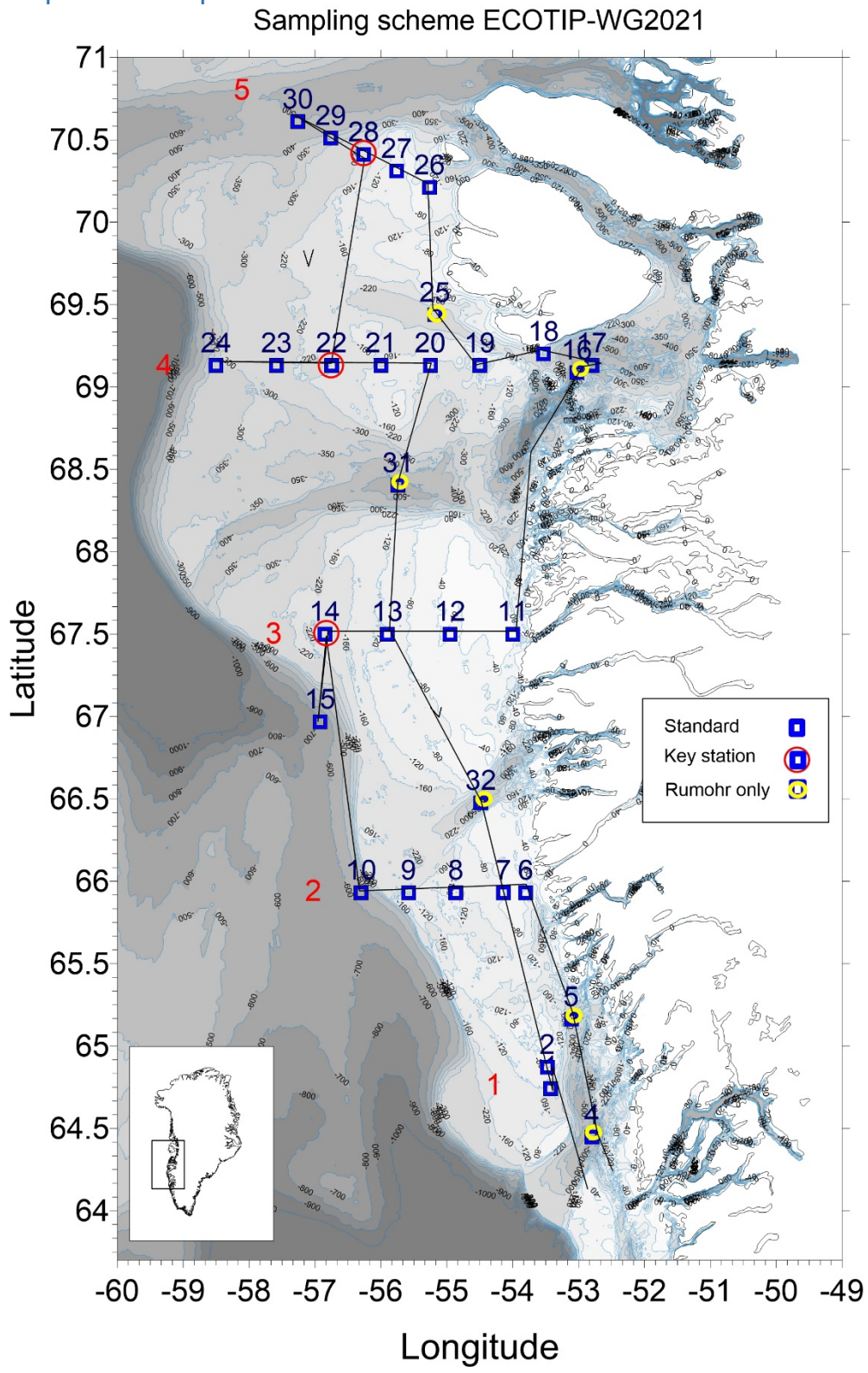

Figure 1 Map of stations and sailing route

ECOTIP

Station, start info and number of procedures

STATION	LATITUDE START	LONGITUDE START	DATE START	HOUR START	MINUTE START	CTD	WP2	MULTINET	30 L WATER	MIK	SEDIMENT TRAP	BOX CORER	RUMOHR CORER		TOTAL PROC.
4	64.26.879 N	052.47.211 W	17-07-2021	23	:51								3		3
5	65.09.747 N	053.06.797 W	18-07-2021	05	:18								3		3
6	65.55.234 N	053.47.970 W	18-07-2021	10	:26	3	6	1		2		4			16
7	65.55.869 N	054.20.549 W	18-07-2021	18	:10	2	2	1		1					6
8	65.55.645 N	054.51.539 W	18-07-2021	22	:52	2	6			1		3			12
9	65.55.535 N	055.34.839 W	19-07-2021	06	:02	1	4			1					6
10	65.55.730 N	056.18.142 W	19-07-2021	10	:10	3	6	2		1		4	3		19
14	67.30.726 N	056.52.080 W	20-07-2021	07	:26	2	4	2	1	1	2	5			17
15	66.59.207 N	056.54.228 W	20-07-2021	17	:32	2	2	2		1		4			11
13	67.30.101 N	055.54.241 W	21-07-2021	09	:49	1	2	1		2					6
12	67.29.995 N	054.57.285 W	21-07-2021	13	:47	1	4	1		2					8
11	67.30.071 N	054.12.429 W	21-07-2021	19	:04	1	3			1					5
16	69.05.103 N	053.01.537 W	22-07-2021	05	:09								3		3
17	69.07.622 N	052.48.404 W	22-07-2021	08	:22	3	4	2		1		4			14
18	69.12.105 N	053.31.300 W	22-07-2021	18	:15	1	4	2		1		4			12
19	69.07.850 N	054.30.039 W	23-07-2021	01	:35	2	4	1	5	1					13
25	69.26.220 N	055.10.697 W	23-07-2021	11	:02								3		3
26	70.12.539 N	055.15.541 W	23-07-2021	15	:55	4	4	1		1		3			13
27	70.18.622 N	055.45.543 W	23-07-2021	20	:42	1	4	1		1					7
30	70.36.826 N	057.15.540 W	24-07-2021	03	:55	4	4	2		1		4			15
29	70.30.665 N	056.45.664 W	24-07-2021	14	:11	1		1		1					3
28	70.24.601 N	056.16.117 W	24-07-2021	18	:05	3	4	1		1	2	5			16
24	69.07.856 N	058.34.782 W	25-07-2021	12	:48	3	4	2		1			3		13
23	69.07.905 N	057.35.502 W	25-07-2021	22	:32	1				1					2
22	69.09.393 N	056.44.695 W	26-07-2021	03	:19	3	4	1		1	2	5			16
21	69.07.629 N	055.59.688 W	26-07-2021	10	:23	2	2	1		1		4			10
20	69.07.661 N	055.00.483 W	26-07-2021	17	:28	1	4	1		1					7
31	68.24.480 N	055.44.435 W	27-07-2021	00	:59								4		4
32	66.28.742 N	054.29.716 W	27-07-2021	18	:28	1							3		4
1	64.44.482 N	053.24.965 W	28-07-2021	08	:15	2	4	1		1		5			13
2	64.51.941 N	053.28.600 W	28-07-2021	13	:21	1	4	1		1					7
															287

Short descriptions of achievements for scientific groups

Hydrographic observations from CTD casts along longitudinal transects

All institutes, here described by Peter Munk DTU Aqua, Technical University of Denmark

The positioning of stations and thus of CTD casts along longitudinal transects avails the possibility to describe changes in hydrography by vertical esctions from inshore to the shelf slope. Further, comparison between transects 1-5 avails an overview of basic latitudinal changes.

The contour plots of the figure below illustrate a first interpolation of key hydrographic measures by vertical sections of salinity, temperature and the fluorescence (indicative of algal abundances).

The two stations of *Transect* 1 do not avail a meaningful vertical section. The profiles illustrate basically the same vertical pattern in salinity and temperature, however, somewhat stronger salinity stratification is apparent at the shallowest station. Note, that the contouring to the left in the figure is not based on observations.

Transect 2. This vertical section illustrates a pattern common for all the subsequent transects: an inshore less-saline upper water mass, and also most offshore another less-saline water mass above approx. 50 m depth. The innermost water mass is the Greenland Coastal current, while the offshore water mass is melt water from the sea ice. At the shelf, at bottom depths 150-50 m we see the Polar Current water mass, distinct by its higher salinity and higher temperature. This meet the other water masses in fronts/pycnoclines (narrowing of contour lines), and in these zones we also see enhanced fluorescence.

Transect 3. Here we met the sea ice at the two othermost stations, and consequently the fresher water in the surface is more pronounced. The inshore part of this transect is shallow (about 50 m) and the water mass is mixed to the bottom, thus the front is offshore the two innermost stations.

Transect 4. At this transect we cover the productive skerry parts at the entrance to Disko Bay (fluorescence in the surface waters!), and productive parts are also seen at mid-transect in the front above the Polar Current. Indications of the colder, less-saline waters of the Baffin Bay Current are seen at the outermost station.

Transect 5. Here the front between the Polar Current and the Coastal water mass is quite marked, apparent at about 100 m bottom depth. Whether the colder water mass at 50-125 m could be distinguished as interfacing Baffin Bay and Polar Current water masses needs further analyses.

Preliminary we can conclude that we overall have covered the important water masses of the West Greenland Banks well availing good possibilities for comparison of different hydrographical and biological conditions.

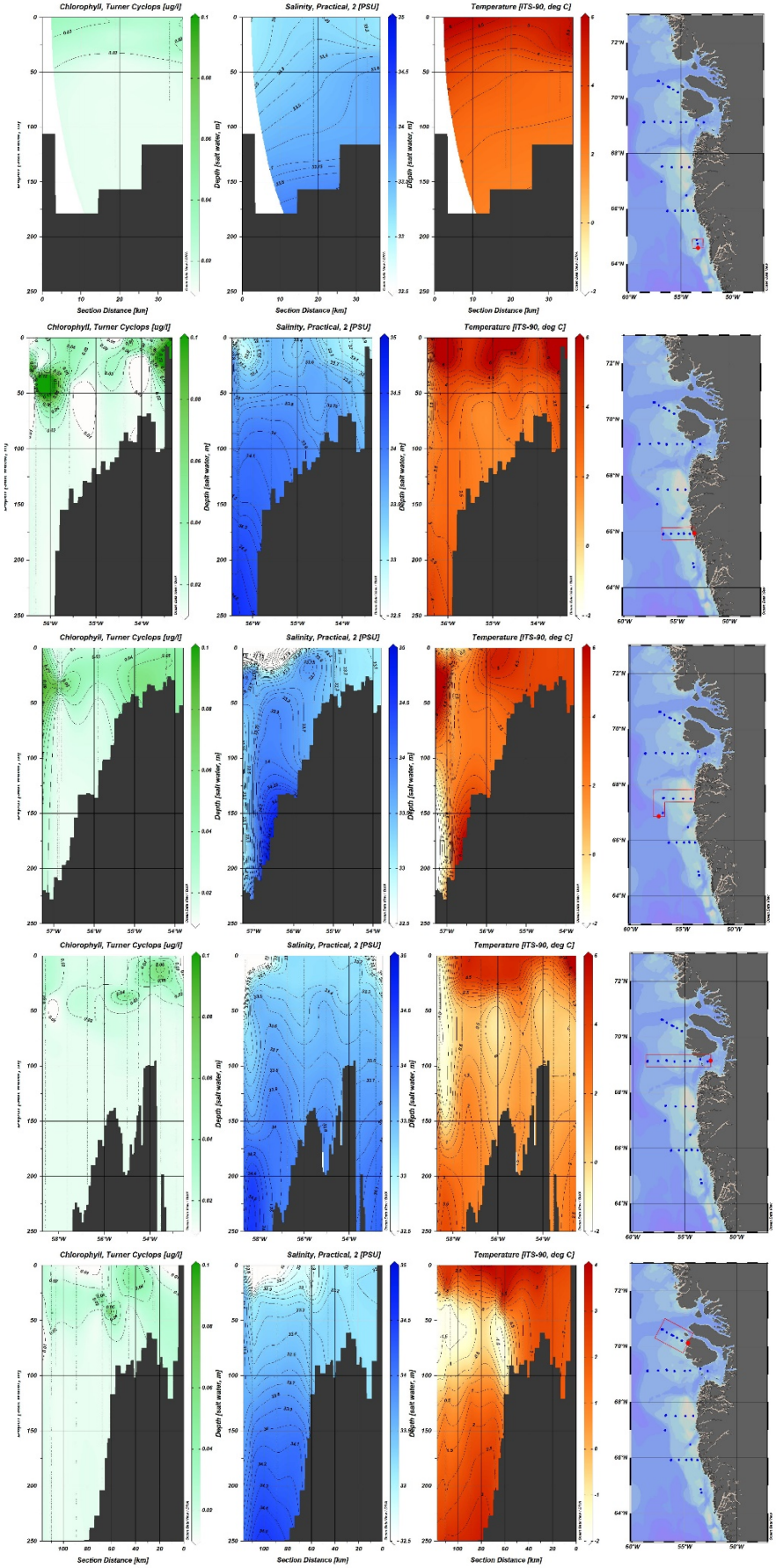

Figure 2. Vertical transect description based on CTD casts. From upper to lower: Transects 1-5, from left to right fluorescence, salinity, temperature, and map of transect position.

Rumohr corer

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Sediment cores retrieved by using the rumohr coring method are widely used in paleoceanographic and paleoclimatic research, since these sediment cores record past fluctuations in climatic and oceanographic conditions of an area. The rumohr corer consists of an unsupported transparent liner made from PC (length: 1-2 m and outside diameter: 80 mm) with weights attached on top (~70 kg) (Figure x). The rumohr corer was lowered to the sea floor by using the central wire from the hind-deck side. When the rumohr corer reaches and penetrates the sea floor, the PC liner is filled with sediment and the loss of tension on the rope releases a small valve on top of the liner, which makes sure that the sediment is retained in liner. This coring method is ideal for the recovery of undisturbed surface sediments, as the sediment surface and water phase is kept intact. A mini CTD was placed approximately 10-15 m above the rumohr core on the wire at stations were the big CTD was not deployed. After sediment recovery, all cores were capped, labelled and placed in the fridge. In total 12 rumohr cores were retrieved during the cruise.

Fig. A: Rumohr corer with recovered sediment. (Photo: Søren Steenholdt)

Box corer

(in addition to other use box coring)

Benthic foraminifera

Approximately two spoonfuls of the upper 0-2 cm surface sediment were retrieved from the box core sediment and put into vials. After retrieval, 76 % ethanol mixed with rose bengal were added to the surface sediment and the vial was shaken until everything was completely mixed. The ethanol and rose bengal mixture ensures that all living benthic foraminifera are dyed pink, enabling the establishment of the modern distribution of benthic foraminifera communities. The vials were stored in the fridge at around 1 °C on board.

Sediment DNA

Additionally, two spoonfuls of the upper 0-2 cm surface sediment were put into sample bags for DNA analysis. The sample bags were stored in black bags to prevent penetration of sunlight and stored in the fridge at around 1 °C on board.

Additional analysis

For other analysis (e.g. grainsize, diatoms, sea-ice biomarkers) another two spoonfuls of surface sediment were sampled from the upper 0-2 cm of the box core sediment and put into sample bags.

Zoobenthic sampling during the ECOTIP cruise to West Greenland 2021

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The aim of the zoobenthic sampling during the cruise was to assess the soft-bottom macrofaunal community structure (species composition, abundance and biomass) and function (trait composition) along environmental gradients (north-south climatic gradient, and coastal to offshore gradient in terms of biotic and abiotic influences) and in relation to benthic-pelagic coupling. The assessments in relation to benthic-pelagic coupling focused particularly on combining the measurements with carbon-flux, nutrient and other water parameter measurements, but also phyto- and zooplankton community assessments.

Soft-bottom macrofauna was sampled using a box-core, sieved (1mm mesh size) and stored in 70% alcohol for further processing and analysis in the laboratory. Furthermore, organic content, P/N ratio and sediment grain size was also sampled at each station (except one: station # 26).

In total, 10 stations (st) and 32 zoobenthic replicate samples were obtained, encompassing transects 1 (1 st.), 2(1 st.), 3(2 st.), 4(3 st.) and 5 (3 st.). Depth varied between 120m to 740m, and the substrate between soft mud, mixed soft-bottom with mud and/or clay, or muddy, sandy gravel. Preliminary results (on-board observations) indicate an overall dominance and high density of tube-forming polychaetes, but also a change in composition along the gradients.

Figures. A. The launching of the boxcorer, and B. muddy samples are on deck and labels are prepared .

Effect of the increasing melting rate on seawater chemistry.

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1. Background

Water and sediment samples were collected to determine the effect of the increasing melting rate of the Greenland Ice Sheet on seawater chemistry. The full set of parameters includes trace metals (TM; including mercury (Hg)), radium isotopes (226Ra, 228Ra, 224Ra, and 223Ra), total alkalinity (AT), total inorganic carbon (CT), and dissolved organic carbon (DOC). All samples were collected according to the commonly used techniques, briefly described below.

2. Methods

Discrete seawater samples were taken from a SBE CTD rosette equipped with 24 x 12 L Niskin bottles and a CTD profiler. The samples were collected from the Niskin bottles using silicone tubing.

Samples for AT, CT, and DOC were taken from 3-5 depths, depending on the depth of the station. For AT and CT, unfiltered water samples were collected in 300 ml BOD bottles (avoiding gas exchange), poisoned using 300 µL of saturated mercury chloride solution (HgCl2), and stored under dark conditions until further analysis. Samples for DOC were filtered through pre-combusted glass fiber filters to 40 mL glass vials and conserved with 50 µL of concentrated hydrochloric acid (HCl). Samples for Hg were taken from the surface mixed layer, the Chlorophyll-α maximum, and the bottom of the water column. TM samples also included intermediate water depths. Hg and TM samples were collected in acid-cleaned 2 L bottles made of glass and HDPE, respectively. The samples were then filtrated through 0.45 µm filters into 2 L glass bottles for Hg and 2 x 0.5 L HDPE bottles for TM. The water samples were then preserved with 15 µL of HCl and stored under dark and cool conditions until further analysis. Filtration was carried out in a Captair Flow (Erlab) clean bench with a HEPA air filtration unit. The filters were dried and frozen for further analysis. For radium sampling, ca. 150 L of bottom water was collected with the CTD rosette, and ca. 150 L of surface water was collected via the ship's seawater pump system with an inlet 4 m below the water surface. The water was then pre-filtered through 10 and 1 µm polypropylene filters and transferred into 100 L canisters. Following this, the sample water was pumped through cartridges packed with manganese dioxide (MnO2) coated acrylic fibers and subsequently discarded. During this procedure, the radium pre-concentrates onto the MnO2 fibers. To rinse residual seawater off the fibers, the cartridges were flushed with 2 L of ultrapure water (MilliQ) and partially dried using compressed air. Subsequently, the cartridges were inserted into a radium delayed coincidence counter (RaDeCC) that records alpha decays of the radon daughters of 223Ra and 224Ra in a scintillation cell. After 2–3 weeks, the radium samples are re-analyzed in the laboratory.

Additionally, sediment samples were collected with a box corer into HDPE bottles and subsequently frozen until further analysis for their TM and Hg content.

3. Sampling performance

Overall, 110 samples were taken for AT and CT as well as 90 samples for DOC. 60 samples were taken for TM and 30 samples were taken for Hg. The total number of radium samples is 26. The sampling campaign was a success as all anticipated samples were collected.

Marine prokaryotic and fungal biomass, activity and metabolism

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We collected seawater samples at 3 depths (surface, DCM and bottom) from an inshore, an off-shore and an intermediate location in the each transect to see how the climate change driven oceanographic conditions (e.g. increased freshwater input, stratification) affect microbial activity and metabolism, as well as to obtain basic microbial parameters in the west Greenland. The samples were mostly filtered and kept frozen during the cruise and will be further analyzed in the home laboratory.

Main parameters and sample list

- Prokaryotic heterotrophic production (PHP, ^{3}H-leucine method)
- Dark DIC fixation determined by uptake of ^{14}C labelled bicarbonate (DICfix)
- Fluorescence in situ hybridization combined with microautoradiography (MarFISH with ^{3}H-leucine and ^{14}C-bicarbonate)
- Community respiration (Resp)
- Bacterial abundance (BA)
- Dissolved amino acids (AA)
- Metaproteomics and -genomics (MetaP&G)
- Fungal biomass (FB)
- Fungal respiration (FResp)
- Fungal isolates (FI)

Tran-sect	Stn	Depth (m)	Depth category	PHP	Mar ^{3}H-Leu	DICfix	Mar DI^{14}C	BA	AA	Resp	MetaP&G	FB	FResp	FI
2	6	57	Bottom	x	x			x	x	x	x	x		x
2	6	25	DCM	x	x			x	x	x	x	x		x
2	6	3.4	Surface	x	x			x	x	x	x	x		x
2	8	111	Bottom	x	x			x	x	x	x	x		x
2	8	35	DCM	x	x			x	x	x	x	x		x
2	8	3	Surface	x	x			x	x	x	x	x		x
2	10	550	Bottom	x	x	x	x	x	x	x	x	x	x	x
2	10	41	DCM	x	x	x	x	x	x	x	x	x	x	x
2	10	3	Surface	x	x	x	x	x	x	x	x	x	x	x
3	15	678	Bottom	x	x	x	x	x	x	x	x	x	x	x
3	15	32	DCM	x	x	x	x	x	x	x	x	x	x	x
3	15	2.5	Surface	x	x	x	x	x	x	x	x	x	x	x
3	11	20	Bottom	x	x	x	x	x	x	x	x	x		x
3	11	3	Surface	x	x	x	x	x	x	x	x	x		x
4	17	473.5	Bottom	x	x	x	x	x	x	x	x	x	x	x
4	17	30.5	DCM	x	x	x	x	x	x	x	x	x	x	x
4	17	3	Surface	x	x	x	x	x	x	x	x	x	x	x
5	26	40	Bottom	x	x	x	x	x	x	x	x	x		x
5	26	3	Surface	x	x	x	x	x	x	x	x	x		x
5	30	480	Bottom	x	x	x	x	x	x	x	x	x		x
5	30	43	DCM	x	x	x	x	x	x	x	x	x		x
5	30	3	Surface	x	x	x	x	x	x	x	x	x		x
5	28	186	Bottom	x	x	x	x	x	x	x	x	x		x
5	28	30	DCM	x	x	x	x	x	x	x	x	x		x
5	28	3	Surface	x	x	x	x	x	x	x	x	x		x
4	24	316	Bottom	x	x	x	x	x	x	x	x	x	x	x
4	24	35	DCM	x	x	x	x	x	x	x	x	x	x	x
4	24	4	Surface	x	x	x	x	x	x	x	x	x	x	x
4	21	147	Bottom	x	x	x	x	x	x	x	x	x		x
4	21	30	DCM	x	x	x	x	x	x	x	x	x		x
4	21	3	Surface	x	x	x	x	x	x	x	x	x		x
1	1	135	Bottom					x	x					
1	1	5	DCM					x	x					
1	1	4	Surface					x	x					
1	2	75	Bottom					x	x					
1	2	25	DCM					x	x					
1	2	3	Surface					x	x					

*Stn: station, Mar: MarFISH

Potential of climate changes to alter the marine phytoplankton community

Søren Steenholdt, Copenhagen University

During the cruise water samples were collected primarily for my master thesis in biology at Copenhagen University. I also had time to process water samples for eDNA, but the down-stream processing of these, will be done by a post doc.

My thesis work is focused on the potential for climate changes to alter the size fraction of the marine phytoplankton community. Increased upper ocean temperature is expected to lead to an increase in the picoplankton size fraction (the smallest of the three ecologically defined groups). It is speculated that this will lead to a decrease in carbon sequestration in the deep ocean via the biological pump. Thus, a decrease of the larger size fraction, particularly the net-phytoplankton may have a cascade effect to higher trophic levels such as zooplankton, fish, seabirds and marine mammals. More specifically, the aim of my thesis is to examine, if phytoplankton in the David´s Street between Nuuk and the Disco island in 2021 has declined in size compared to data collected over the last 20 years for the same area. In addition, the aim is to determine if the different species or families of phytoplankton collected at the different depths and sites are correlated to abiotic factors such as temperature, salinity and nutrients.

For each of 18 stations, I carried out the following tasks:

Species determination

- Water samples of 4 x 250 ml from surface, Deep chlorophyll max (DCM), DCM+ 25m (DCM+) and bottom. The samples were fixed in 3% Lugol´s iodine (final concentration) immediately after collection.

Size fractioning and eDNA filtering

- Water sample of 3 x 10 l from surface, DCM and DCM+ plus 10 l from bottom
- Size fraction: Tipple filtering (n = 3) of water from surface, DCM and DCM+ in three size fractions (Pico- 0.7 – 2,7 µm, nano- 2,7-20 µm and net-phytoplankton 20 – 200 µm). Potentially 486 filters in total.
- eDNA: Single filtering of water from surface, DCM, DCM+ and bottom in two size fractions (Pico and nanoplankton 0,22 – 20 µm and net-phytoplankton 20 – 200 µm). Potentially 144 filers in total.
- All potentially 630 filters were frozen after filtration

The collection of the water samples and the subsequent filtration were successful. Further analysis of the samples will take place in the laboratory during the autumn of 2021.

Vertical flux of carbon and pigments –

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The Arctic University of Norway | UiT

An important component of any marine ecosystem is the vertical transport of organic carbon to the ocean floor. While such transport partakes in the removal of carbon from the atmosphere in the open ocean, often referred to as the biological pump, it has an additional role in fjords and coastal areas: it fuels the entire benthic community. Vertical export of organic carbon from pelagic to benthic ecosystems consists mainly of copepod faecal pellets and detrital aggregates (marine snow). However, it is estimated that 20-70 % of the aggregate-associated carbon is degraded by grazing organisms within the euphotic zone. Therefore, the vertical flux of organic carbon often decreases with increasing depth.

Vertical flux was measured with short-term (approx. 24 h), surface tethered sediment traps (KC Denmark) at three key stations (table 1). The traps were anchored in the vicinity of the key stations at transects 3, 4 and 5. Sinking material was collected at 20, 30, 50, 90 and 120 m. Parameters sampled from the trap cylinders were; particulate organic carbon and nitrogen (POC/PON), chlorophyll a (Chl *a*, total and > 10 µm), phytoplankton taxonomy and faeal pellets. Where the sediment traps were deployed, the water column was sampled for POC/PON, Chl *a*, phytoplankton (at Chl *a* maximum only) and nutrients (surface, 5, 20, 30, 50, 90, 120 and bottom). At each of the transects where traps were deployed, water column samples were collected at least three additional stations.

Table 1. Sampled stations with the sediment traps.

Station	date	latitude	longitude	Deployment time
14	20.07.21	67.29.264 N	056.48.729 W	Approx. 24 h
28	24.07.21	70.23.044 N	056.05.237 W	Approx. 24 h
22	25.07.21	69.08.876 N	056.44.074 W	approx 12 h

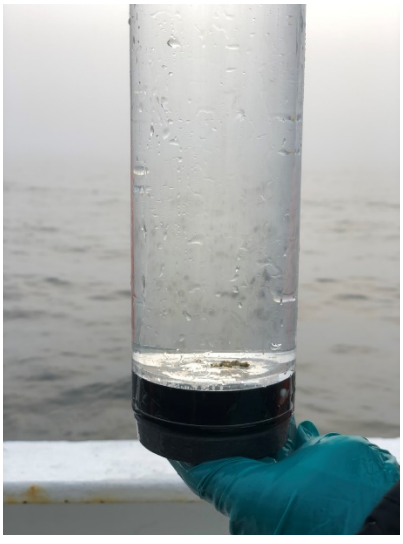

Fig. A. Sediment trap cylinder

Community composition, feeding, lipid content and mercury accumulation in zooplankton

Camilla Svensen1, Delove Asiedu2, Sigrun Jónasdóttir2, Marja Koski2
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Zooplankton investigations during the cruise included vertical multinet samples with two different mesh sizes (50 and 300 µm). The zooplankton from the diverse net samples were subsampled and used for diverse measurements: dead-life staining to estimate the concentrations of copepod carcasses, sampling for gut-chlorophyll and lipid composition of copepods, incubations for pellet production of the dominant species, incubations for aggregate feeding of *Microsetella norvegica* and sampling for mercury accumulation in different size classes of plankton. The main objectives of the studies were 1) to investigate the proportional importance and functional role of large copepods (represented by *Calanus* spp.) vs. small copepods (represented by *M. norvegica*, *Oithona* spp., *Oncaea* spp. and various small calanoids) along the onshore-offshore and north-south transects and 2) to investigate whether the recently measured high mercury concentrations in the melt water in Greenlandic fjords and coastal waters are reflected in plankton. The combinations of the diverse measurements should allow us both to investigate the effect of environmental factors on zooplankton community composition and to link the community composition to the biological pump through its effect on particle production (pellets and carcasses), consumption (feeding on suspended phytoplankton and aggregates) and vertical distribution of lipids.

At present, most of the samples are being analyzed and the results not yet available. However, it was clear that the different stations featured very different zooplankton communities, ranging from a clear dominance of *Calanus* spp. to stations where zooplankton consisted almost entirely of *Oithona* spp., rotifers and meroplankton larvae. Also, the pellet production (Figure) and gut chlorophyll differed between stations, suggesting differences in the productivity and / or phytoplankton composition. Generally, it appeared that *Calanus* spp. and *Pseudocalanus* spp. represented species that fed on suspended phytoplankton, whereas the gut chl of *M. norvegica* suggested a different feeding pattern.

The cruise and the sampled stations therefore appeared ideal for our purpose to investigate the environmental forcing on zooplankton community composition and its effect on the biological pump.

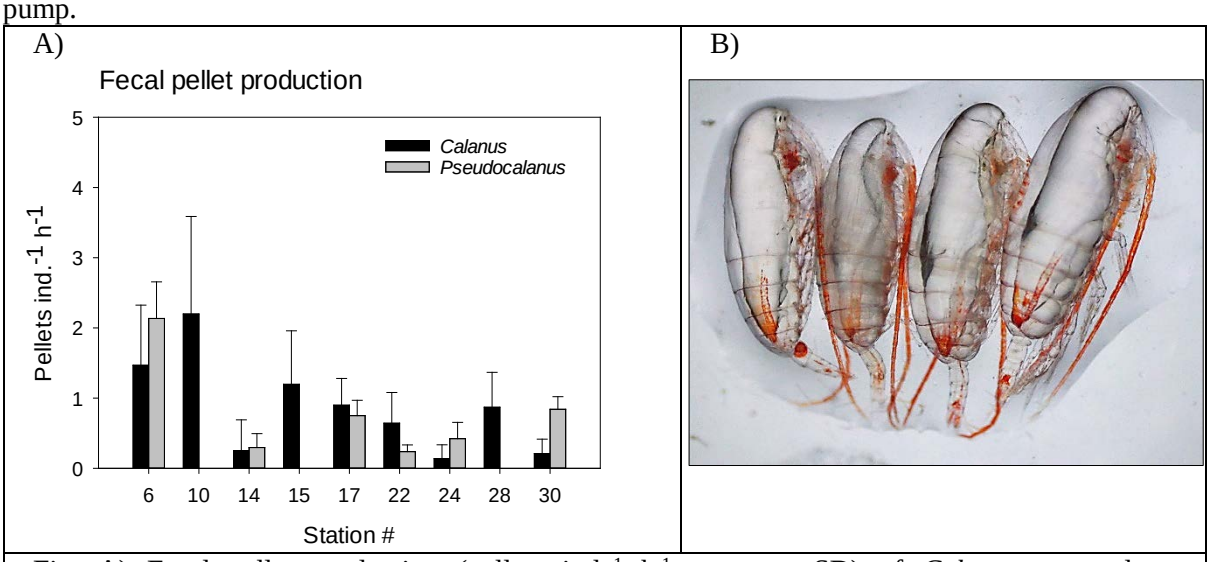


Fig. A) Fecal pellet production (pellets ind.$^{-1}$ h^{-1}; mean ± SD) of *Calanus* sp. and *Pseudocalanus* sp. at the different stations. B) *Calanus glacialis* and *C. hyperboreus* with large lipid sacs.

Fish larvae and spawning sites of common fish species

Peter Munk
DTU Aqua, Technical University of Denmark

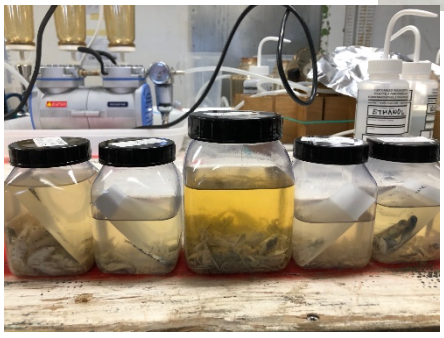
The fish larvae sampling was based on oblique hauls of a 2 meter wide ring net (a so-called MIK). At the first sampling station (st.6), we tested two different mesh types used for the ring net: a white net of 1 mm mesh size, and a black version of 1.6 mm mesh. The catches from these two nets were insignificantly different, and the white net was (firstly) chosen as gear. However, after the first 5 stations, this gear became teared, and was replaced by the black. Based on the findings from the initial test, together with other tests performed earlier, we subsequently assumed that the black and white nets basically illustrate equal abundances for the present (>2 cm) larval sizes. Further, catches in a smaller net attached to the MIK ring, confirm that there are no smaller larvae present than those we find in the black net.

All larvae were sorted immediately after the net was retrieved and stored in 96% ethanol. We only made a quick view of larval species and abundances, the detailed processing remains to be carried out in the laboratory. Generally the catches of larvae were useful with respect to describing presence and general size of species. Station distances were of a magnitude that do not allow for more detailed description of distribution patterns, however, preliminary observations show– in accordance with historical observations- that larval species composition change in a foreseeable pattern from inshore to offshore. I.e. given species of larvae are generally found in specific hydrographic regimes.

Of the more common species were: sandeel (*Ammodytes sp.*), American plaice (*Hippoglossoides platessoides),* Greenland halibut *(Reinhardtius hippoglossoides*), Arctic shanny (*Stichaeus punctatus*), Atlantic cod (*Gadus morhua*), polar cod (*Boreogadus saida*). Especially the distributions of cod and polar cod was remarkable, these larvae were found in relatively high numbers offshore, in fronts at about 80 m bottom depths, often together. Generally the cod larvae were quite abundant and widespread, more common than observed in earlier cruises (1996 onwards). The present observations of larval diversity and abundances will be analyzed in detail when the final processing of samples has been carried out.

B

A



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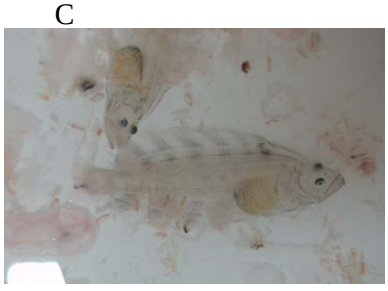

Fig. A Samples from Transect 2, illustrating the amount of larvae across the transect (high abundance in central part).
Fig. B The polar cod (upper) and the Atlantic cod.
Fig. C Greenland halibut (hellefisk) in the sample tray together with other plankton.

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OVERVIEW PROCEDURES

Procedutre no	Institute	PI (specifying)	Request	Gear
1	DTU	Peter Munk	CTD profiles	CTD to 1-2 m above bottom
2			Chl a POC/PON Phytoplankton Nutrients	CTD bottles
3	IOPAN	Artur Palacz	Water samples	Bathometer
4				CTD bottles
5	DTU	Paulina Urban	Water samples for eDNA	CTD bottles (volume 1,5 L/ depth)
6	DTU-MILJØ	Jixin Qiao	Water samples for radioactivity	Using ships hose
7	UNIVie	Thomas Reinthaler	Bact. abundance Bact. respiration Bact. Production MICRO-CARD CARD-FISH	3-4 depths CTD bottles
8	UNIVie	Thomas Reinthaler	Metaproteomics Exo-Proteomics	2 depths CTD bottles
9	UNIVie	Federico Baltar	Fungi abundance (Calcofluor&FISH) Fungi biomass and POC (Particulate organic Carbon) Fungi isolates Fungi respiration (Redox sensor green)	3-4 depths CTD bottles
10	UNIVie	Chie Amano	Metagenomics Proteomics	2 depths CTD bottles
11	DTU	Marja Koski	Zooplankton sampling (small)	Multinet 45 my net, stratified 5 layers
12	DTU	Marja Koski	Zooplankton sampling (larger)	Multinet 300 my net, stratified 5 layers
13	DTU	Sigrun Jonasdottir	Sample for live copepods	WP2 net
14	DTU	Peter Munk	Macro and ichtyoplankton. Abundance estimation.	2 meter ring net 1 or 1.6 mm mesh
15	ABO	Anna Törnroos	Benthos: Benthos abundance Benthos biomass Stable isotopes 13C & 15N Sediment characteristics Sediment chla, Sediment organic content Specific traits (e.g. size distribution)	Box corer (HAPS?)
16	AU	Marit-Solveig Seidenkrantz	Surface sediment	Box core –
17	AU	Marit-Solveig Seidenkrantz	Sediment cores	Rumohr cores
18	UiT	Camilla Svensen	Copepod feeding experiments	
19	UiT	Camilla Svensen	Sediment trap deployment (vertical carbon flux)	Sediment traps mounted on a mooring (rope with attachments)
20	HZG	Claudia Schmidt	Water column samples	CTD bottles (3-4 depths?)
21	HZG	Claudia Schmidt	Surface sediment	Box corer
22	HZG	Claudia Schmidt	Ra isotope water samples	Peristaltic pump
23	UCPH	Katherine Richardson	CTD profile and nutrient data Water for fractionated and total chlorophyll + for eDNA and plankton samples	CTD and bottles