# CASES 2004, Leg 9

# CCGS *Amundsen*
# Cruise & Preliminary Data Report
# and

# ArcticNet Preliminary Cruise Report

05 August to 25 August 2004

Edited by André Rochon

*I would like to express, in my name in that of my colleagues, my gratitute to captain Stéphane Julien, the officers and crew of the CCGS Amundsen for their support, their help, and friendship throughout this leg and throughout the year-long CASES cruise.*

## 1a. On board participants

| Name | Affiliation |
|---|---|
| ***Amundsen Crew*** | |
| JULIEN, Stéphane (Commanding officer) | Canadian Coast Guard |
| THIBAULT, Marc (Chief officer) | Canadian Coast Guard |
| HARDY, René (1st Lieutenant) | Canadian Coast Guard |
| DIONNE, Nadia (2nd Lieutenant) | Canadian Coast Guard |
| GIASSON, Réjean (Chief engineer) | Canadian Coast Guard |
| DIONNE, Gaston (Electrician) | Canadian Coast Guard |
| BRETON, Alain (Logistic officer) | Canadian Coast Guard |
| LEMELIN, Sylvie (Medical officer) | Canadian Coast Guard |
| RICHARD, Martin (Electronic technician) | Canadian Coast Guard |
| GAGNON, Gaétan (Helicopter pilote) | Canadian Coast Guard |
| RAYMOND, Michel (Helicopter technician) | Canadian Coast Guard |
| MAINVILLE, Thomas (Senior engineer) | Canadian Coast Guard |
| LAPOINTE, Éric (1st engineer) | Canadian Coast Guard |
| PELLETIER, Steven (2nd engineer) | Canadian Coast Guard |
| BOUCHARD, Éric (Assistant engineer #1) | Canadian Coast Guard |
| ÉLÉMENT, Félix (Assistant engineer #2) | Canadian Coast Guard |
| SAVARD, Audrey (Assistant engineer #3) | Canadian Coast Guard |
| MICHAUD, Claude (Assistant engineer #4) | Canadian Coast Guard |
| FORTIN, Stéphane (Assistant engineer #5) | Canadian Coast Guard |
| FRÉCHETTE, Marc-André (Assistant engineer #6) | Canadian Coast Guard |

| | |
|---|---|
| BERNARD, Manou (Steersman) | Canadian Coast Guard |
| LEBLANC, Yves (Steersman) | Canadian Coast Guard |
| MICHEL, Sarah (Steersman) | Canadian Coast Guard |
| DESPRÉS, Guy (Boatswain) | Canadian Coast Guard |
| MASSICOTE, Stéphane (Seaman) | Canadian Coast Guard |
| PAQUIN, André (Seaman) | Canadian Coast Guard |
| BERNIER, Marc (Seaman) | Canadian Coast Guard |
| BARTHE, Mathieu (Seaman) | Canadian Coast Guard |
| DUMONT, Alain (Chief cook) | Canadian Coast Guard |
| CHAPUT, Monique (Store keeper) | Canadian Coast Guard |
| LEBLANC, Pierre (Stewart) | Canadian Coast Guard |
| MASSÉ, Danny (Stewart) | Canadian Coast Guard |
| ZARAGOZA, Manuel (Stewart) | Canadian Coast Guard |
| ANGULO, Miguel (Stewart) | Canadian Coast Guard |
| HÉBERT, Yvette (Stewart) | Canadian Coast Guard |
| ALAIN, Charles (Stewart) | Canadian Coast Guard |

***Scientific Crew***

| | |
|---|---|
| ROCHON, André (Chief scientist) | ISMER-UQAR |
| ARYCHUK, Mike | DFO-IOS |
| BEAUDOIN, Jonathan | UNB |
| BELL, Patricia | CBC Radio |
| BRAEKEVELT, Eric | DFO |
| BRUCKER, Steve | UNB |
| BRUGEL, Sonia | ISMER-UQAR |
| CIZMELI, Servet | Sherbrooke |
| CAUCHON-VOYER, Geneviève | Laval |
| DARNIS, Gérald | Laval |
| HILL, Barry | Dalhousie |
| JUUL-PEDERSEN, Thomas | DFO |
| LACOSTE, Karine | ISMER-UQAR |
| LÉTOURNEAU, Louis | Laval |
| MACDONALD, Adam | NRCan |
| MACHUTCHON, Allison | DFO |
| MARTINEAU, Christine | Laval |
| MASSOT, Pascal | Laval |
| MICHAUD, Luc | Laval |
| VIDAL, Monserrat | CIEM |
| PAYET, Jérôme | UBC |
| PROKOPOWICZ, Anna-Justyn | Laval |
| RAIL, Marie-Emmanuelle | Laval |
| RYOSUKE, Makabe | Ishinomaki |
| SASAKI, Hiroshi | Ishinomaki |
| SCHELL, Trecia | Dalhousie |
| TRELA, Piotr | Memorial |
| TREMBLAY, Jean-Éric | McGill |

# 1b. General operations

The crew change between Legs 8 and 9 was scheduled for August 4 at Cap Parry. Everything went on schedule for disembarking the crew and the last passengers were off the ship by 22:00. However, the flights carrying food and equipment supplies scheduled for the following morning arrived late at 18:00, so we could only leave the area for the first station (overwintering site) at around 21:00 on the 5th of August.

Because of the relatively short time period available to complete the CASES sampling program, approximately 5 days, we had to devise a sampling strategy that would cover most of the stations that had not been visited during previous legs of summer 2004. Stations located along the 100 transect were submitted to the scientific crew. They consisted of the overwintering site and a series of stations along transect 100 comprising stations 124, 118, 112 and 106 (see figure 1).

Scientific operations were carried out without problems from August 06 until August 10 due to excellent weather conditions. A total of 2 full and 3 basic stations were realized during those 5 days. The MVP was used only once during that period along a transect between stations 200 and 124, but stored unserviceable during the remainder of Leg 9. The bracket connecting the cable and the MVP itself is made of stainless steel and suffered from multiple fissures, possibly due to the stress caused by lowering and raising the equipment in and out of the water. Towing the equipment at high speed (e.g. > 10 knots) may also be one of the causes for this situation. It was unclear if the crew (both scientific and Coast Guard) misused the equipment or if the latter was defective to start with. An attempt at soldering a reinforcing plate was made, but soldering stainless steel requires conditions that could not be met onboard and new fissures appeared. It was decided that the MVP would not be used for the rest of the trip. A replacement bracket was ordered and shipped to Churchill (Manitoba) by Marc Ringuette for the ArcticNet cruise scheduled for August 27, 2004. The last sample, a drifting sediment trap, was collected around 18:00 that same day. We left the CASES sampling area at around 20:00 on August 10, 2004, bringing to an end the year-long scientific cruise of the CCGS Amundsen.

The transit through the Northwest Passage on the way back to Churchill (Manitoba) was the occasion to realize preliminary sampling and bottom surveys for biologists and geologists. Since no cruise plan had been submitted prior to Leg 8, a preliminary ArcticNet cruise plan was presented in June 2004 based on the coring stations from the geology group. The stations were selected based on the multibeam and sub-bottom profiles realized during the transit to the CASES working area the previous year, during the autumn 2003. The cruise plan consisted of 9 stations where the sediment thickness and properties seemed appropriate to obtain high-resolution sediment cores (figure 1 and Part 5). Other scientific activities, including water column and contaminant sampling (see Part 3 for the complete listing of daily activities), were carried out at these stations as well. We also had several short stations at which CTD profiles were realized in order to calibrate the multibeam system.

The coring team encountered a problem at station 002, when the piston cable wrapped itself around the corer head. This happened because too much cable was reeled out from the winch. This caused the corer to be retrieved and brought back up at an angle. In order to avoid a possibly dangerous situation when the corer would be taken out of the

water, the hook of the port side crane was lowered at water level to be attached to the corer head by a team in the Zodiac. The corer was safely brought back on board but the recovery of sediment was only of ~80 cm and the piston cable was kinked and became unusable. Because of time constraints we did not repeat the coring and proceeded to the next station.

On that date, the ice charts for the Northwest Passage were not promising. The charts indicated that an area comprising Victoria Strait, Larsen and Peel sounds and McClintock Channel was covered with 100% of thick first year ice, with some multi-annual ice. We were hoping to follow the trace of the CCGS Louis S St-Laurent that was in the area several days before, but without luck. We also had to meet with the CCGS Desgroseillers on August 15 near Resolute Bay to transfer food and supplies for the upcoming ArcticNet cruise. Several ice patrols by helicopter were done in order to find leads that would ease our progression. The ice front was located right at the edge of station 003. It was estimated that it would take several days to reach Peel Sound, so we decided to cancel that station and all the subsequent ones located in the area. We entered the ice around 23:00 on August 11, 2004. Our progression through the ice was very slow, at a speed of about 4-5 knots. On several occasions we had to stop for a few hours to let the engines cool down. Because of our slow progress, it was then decided to cross through Bellot Strait and sail north in Prince Regent Inlet to meet the Desgroseillers in Maxwell Bay (Devon Island). We finally reached Bellot Strait at ~10:00 on August 16, and waited for the fog to dissipate before entering, at around 13:00. The crossing went well and we resumed our transit north once we reached Prince Regent Inlet.

Prince Regent Inlet was free of ice and we managed to arrive in Maxwell Bay and meet with the Desgroseillers on August 17 at 09:00. We spent the most part of the day transferring frozen food goods in addition to medical supplies from the Desgroseillers to

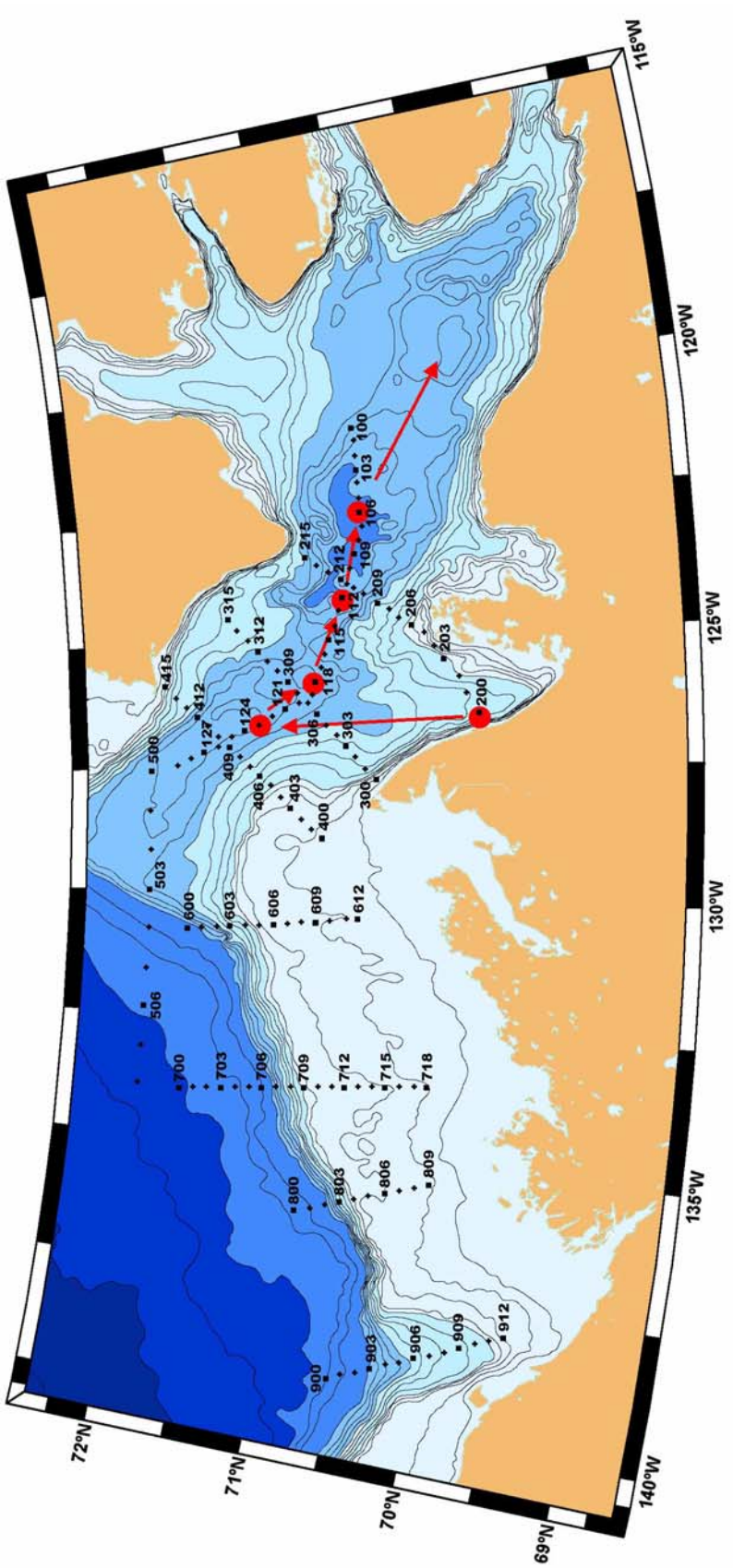



Figure 1. Location of coring stations and trajectory of CASES Leg 9 in Amundsen Gulf.

the Amundsen, which required most of the scientific and Coast Guard crews for the day. We left Maxwell Bay at 20:00 the same day and resumed our scientific program in Lancaster Sound before heading toward Churchill. A transect of 6 stations was done in Lancaster Sound, including CTD stations (figure 2). Everything went well in this part of the cruise. Most biologists on board were done with their sampling, which left some time for coring and surveying activities. The last station visited was 009 located at the eastern end of Lancaster Sound. Just as we were bringing the boxcore back on board, the captain received a distress call for 9 missing persons near Bylot Island. Therefore, we had to tie everything down and sail full speed to begin a search and rescue operation. About 15 minutes after we sailed, the captain received another call announcing that the missing people had been found. Therefore, we went back to the station and resumed scientific activities.

We left Lancaster Sound at 13:00 on August 18 on route to Churchill for the scientific crew change. We did a short detour through Scott Inlet and Clark & Gibbs fjords (Baffin Island) along the way. We took the opportunity to do some sight seeing, but also to do a multibeam survey of the area.

The remainder of the transit to Churchill went well, thanks to the weather conditions. We did 3 CTD stations along the way in order to calibrate the multibeam system. We arrived in Churchill in the afternoon of August 25, 2004 and proceeded with demobilisation. Every member of the scientific crew participated in the activity, which consisted of cleaning the laboratories, removing, storing and packing the equipment and samples that had accumulated over the year long cruise. The ArcticNet scientific crew arrived on August 27, and we departed not long after for the airport to come back home.

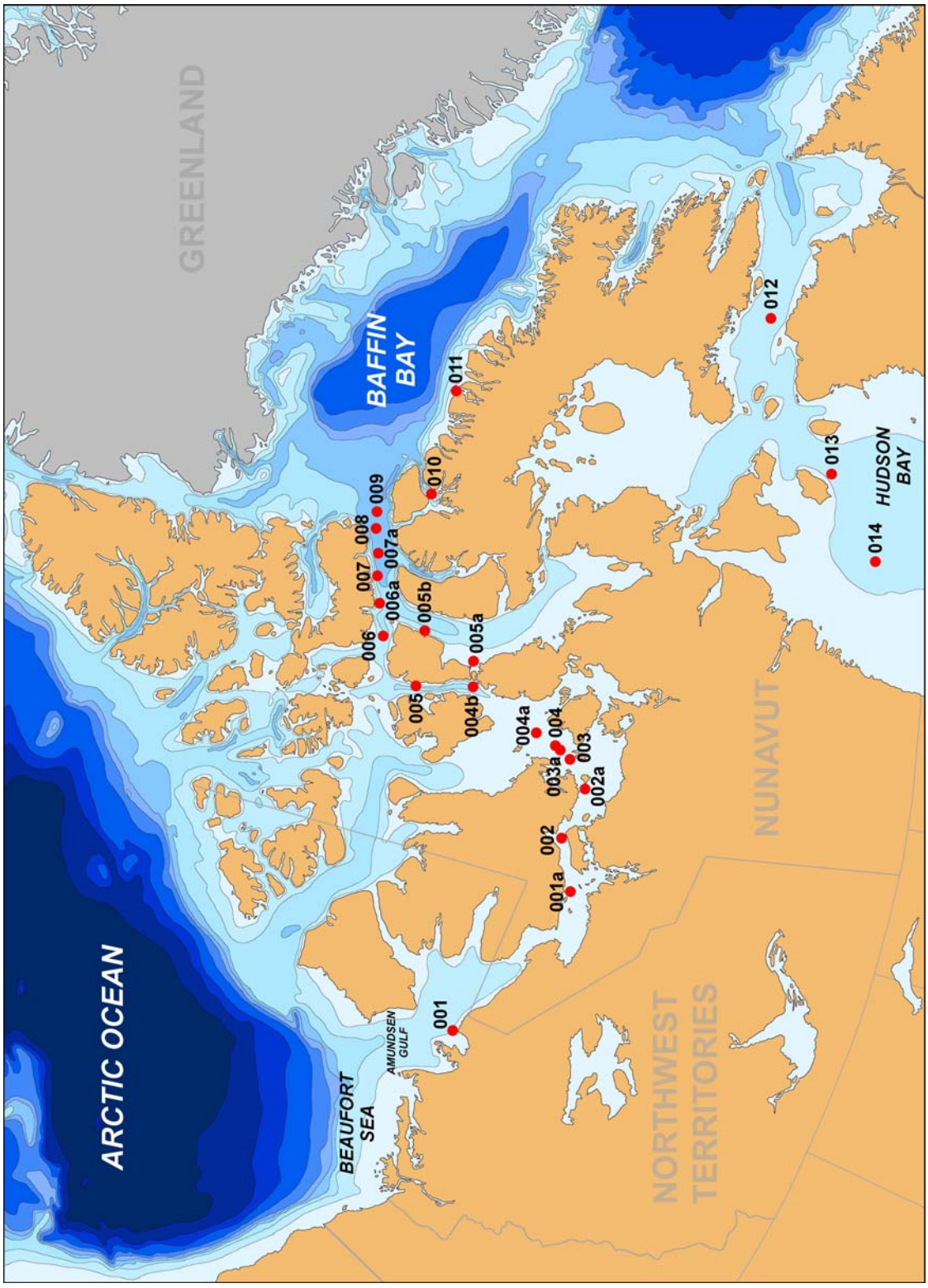



Figure 2. ArcticNet stations visited during the preliminary cruise of summer 2004

# PART 2

# Leg 9 – Team cruise reports

# Leg 9 Cruise Report, Contaminants

On Board: Eric Braekevelt and Allison MacHutchon (Fisheries and Oceans Canada)

## *Research objectives:*

The overriding question this project hopes to answer is how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect organohalogen and trace metal contaminant cycling. Ultimately, we propose to relate changes in delivery and biogeochemical cycling of these contaminants to their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets. Mercury, which cycles globally in the atmosphere, is deposited uniquely in polar regions through mercury depletion events (MDEs; oxidation of Hg (0) to Hg (II)), and these appear highly sensitive to ice and ocean climate variables.

Detailed mass balance and fate studies will be conducted to formulate a mass balance model for mercury in the Beaufort Sea marine system. In conjunction with the work being done to quantify vertical and organic material fluxes, such a model will form an interpretive basis for monitoring components of the system and interpreting proxy records. To conduct these mass balance studies we envision making the following measurements for mercury and organohalogen contaminants in ocean water: water and suspended sediment from the Mackenzie and other smaller rivers, near surface air, snow and ice cores, permafrost, and lake and marine sediment cores. Water $\delta^{18}O$ and salinity measurements will also be made to distinguish between freshwater sources (runoff and sea-ice melt) such that the relative roles of import of Hg from the drainage basin versus Hg cycling through ice formation and melting can be evaluated.

In addition, a graduate student in our group (Lisa Loseto) is interested in why Beaufort Sea belugas have higher mercury levels relative to other populations. To do this, mercury levels in their diet need to be determined. Thus, all biological samples collected will be measured for Hg along with stable isotopes to place organisms into their associated trophic levels. Fatty acids will also be determined to assist in understanding the species in beluga diet. Beaufort beluga fatty acid signatures will be determined from collections this summer on Hendrickson Island. In addition, Beaufort beluga whales will have satellite tags placed on them to understand where they travel and from where they are obtaining mercury.

Due to space, material and safety constraints, no analyses could be performed while on the ship. All samples were preserved or frozen and will be sent to various laboratories for analysis.

## *Sampling Protocols*

### Mercury and Methyl Mercury

Water was collected from the rosette at every full station for analysis of total mercury (in duplicate), methyl mercury as well as salinity and $\delta^{18}O$. A total of 80 total mercury, 40 methyl mercury, 33 salinity and 33 $\delta^{18}O$ samples were collected.

## High Volume Water Collection (organic contaminants)

Large volumes of water (~100 L/sample) were collected from the rosette at full stations. The high demand on the rosette and the filtration time required to free up sample bottles allowed only a few depths to be sampled at each station. To ease demand on the rosette and to collect greater volumes (~200 L/sample), surface water was sometimes collected from the side of the ship using a bucket. Water was pumped through glass-fibre filters followed by an XAD-2 resin cartridge. A total of 13 water samples were collected and filtered.

## Low Volume Water Collection (HCH and endosulfan)

Water was collected from the rosette at full stations. This analysis was carried out to examine hexachlorocyclohexanes (HCH) and endosulfan (both chlorinated pesticides) at depths such as the chlorophyll maximum, temperature inversion and nephloid layer. Water (4 L) was pumped through a glass-fibre filter followed by an ENV+ solid-phase extraction (SPE) cartridge. A total of 13 water samples were collected and filtered.

## Air Sampling (organic contaminants)

The air sampler was set up at the bow of the ship. Samples were collected on a glass fibre filter and polyurethane foam (PUF) for the analysis of organic contaminants. Air samples were collected for about 48 hours per sample. Three samples were collected.

## Biotic Sampling (stable isotopes, mercury, organic contaminants)

Biological samples were collected for the analysis of total mercury, methyl mercury, organic contaminants, stable isotopes (N and C), and fatty acids. Zooplankton was provided by the zooplankton team at all full stations and some basic stations. Zooplankton was sorted into the following: *Calanus hyperboreus*, *Pareaucheata* spp., *Chaetognath* spp.(arrow worms), *Themisto* spp.and bulk remains. Many of the samples were collected with the large RMT net. It collects large volumes of zooplankton, but the large mesh size tends to kill a lot of the smaller species. It was generally not sorted, although some larger species, such as mysids and large *Themisto* were removed. A total of six zooplankton samples were collected.

# Phytoplankton dynamics and microphytobenthos characteristics in the Cape Bathurst polynya and in the Amundsen Gulf along with preliminary stations of Arctic Net

**(Sub-project leader : Serge Demers, Institut des Sciences de la Mer de Rimouski, Université du Québec à Rimouski, Québec, Canada)**

***Cruise participants: Karine Lacoste and Sonia Brugel***

## Objectives

- to determine the biomass and the production of pico-, nano- and microphytoplanktonic cells in the photic zone
- to determine species composition and pigment composition of phytoplankton in the water column
- to evaluate the relative contribution of phytoplankton and microphytobenthos to the total primary production
- to assess the effects of the bio-optical factors on the vertical attenuation of the ultraviolet component of the solar spectrum in the water column, and
- to define the bio-optic characteristics of the assemblages of pico- and nanophytoplanktonic cells by flow cytometry

## Methods

*Study site*

From August 6$^{th}$ to the 10th, basic and full stations were sampled in the Cape Bathurst polynya and in the Amundsen Gulf areas. A total of 5 stations were sampled during that period: 2 "full stations" and 3 "basic stations" (Table 1). From August 11$^{th}$ to the 18$^{th}$, 3 Arctic Net stations were sampled.

### *Water column sampling and analyses*

Ambient irradiance was collected using a GUV-510 surface radiometer (Biospherical Instruments) mounted at the top of the wheelhouse of the ship, that provides a measure of cosine-corrected downwelling irradiance in 5 discrete channels in the UVR range (305, 313, 320, 340 and 380nm) and a measurement of cosine-corrected PAR. Vertical light profiles were performed at 3 stations (Table 1) using a PUV-511 underwater radiometer (Biospherical Instruments). Irradiances were corrected by the dark values and normalized

to the ambient conditions at the beginning of the profile, using ambient values given by a GUV-510 surface radiometer.

Water samples were prefiltered (335µm) after having been collected with a rosette sampler (twenty four bottles of 12L each) at selected depths of the water column (0, 5, 10, 15, 25, 50, 75, 100, 200, 400m, bottom, chlorophyll maximum, and/or 100%, 50%, 25%, 10%, and 1% light attenuation) for the determination of chlorophyll a (chl a), particulate organic carbon and nitrogen (POC and PON, respectively), pigment composition (HPLC), particulate organic carbon and nitrogen (POC and PON, respectively), biogenic silicate (BioSi), and species composition. Samples were also taken for further analysis on flow cytometry to determine the population composition of the small size class of phytoplankton and cells fluorescence. (Table 1).

Chl a concentration was used as a proxy for phytoplankton biomass. Samples were filtered (250ml or more) onto Whatman GF/F filters, 5µm polycarbonate filters (Millipore), and 20µm filters (nitex). Chl a concentrations for all fractions were determined with a 10-AU Turner Designs fluorometer following 24h extraction in 90% acetone at 5°C without grinding. To determine POC and PON concentrations, water samples were filtered (250mL or more) through pre-combusted (5h at 500°C) Whatman GF/F glass fibre filters. Filters were then folded into pre-combusted aluminium foil and frozen at -80°C for later analyses. To determine pico- and nanophytoplankton populations characteristics, water samples were collected at all depths sampled within the first 100m, preserved with paraformaldehyde and frozen at -80°C for later analysis using a flow cytometer; samples for the determination of bacterial populations characteristics were also taken, preserved in glutaraldehyde and frozen at -80°C. Finally, 250ml subsamples of water were collected at three depths (surface, 1% light and chlorophyll maximum if available) for phytoplankton cell identification and enumeration. The samples were fixed with acid Lugol and maintained in a darkroom at 4°C.

The potential and the actual photochemical efficiency of the reaction centres of PSII (Fv/Fm and ΔF/F'm, respectively) of phytoplankton cells (collected at full stations at different depths) were determined by Pulse Amplitude Modulated (PAM) fluorescence. The instrumentation used consisted in an Optisciences pulse-amplitude fluorometer (model OS5-FL Opti-Sciences). The ratio of variable to maximal fluorescence (Fv/Fm) was determined in dark-acclimated phytoplankton (45 minutes) and used as an indicator for the potential photochemical efficiency of the reaction centres of PSII. Fv = Fm - Fo, Fo is the initial sample fluorescence (all reaction centres of photosystem II are oxidized or "opened") and Fm is the maximal fluorescence reached under strong light irradiance e.g. saturating pulse of white light (all reaction centres of photosystem II are reduced or "closed"). Under actinic intensity, the photosynthetic yield (Y e.g. ΔF/F'm) or actual photochemical efficiency of the reaction centres of PSII, which corresponds to the ratio of variable Fv to maximal fluorescence Fm under actinic light was evaluated.

Primary production rates were determined at full stations (Table 1). Particulate pelagic primary production was estimated for 5 photic depths (i.e. 100%, 50%, 25%, 10% and 1%) using the 14C uptake method. These depths were determined after calculating the light attenuation coefficient, Kd, using data from a Secchi disk. Measurements of simulated in situ carbon fixation by phytoplankton were made in 500 ml polycarbonate

bottles (two light and one dark; inoculated with 10-20 µCi of $NaH^{14}CO^{3-}$) placed into 5 deck incubators Temperature was maintained by circulating water from the upper mixed layer through the incubators and in-situ irradiance was simulated by neutral density filters. The total added activity was determined in triplicates by adding 200µl of the inoculated water subsample into 10ml Ecolume scintillation fluid (ICN) containing 200µl of Ethanolamine. After 24 hours of incubation, subsamples (150ml) were filtered onto GF/F glass-fiber filters (Total particulate primary production), 5µm polycarbonate filters (Poretics) and 20µm filters (nitex). Non-incorporated 14C was removed by addition of 100µl of 0.5N HCl. Upon evaporation of the acid, 10ml of Ecolume scintillation liquid were added. Activity will determined using a Packard Liquid Scintillation Analyzer Tri-Carb® 2900 TR. All counts will be dark-corrected.

The response of photosynthetic carbon assimilation to light was obtained by 14C uptake using a small-volume, short-incubation time method. In dim light, one 100ml water subsample was poured into a flask to which 80 µCi of $NaH14CO_3$ were added. After a gentle homogenisation, 3ml-aliquots were dispensed into 23 clean 20 ml-borosilicate scintillation vials. The vials were then placed under a light gradient ranging from 0 to ca 1000 µE $m^{-2}$ $s^{-1}$ in a linear incubator. Three scintillation vials were incubated in the dark. The total added activity was determined (triplicates) by adding 200µl of the inoculated water subsample into 10ml Ecolume scintillation fluid (ICN) containing 200µl Ethanolamine. After 1 hour of incubation, non-incorporated 14C was removed by adding 500µl of 6N HCl. After 30 min, 500µl of 6N NaOH was added to the samples to avoid pH changes. 15ml of scintillation cocktail were then added and the samples were counted using the same scintillation counter

***Sediment sampling and analyses***

Sediment samples were collected with a Box core at 1 station (Table 2) for the determination of chl a, species composition, meiofauna determination and to perform photosynthesis-irradiance experiments for the shallow stations.

The top first cm of a sediment subsample was taken using a corer of 25mm internal diameter. Three or four sediment subsamples were collected with the corer described above. The top first cm of sediment was cut and placed in a 50ml polyethylene bottle with 30ml of 90% acetone for the extraction of pigments. Microphytobenthic biomass was estimated as chlorophyll a (chl a) concentration which was measured using a 10-AU Turner Designs fluorometer. Two sediment subsamples were collected for microphytobenthic cell and meiofauna identification and enumeration. The samples were fixed with formalin.

**Table 1. Description of water column sampling program**. Chl a: Biomass of phytoplankton (Total, >5µm, and 20µm); CHN: POC/ PON; Cells: taxonomy (surface, Chl max, and 1% light); Cytometry: Flow cytometry; BioSi: biogenic silica; HPLC: pigment composition; PAM: pulse amplitude modulated fluorescence; PP: primary production; PI: photosynthesis-irradiance relationships; PUV: UV profile.

| Station | Date | Chl *a* | CHN | Cells | Cytometry | BioSi | HPLC | PAM | PP | PI | PUV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | 06/08 | X | X | X | X | X | X | X | X | X | X |
| 124 | 07/08 | X | X | X | X | | | | | | |
| 118 | 08/08 | X | X | X | X | | | | | | X |
| 112 | 09/08 | X | X | X | X | | | | | | |
| 106 | 10/08 | X | X | X | X | X | X | X | X | X | X |
| Arctic Net 002 | 10/08 | X | X | X | X | X | | | | | |
| Arctic Net 007 | 12/08 | | | X | | | | | | | |
| Arctic Net 009 | 18/08 | | | X | | | | | | | |

**Table 2**. **Description of sediment sampling program**. Chl a: Biomass of microphytobenthos; Cells: Taxonomy.

| Station | Date | Chl *a* | Cells | Meiofauna |
|---|---|---|---|---|
| 106 | 06/08 | X | X | X |

**Cruise Report Leg 9**

**Free-drifting Sediment Traps**

**Principal Investigator : Christine Michel**

*Cruise participants:* *Thomas Juul-Pedersen*

*Collaborators:* *Paul Wassmann (Norway), Don Deibel (Canada), Josef Wiktor (Poland), André Rochon (Canada) and Kirk Cochran (USA)*

During Leg 9 of the CASES program, the sedimentation team aboard the NGCC Amundsen was composed of 1 graduate student. Thomas Juul-Pedersen is a Ph.D. student at Rimouski University. The projects conducted by members of the CASES research network are described below.

### *Free-drifting sediment traps.*

The free-drifting sediment trap program helps to strengthen the bio-geochemical approach in CASES of studying biogenic (including carbon and other bio-geochemical constituents) fluxes and shelf-basin interactions. Regular deployments of Free-drifting Sediment Traps (FSTs) provide a means to investigate pelagic-benthic coupling processes and link primary production and surface exchange processes with export of material at different depths. The FST Program is thus tightly related to other components of CASES, for example with aspects of primary production, carbon and nutrient fluxes to grazers and recycling, sedimentation and accumulation at depth.

The general objectives of the FST program were to:

- Evaluate the sinking export of organic and inorganic material from the euphotic zone (at full stations of the CASES expedition plan),
- Assess vertical changes in sedimentation of organic and inorganic material within and below the euphotic zone, and
- Characterize the type of material sinking at each depth and exported from and below the euphotic zone.

The sampling was carried out according to original plans. At two of the full stations of the CASES expedition plan, free-drifting trap was deployed and successfully recovered arrays during leg 9.

In order to account for potential physical and bio-geochemical features and to capture changes along the depth axis, our sampling approach was to install traps at multiple depths within and below the euphotic zone. The traps were installed at 7 depths ranging from 15 to 150 m (Table 1). The trap setup was deployed for ca. 24 h (Table 1). The traps were PVC cylinders 10 cm diameter, with a height to diameter ratio of 7. Upon deployment, the traps were filled with deep seawater (200 meters deep) collected at a previous station and filtered through 0.22 μm filter; two traps were installed at each depth. The traps did not contain any poison or preservative. Upon recovery, the traps were placed in a dark cold room (-1.0$^{o}$C) and the material was allowed to sediment during 8 h. After that period, the bottom fraction of each trap was collected and pre-

screened using a 425 μm Nitex mesh. Trap bottom fractions from the same depth (from two traps) were combined in order to obtain only one sample from which all subsamples were taken for further analysis.

One trap, located at 50 m, was given untreated to Piotr Trela (Post Doc. At Don Deibel) for faecal pellets identification and count.

Subsample from all depths was given to André Rochon (Prof. at UQAR) for later microscopically analyses.

Our trap samples were processed as follows. Duplicate subsamples were filtered on Whatman GF/F filters for the fluorometric determination of chlorophyll *a* (chl *a*) and phaeopigments (Turner Designs 10AU fluorometer), after 24 h extraction in 90% acetone (Parsons et al., 1984). Additional subsamples were filtered on pre-combusted Whatman GF/F filters for particulate organic and inorganic carbon, and nitrogen, analysis. The samples were dessicated at 60$^{o}$C during 24 h and brought back to our laboratory for analysis. Subsamples were filtered on Nuclepore polycarbonate 0.6 μm filters, on an all-plastic system, for the determination of biogenic silica. The filters were dessicated at 60$^{o}$C during 24 h and brought back to our laboratory for analysis. Subsamples were also preserved in acidic lugol's solution for cell identification and counts, and in borate-buffered formalin for faecal pellet counts. In general, the small amount of material collected did not allow for additional analyses.

*Table 1. Details of free-drifting sediment trap deployments during the CASES 2004 Leg 9 cruise.*

| Station | ***Trap depths (m)*** | Recovery Date | Duration (Days) |
|---|---|---|---|
| 200 | 15, 25, 50, 75, 100, 125, 150 | 07/08/2004 | 1.06 |
| 106 | 15, 25, 50, 75, 100, 125, 150 | 10/08/2004 | 1.00 |

**Production of faecal pellets.** Arctic pelagic ecosystems are characterized by large, overwintering copepod species. During early spring, they emerge from their diapause and migrate to the euphotic zone, ready to utilize the developing bloom. This distinctive life cycle enables an efficient utilization of the developing spring bloom.

Copepods influence the carbon cycling by packing the egested material into large fast sinking faecal pellets favoring vertical export of carbon. However, they also graze upon the faecal pellets (coprophagy). Studies have shown that a large fraction of the material leaks out of faecal pellets as dissolved material, which benefits the pelagic microbial community and influences remineralization processes. To get a better understanding of the role of copepods in carbon export and remineralization, information on the production rate and the sedimentation rate of faecal pellets is needed.

*Specific objective 1: Determine the faecal pellet production rate for two different size groups of copepods and three common copepod species.* Faecal pellet production experiment was conducted during Leg 9. Thomas Juul-Pedersen conducted his production rate experiment with two size groups of copepods (200-1000 μm and >1000 μm). Copepods and faecal pellets from the experiment were preserved for later analyses in Winnipeg.

*Specific objective 2: Determine the sedimentation rates of faecal pellets at all trap depths.* Sub-samples for faecal pellets were taken from each trap depth. Faecal pellets in these samples will be enumerated, measured and classified in Winnipeg.

*Table 2: Completed experimental work for 9*

| **Sampling type** | **Leg 9** |
|---|---|
| Faecal pellet production experiments (size-fractioned) | 1 |

**Acknowledgments**: I would like to thank the captain, officers and crew of the *NGCC Amundsen* for their outstanding support during Leg 9 of CASES. I would also like to thank our chief scientist André Rochon for his support and excellent logistical operation throughout the scientific cruise and during the demobilization phase.

# Geology Report for Leg 9
# (04 August – 26 August 2004)

## CASES & Arctic Net

Work began with the installation of the gamma source for the Multi-Sensor Core Logger on 04 August 2004 in the Geo/Paleo lab! On Leg 9, the coring team consisted of A. Rochon (UQAR, and chief scientist), T. Schell (Dalhousie U., post-doc.), A. MacDonald (NRCan/GSC – Bedford Institute of Oceanography, piston coring technician), G. Cauchon-Voyer (volunteer MSc. Student, U. Laval), and B. Hill (volunteer B.Sc.H. Student, Dalhousie U.)

New material collected on Leg 9 includes – Stn. 200 (bxc), Stn. 124 (pc&twc), Stn. 112 (bxc), Stn. 106 (bxc) were taken for CASES, and then the beginning of ArcticNet began with Stn. 002 in Dease Strait (bxc, pc & twc), and Stn. 007(bxc), Stn. 009 (bxc, pc) in Lancaster Sound. All boxcores were successful upon their first deployment with the exception of Stn. 009, and required a second deployment. The success of the piston core was unpredictable. The apparent penetration was generally a full 900 cm, but generally the length of successful core recovery was 600 cm or less; see Table below for further details. The trigger weight core successful recovery was also unreliable.

Core material was only collected on Leg 8 – all analysis on this material was done during Leg 9, in addition to the new material collected. The 6 piston cores & 5 Trigger weight cores from Leg 8, and ~70 smaller pushcores from the 35 boxcores were MSCL'ed (Multisensor core logger), and also the 2 piston and 2 trigger weight, and 12 pushcores from 6 boxcores collected on Leg 9, for a total of ~5500 cm of core material being logged for gamma density, p-wave velocity, core thickness, magnetic susceptibility and temperature.

Of the 8 piston cores obtained on Legs 8 & 9, all but the last Arctic Net station 009 (core 2004-804-009) was split into a Working & Archive half, a sediment description compiled, and digital color photographs of both halves was obtained. In total - 3969 cm of core material was processed.

Subsamples were taken every 10 cm from the Working core half - for micropaleontology (foraminifera & thecamoebians, 10 cc's for T. Schell), diatoms (5 cc's for T. Schell), marine palynomorphs (dinoflagellates & pollen, 10 cc's for A. Rochon). In addition a complete u-tube (or mini-core) was taken of the entire core length for paleomagnetic study (for G. St.-Onge, UQAR). In total, 1191 subsamples and 3969 cm of U-channel/minicores for paleomagnetism.

Both the Working and Archive core halves are held in cold storage (~ 4$^{o}$C), in a sturdy storage rack, along with the unsplit boxcore pushcores and one unsplit piston core – in the refrigerated container that will remain on board the CCGS Amundsen until its return to Quebec City in October 2004.

Unfortunately, time did not allow for the x-raying of the Archive half of the split cores while on board, that shall be done when the sediment cores are placed in the National Core Repository, with the Geological Survey of Canada (Natural Resources Canada) at the Bedford Institute of Oceanography. The material will probably be x-rayed at the Centre for Environmental and Marine Geology, at Dalhousie University this Fall 2004.

| Date | Location | Sample ID | Equipment | Latitude | Longitude | WD | time | AGC # |
|---|---|---|---|---|---|---|---|---|
| 07-08-04 | Amundsen Gulf | 2004-804-200 | Bxc-Surface samples 20cc's dinos & forams | 70°02.70N | 126°17.1W | 236 m | 06:45 | 43A, 43B |
| 08-09-04 | Amundsen Gulf | 2004-804-124 | Piston (442 cm; app. 900cm) & twc (47 cm); core cutter & catcher | 71°24.8N | 126°46.1W | 426 m | 06:40 | Pc44, twc44 |
| 09-08-04 | Amundsen Gulf | 2004-804-112 | Bxc-pushcore A&B, surface 20cc's dinos & forams | 70°45.2N | 124°13.9W | 511 m | 10:17 | 45A, 45B |
| 10-08-04 | Amundsen Gulf | 2004-804-106 | Bxc-pushcore A&B, surface 20cc's dinos & forams | 70°36.0N | 122°37.8W | 122 m | 16:30 | 46A, 46B |
| 12-08-04 | Dease Strait | 2004-804-002 | Bxc-pushcore A&B, surface 20cc's dinos & forams; Piston (0 cm; app. 900cm) & twc (71cm) | 68°59.9N | 106°35.1W | 115 m | 09:56 | 47A, 47B, twc47 |
| 18-08-04 | Lancaster Sound | 2004-804-007 | Bxc-pushcore A&B, surface 20cc's dinos & forams | 74°16.9N | 085°36.1W | 534 m | 10:15 | 48A, 48B |
| 19-08-04 | Lancaster Sound | 2004-804-009 | Bxc-pushcore A&B, surface 20cc's dinos & forams; Piston (~600 cm; app. 950cm) & twc (0 cm) | 74°11.2N | 081°11.7W | 781 m | 09:08 | 49A, 49B, 49Pc |

# Cruise report of the Japanese CASES team on Leg 9

Participants on Leg 9:
Ryosuke Makabe (Senshu University of Ishinomaki, Japan: dL160002@isenshu-u.ac.jp)
Hiroshi Sasaki (Senshu University of Ishinomaki, Japan: sasaki@isenshu-u.ac.jp)

**General objectives of one-year observations for the Japanese team**
**(Participants on every legs of the Amundsen Cruise are shown below, *: PI)**

1. **To know seasonal and regional variability in downward particulate flux in the entire CASES study area (Hiroshi Sasaki*, Makoto Sampei, Takahiro Nakanishi & Ryosuke Makabe).**
2. **To know the overwintering strategy of zooplankton; from microzooplankton to large-sized copepods (Hiroshi Hattori*, Sohei Matsuda, Takashi Ohta & Toshikazu Suzuki).**
3. **To know the photosynthetic characteristics of psychrophilic phytoplankton (Atsushi Matsuoka, Shinya Yamamoto, Shinpei Aikawa).**

As for 1, some of the moored sediment traps were recovered during the last leg (Leg 8), and the rest of them will be recovered during the Laurier Cruise next month (September 2004). Positions and the periods of duration of those traps are shown in Table 1.

***1-1. Long-term sediment trap mooring experiments.***

Table 1. Stations and deployment depths of time-series sediment traps.

| | Station | depth (m) | | station | depth (m) |
|---|---|---|---|---|---|
| Recovered by Amundsen Cruise (Leg 8) | CA 5 | 100 | Will be recovered by Laurier Cruise (Sept) | CA 4 | 100 |
| | CA 8 | 100 | | | 200 |
| | | 200 | | CA 6 | 100 |
| | CA 12 | 100 | | | 200 |
| | | 200 | | CA 7 | 100 |
| | | 1000 | | | 200 |
| | CA 15 | 100 | | CA 10 | 100 |
| | | 200 | | | 200 |
| | CA 18 | 100 | | CA 11 | 100 |
| | | 200 | | | 200 |
| | | 400 | | CA 13 | 100 |
| | CA 20 | 100 | | | 200 |
| | | 200 | | CA 14 | 100 |
| | | | | | 200 |

***1-2. Box core samplings***

Sediment core samples were collected using a Box Corer for the measurements of naturally occurring radionuclides, such as $^{210}$Pb. These estimates indicate sedimentation rates of material to the sea floor on seasonal and decadal times scales, and

the sedimentation rate can be coupled with downward particle flux in mid-depth layers where the time-series sediment traps were deployed. After the core sample (cylindrical core with 10 cm in diameter and 20-30 cm long) was taken from the chamber of the Box Corer, the sample was sliced into pieces (each of 10 cm in diameter and 1 cm thickness) and were frozen at -20 $^{o}$C. The sediment samples were obtained from 11 stations in total; 4 stations during Leg 9 (Table 2) and 7 stations during Leg 2 (100, 124, 300, 309, 500, 709 and 718).

Table 2. Stations, dates and the approximate depths where the box sampling were made.

| Station | date | Depth |
|---|---|---|
| 200 | 07/Aug | 236m |
| 118 | 08/Aug | 395m |
| 112 | 09/Aug | 484m |
| 106 | 10/Aug | 531m |

As for 2, zooplankton samplings as the Japanese routine work were made at 5 stations.

***2-1. Tucker net tows to collect large-sized zooplankton***

The Tucker net tows (called live tow) were carried out in the shallow waters (200-0 m, 100-0 m) to observe seasonal variation of large-sized zooplankton communities, and to compare with compositions of swimmers caught with the long-term sediment traps. Each sample was divided into two aliquots after filtration through a 330-μm nylon mesh: one was fixed with 5 % buffered formaldehyde and the other was frozen at -80$^{o}$C for later chemical analysis.

***2-2. Water samplings to collect microzooplankton***

We collected water samples at three depths (0 m, chlorophyll maximum depth, below the chl. Max. normally 50 or 75 m) with RMS (Rosette Multiple Sampler) for microscopic observations. Samples were preserved with acid Lugol's solution (2% final concentration). At station 200 (overwintering station), we took surface water samples with a bucket 6 times a day to know a daily rhythm of microzooplankton abundance and their specific cell cycles, which can indicate their *in situ* growth rates.

***2-3. Ring net tows to collect small-sized zooplankton and copepod fecal pellets***

Additional samplings of small-sized zooplankton and suspended fecal pellets produced mainly of large-sized copepods were made using a ring net (50 cm in diameter, 200 cm long, 100 μm in mesh size).

Large fecal pellets (LFP: usually >100 μm width) are thought to be an important role in contributing the size of export flux from surface layers. Especially in arctic waters including CASES area, there can be many LFP with rapid sinking rates produced by large-sized calanoid copepods, such as *Calanus hyperboreus*, which are known as the biggest copepods among arctic copepod species. According to previous reports, small-sized zooplankton, such as *Oithona similis* are ubiquitous in the Arctic Ocean, and the animals can act as a coprophagous filter which means consumption processes on sinking fecal pellets from surface layers. We would like to get fundamental information on the abundance, biomass and regional changes in the CASES area of both parameters. Vertical net tows from 100 m to the surface have been carried out 8 times at 6 stations (Table 1). Samples were preserved with 5% buffered formalin.

Table 3. Stations and date (local time) of samplings for small-sized zooplankton and fecal pellets using a ring net.

| Station | Date | Time |
|---|---|---|
| 200 | 6-Aug | 10:00 |
| 200 | 6-Aug | 23:20 |
| 124 | 7-Aug | 23:30 |
| 118 | 8-Aug | 14:20 |
| 112 | 9-Aug | 5:10 |
| 106 | 9-Aug | 23:20 |
| 106 | 10-Aug | 13:30 |
| 002 | 12-Aug | 5:22 |

As for 3, PAM (pulse-amplitude-modulation) fluorometer measurements as the Japanese routine works were made at 4 stations.

Water samples from two depth layers (0 m and at around the chlorophyll maximum depth: 40 m) were collected using RMS at 4 stations (200, 124, 118 and 106) and the photosynthetic characteristics of phytoplankton were measured using PAM fluorometer (Phytoplankton Analyzer: PHYTO-PAM) within a few hours. According to the previous observation in the NOW (North Water Polynya in the northern Baffin Bay, Kashino et al., 2002), phytoplankton in surface layers was characterized by the highly activated xanthophyll cycle, which is responsible to protect photosystems from high irradiance. The seasonal variation of the PAM-derived photosynthetic activities can lead to understand fundamental processes of primary production of psychrophilic phytoplankton in the arctic waters.

# Microbial ecology CASES 2003-2004 leg 9

Warwick F. Vincent, Département de biologie, Université Laval, Québec,Canada

Curtis Suttle, University of British Columbia, Canada

Carles Pedros-Alió, Institut Ciènces del Mar, Barcelona, Spain

*Cruise participants: Christine Martineau, Montserrat Vidal & Jérôme Payet*

## OBJECTIVES

The central hypothesis in CASES concerns the processing of organic matter in the Mackenzie delta versus offshore waters and its relationships with sea ice conditions. Microorganisms are likely to contribute substantially to the biological carbon stocks across this region, and to play a leading role in the biogeochemical fluxes of organic matter. The microbial ecology subprogram intends to (1) describe the microbial community structure and to measure production dynamics throughout the CASES study region and (2) to examine the relationships of these variables with particulate loading and sea ice conditions. Our work includes comparative measurements in the inshore delta and Mackenzie River source waters.

## MICROBIAL PRODUCTION AND COMMUNITY STRUCTURE

The Mackenzie River brings large amount of organic and inorganic sediments to the Beafort Sea shelf which load of matter may affect the composition, the distribution and the production of the bacterial communities. Key objective of the microbial subprogram on Leg 9 was to cover the Amundsen Gulf and study the abundance, diversity and production of the microbial community.

In order to distinguish the bacterial community and the heterotrophic activity associated with cells attached to particles, size separation of material larger than 3 μm data was done by filtration. Total and small fractions (<3 μm) where made for bacterial production incubations, bacteria DAPI-slides, pigment samples (chlorophyll *a* and HPLC) and seston dry weight. Several microbial groups were targeted for microscopic and molecular analysis. Protist communities were sampled as a guide to the balance of phototrophy versus heterotrophy. Picoeukaryotes and picocyanobacteria were sampled to evaluate whether there is a gradual seasonal change towards dominance by eukaryotic taxa, and a selective loss of prokaryotic phototrophs. Additional samples were obtained to determine the characteristics, sources and photoreactivity of coloured dissolved organic matter (CDOM) and dissolved lignin, and the influence of CDOM and other optically active constituents on the underwater attenuation of UV and PAR.

### *Methodology*

*A. Sampling*

During leg 9, the Amundsen was sailing in open water, in Amundsen Gulf. Samples were taken at 4 stations with a 24-bottle CTD Rosette from 4 photic depths (100%, 10%, 1%, 0.1% surface PAR), the near-bottom and from the depths of the chlorophyll *a* maximum (chl max), the temperature inversion features and the nepheloid layer (neph) whenever present.

*B. Microbial Community Structure*

The following samples were taken from 100%, 10%, 1%, and 0.1% surface PAR; bottom; chl max; t°C inv and neph whenever present:

| | |
|---|---|
| Heterotrophic bacteria (bact) | glutaraldehyde fixation then 0.2 μm black filters on slides with immersion oil DAPI slides |
| Picoplankton (pico) | 0.2 μm black filters on slides with immersion oil |
| Flow cytometry samples (cyto) | paraformaldehyde-glutaraldehyde fixation then frozen in liquid nitrogen |
| Nanoflagellates (nano) | glutaraldehyde fixation then black filters on slides with immersion oil |
| Protists | preserved for fluorescence-Nomarski-Utermöhl microscopy |
| Chlorophyll *a* (chl*a*) | GF/F and 3 μm filtration to separate *Micromonas* and other picophytoplankton |
| Seston dry weight | Preweighted and precombusted GF/F filters |

Sample from surface water and chl max were taken for the following variables:

| | |
|---|---|
| HPLC pigments | GF/F and 3 μm filtration for measurement of MAAs |
| Eukaryotic DNA analysis | 3 μm prefilter and 0.2 μm Sterivex filter. Then preserved in lysis buffer and frozen at –80 degrees. |
| BIOLOG | Inoculate BIOLOG plate and incubate at 4 degrees 10 days. |
| MARFISH | Analyse the uptake of 3H-glucose, 3H-aminoacids and 3H-ATP by heterotrophic bacteria (incubate with substrates and filter). |

*C. Bacterial Production*

Samples were obtained at full and basic stations from depths corresponding to the 4 photic depths, and from the additional depths mentioned above, if present. Bacterial production measurements (Smith & Azam 1992) refined by Josep M. Gasol (ICM, Barcelona, Spain), were assessed for the total and the <3 μm fractions.

Triplicates from each depth were then incubated for 4 h with L-[4, 5-$^3$H] leucine ($^3$H-Leu, final conc. 10 to 20 nM) to measure bacterial protein synthesis. At some selected stations, incubations were also done with [methyl-$^3$H] thymidine ($^3$H-Tdr, final conc. 10 to 20 nM) to measure bacterial DNA synthesis. The incubations were terminated by the addition of trichloroacetic acid (TCA, final 5%). Samples were centrifuged (12 500 rpm for 10 min) and the surnageant was removed by suction and the microtubes were rinsed with ice-cold TCA (5%). Another centrifugation was done in order to rinse the sample. The surgnageant was removed a

second time and scintillation cocktail was added to microtubes. After 24-48h of rest in the dark, the samples were counted with a TriCarb 2900 (Packard). For all depths, two additional time-zero ($T_0$) samples were fixed within 30 seconds of the addition of the isotopes.

*D. Grazing experiments*

One experiment was carried with surface water for an estimation of rates of bacterivory, 3 L bottles were incubated at *in situ* temperature and in the dark for 48 h with addition of FLB (Fluorescenced Labelled Bacteria) at a final concentration of aprox. $10^5$ cells/ml. Samples for flow-cytometry, bacteria and nanoflagellates abundance (DAPI-slides) were taken at time 0, 24 and 48 h from the beginning of the experiment, Initial and final samples were also taken for ciliates (lugol fixation for inverted microscopy).

*E. Complementary samples*

At each of the full stations, additional samples from 4 photic depths and, whenever present, from the depths of the chl*a* max, T°C inv and the neph, where taken for CDOM (colored dissolved organic matter) spectral absorption and DOC (dissolved organic matter).

At the winter station (full 200), surface water were filtered through precombusted GF/F filter for stable isotopes $\delta^{13}C$ and $\delta^{15}N$ analysis of POM.

At stations 200 and 106, samples for the determination of macromolecular ratios of particulate material, (POC/PON, POP and DNA/RNA/protein) that are used to obtain an indication of the physiological and nutritional state of the microplankton communities were also taken (at the surface, chla max and bottom depths). Five liters were filtered for each parameter through a precombusted GF/F filter and immediatly frozen in liquid nitrogen. Analysis will be conducted in ICM (Barcelona).

## *F. Additional experiment carried (Microcosm experiment).*

*Introduction*

One key ecological feature of the arctic marine environment is its strong seasonality, with winter periods of darkness and presence of sea ice during a large part of the year. Phytoplankton concentrations in the water column are very low during the winter and, typically, do not start to increase until late spring. One interesting question that can be asked is: how provision of light to a water sample during the dark period and early spring (pre-bloom) period of the year would affect the taxonomical and biochemical composition of the phytoplankton assemblage in the sample? Furthermore, would these characteristics be similar to those of the natural spring bloom assemblage? In order to approach these topics we designed a series of microcosm experiments to be carried out during winter, spring and summer legs of CASES. The winter experiment was done in leg 3, spring experiment was done in leg 6 and summer experiment through legs 8 and 9. Here, we describe the set-up of these experiments and some preliminary results of the summer experiment.

*Methods*

Surface water was taken at Winter station (without prefiltration) and was distributed into six 10 l Nalgene bottles, which were placed in a container with controlled temperature between 2 - 4 ºC. The bottles were illuminated with four pairs (1 Cool light + 1 Gro-lux) of fluorescent

lamps. Three of the bottles (Light-bottles) received a light intensity of 70-µEinstein $m^{-2}$ $s^{-1}$ (form 0:00 to 23:00 p. m.) and three (Dark-bottles) were covered with black gauze to lower the illumination to about 30 µEinstein $m^{-2}$ $s^{-1}$. Two of the Light (Light 1 and Light 2) and two of the Dark (Dark 1 and Dark 2) bottles received nutrient additions at the following final concentrations: 16 µM nitrate, 1 µM phosphate, 32 µM silicate. A solution of minerals was also added, at the same ratio of nitrate to minerals as in the f/2 medium. The third bottle of each of the Light and Dark sets was left unmodified as a control (Light control and Dark control, respectively). After 15 days of this set-up, final samples were taken from the three Light bottles, in which chlorophyll *a* (Chl *a*) had decreased very strongly. The Dark bottles were left unmodified till leg 9. A new experiment was started on 12 August with the 3 remaining bottles (Light bottles). Each of these Light bottles received an illumination of 20 µEinstein $m^{-2}$ $s^{-1}$.

Samples for measurement of nitrate, phosphate, silicate and POC, PON and POP concentrations were taken at the beginning and the end of the experiments. Every other day, the bottles were sampled for determination of Chl a, bacteria (flow cytometry), nanoflagellates (epifluorescence microscopy) and phytoplankton (inverted light microscopy). Fixation and preparation of the samples was done as described in the Microbial Ecology report.

*Preliminary results*

Chl *a* concentrations increased in all the Light and Dark bottles during the first 10 days after the beginning of the experiment (Fig. 1). The rate of increase was strongest in the Light bottles, exposed to the highest irradiance, than in the Dark ones. Differences between nutrient treatments were found in the Light bottles, with the nutrient enriched bottles showing higher Chl *a* concentration than the controls. However, the same differences were not found in the Dark bottles. The second experiment (20 µEinstein $m^{-2}$ $s^{-1}$) showed the same trend of increasing chl *a* concentrations than the previous in Dark bottles (30 µEinstein $m^{-2}$ $s^{-1}$, Fig. 2). Indeed, this experiment showed a clear stimulating effect of nutrient enrichment. Despite these preliminary results indicated an effect of both light and nutrient conditions on chl *a* concentrations, an interpretation of the microcosm experiment results will have to wait until processing of the samples is completed. Among other aspects, it will be important to ascertain whether the phytoplankton taxa growing in the experiments are typical of phytoplankton blooms in the region, and if the different treatments have an effect on the plankton composition and stoichiometry.

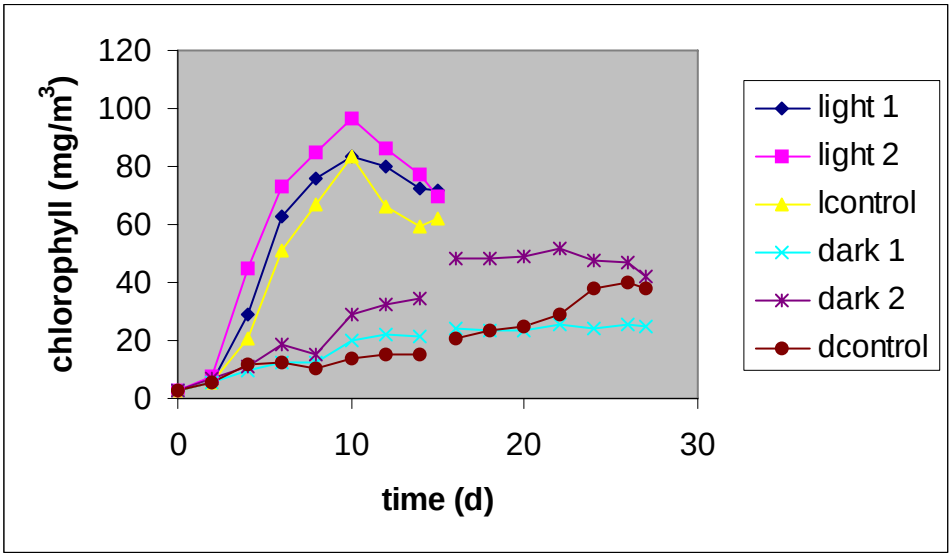


Figure 1: Time course of chlorophyll concentrations in the microcosm summer experiment (legs 8 & 9).

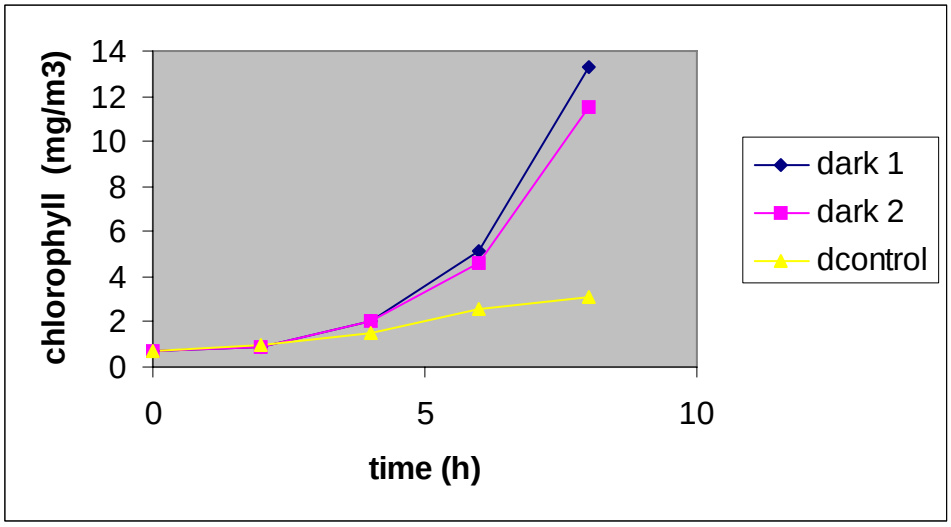



Figure 2: Time course of chlorophyll concentrations in the second summer experiment (9).

Virus studies

Unlike temperate and tropical regions, little is known about the distribution, production, or diversity of marine viruses in polar regions. The objectives of the viral component of the microbial subprogram are to 1) determine the vertical/horizontal distribution of viral particles; 2) determine the diversity of viral isolates and viral genes; and 3) determine the rates of virus production and viral-induced mortality; all on a spatial and temporal basis. The achievement of complete synergy with the remaining microbial components is of paramount importance – all samples/depths/locations analysed for microbiological parameters will be targeted for virus study.

## *Methodology*

*A. Viral Community Structure*

All depths, from full stations, that were targeted for microbial community structure (see above) were also targeted for viral study with the following samples:

| | |
|---|---|
| Total viral abundance (virus) | 0.02 μm anodisc filters, stained with YO-PRO, on slides |
| Flow cytometry samples (vcyto) | 2 mL sample fixed with gluteraldehyde |

B. Viral Diversity

To examine the viral diversity, about 70 to 90 L of seawater was sampled at 3 selected depths (surface, chl a max, below chl a max) and was further concentrated ~400-fold to 0.5 L using pre-filtration and ultrafiltration processes (Suttle *et al.* 1990). The resultant viral concentrates (VCs) will be analysed in the laboratory for the presence of viruses infecting a selection of phytoplankton and bacterial species. The VCs also provide an adequate source of viral DNA for genetic analysis of the entire viral community, or subsets therein (ex: micro-algal viruses vs. classes of bacteriophages).

C. Virus Production and Virus-Induced Mortality

Three experiments were carried out in order to estimate virus production (vprod), lysogenic induction (lyso) and virus-induced mortality (vmort) with water from chla max depth at station 200. Virus production rates are measured by diluting and re-suspending the native bacterial community using virus-/bacteria-free seawater (ultrafiltrate – a by-product of the VC process) from the same depth. The community is re-suspended to ambient concentration with a now reduced background of native viruses. The production of new viruses is then monitored over time using both epifluorescence microscopy and flow cytometry. The induction of lysogenic bacteria in the water column was estimated in the presence a known mutagen agent (Mitomycin C). Virus-induced mortality rates are measured by a dilution technique, modified originally from plankton grazing experiments. Whole water is diluted with 0.22 μm-filtered seawater or ultrafiltrate from the same location/depth to create a gradient of whole water fractions (10, 40, and 60%). Growth rates are then obtained from each fraction and plotted to show the suppression of growth by viral infection (ultrafiltrate dilutions) and grazing (0.22 μm-filtered dilutions).

References

Evans C, Archer SD, Jacquet S, and Wilson WH (2003) Direct estimates of the contribution of viral lysis and microzooplankton grazing to the decline of a *Micromonas* spp. population. Aquatic Microbial Ecology 30:207-219

Smith DC and Azam F (1992) A simple, economical method for measuring bacterial protein synthesis rates in seawater using $^{3}$H-leucine. Marine Microbial Food Webs 6: 107-114

Suttle CA, Chan AM, and Cottrell MT (1990) Use of ultrafiltration to isolate viruses from seawater which are pathogens of marine phytoplankton. Applied and Environmental Microbiology 57:721-726

Wilhelm SW, Brigden SM, and Suttle CA (2002) A dilution technique for the direct measurement of viral production: a comparison in stratified and tidally mixed coastal waters. Microbial Ecology 43:168-173

**Table 1. Summary of leg 9 samples**

| Date | Station | Depths | Samples |
|---|---|---|---|
| 06-august-2004 | 200 full | Surface, 10% (T.inv.), 1%, 0.1%, Chl max, Bottom | $^{3}$H-TdR and $^{3}$H-Leu, Chl*a* (total and <3µm), FCM, ciliates and FISH bacteria and flagellates (all depths except 0.1 %), POC/PON (total and <3µm), CDOM, DOC, HPLC (total and <3µm), Pico slides, Nanoflagellate DAPI slides, Bacteria DAPI slides (totale and <3µm), protists, virus, vcyto. |
| 06-august-2004 | 200 full | Surface, Chl max, Bottom | VC, vprod, lyso, vmort, eukariotic DNA, POC/PON/POP, DNA/RNA/protein, Chl*a* (total, < 50 µm and <3µm) |
| 06-august-2004 | 200 full | Surface | BIOLOG, DMS/DMSP, MAR-FISH (3H- glucose, aminoacids, ATP and leucine), grazing experiment. |
| 08-august-2004 | 124 basic | Surface, Chl max | $^{3}$H-TdR and $^{3}$H-Leu, Chl*a* (tot and <3µm ), POC/PON (total and <3µm), CDOM, DOC, HPLC (total and <3µm), Pico slides, Nanoflagellate DAPI slides, Bacteria DAPI slides (totale and <3µm), protists. |
| 09-august-2004 | 106 full | Below Pycnocline, Chl max, Surface | VC |
| 10-august-2004 | 106 full | Surface, 10%, 0.1%, Chl max (1%, neph), T.inv., | $^{3}$H-TdR and $^{3}$H-Leu,, Chl*a* (total and <3µm), POC/PON (total and <3µm), CDOM, DOC, HPLC |

| | | | |
|---|---|---|---|
| | | Bottom | (total and <3µm), Pico slides, Nanoflagellate DAPI slides, Bacteria DAPI slides (total and <3µm), protists, virus, vcyto. |
| 10-august-2004 | 106 full | Surface | FCM, FISH bacteria and flagellates, Chl*a* (total, <50µm and <3µm), eukariotic DNA, POC/PON/POP, DNA/RNA/protein, BIOLOG, DMS/DMSP and ciliates. |
| 18-august-2004 | 007-ArcticNet | Surface, Chl max | $^{3}$H-TdR and $^{3}$H-Leu, Chl*a* (tot and <3µm), POC/PON (total and <3µm), CDOM, DOC, HPLC (total and <3µm), Pico slides, Nanoflagellate DAPI slides, Bacteria DAPI slides (totale and <3µm), protists, |

**Ocean Mapping Group Cruise Report**

Cruise participants: Jonathan Beaudoin & Steve Brucker

## Introduction

The Ocean Mapping Group (OMG) was onboard Leg 9 of CASES to perform seabed mapping as part of its role in the ArcticNet project (P1.6). The primary purpose of the mapping on this leg was to collect as much bathymetry and sub-bottom information as possible while transiting between CASES science stations and during the return transit through the Northwest Passage. Aside from ~3 days of ice breaking operations during the return transit, bathymetry and sub-bottom data were successfully collected during the entire cruise. The limiting factor in the quality of the bathymetry data was the infrequent sound speed profile collection. High vessel speeds (14-15kts) en route to Churchill reduced the accuracy of the EM300 bathymetric solutions in addition to degrading the sector performance and along-track coverage in deeper waters. The high transit speed also introduced noise into the K320R sub-bottom profiles.

## Equipment

Kongsberg-Simrad EM300 Multibeam echosounder
Knudsen K320R Sub-bottom profiler
Applanix POS/MV 320
C&C Technologies CNAV GPS
Surface sound speed probe
Surface temperature and salinity probe
SBE Seabird19
SBE Seabird19plus
Brooke Ocean Technology (BOT) MVP-300

## Onboard Logging and Processing Procedures

The EM300 data were logged in the Kongsberg-Simrad raw format and converted to the OMG format after line completion (new survey lines were automatically generated on an hourly basis). The soundings were cleaned and inspected on a daily basis. Backups of the raw data being were made every few days on an exabyte tape (though they were copied to the processing computer on a daily basis). The processed data files were backed up on a separate laptop and an external 160GB USB hard drive.

The K320R data were logged in the Knudsen binary format (.keb), though some of the lines were logged in SEG-Y format on special request during one of the reconnaissance surveys. Data were converted to OMG format and then backed up in the manner mentioned earlier.

The CNAV data consisted of NMEA strings and were captured to a text file using HyperTerminal, with a new files being created at approximately midnight (UTC) every

day. At the end of each day (UTC), these data were backed up to the processing computer and converted to OMG format.

For surface sound speed, the probe data (when functioning) were logged directly into the EM300 raw data files. Given the grossly erroneous readings provided from the probe, the only other source of surface sound speed came from a temperature and salinity probe (TS probe), operated by the oceanography team onboard. The data were logged to a PC in the acquisition room and were used on an hourly basis to update the surface sound speed. These data were also made available as a time-series for correction of the EM300 beam pointing angles in post-processing. The TS probe raw data format consisted of ascii text files in columnar format. At the end of each day (UTC), the data were backed up to the processing computer and converted to the OMG format.

Sound speed profiles were collected on either the rosette shack PC or the OMG laptop. Raw files (collected in binary format) were converted to text files, copied to the processing PC and finally converted to OMG format, at which time the profiles were visually inspected for spurious data points. Profiles were tagged with time and position in real-time when provided by the rosette shack. The OMG collected profiles were tagged with time and position by hand after the collection since the SeaBird internal clock was not synchronized to UTC. The sound speed profile log below gives the date, time and location of each dip collected for use with the EM300.

The BOT MVP-300 data were transferred to the processing computer and backed up to the OMG laptop and external USB disk.

**Mapping Procedures & System Performance**

Given time constraints in Leg 9, there was little time dedicated to mapping. As such, mapping operations were limited to transit lines between science stations and 2 small reconnaissance surveys at box-core sites.

The EM300 and K320R performed as well as expected given the ice conditions throughout the passage. The ice-free transit data were of good quality, the limiting factor being the frequency of sound speed profile collection. The MVP300 was deployed early in the cruise (August 7$^{th}$), however, the bridle supporting the towfish had come critically close to failure and it was not used after the initial deployment (the deployment ran for 7.5 hours with a vessel speed of 10kts; depths ranged from 200 to 400 metres, yielding a total of 60 profiles). The rosette/CTD casts at each science station provided adequate sound speed profiles in the Beaufort Sea during science operations, yielding 20 profiles in the first four days of the cruise.

After the return transit began through the passage, sound speed profiles were collected using a SeaBird19 on the forward deck (not that the winch was limited to ~500 metres), with the sampling frequency dropping to one profile per day on average. Ideally, several profiles per day could have been collected, however, there was little time to spare during the return transit due to unknown ice and weather conditions. Sound speed profiles were

uploaded to the EM300 transceiver as soon as possible to allow for real-time application of the profile.

The surface sound speed probe, which was discovered to be broken during leg 8, was repaired 18 days into the cruise. A subset of the data is plotted below with the sound speed derived from the TS probe for comparison. It is clear that the speed probe is providing grossly inaccurate readings of sound speed.

Post-processing steps will consist of repointing the sonar-relative beam angles using the surface sound speed derived from the TS probe, followed by re-raytracing using an appropriate sound speed profile.

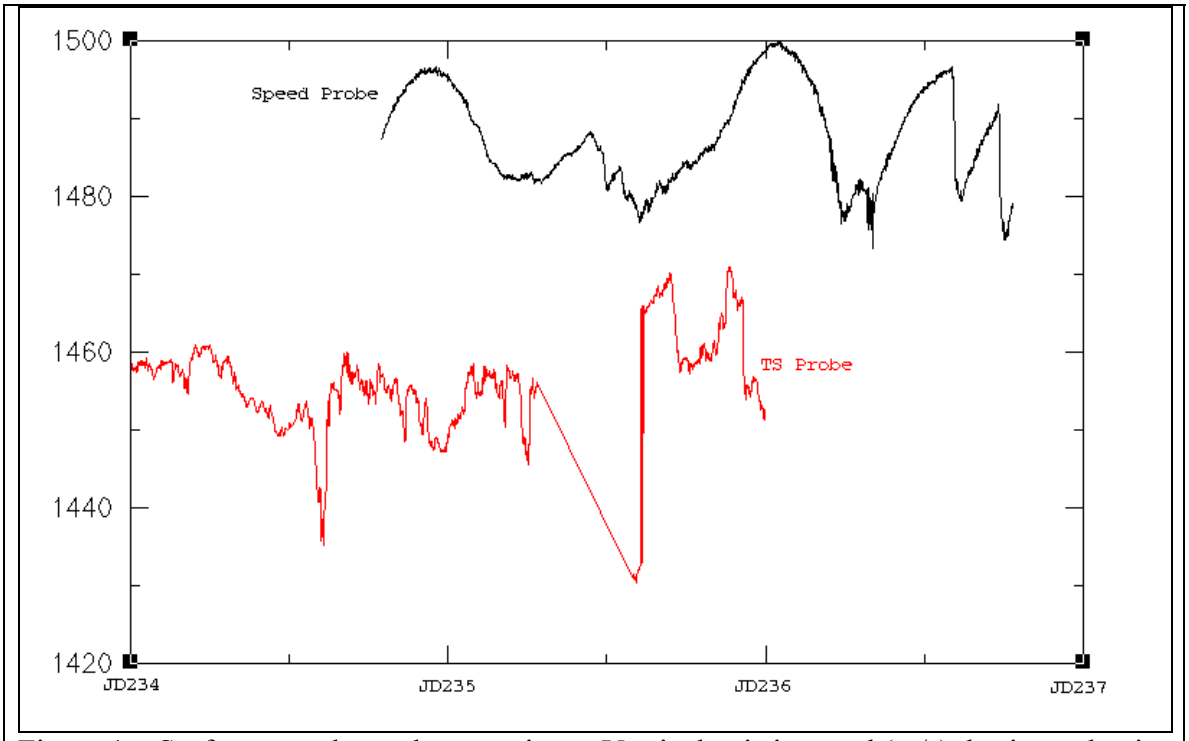



Figure 1. Surface sound speed comparison. Vertical axis is speed (m/s), horizontal axis is day of the year. The speed probe data do not agree at all with those provided by the TS probe, suggesting that the speed probe readings are not to be trusted.

## Appendices

## Sound Speed Profile Log

| Date | File | Latitude | Longitude |
|---|---|---|---|
| 8/6/2004 6:10 | 0406001.svp | 70.06433 | -126.301 |
| 8/6/2004 10:09 | 0406002.svp | 70.044 | -126.286 |
| 8/6/2004 12:13 | 0406003.svp | 70.03967 | -126.279 |
| 8/6/2004 14:42 | 0406004.svp | 70.04183 | -126.261 |
| 8/6/2004 20:09 | 0406005.svp | 70.03017 | -126.237 |
| 8/7/2004 2:18 | 0406006.svp | 70.0405 | -126.176 |
| 8/7/2004 9:51 | 0406007.svp | 70.04283 | -126.3 |
| 8/7/2004 11:51 | 0406008.svp | 70.045 | -126.292 |
| 8/7/2004 16:34 | Begin MVP (August07_003.svp) | 70.09648 | -126.17 |
| 8/7/2004 23:53 | End MVP (August07_060.svp) | 71.27827 | -126.389 |
| 8/8/2004 2:45 | 0406009.svp | 71.4035 | -126.798 |
| 8/8/2004 7:34 | 0406010.svp | 71.39717 | -126.683 |
| 8/8/2004 18:07 | 0406011.svp | 70.941 | -125.85 |
| 8/9/2004 0:19 | 0406012.svp | 70.94083 | -125.851 |
| 8/9/2004 8:03 | 0406013.svp | 70.75467 | -124.239 |
| 8/9/2004 13:33 | 0406014.svp | 70.75433 | -124.239 |
| 8/9/2004 23:09 | 0406015.svp | 70.60067 | -122.633 |
| 8/10/2004 3:06 | 0406016.svp | 70.60433 | -122.661 |
| 8/10/2004 10:33 | 0406017.svp | 70.60033 | -122.631 |
| 8/10/2004 12:49 | 0406018.svp | 70.60117 | -122.628 |
| 8/10/2004 16:42 | 0406019.svp | 70.59417 | -122.611 |
| 8/10/2004 21:42 | 0406020.svp | 70.59933 | -122.622 |
| 8/12/2004 1:15 | 20040812_011500.svp | 68.52661 | -110.013 |
| 8/12/2004 8:47 | 0407001.svp | 69.0005 | -106.584 |
| 8/13/2004 3:02 | 20040813_030200.svp | 68.66976 | -102.684 |
| 8/17/2004 6:30 | 20040817_063000.svp | 73 | -91.333 |
| 8/18/2004 3:00 | 20040818_030000.svp | 74.64333 | -88.7833 |
| 8/18/2004 8:06 | 0406022.svp | 74.28683 | -85.5875 |
| 8/18/2004 19:26 | 0406023.svp | 74.226 | -83.3375 |
| 8/18/2004 23:01 | 0406024.svp | 74.15967 | -81.2423 |
| 8/20/2004 1:39 | 20040820_013900.svp | 72.67333 | -78.9167 |
| 8/20/2004 16:15 | 20040820_161500.svp | 71.1295 | -71.299 |
| 8/23/2004 18:00 | 20040823_180000.svp | 62.59333 | -72.645 |
| 8/24/2004 13:41 | 20040824_134100_a.svp | 62.01667 | -82.4 |
| 8/24/2004 13:41 | 20040824_134100_b.svp | 62.01667 | -82.4 |
| 8/25/2004 2:20 | 20040825_022000.svp | 60.905 | -86.8017 |

# *Nutrients and New Production*

Cruise Report for the CASES and ArcticNet components of Leg 9

*Jean-Eric Tremblay*

*Participant: Jean-Eric Tremblay (McGill University)*
*Principal investigator : Neil Price (McGill University)*

## Introduction

Roughly one third of the water outflow from the Arctic Ocean escapes through the channels of the Canadian Archipelago and influences physical and chemical properties of downstream marginal seas and bays. Because the chemical composition of waters derived from the Pacific, rivers and the Atlantic differs markedly, nutrient ratios can be used to track the large-scale circulation and quantify the penetration of different water masses into the archipelago. In addition to physical processes, biological activity imparts a strong seasonal signal on nutrient inventories. In the western Arctic, blooms typically develop when melting stratifies the upper water column in July or August. A striking exception occurs in polynyas, where phytoplankton bloom as early as May owing to the precocious appearance of completely or partially open waters. Incidentally, the magnitude of the seasonal nutrient deficit in surface waters provides a time-integrated estimate of new phytoplankton production. The stripping of nutrients from the surface by convection and biological uptake in polynyas presumably limits summer nutrient inventories and ecosystem productivity downstream in the Baffin Land and Labrador current systems. However, little is known about the temporal variability of the large-scale circulation, the penetration of different water masses and the magnitude of new production in the Canadian Archipelago.

### Specific objectives

The main objective for leg 9 was to measure nutrients in the Amundsen Gulf (Cape Bathurst Polynya), during the northward transit to Barrow Strait, and along Lancaster Sound (including the site of the Lancaster Sound Polynya). Due to difficult ice conditions during transit, sampling was limited to one station in Victoria Strait and two stations in Lancaster Sound. The secondary objective of the leg was to complete the analysis of samples collected at the overwintering site from legs 3 to 6.

## Methods

High-resolution sampling of the water column was performed with a Rosette sampler equipped with 12-l Niskin bottles and an ISUS nitrate probe. Special attention was given to resolving the steep vertical gradients of silicate across the Arctic halocline. Concentrations of nitrate, nitrite, orthophosphate and orthosilicic acid were determined on fresh samples using a Bran+Luebbe Autoanalyzer 3 system with colorimetric methods adapted from Grasshof (1999). Frozen samples from the winter were melted rapidly in a tepid water bath and shaken exhaustively to avoid salt errors.

**Table 1**. List of stations and measurements

| Station | Cast(s) | Date | Longitude | Latitude | Measurement |
|---|---|---|---|---|---|
| CASES 200 | 002 | 06/08/04 | 126° 16.74 | 70° 02.39 | Nutrients |
| CASES 124 | 003 | 06/08/04 | 126° 47.80 | 71° 24.22 | Nutrients |
| CASES 118 | 009 | 08/08/04 | 125° 51.14 | 70° 56.40 | Nutrients |
| CASES 112 | 011 | 08/08/04 | 124° 14.32 | 70° 45.29 | Nutrients |
| CASES 106 | 013 | 09/08/04 | 122° 37.22 | 70° 36.06 | Nutrients |
| ArcticNet 002 | 018 | 10/08/04 | 106° 35.00 | 69° 00.03 | Nutrients |
| ArcticNet 007 | 021 | 12/08/04 | 085° 35.22 | 74° 17.22 | Nutrients |
| ArcticNet 009 | 022 | 18/08/04 | 081° 14.56 | 74° 09.58 | Nutrients |

## Reference

Grasshoff, K., Methods of seawater analyses, Weinheim, New-York, 600 p., 1999.

# Zooplankton / Young-Fish Team Report
# CASES 03/04 Leg 9

**Participants :**

Gérald Darnis,
Louis Létourneau,
Luc Michaud and
Anna Prokopowicz,
with the assistance of Pascal Massot.

## General objectives and summary of achievements

The brief leg 9 was essentially a continuation of the sampling scheme implemented at the end of leg 8. During the 5 day duration of the last sampling period of CASES, the effort was concentrated on the Cape Bathurst Polynya study area with the overwintering site in Franklin Bay (station 200) being also sampled. The objectives of our team were to: 1) pursue open water sampling of zooplankton and fish larvae by using various mesozooplankton nets (vertical and horizontal plankton nets, Bioness) and a macro-zooplankton / small fish Rectangular Midwater Trawl (RMT) to better describe their distribution (both vertically and spatially) and community structure; 2) measure lipid content and dry mass and estimate egg production and respiration rates of key copepod species 3) assess the feeding and physiological states of the amphipod *Themisto libellula.*

Two full and 3 basic stations were visited during leg 9. Integrated vertical tows for zooplankton were completed with a variety of samplers (see below), twice at full and once at basic stations. Oblique tows were performed with the 2x1-$m^2$ Tucker net on the same schedule as the vertical tows. The Bioness was deployed twice at each of the two full stations ant the RMT once at the same stations. Integrated vertical tows for zooplankton were completed twice at full and once at basic stations. At full stations a rosette cast was dedicated to sampling of microzooplankton (50µ) associated with the mesozooplankton and larval fish distribution obtained from Bioness profiles. Our seawater needs for live experiments were provided by bottles taken on these same casts.

## ***I : Open Water Sampling***

Open water sampling resumed shortly after the crew change in the vicinity of the overwintering site (full station 200); details of all sampling operations are provided in Appendix 1.

### *a) Vertical tows (2x1-$m^2$ Square Nets)*

Overall, vertical tows were completed at 2 full and 3 basic stations during leg 9. Integrated vertical tows for zooplankton were conducted with a sampler composed of a frame supporting two 1-$m^2$ aperture square nets (200-µm and 50-µm Nitex mesh) equipped with rigid, closed cod ends for capturing live specimens and a TSK upward-counting flowmeter. *De visu*, *Calanus hyperboreus* and *Metridia longa* seem to be the two more abundant large species in these two regions, whereas distribution and abundance of *Calanus glacialis* were irregular but associated mainly with deeper waters.

### *b) Oblique tows (Tucker trawl, Bioness and RMT)*

Oblique tow sampling during leg 9 was specifically aimed towards catching amphipods (*Themisto libellula*) as well as larval and juvenile fish. The efficient and reliable 2 x 1-$m^2$ Tucker trawl was equipped with 50 µm, 500 µm and 750 µm nets. On the four times it was used the Bioness failed once at stratifying the first meters of the water column at station

106. As on leg 8 the Tucker trawl remained generally more efficient than the Bioness at catching *T. libellula* and fish larvae. The large RMT was deployed twice during leg 9 and again used in conjunction with the monitoring of the EK-60 echosounder. Although unsuccessful, the recorded data will be further analysed after completion of the CASES field program to gain new information on fish distribution and behaviour.

## ***II: Laboratory Measurements and Experiments***

The emphasis given to laboratory experiments on previous legs was maintained on leg 9. Egg production measurements on two of the three main Arctic copepods (*Calanus hyperboreus, Calanus glacialis* and *Metridia longa*) were realised twice and indicated that *C. glacialis and M. longa* were still spawning in the polynya. Incubations for estimating egg production of *C. hyperboreus* had been ended on leg 8 as the gonad maturation state of the females showed that this species had completed its reproduction season. Lipids were assessed on the three species of large copepods as well as on *Themisto libellula* juveniles, the most abundant stage of the four species, using recorded images and samples preserved in dichloromethane. Respiration was measured directly as oxygen consumption on the different stages of the three copepod species. Specimens were also deep frozen for later analysis of the Electron Transport System (ETS), an enzymatic index of respiration. Finally incubations were implemented at full stations to measure the grazing rates of different development stages of the same three species of copepods.

### *a) Egg production*

Thirty females of *C. glacialis* and *M. longa* were selected from the 200 µm mesh nets of the vertical tows. Individual females were incubated for a period of four days at sea temperature in a petri dish filled with filtered seawater. A false bottom sieve was placed in the dish to prevent cannibalism on the eggs. Eggs were counted after every 24 hour period and at the end of the incubation when the prosome length was measured. An analysis of the state of gonad maturation was also conducted on the incubated females. A total of 60 female *C. glacialis* and 30 female *M. longa* were incubated during this leg (Table 1). Scarcity of females already encountered on leg 8, especially of *C. glacialis*, made difficult the sorting of animals for egg production

The long term egg production experiments on batches of females collected July 20 and 23 were continued until the 16 of August. Furthermore, the hatching success experiment

with eggs of *C. glacialis* collected on July 20 and 23 was pursued until the 10 of August. Preliminary results indicate that *C. hyperboreus* has finished completely his winter spawning and that *C. glacialis* is still producing eggs. However, increasing number of spent females and a decrease in egg production rate indicate that the reproduction of this species is declining. *M. longa* was spawning slowly and continuously non-viable eggs during leg 9.

**Table 1.** Egg production measurements performed during leg 9.

| ***Date*** | **Station** | ***C. glacialis*** ♀ | ***M. longa*** ♀ |
|---|---|---|---|
| **(2004)** | | | |
| 06 August | Overwintering | 30 | 30 |
| 10 August | 106 | 30 | - |

***b) Dry Mass experiments***

Copepods CIV, CV and females of the three major calanoid species were collected at the overwintering site and at station 112 as shown in Table 2. The animals were put individually in tin pre-weighed capsules for dry mass and CHN measurements that will be realized at University Laval.

**Table 2.** Calanoid copepodites & adults preserved for dry mass measurements during leg 9.

| ***Date*** | **Station** | ***M. longa*** | | | ***C. glacialis*** | | | ***C. hyperboreus*** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **(2004)** | | **CIV** | **CV** | ♀ | **CIV** | **CV** | ♀ | **CIV** | **CV** | ♀ |
| 06 August | Overwintering | 0 | 15 | 15 | 0 | 15 | 15 | 15 | 15 | 15 |
| 09 August | 112 | 15 | - | - | - | - | - | - | - | - |

***c) Lipid analyses***

Copepod CV and females of the three major Calanoid species were collected at the overwintering site in order to carry out analyses of individual lipid content. Live animals were immediately measured and sexed. All individuals were filmed in dorsal and lateral view to evaluate the volume of their lipid storage sac. They were dried on filter paper before being dispatched individually in 5 ml glass cryovials. Dichloromethane (3 ml) was added to each vial which was then flushed with nitrogen and stored at - 20°C.

**Table 3.** Calanoid copepodites & females used for lipid analyses during leg 9 of CASES04.

| **Date** | **Stations** | ***M. longa*** | | ***C. glacialis*** | | ***C. hyperboreus*** | |
|---|---|---|---|---|---|---|---|
| **(2004)** | | **CV** | ♀ | **CV** | ♀ | **CV** | ♀ |
| 06 August | Overwintering | 10 | 10 | 10 | 10 | 10 | 10 |

***d) Respiration rates and Electron Transport System (ETS)***

Respirometry was performed at stations 118 and 106. All the animals used for the measurement of respiration rates were preserved for later measurements of ETS. The following table details the number of organisms incubated and preserved.

**Table 4.** Calanoid copepodites & adults used for respirometry and ETS.

| ***Date*** | **Station** | ***M. longa*** | | | ***C. glacialis*** | | | ***C. hyperboreus*** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **(2004)** | | **CIV** | **CV** | ♀ | **CIV** | **CV** | ♀ | **CIV** | **CV** | ♀ |
| 06 August | 118 | | | | | 60 | 50 | | | 20 |
| 10 August | 106 | | 70 | 60 | | | | | | |

***e) Grazing experiment***

Incubations for the assessment of the grazing rate of stages CV and females of the copepods *C. glacialis, C. hyperboreus* and *M. longa* were performed on the 06 and 10 of August respectively at stations 200 (Overwintering) and 106. For that purpose, water was collected in the chlorophyll maximum layer and placed in 2l liter bottles before adding a known density of selected stages of copepods. During these two experiments, some technical adjustments had to be done on our first zooplankton wheel. Before the

experiment, the chl a level was measured and water preserved for further analysis of the abundance of microzooplankton prey. After about 40 hours of incubation, the chl a in the incubated water was again measured in the control bottles and those with the animals to evaluate the diminution of chl a. The cell counts will be done at University Laval after the cruise.

***f) Larval fish morphometry***

The emphasis on collecting arctic cod (*Boreogadus. saida*) larvae was maintained as for leg 8. Larvae were obtained from both the vertical profiles from the BIONESS and the regular samples from the Tucker oblique tows used to monitor the surface layers of the surveyed regions. Morphometry measurements were conducted on the first 25 *B. saida* collected at each station. All fish larvae measured were preserved separately in ethanol 95% while the remaining larvae in each sample were simply counted for further quantitative analyses.

***g) Themisto libellula processing***

Leg 9 was mainly focusing on the feeding experiments. All the individuals were fed manually by non stained preys. *T.libellula* were incubated for 6 and 14 days in filtered seawater. Among all incubated animals just on 20 of them the experiment was successfully conducted. The feeding was processed under microscope in a cold room (0.8°C). Preys like *C.hyperboreus* CV, *C.glacialis* CV, *M.longa* F, *and Chaetognaths, Boreogadus saida* were used for feeding exp. To obtain information on any differences about digestion time related to the number of eated preys. *T.libellula* were fed with different numbers of preys. After the feeding procedure some of the animals were incubated for 24h, 36h, 48h, 60h, 72h and preserved in formaldehyde. The different time of incubation will allow tracing the digested prey in their stomach.

Preliminary observations:

- Small size preys were eaten completely while the larger ones were cut in half and just the inner part was taken (see picture)
- After feeding with *Chaetognaths* the entire body was consumed except of the head part where the spines are attached (see picture)
- No feeding was observed on fish larvae (probably due to the non fresh prey)

- Either *T. libellula* accepted either alive or dead preys

**Table 1: Summary of Laval zooplankton team activities**

| Date | Station | Type | Depth (m) | 2 X2 Vertical Square Net | Oblic Double Square Net | Bioness | RMT | Rosette | Eggs production | Respiration rates | ETS | Lipids content | Dry Weight | Grazing | Fish Larvae morphometry | Themisto Processing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ###### | 200 | Full | 225 | X | X | X | X | X | X | X | X | X | X | X | X | X |
| ###### | 124 | Basic | 432 | X | | | | | | | | | | | X | X |
| ###### | 118 | Basic | 400 | X | X | | | | | | | | | | X | X |
| ###### | 112 | Basic | 490 | X | X | | | | | | | | X | | X | X |
| ###### | 106 | Full | 539 | X | X | X | X | X | X | X | X | | | X | X | X |
| ###### | End of CASES-Heading to Churchill | | | | | | | | | | | | | | | |

Last sample of CASES project was taken 10 of August at station 106.

# CASES LEG 9 report:

**Group:** Ocean Science Centre of Memorial University of Newfoundland, St. John's, Canada

**Group leader:** Don Deibel

**Leg 9 participant:** Piotr Trela

## Primary themes:

- **Theme 5:** Pelagic Food Web: Structure, Function and Contaminants
- **Theme 6:** Organic and inorganic fluxes
- **Theme 7:** Benthic processes and carbon cycling

# Introduction:

The main interests of our group are the flows of organic and inorganic carbon through the zooplankton community and into the epibenthic community. To study these flows, during leg 9 I collected data on:

(1)The abundance and vertical distribution of mesozooplankton,

(2) The biogeochemical composition of water column zooplankton, particulate matter and zooplankton faecal pellets,

(3) The biogeochemical composition of particulate matter in the epibenthic layer

# 1. The abundance and vertical distribution of the mesozooplankton

We are interested in fine vertical distribution of mesozooplankton and its potential food sources (marine snow, diatoms) in the water column. For this objective we have been collecting data using underwater video technology. Video instruments allow the observation of mesozooplankton and marine particles in their natural environment, at scales much smaller than those possible with traditional tools such as nets. This technology allows also observation of fragile organisms and particles that are easily destroyed in nets or other sampling tools. Of course, the video recorders have their own limitations - one cannot preserve the observed organisms or analyze their composition, and the sampled volume is much smaller than the volume sampled by the nets. Therefore, video systems could complement, not replace, the traditional methods.

In the CASES program we have been using two video system - Video Plankton Recorder (called here: VPR), based on the design by *Tiselius*, (MEPS 164:, 293-299, 1998) and AutoVPR produced by Seascan (called here: "Particle Camera"). During leg 9 I used both of them.

The VPR consists of a strobe light, video camera, video cable providing the real-time image to the monitor and S-VHS VCR on the ship, and a CTD mounted on the VPRs frame. During the CASES component of leg 9 I have carried 8 VPR casts and 9 casts using Particle Camera. Each cast consisted of several vertical tows, at speed of 30 metres

per minute. The maximum deployment depth was 200m for the VPR and 500m for the Particle Camera.

### Preliminary results:

The video files from the Video Plankton Recorder and the Particle Camera contain many images of zooplankton (chaetognaths, ctenophores, copepods, jellyfish and others).

I will try to correlate the distribution of the organisms recorded by the VPR and the Particle Camera with the vertical profiles of seawater properties from CTDs mounted on these instruments and relate them to data collected by other groups, in particular with net zooplankton abundance data collected by the Fortier's group.

## 2. Biogeochemical composition of the water column zooplankton, suspended particulate matter and faecal pellets.

The primary goal here is to determine the source of food of zooplankton. To achieve this, a member of our group (*T. Businsky*) will use fatty acid biomarkers and C/N ratioes to distinguish between the marine and the terrestrial signals. She predicts that herbivorous copepods would feed selectively on marine plankton, whereas appendicularians, as non-selective feeders, will incorporate the terrestrial organic material in proportion to its abundance in the water column (see also *Parsons et al.*, Polar Biol. 1989, 9: 261-266).

During Leg 9 at full stations: 200 and 106, in the live tows from a Tucker net obtained courtesy of the Fortier's group, I identified 5 dominant taxa, picked up to 40 individuals in each taxon, measured the length of 20 of them, and preserved for further analysis of the fatty acid markers in chloroform. Also up to 20 organisms from each group were frozen at -20C for CHN analysis.

From the same two full stations I filtered the water to provide material for the lipid and CHN analysis of the suspended particulate matter. The water was collected by the ship's CTD rosette from the surface, near-bottom, and "special feature" depth - the chlorophyll maximum or nepheloid layer.

I also collected copepod and appendicularian faecal pellets from vertical tows (200m - 0m) using a diatom net and from samples obtained from the floating sediment traps, deployed at 50 m (courtesy of Thomas Juul-Pedersen).

## 3. The biogeochemical composition of particulate matter in the epibenthic layer

I obtained the near-bottom water using bottom-tripping Niskin at stations 200 and 124.

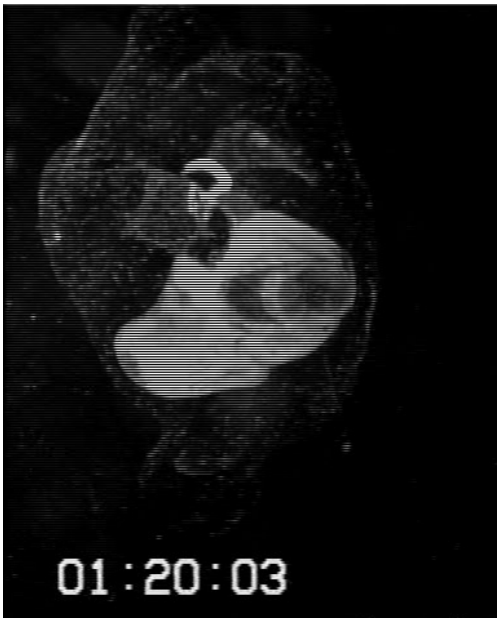
The suspended matter in the samples was filtered and frozen for the future lipid and CNP analyses.

## The ArcticNet component

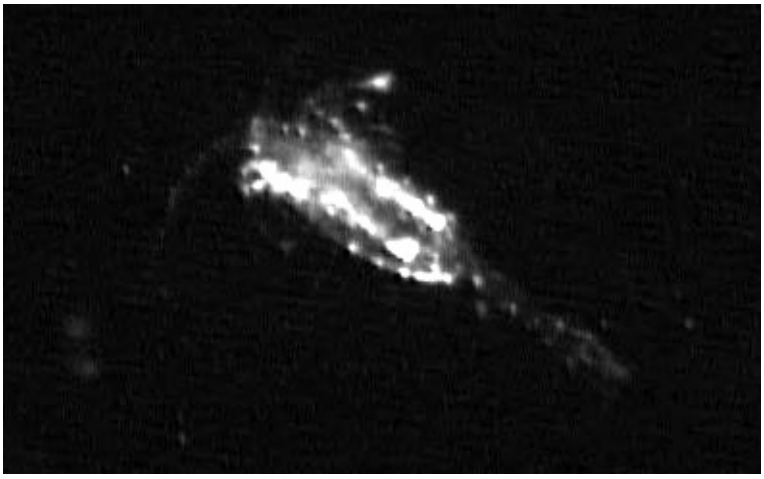
In addition to the described above sampling activity in the CASES area, I carried the VPR and Particle Camera on three Arctic Net stations on the way to Churchill.

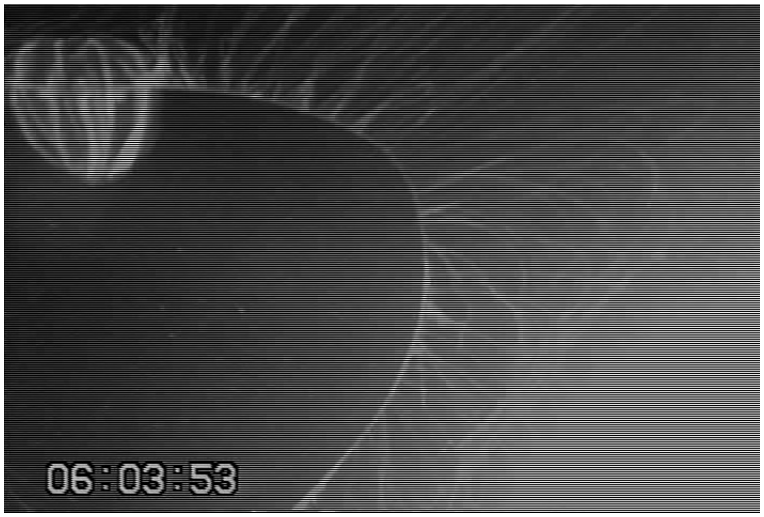
At the last two stations, in the Lancaster Sound, in addition to usual zooplankton images I observed not yet unidentified objects that look like strings of organic matter. Also the

images from the VPR in the top 50 metres were quite grainy, perhaps indicating presence of some coarse particles and/or results of the flocculation processes.








06:03:53


06:00:57

# PART 3

# Leg 9 log of daily activities

**CASES Leg 09 daily sampling schedule**

| | 01:00 | | | |
|---|---|---|---|---|
| **Date** | **start** | **stop** | **duration** | **Activity** |
| 2004-08-06 | 00:00 | 00:30 | 0.50 | rosette + CTD cast 200m (Marie-Emmanuelle) |
| Friday | 00:30 | 04:00 | 3.50 | **transit to 200 (full station: 236 m)** |
| | 04:00 | 05:00 | 1.00 | rosette 1 - contaminants 1 (Eric) |
| | 05:00 | 06:00 | 1.00 | Particle camera (Piotr) |
| | 06:00 | 07:00 | 1.00 | rosette 2 - primary production + chemistry (Jean-Éric) |
| | 07:00 | 08:30 | 1.50 | Trap deployment (Thomas) |
| | 08:30 | 09:30 | 1.00 | rosette 3 - microbe (Christine) |
| | 09:30 | 13:30 | 4.00 | day bioness + tucker + live tows (Luc) |
| | 13:30 | 14:30 | 1.00 | rosette 4 - microzooplankton (Gérald) |
| | 14:30 | 15:30 | 1.00 | light profile (Servet) |
| | 15:30 | 18:30 | 3.00 | tucker + RMT + live tows (Luc) |
| | 18:30 | 20:00 | 1.50 | day VPR (Piotr) |
| | 20:00 | 21:00 | 1.00 | rosette 5 - virus (Jérôme) |
| | 21:00 | 21:45 | 0.75 | bottom Niskin (Piotr) |
| | 21:45 | 22:45 | 1.00 | diatom net (Piotr) |
| | 22:45 | 01:45 | 3.00 | night bioness + Tucker + live tow (Luc) |
| 2004-08-07 | 01:45 | 03:15 | 1.50 | night VPR (Piotr) |
| Saturday | 03:15 | 03:45 | 0.50 | repositioning |
| | 03:45 | 04:45 | 1.00 | rosette 6 - contaminants 2 (Eric) |
| | 04:45 | 05:45 | 1.00 | particle camera (Piotr) |
| | 05:45 | 06:45 | 1.00 | rosette 7 deep and special (Jean-Éric) |
| | 06:45 | 08:15 | 1.50 | boxcore (Hiroshi) |
| | 08:15 | 10:15 | 2.00 | trap recovery (Thomas) |
| | 10:15 | 19:00 | 8.75 | **transit to 124 basics (10 knots, 417 m), MVP, EM300, K320R** |
| | 19:00 | 20:00 | 1.00 | Subottom Survey (Beaudoin) |
| | 20:00 | 21:00 | 1.00 | rosette 1 (Jean-Éric) |
| | 21:00 | 23:45 | 2.75 | vertical zooplankton tows (Luc) |
| 2004-08-08 | 23:45 | 01:15 | 1.50 | particle camera (Piotr) |
| Sunday | 01:15 | 02:15 | 1.00 | rosette 2 (Marie-Emmanuelle) |
| | 02:15 | 03:45 | 1.50 | VPR (Piotr) |
| | 03:45 | 04:45 | 1.00 | bottom Niskin (Piotr) |
| | 04:45 | 07:45 | 3.00 | Piston core (Trecia) |
| | 07:45 | 12:00 | 4.25 | **transit to 118 - basics (12 knots, 395 m), EM300, K320R** |
| | 12:00 | 13:00 | 1.00 | rosette 1 (Jean-Éric) |
| | 13:00 | 15:45 | 2.75 | vertical zooplankton tows (Luc) |
| | 15:45 | 16:45 | 1.00 | light profile (Servet) (not if cloudy) |
| | 16:45 | 18:15 | 1.50 | particle camera (Piotr) |
| | 18:15 | 19:15 | 1.00 | rosette 2 (Marie-Emmanuelle) |
| | 19:15 | 20:45 | 1.50 | VPR (Piotr) |
| | 20:45 | 23:00 | 2.25 | boxcore (Hisashi) |
| 2004-08-09 | 23:00 | 02:00 | 3.00 | **transit to 112 - basics (12 knots, 484 m), EM300, K320R** |

| | | | | |
|---|---|---|---|---|
| Monday | 02:00 | 03:00 | 1.00 | rosette 1 (Jean-Éric) |
| | 03:00 | 05:45 | 2.75 | vertical zooplankton tows (Luc) |
| | 05:45 | 07:15 | 1.50 | VPR (Piotr) |
| | 07:15 | 08:15 | 1.00 | rosette 2 (Marie-Emmanuelle) |
| | 08:15 | 09:45 | 1.50 | Particle camera (Piotr) |
| | 09:45 | 10:45 | 1.00 | boxcore (Hisashi) |
| | 10:45 | 13:45 | 3.00 | **transit to 106 - Full (12 knots, 531 m) MVP (Maybe), EM300, K320R FIRE DRILL FROM 15:00 TO 17:00)** |
| | 13:45 | 15:00 | 1.25 | light profile (Servet) |
| | 15:00 | 17:00 | 2.00 | **FIRE DRILL** |
| | 17:00 | 18:00 | 1.00 | rosette 1 - contaminants 1 (Eric) |
| | 18:00 | 19:00 | 1.00 | Trap deployment (Thomas) |
| | 19:00 | 19:45 | 0.75 | diatom net (Piotr) |
| | 19:45 | 20:45 | 1.00 | Particle camera (Piotr) |
| | 20:45 | 21:45 | 1.00 | rosette 2 - virus (Jérôme) |
| 2004-08-10 | 21:45 | 01:45 | 4.00 | night bioness + Tucker + live tow (Luc) |
| Tuesday | 01:45 | 03:15 | 1.50 | night VPR (Piotr) |
| | 03:15 | 04:15 | 1.00 | bottom Niskin (Piotr) |
| | 04:15 | 05:15 | 1.00 | rosette 3 - Microbes + Deep and special (Christine) |
| | 05:15 | 06:15 | 1.00 | day VPR (Piotr) |
| | 06:15 | 06:45 | 0.50 | repositioning |
| | 06:45 | 07:45 | 1.00 | rosette 4 - primary production + chemistry (Jean-Éric) |
| | 07:45 | 10:45 | 3.00 | tucker + RMT + live tows (Luc) |
| | 10:45 | 11:45 | 1.00 | rosette 5 - Contaminant 2 (Eric) |
| | 11:45 | 14:45 | 3.00 | day bioness + tucker + live tows (Luc) |
| | 14:45 | 15:45 | 1.00 | rosette 6 - microzooplankton (Gérald) + light profile (Servet) |
| | 15:45 | 17:15 | 1.50 | boxcore (Hiroshi) |
| | 17:15 | 19:15 | 2.00 | trap recovery (Thomas) |
| 2004-08-11 | 19:15 | 20:15 | 25.00 | **Transit to 001a -CTD cast, EM300, K320R** |
| Wednesday | 20:15 | 20:45 | 0.50 | CTD cast (Beaudoin) |
| | 20:45 | 03:45 | 7.00 | **Transit to 002 (110 m) - Basic, EM300, K320R** |
| | 03:45 | 04:30 | 0.75 | Rosette 1 (Jean-Éric) |
| | 04:30 | 07:30 | 3.00 | Live tow + ring tow + RMT (Luc) |
| | 07:30 | 08:00 | 0.50 | VPR (Piotr) |
| | 08:00 | 09:00 | 1.00 | Particle camera (Piotr) |
| | 09:00 | 13:40 | 4.68 | Piston + boxcoring (Trecia) |
| | 13:40 | 21:30 | 7.82 | **Transit to 002a -CTD cast, EM300, K320R** |
| | 21:30 | 22:00 | 0.50 | CTD cast (Beaudoin) |
| 2004-08-12 | 22:00 | 22:00 | 0.00 | **Transit to Station 003 (Cancelled because of ice)** |
| Thursday | 22:00 | 22:00 | 0.00 | Rosette 1 (Jean-Éric) |
| | 22:00 | 22:00 | 0.00 | Live tow + ring tow + RMT (Luc) |
| | 22:00 | 22:00 | 0.00 | VPR (Piotr) |
| | 22:00 | 22:00 | 0.00 | Particle camera (Piotr) |
| | 22:00 | 22:00 | 0.00 | Piston + boxcoring (Trecia) |
| | 22:00 | 22:00 | 0.00 | **Transit to 003a -CTD cast, EM300, K320R (Cancelled because of ice)** |

| | | | | |
|---|---|---|---|---|
| | 22:00 | 22:00 | 0.00 | CTD cast (Jonathan) |
| | 22:00 | 22:00 | 0.00 | **transit to 004a -Basic, EM300, K320R Cancelled because of ice** |
| 2004-08-16 | 22:00 | 22:00 | 0.00 | Rosette 1 (Jean-Éric) |
| Monday | 22:00 | 22:00 | 0.00 | **Transit to 004b -CTD cast, EM300, K320R (cancelled because of ice)** |
| 2004-08-17 | 22:00 | 13:00 | 87.00 | **Transit to Bellot Strait** |
| Tuesday | 13:00 | 20:00 | 31.00 | **Transit to Maxwell Bay (Devon Island) + meet with the Des Groseilliers** |
| | 20:00 | 22:00 | 2.00 | **Transit to station 006a (370 m) + CTD cast, EM300, K320R** |
| | 22:00 | 22:30 | 0.50 | Station 006a - CTD cast |
| 2004-08-18 | 22:30 | 03:00 | 4.50 | **Transit to Station 007 (526 m) - Basic EM300, K320R** |
| Wednesday | 03:00 | 04:00 | 1.00 | Rosette (Jean-Éric) |
| | 04:00 | 07:00 | 3.00 | Tucker +RMT (Luc) |
| | 07:00 | 08:30 | 1.50 | VPR (Piotr) |
| | 08:30 | 10:00 | 1.50 | Particle camera (Piotr) |
| | 10:00 | 11:00 | 1.00 | Boxcore (Trecia) |
| | 11:00 | 14:30 | 3.50 | **Transit to 007a (720 m)** |
| | 14:30 | 15:00 | 0.50 | CTD cast with rosette (Jonathan + Marie-Emmanuelle) |
| | 15:00 | 18:00 | 3.00 | **transit to 009 (800 m) - Basic EM300, K320R** |
| | 18:00 | 19:00 | 1.00 | Rosette (Jean-Éric) |
| | 19:00 | 22:30 | 3.50 | Live tow + Tucker +RMT (Luc) |
| | 22:30 | 00:30 | 2.00 | Moon pool winch testing (Luc) |
| | 00:30 | 02:00 | 1.50 | VPR (Piotr) |
| | 02:00 | 03:45 | 1.75 | Particle camera (Piotr) |
| | 03:45 | 07:00 | 3.25 | Bottom and subbottom survey (Jonathan + Steve) |
| 2004-08-19 | 07:00 | 12:45 | 5.75 | Boxcore + Piston (Trecia) |
| | 12:45 | 20:45 | 8.00 | **transit to Station 010 (763 m) - EM300, K320R** |
| | 20:45 | 21:15 | 0.50 | CTD cast (Jonathan + Steve) |
| 2004-08-20 | 21:15 | 11:30 | 14.25 | **transit to Station 011 (264 m) - EM300, K320R** |
| | 11:30 | 17:00 | 5.50 | CTD cast (Jonathan + Steve) + bottom and sub-bottom survey |
| 2004-08-23 | 17:00 | 12:40 | 67.68 | **transit to Station 012 (358 m) - EM300, K320R** |
| ↓ | 12:40 | 13:10 | 0.50 | CTD cast (Jonathan + Steve) |
| | 13:10 | 08:40 | 19.50 | **transit to Station 013 (196 m) - EM300, K320R** |
| | 08:40 | 09:00 | 0.33 | CTD cast (Jonathan + Steve) |
| | 09:00 | 21:20 | 12.33 | **transit to Station 014 (211 m) - EM300, K320R** |
| | 21:20 | 21:50 | 0.50 | CTD cast (Jonathan + Steve) |
| 2004-08-25 | 21:50 | 15:00 | 17.17 | **Transit to Churchill, EM300, K320R** |
| | 15:00 | 15:00 | 0.00 | **Demobilisation in Churchill** |

# PART 4

# Leg 9 – Operation Plan

**CASES Leg09 operation plan**

| | 01:00 | | | | |
|---|---|---|---|---|---|
| **start** | | **stop** | | **duration** | **Activity** |
| 06-août-04 | 04:00 | 07-août-04 | 10:15 | 30.25 | transit + full overwintering site 200 (236 m) |
| 07-août-04 | 10:30 | 07-août-04 | 18:15 | 7.75 | Transect MVP 200-124 (10 knots) |
| 07-août-04 | 19:25 | 08-août-04 | 07:30 | 12.08 | transit + basic (Piston) 124 (417 m) |
| 08-août-04 | 12:00 | 08-août-04 | 22:45 | 10.75 | transit + basic 118 (395 m) |
| 09-août-04 | 02:00 | 09-août-04 | 10:45 | 8.75 | transit + basic 112 (484 m) |
| 09-août-04 | 13:45 | 10-août-04 | 18:00 | 28.25 | transit + full 106 (584 m) |
| 10-août-04 | 20:20 | 10-août-04 | 20:47 | 0.45 | transit + CTD cast stn 001a (105 m) |
| 12-août-04 | 03:45 | 12-août-04 | 13:40 | 9.92 | transit + basic 002 (115 m) |
| 12-août-04 | 21:30 | 12-août-04 | 22:00 | 0.50 | transit + CTD cast 002a (120 m) |
| 12-août-04 | 22:00 | 12-août-04 | 22:30 | 0.50 | transit + CTD cast 005b (250 m) |
| 17-août-04 | 22:00 | 17-août-04 | 22:30 | 0.50 | transit + CTD cast 006a (370 m) |
| 18-août-04 | 03:00 | 18-août-04 | 11:00 | 8.00 | transit + basic 007 (526 m) |
| 18-août-04 | 14:30 | 18-août-04 | 15:00 | 0.50 | transit + CTD cast 007a (720 m) |
| 18-août-04 | 18:00 | 19-août-04 | 12:45 | 18.75 | transit + basic 009 (800 m) |
| 19-août-04 | 20:45 | 19-août-04 | 21:15 | 0.50 | transit + CTD cast 010 (720 m) |
| 20-août-04 | 11:30 | 20-août-04 | 17:00 | 5.50 | transit + CTD + EM300 survey 011 (264 m) |
| 23-août-04 | 12:40 | 23-août-04 | 13:10 | 0.50 | transit + CTD 012 (358 m) |
| 24-août-04 | 08:45 | 24-août-04 | 09:00 | 0.25 | transit + CTD 013 (196 m) |
| 24-août-04 | 21:20 | 24-août-04 | 21:40 | 0.33 | transit + CTD 014 (211 m) |

# PART 5

# Leg 9 – Detailed list of stations

| Station No. | Latitude | Longitude | Water depth (m) | Station type | CASES/ ArcticNet | Completed |
|---|---|---|---|---|---|---|
| 200 | 70º02.70’ | 126º17.80’ | 236 | full | CASES | yes |
| 124 | 71º24.10’ | 126º46.80’ | 417.9 | basic | CASES | yes |
| 118 | 70º56.50’ | 125º50.70’ | 394.7 | basic | CASES | yes |
| 112 | 70º45.30’ | 124º14.30’ | 484.2 | basic | CASES | yes |
| 106 | 70º36.00’ | 122º37.70’ | 530.5 | full | CASES | yes |
| 001 | 69º54.80’ | 122º57.20’ | 210 | basic | ArcticNet | no time |
| 001a | 68º31.75’ | 110º00.00’ | app. 105 | CTD | ArcticNet | yes |
| 002 | 69º00.10’ | 106º35.10’ | 110 | basic | ArcticNet | yes |
| 002a | 68º39.90’ | 102º39.82’ | app. 115 | CTD | ArcticNet | yes |
| 003 | 69º10.00’ | 100º41.50’ | 45 | basic | ArcticNet | no (sea ice) |
| 003a | 69º30.00’ | 99º53.30’ | app. 70 | CTD | ArcticNet | no (sea ice) |
| 004 | 69º35.80’ | 99º45.60’ | 75 | basic | ArcticNet | no (sea ice) |
| 004a | 70º01.00’ | 98º58.00’ | app. 230 | CTD | ArcticNet | no (sea ice) |
| 004b | 71º57.18’ | 95º55.20’ | app. 53 | CTD | ArcticNet | no (sea ice) |
| 005 | 73º16.60’ | 95º52.30’ | 250 | basic | ArcticNet | no (sea ice) |
| 005a | 71º55.70’ | 93º30.00’ | app. 110 | basic | ArcticNet | no (sea ice) |
| 005b | 73º13.80’ | 91º00.00’ | app. 280 | CTD | ArcticNet | yes |
| 006 | 74º16.60’ | 91º12.00’ | app. 320 | basic | ArcticNet | no time |
| 006a | 74º18.20’ | 88º20.00’ | app. 328 | CTD | ArcticNet | yes |
| 007 | 74º17.20’ | 85º35.00’ | 526 | basic | ArcticNet | yes |
| 007a | 74º13.50’ | 83º20.00’ | app.720 | CTD | ArcticNet | yes |
| 008 | 74º03.00’ | 79º56.00’ | app. 800 | basic | ArcticNet | no time |
| 009 | 74º10.00’ | 81º15.00’ | app. 775 | basic | ArcticNet | yes |
| 010 | 72º40.40’ | 78º54.70’ | 763 | CTD | ArcticNet | yes |
| 011 | 71º09.10’ | 71º15.10’ | 264 | CTD | ArcticNet | yes |
| 012 | 62º35.60’ | 72º38.80’ | 358 | CTD | ArcticNet | yes |
| 013 | 62º01.20’ | 82º23.80’ | 196 | CTD | ArcticNet | yes |
| 014 | 60º54.30’ | 86º48.30’ | 211 | CTD | ArcticNet | yes |