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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2007/2008 (ANT-XXIV/2)

Edited by
Ulrich Bathmann
with contributions of the participants

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ANT-XXVI/2

28 November 2007 - 4 February 2008

Cape Town - Cape Town
Weddell Sea

Chief Scientist: Ulrich Bathmann

Koordinator / Coordinator

Eberhard Fahrbach

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1. ÜBERBLICK UND FAHRTVERLAUF

Ulrich Bathmann
Alfred-Wegener-Institut

Die Expedition begann am 28. November 2007 in Kapstadt, führte zur Antarktisstation Neumayer, wohin sie nach einer kurzen Forschungsperiode in der Lazarew See am 6. Januar zurückkehrte, um eine Eisrampe für die Entladung der *Naja Arctica* freizubrechen. Nach weiteren 14 Forschungstagen beendete *Polarstern* die Expedition am 4. Februar 2008 in Kapstadt.

Es wurden über 7600 Seemeilen in den 68 Tagen (= 1632 Stunden) zurückgelegt, in denen 456 Stunden Forschungsgeräte eingesetzt wurden. Die restliche Zeit wurde für Fahrtstrecken, Transit oder Logistik benötigt. Unsere Forschungsministerin A. Schavan besuchte mit ihrer südafrikanischen Kollegin N.C. Dlamini Zuma am 5. Februar das Schiff.

Die wissenschaftliche Forschung konzentrierte sich auf das IPY Kernprogramm ICED, dass das Dach für die 3 IPY Projekte dieser Fahrt bildet. SCACE, SYSTCO und LAKRIS trugen zum besseren Verständnis der biologischen, chemischen und physikalischen Prozesse in der Ozeandeckschicht, die durch Meereisdynamik beeinflusst wird, und deren Verbindungen durch die Wassersäule in die Tiefsee zur Biodiversität und den geochemischen Umsätzen.

Die wichtigsten Ergebnissse, die unter den erschwerten Bedingungen der logistischen Aufgaben erreicht werden konnten, sind:

- Beschreibung einer 700.000 km^2 großen Eisrandblüte; ihre physikalischen ursachen und biologischen Auswirkungen wie z.B. die Reduktion des pCO_2 Partialdruckes im Oberflächenwasser von 380 auf 300 ppmv.
- Erstmalige Wiederholungsmessung biogeochemischer Flussraten im Tiefseesediment nach 7 Wochen, um den Effekt einer absinkenden Plankton-blüte auf die Tiefseebiogeochemie der Antarktis nachzuweisen.
- Erstmalige biogeochemische Beprobung der antarktischen Tiefsee im Anstand von 12 Seemeilen, um die mesoskalige Heterogenität im Sediment zu untersuchen.
- Weltweit südlichste Beprobung der *in-situ* Flüsse am Meeresboden bei 69°40.4'S, die hohe biologische Aktivitäten nachwies.
- Erstmalige Prozessstudien von der Meeresoberfläche zum Tiefseesediment in der Antarktis an 5 Stationen als Voruntersuchung künftiger Programme.
- Abschluss der saisonalen Untersuchungen zum Lebenszyklus antarktischen Krills mit dem Nachweis einer engen positiven Kopplung von Meereis und Krillhäufigkeit in der Lazarewsee.

Während der logistischen Unterstützung des Frachtschiffes *Naja Arctica*, die die Bauteile der Neumayer III Station geladen hatte, wurde ein Anleger an der Schelfeiskante vom Festeis befreit. Die Operation ist in separaten Berichten ausführlich dargestellt. Am 4. Februar war das gesamte Baumaterial entladen und die Bauarbeiten schreiten gut voran.

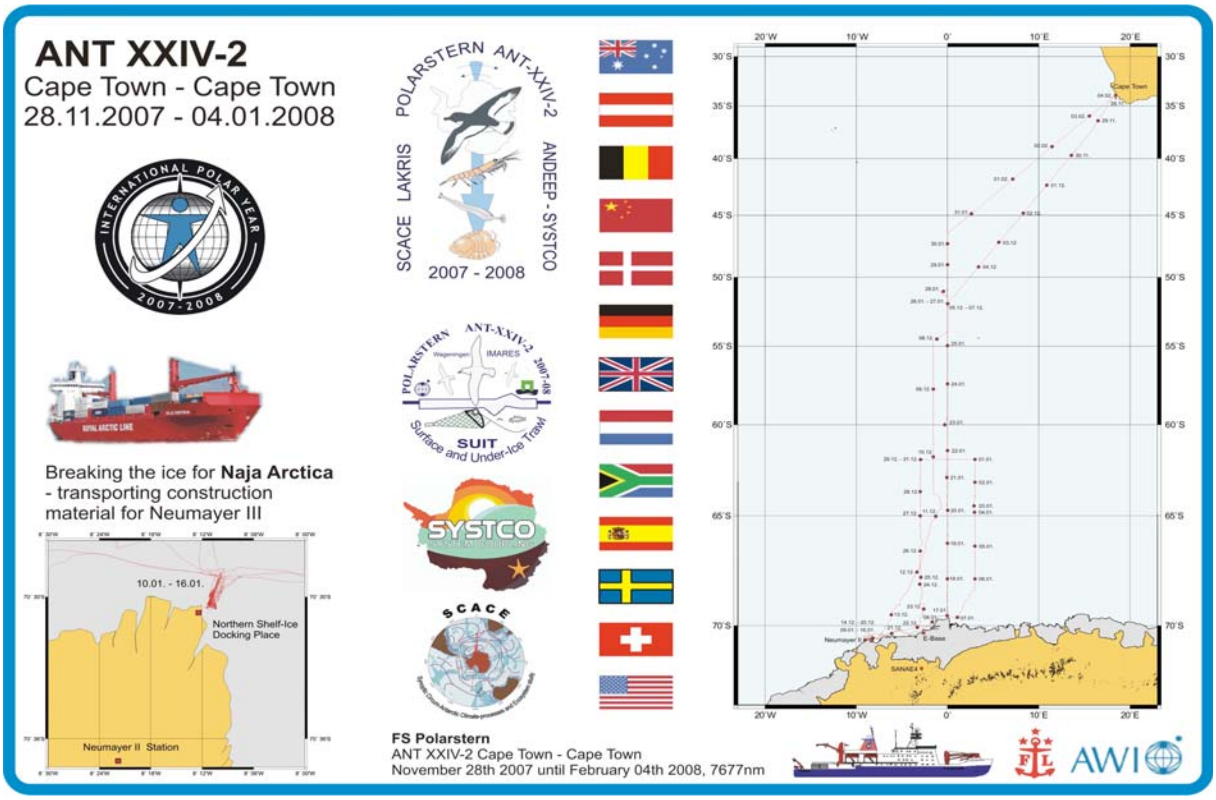

Fig. 1.1: Fahrtverlauf / Cruise Track ANT-XXIV/2

ITINERARY AND SUMMARY

The cruise departed from Cape Town on 28 November 2007 headed south to Neumayer performed research in the Lazarev Sea, steamed back to Neumayer and had another 14 days research on its way north.

In total we sailed more than 7,600 nautical miles. From the 68 days (= 1632 hours) at sea, we used 456 hours to deploy instruments, the rest was steaming time, transit or logistics. The cruise ended on 4 February 2008 in Cape Town. Our federal Minister for Science and Technology A. Schavan visited the ship with her South African counterpart N.C. Dlamini Zuma on 5 February in the afternoon.

The scientific programme centred on the IPY core programme ICED that provided the umbrella for 3 IPY projects performed during this cruise. SCACE In combination with SYSTCO and LAKRIS contributed during the ANT-XXIV/2 expedition of *Polarstern* to a better understanding of upper ocean physical and biological processes influenced by sea ice and their linkage through the water column to the deep-sea abyss and its biogeochemistry and impact on biodiversity.

Main achievements were reached despite the intense constrains set by logistic operation of *Polarstern*: The main results are:

- Determination of 700.000 km^2 large ice-edge bloom; its physical causes and biological effects, e.g. the draw down of pCO_2 in surface ocean waters from 380 to 300 ppmv (units).
- First biogeochemical *in-situ* measurement repeated after 7 weeks to investigate the effect of phytoplankton bloom on benthos and demonstration that surface productivity is linked to the seafloor biogeochemistry in the high Antarctic.
- First biogeochemical sampling of deep-sea stations 12 nm apart in order to look at small-scale heterogeneity in the sediment.
- Worldwide southernmost *in-situ* benthic flux measurement at 69°40.4'S (Polynia station), with indication of high benthic activity.
- First sampling through the complete water column in the Southern Ocean from surface and ice flora and fauna down to bathyal or abyssal depths (5 stations, partly incomplete) as precursor for later programmes.
- Completion of year round sampling to study life cycle patterns of Antarctic krill indicate strong correlation of krill abundance and success to sea ice occurrence.

In detail

We observed an ice edge phytoplankton bloom. The bloom that *Polarstern* crossed in the eastern Weddell Sea was also clearly visible from space. As recorded by satellite-mounted ocean colour sensors it covered an area of about 700.000 km^2, roughly two times the size of Germany. Measurements performed in the upper water column by a Conductivity-Temperature-Depth (CTD) probe revealed that the bloom developed in lenses of melt water left behind the seasonally retreating sea ice cover. Together with the chemical measurements made, the new data set will allow for a better quantification of the controversially debated role of ice edge blooms for the sequestration of atmospheric carbon dioxide.

Better understanding of the physical control of the regional distribution of marine life and of biological processes that influence the uptake of carbon from the atmosphere and its transport to the ocean interior and underlying sediments is also the aim of the IPY project SCACE, led by AWI oceanographer Volker Strass. For this project, the Synoptic Circum-Antarctic Climate-processes and Ecosystem study, physical, biological and chemical data where collected down to 1,000 m depth every 55.6 kilometres (30 nautical miles) along a transect that extends over more than 2,600 km. The transect ran northward along the Greenwich Meridian from the Antarctic coast and crossed the major hydrographic features of the Southern Ocean, the Coastal Current, the Weddell Gyre and the Antarctic Circumpolar Current. The SCACE transect represents a major German contribution to an international endeavour to perform in the Polar Year similar meridional transects in all sectors of the Southern Ocean, aimed at a circumpolar assessment of the present status of its climate and ecosystem.

The ANDEEP-SYSTCO team led by Prof. Angelika Brandt, University Hamburg investigated 5 deep-sea locations in detail. At 52°S the deep sea at the Southern Polar front is characterised by low diversity and abundance, in the macrofauna even after a slight plankton bloom in spring (revisit of stations after 7 weeks). The Eastern Weddell Sea and Lazarev Sea is generally poorer in species and abundance of organisms in the deep sea. Maud Rise (seamount) differs completely in taxon composition from the abyssal stations, perhaps due to the unique physical ocean characteristics including Taylor column influencing localised entrainment of larvae. Brooders, on the contrary, occur only as a minor fraction in the macrobenthic sample.

The LAKRIS project lead by Prof. Ulrich Bathmann, AWI, investigates the life cycle patterns of Antarctic Krill in the Lazarev Sea that is part of the Southern Ocean facing the Neumayer Station. Krill abundance was rather poor this spring, especially compared to the 2006 winter situation. Only in the regions north of 62°S abundant swarms of adult krill occurred and attracted many top predators, especially Minke and Humpback Whales. One Blue Whale was seen in the ice, where it should not occur.

The logistic operation to free the shelf ice for unloading the cargo vessel *Naja Arctica* that contained construction material for Neumayer III station is reported in detail in special reports. On 4 February, all cargo had been unloaded and the construction of the new base was up to full speed to secure the site before the next winter.

2. SCACE: SYNOPTIC CIRCUM-ANTARCTIC / CLIMATE-PROCESSES AND ECOSYSTEM STUDY - A PROJECT OF THE IPY –

Volker Strass[1)], Ulrich Bathmann[1)], Richard Bellerby[2)] (not on board), Graham Hosie[3)] (not on board)

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Objectives

The overarching goal of SCACE is to use the outstanding chance provided by the International Polar Year (IPY) to collect in international collaboration a unique data set that can serve as a benchmark for comparison with existing and future data to identify and quantify polar changes. SCACE is listed as IPY project number 16 by the International Polar Year Programme Office (http://classic.ipy.org/development/eoi/details.php?id=16; for a German description of SCACE please see http://www.polarjahr.de/The-project.263+M54a708de802.0.html).

SCACE aims at welding together a broad range of ocean science disciplines in order to address currently elusive questions such as:

- Which physical, biological and chemical processes regulate the Southern Ocean system and determine its influence on the global climate development?
- How sensitive are Southern Ocean processes and systems to natural climate change and anthropogenic perturbations?

The Southern Ocean is critically involved in the machinery driving earth´s climate. The Antarctic Circumpolar Current (ACC) connects all the other oceans. Thus, it plays a major role in the global transports of heat and fresh-water and the ocean-wide cycles of dissolved substances. It harbours a series of distinct ecosystems that displace each other with changing climate regimes. Upwelling of deep water masses results in an extraordinary high supply of plant macronutrients, which could sustain much higher phytoplankton primary production and hence CO_2 uptake than normally observed. While the Southern Ocean exerts a control on earth's climate, it is itself sensitive to climatic changes, which may occur on various time scales and affect the biota. There are, however, also direct anthropogenic influences on the ecosystem, for instance by harvesting marine living resources such as krill.

Although much progress has been made during the last decades in documenting the Southern Ocean hydrographic and biographic features, in quantifying fluxes and in understanding the dominating forcing, there is still a big gap in knowledge, especially with regard to the interaction of physical, chemical and biological processes. While this gap in knowledge is basically due to the remoteness of the area and its inhospitality for humans, it is also due to the fragmentation of research as carried out usually. Collaboration across the traditional boundaries between the physical, chemical and biological disciplines of the marine sciences is hence an essential element of SCACE.

By cooperation with the ocean circulation IPY lead project CASO (Climate in Antarctica and the Southern Ocean) and by coordination under the umbrella of the biogeochemistry lead project ICED (Integrated Climate and Ecosystem Dynamics), SCACE strives for performing in the same season and year meridional sections that extend from the Antarctic continent and cross the ACC at several key longitudes. Such synoptic circumpolar assessment is the only way to document the current state of the environment without bias introduced by interannual variability.

With regard to the processes that potentially exert a control on global climate, SCACE is aimed at obtaining new insights into the coupling between atmospheric forcing of the mixed layer dynamics, phytoplankton primary production in the near-surface euphotic zone, the flow of energy from the primary producers through the food web, and subsequently the transport of biogenically fixed carbon to the deep ocean layers and the sea floor. Assessing the vertical transport of biogenic carbon, hence providing an indication of carbon sequestration from the atmosphere, is one of the particular objectives of SCACE. By cooperation with the IPY biodiversity lead project ANDEEP-SYSTCO (chapter 14) and the related DFG project DOMINO (chapter 16), which are focused on benthic biology and sediment geochemistry, respectively, SCACE is extending the investigation of the vertical carbon flux into the benthic biota and the sediment. Vice versa, SCACE provides ANDEEP-SYSTCO with information about processes and fluxes from the atmosphere-ocean interface through the whole watercolumn overlaying the seafloor.

Work at sea

A significant part of the measurements performed during *Polarstern* cruise ANT-XXIV/2 constitutes the German contribution to SCACE. The SCACE data set comprises physical measurements made with a CTD (Conductivity, Temperature, Depth) probe at hydrographic stations, from which vertical profiles of the state variables temperature, salinity and density are derived. The CTD range of variables is extended by accessory instruments such as a chlorophyll-sensitive fluorometer to provide an indication of the abundance of phytoplankton, a transmissiometer to measure the attenuation of light, which in the open ocean is determined by the concentration of particulate organic carbon (POC), and an oxygen sensor. The CTD measurements are described in more detail in section chapter 3. Samples taken from the carousel bottle water sampler attached to the CTD were used for chemical analyses performed to give the concentrations of the plant nutrients nitrate and silicate, of dissolved inorganic carbon and alkalinity, and of oxygen. A more rigorous description of the chemical measurements is provided in chapter 16. Also biological data, such as the concentration of phytoplankton pigments, of POC, and occasionally of the phytoplankton species composition, were collected from the CTD bottles. For details of the biological measurements see chapter 5.

Hydrographic stations pertinent to SCACE are aligned at half a degree of latitude intervals along the Greenwich Meridian between the Antarctic continental shelf edge at 69.6°S and the northern flank of the Antarctic Circumpolar Current at 46.5°S. Stations south of 62°S along the Greenwich Meridian also constitute a contribution to LAKRIS, the BMBF-funded Lazarev Sea Krill Study, while all hydrographic stations along the 3°E and 3°W meridians constitute a contribution to both SCACE and LAKRIS. For a map of the station positions see Fig. 2.1.

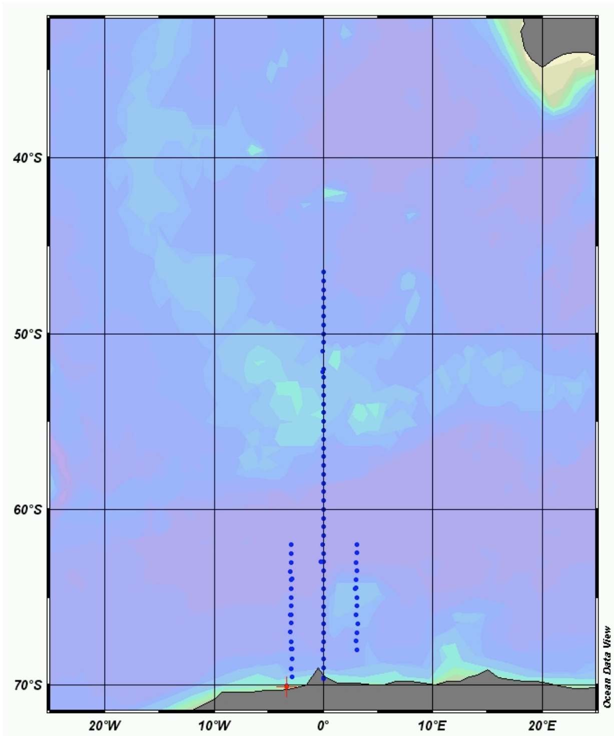

Fig. 2.1: Positions of CTD stations performed as a contribution to SCACE and, south of 62°S, as a contribution to SCACE as well as to LAKRIS

The majority of the biological measurements for SCACE were obtained with different types of plankton nets, deployed for vertical hols as well as for horizontal tows near the hydrographic stations. The various nets, their deployment position and the suite of data collected by them are described in chapter 7.

Overall, only less than half of the planned measurements at hydrographic stations could however be performed because ten days of shiptime had to be sacrificed by marine science for the sake of ice breaker support by *Polarstern* for a freighter carrying construction material for the new German Antarctic Base Neumayer III. In consequence, the CTD was mostly lowered just to 1,000 m depth instead of down to the sea floor; the section worked southward along 3°E had to be stopped before the continental shelf break was reached; the Greenwich Meridional section could not be conducted northward enough to extend to the north of the Subantarctic Front, i.e. to fully cover the width of the ACC; and plankton nets could not be deployed as frequently as originally intended.

Less affected by the rededication of shiptime than the hydrographic station work was the collection of data in quasi continuous mode. Physical data, consisting of vertical profiles of ocean currents down to about 250 m, were obtained almost continuously with the vessel-mounted acoustic Doppler current profiler (ADCP; detailed description in chapter 3 *'underway measurements of ocean currents'*) while operating outside of national Exclusive Economic Zones (South African EEZ in case of this cruise). Other physical data, such as sea-surface temperature and salinity as well as various meteorological variables were collected and stored by the *Polarstern* Data Acquisition System, PODAS. Quasi continuous data of the zooplankton assemblage have been obtained from the vessel-mounted multi-frequency echosounder Simrad EK-60 (details in chapter 35). Quasi continuous measurements of the zooplankton assemblage at a nominal depth of 10 m have also been obtained with a continuous plankton recorder (CPR; for details see chapter 6). The CPR was towed during periods of long-distance steaming, at the begin of the cruise after leaving the South African EEZ on the way towards Neumayer Base and at the end of the cruise after the final CTD station on the way back to the South African EEZ.

Preliminary results

A scientific highlight contained in the SCACE data set certainly is the documentation of an ice edge bloom that occupied an area of approximately 700,000 km^2 as revealed by satellite remote imaging (chlorophyll concentration from the official ESA MERIS satellite data algal-1 level-2 product composed to maps by T. Dinter (Institute of Environmental Physics, Bremen) and A. Bracher (AWI, Bremerhaven); personal communication). For a first impression of the collected data see chapter 3 *'hydrograhic station work'* and chapter 4 *'underway measurements of ocean currents'*.

3. PHYSICAL OCEANOGRAPHY: MEASUREMENTS AT HYDROGRAPHIC STATIONS

Volker Strass[1)], Silvia Maßmann[1)], Falk Richter[1)], Daniela Ewe[1)], Mark Olischläger[1)], Harry Leach[2)], Timo Witte[3)]

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[2)]University of Liverpool, United Kingdom
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Objectives and work at sea

Vertical profiles of temperature, salinity and density were derived from measurements made by lowering a CTD (Conductivity, Temperature and Depth) probe at hydrographic stations. The CTD used was of type Sea-Bird Electronics SBE 911*plus*, supplemented by an oxygen sensor type SBE 43 and additional instruments such as an altimeter (Benthos PSA-916) to measure the distance to the sea floor, a transmissiometer type Wet Labs C-Star (660 nm wavelength) to measure the attenuation of light, which in the open ocean is indicative of the concentration of particulate organic carbon (POC), and a chlorophyll-sensitive fluorometer (Dr. Haardt BackScat). The temperature and conductivity sensors (two pairs of sensors) were calibrated at the factory prior to the cruise to an accuracy of better than 0.001°C and 0.001 S m^{-1}, respectively. They will be sent to the manufacturer after the cruise for re-calibration. The CTD data, as well as the data taken by the additional sensors and instruments, at present are thus to be considered preliminary, subject to a later correction for possible temporal drifts and to calibration in absolute units.

The CTD was mounted with a multi-bottle water sampler type Sea-Bird SBE 32 Carousel holding 24 12-liter bottles. Salinity derived from the CTD measurements will later be re-calibrated by comparison to salinity samples taken from the water bottles, which were analyzed by use of a Guildline-Autosal-8400A salinometer to an accuracy generally better than 0.001 units on the practical salinity scale, adjusted to IAPSO Standard Seawater. The water bottles also served to supply several other working groups on board with samples. Water samples have, for instance, been taken to be analyzed for the concentrations of particulate organic carbon (POC) and of phytoplankton pigments such as chlorophyll (see chapter 5). The bottle data of oxygen, POC and chlorophyll will, once finally analyzed, be also used for the calibration of the respective CTD sensors and instruments.

All together, 95 CTD casts were carried out (see Table 3.1). Of these, 24 extended to full ocean depth while the others were limited mostly to the upper 1,000 m of the water column, including 17 at which the CTD was lowered to just 250 m. The CTD stations were distributed along three meridional sections (see Table 3.2) running along 3°W, 0°E and 3°E. The distance between stations along the meridional sections was nominally 30 nm.

Tab. 3.1: List of CTD Stations

Station	Cast	Latitude [°]	Longitude [°]	NBS depth [m]	minimum distance to bottom [m]	Pmax [dbar]	Start [dd.mm.yy hh:mm]	at depth [dd.mm.yy hh:mm]	Stop [dd.mm.yy hh:mm]
13	4	-52.035900	-0.016883	-	-	252	05.12.07 13:56	05.12.07 14:06	05.12.07 14:20
13	6	-52.037300	-0.016633	2995	16.00	2993	05.12.07 17:00	05.12.07 18:00	05.12.07 19:21
13	10	-52.036783	-0.017083	2996	-	2999	05.12.07 22:45	05.12.07 23:52	06.12.07 01:17
17	5	-70.066200	-3.411083	-	-	2038	22.12.07 02:09	22.12.07 03:00	22.12.07 03:49
17	8	-70.055933	-3.430400	-	-	253	22.12.07 06:41	22.12.07 06:50	22.12.07 07:04
18	1	-69.536983	-2.889333	-	-	1003	23.12.07 07:35	23.12.07 07:57	23.12.07 08:24
19	4	-69.071867	-3.011317	3641	8.99	3656	23.12.07 19:42	23.12.07 20:55	23.12.07 22:23
20	1	-68.486217	-2.905000	-	-	1000	24.12.07 06:47	24.12.07 07:10	24.12.07 07:46
21	2	-67.930367	-2.952183	4151	8.28	4186	25.12.07 08:39	25.12.07 10:00	25.12.07 11:18
21	5	-67.918167	-2.873000	-	-	251	25.12.07 14:39	25.12.07 14:48	25.12.07 15:03
22	1	-67.515683	-3.002933	-	-	1002	25.12.07 20:23	25.12.07 20:49	25.12.07 21:15
23	1	-66.972867	-3.074867	4486	9.30	4534	26.12.07 05:01	26.12.07 06:26	26.12.07 07:50
24	1	-66.477733	-2.956167	-	-	1001	26.12.07 13:58	26.12.07 14:21	26.12.07 14:47
25	3	-66.010233	-3.044800	4785	8.91	4854	26.12.07 20:22	26.12.07 21:56	26.12.07 23:30
25	6	-66.002400	-3.005617	-	-	250	27.12.07 02:48	27.12.07 02:57	27.12.07 03:12
26	1	-65.500217	-3.004117	-	-	1002	27.12.07 06:17	27.12.07 06:42	27.12.07 07:06
27	1	-65.003283	-2.999300	5047	9.01	5122	27.12.07 11:07	27.12.07 12:45	27.12.07 14:11
28	2	-64.503650	-3.001250	-	-	1001	27.12.07 20:03	27.12.07 20:26	27.12.07 20:54
29	1	-63.975850	-2.951083	5190	8.90	5272	28.12.07 01:47	28.12.07 03:28	28.12.07 05:03
29	6	-63.966333	-2.935700	-	-	251	28.12.07 10:00	28.12.07 10:09	28.12.07 10:20
30	1	-63.520817	-3.023683	-	-	1001	28.12.07 13:44	28.12.07 14:06	28.12.07 14:33
31	1	-63.001000	-2.999633	5274	9.60	5360	28.12.07 19:24	28.12.07 21:03	28.12.07 22:39
32	1	-62.499950	-2.997717	-	-	1001	29.12.07 05:43	29.12.07 06:06	29.12.07 06:36
33	4	-62.011433	-2.966967	5335	8.50	5425	29.12.07 13:27	29.12.07 15:07	29.12.07 16:39
33	6	-62.010933	-2.962333	-	-	252	29.12.07 19:07	29.12.07 19:16	29.12.07 19:31
34	2	-62.000050	3.000433	5378	8.30	5470	01.01.08 10:34	01.01.08 12:18	01.01.08 14:08
34	4	-61.999933	3.000367	-	-	253	01.01.08 16:28	01.01.08 16:36	01.01.08 16:48
35	2	-62.487150	3.005250	-	-	1002	01.01.08 22:17	01.01.08 22:41	01.01.08 23:06
36	3	-63.014750	2.980617	5358	9.82	5448	02.01.08 04:43	02.01.08 06:26	02.01.08 07:58
37	2	-63.488550	3.007700	-	-	1001	02.01.08 14:42	02.01.08 15:05	02.01.08 15:30
38	2	-63.995500	2.986183	2831	8.69	2823	02.01.08 20:17	02.01.08 21:14	02.01.08 22:11
39	3	-64.491083	2.848433	2141	9.67	2122	03.01.08 04:32	03.01.08 05:15	03.01.08 05:57
39	8	-64.476333	2.983833	-	-	251	03.01.08 13:52	03.01.08 14:01	03.01.08 14:14
40	1	-65.000200	2.998300	2410	9.70	2395	04.01.08 13:14	04.01.08 14:02	04.01.08 14:47
41	1	-65.502617	2.995500	-	-	1002	04.01.08 19:50	04.01.08 20:12	04.01.08 20:41
42	2	-66.001917	2.986283	3351	6.90	3497	05.01.08 01:37	05.01.08 02:47	05.01.08 03:54
42	4	-66.008117	2.980200	-	-	251	05.01.08 06:23	05.01.08 06:31	05.01.08 06:43
43	2	-66.512200	3.081967	-	-	1002	05.01.08 14:20	05.01.08 14:43	05.01.08 15:11
44	2	-67.005167	3.015183	3232	7.13	3234	05.01.08 20:24	05.01.08 21:25	05.01.08 22:24
45	1	-67.490167	2.995083	-	-	1001	06.01.08 03:31	06.01.08 03:53	06.01.08 04:18
46	3	-67.999650	2.996567	4526	9.99	4576	06.01.08 10:10	06.01.08 11:42	06.01.08 13:05
49	3	-69.609183	0.001583	1509	9.00	1493	17.01.08 08:52	17.01.08 09:30	17.01.08 10:03
49	6	-69.588850	-0.045567	-	-	251	17.01.08 11:52	17.01.08 12:01	17.01.08 12:16
50	2	-69.004450	-0.012000	3378	9.80	3387	17.01.08 17:50	17.01.08 18:54	17.01.08 19:56
50	6	-69.012267	0.025583	-	-	256	17.01.08 23:12	17.01.08 23:21	17.01.08 23:31
51	2	-68.486900	0.028017	4258	8.70	4298	18.01.08 05:37	18.01.08 06:58	18.01.08 08:17

Table 3.1: Continuation

Station	Cast	Latitude [°]	Longitude [°]	NBS depth [m]	minimum distance to bottom [m]	Pmax [dbar]	Start [dd.mm.yy hh:mm]	at depth [dd.mm.yy hh:mm]	Stop [dd.mm.yy hh:mm]
52	3	-67.992517	-0.084950	-	-	1002	18.01.08 13:16	18.01.08 13:38	18.01.08 14:03
52	5	-68.002550	-0.105583	-	-	251	18.01.08 16:35	18.01.08 16:44	18.01.08 16:57
53	2	-67.508433	0.005083	-	-	1001	18.01.08 21:42	18.01.08 22:05	18.01.08 22:33
54	1	-67.000700	-0.009000	-	-	1002	19.01.08 02:33	19.01.08 02:55	19.01.08 03:19
55	1	-66.499400	0.004633	-	-	1002	19.01.08 08:50	19.01.08 09:12	19.01.08 09:41
56	2	-66.002650	-0.001833	-	-	2003	19.01.08 14:34	19.01.08 15:14	19.01.08 16:04
56	4	-66.005067	0.002150	-	-	252	19.01.08 18:29	19.01.08 18:37	19.01.08 18:49
57	2	-65.513800	-0.002167	-	-	1001	19.01.08 23:55	20.01.08 00:21	20.01.08 00:49
58	3	-65.004383	-0.007250	3744	9.50	3765	20.01.08 05:56	20.01.08 07:08	20.01.08 08:16
58	6	-65.003500	-0.014033	-	-	252	20.01.08 09:55	20.01.08 10:03	20.01.08 10:15
59	1	-64.501867	-0.001583	-	-	1001	20.01.08 13:26	20.01.08 13:48	20.01.08 14:16
60	1	-64.003850	-0.002633	-	-	1003	20.01.08 20:28	20.01.08 20:50	20.01.08 21:15
61	1	-63.501717	-0.000917	-	-	1001	21.01.08 02:49	21.01.08 03:10	21.01.08 03:39
62	3	-62.998017	0.014000	-	-	2003	21.01.08 09:10	21.01.08 09:52	21.01.08 10:37
62	5	-62.995650	-0.246600	-	-	251	21.01.08 15:28	21.01.08 15:37	21.01.08 15:53
63	2	-62.502683	-0.005433	-	-	1001	21.01.08 20:53	21.01.08 21:07	21.01.08 21:38
64	4	-62.019883	-0.073767	-	-	2002	22.01.08 02:53	22.01.08 03:32	22.01.08 04:15
64	6	-62.021050	-0.077450	-	-	251	22.01.08 06:40	22.01.08 06:48	22.01.08 07:00
65	1	-61.500917	-0.002150	-	-	1002	22.01.08 11:43	22.01.08 12:06	22.01.08 12:37
66	1	-60.998550	0.000317	-	-	1001	22.01.08 16:37	22.01.08 16:58	22.01.08 17:23
67	1	-60.502333	0.000033	-	-	1002	22.01.08 22:07	22.01.08 22:31	22.01.08 22:56
68	1	-59.998300	0.004017	5355	9.10	5447	23.01.08 02:41	23.01.08 04:25	23.01.08 06:17
69	1	-59.500350	0.004200	-	-	1002	23.01.08 17:42	23.01.08 18:07	23.01.08 18:32
70	1	-59.004083	0.001417	-	-	1002	23.01.08 21:41	23.01.08 22:04	23.01.08 22:27
71	1	-58.499267	-0.001217	-	-	1003	24.01.08 02:19	24.01.08 02:40	24.01.08 03:07
72	1	-58.008633	-0.006100	-	-	1001	24.01.08 06:24	24.01.08 06:47	24.01.08 07:14
73	1	-57.504733	0.002133	-	-	1001	24.01.08 11:42	24.01.08 12:08	24.01.08 12:36
74	1	-57.000150	-0.001317	-	-	1001	24.01.08 16:36	24.01.08 16:58	24.01.08 17:22
75	1	-56.500950	0.005050	-	-	1002	24.01.08 21:34	24.01.08 21:57	24.01.08 22:25
76	1	-55.999783	0.003100	-	-	1004	25.01.08 01:35	25.01.08 01:58	25.01.08 02:27
77	1	-55.499750	0.001650	-	-	1002	25.01.08 06:17	25.01.08 06:39	25.01.08 07:03
78	1	-55.001600	0.000317	-	-	1003	25.01.08 10:11	25.01.08 10:32	25.01.08 10:56
79	1	-54.493500	-0.003267	-	-	1002	25.01.08 14:49	25.01.08 15:12	25.01.08 15:43
80	1	-53.999800	-0.001383	-	-	1003	25.01.08 18:49	25.01.08 19:10	25.01.08 19:35
81	1	-53.503333	0.007100	-	-	1003	25.01.08 23:30	25.01.08 23:53	26.01.08 00:28
82	1	-53.000833	0.001950	-	-	1002	26.01.08 03:47	26.01.08 04:08	26.01.08 04:37
83	1	-52.500983	0.003017	-	-	1003	26.01.08 08:47	26.01.08 09:13	26.01.08 09:44
84	3	-52.196550	-0.107917	3001	11.00	3004	26.01.08 16:00	26.01.08 16:58	26.01.08 18:30
85	4	-52.019983	0.006833	-	-	503	26.01.08 22:16	26.01.08 22:29	26.01.08 22:44
86	1	-51.010250	-0.063067	-	-	1001	28.01.08 14:15	28.01.08 14:36	28.01.08 15:03
87	1	-50.501317	0.000933	-	-	1001	28.01.08 18:45	28.01.08 19:17	28.01.08 19:41
88	1	-50.006350	0.022300	-	-	1004	28.01.08 23:12	28.01.08 23:44	29.01.08 00:08
89	1	-49.498817	-0.002383	-	-	1002	29.01.08 03:41	29.01.08 04:03	29.01.08 04:32
90	1	-49.004983	-0.001850	3946	8.80	3981	29.01.08 07:37	29.01.08 09:08	29.01.08 10:20
91	1	-48.496667	-0.004783	-	-	1001	30.01.08 00:24	30.01.08 00:52	30.01.08 01:27
92	1	-48.000633	0.001300	-	-	1003	30.01.08 05:16	30.01.08 05:41	30.01.08 06:06

Table 3.1: Continuation

Station	Cast	Latitude [°]	Longitude [°]	NBS depth [m]	minimum distance to bottom [m]	Pmax [dbar]	Start [dd.mm.yy hh:mm]	at depth [dd.mm.yy hh:mm]	Stop [dd.mm.yy hh:mm]
93	1	-47.500383	-0.003167	-	-	1028	30.01.08 09:15	30.01.08 09:38	30.01.08 10:05
94	1	-47.003317	-0.000683	-	-	1003	30.01.08 14:12	30.01.08 14:34	30.01.08 15:04
95	1	-46.499283	0.005100	-	-	1003	30.01.08 18:24	30.01.08 18:50	30.01.08 19:18

Tab. 3.2: Nominal Geographic Distribution of CTD Stations (Station Numbers)

	Longitude		
Latitude °S	**3°W**	**0°E**	**3°E**
45.0			
45.5			
46.0			
46.5		95	
47.0		94	
47.5		93	
48.0		92	
48.5		91	
49.0		**90**	
49.5		89	
50.0		88	
50.5		87	
51.0		86	
51.5			
52.0		**13, 84,** 85	
52.5		83	
53.0		82	
53.5		81	
54.0		80	
54.5		79	
55.0		78	
55.5		77	
56.0		76	
56.5		75	
57.0		74	
57.5		73	
58.0		72	
58.5		71	
59.0		70	
59.5		69	
60.0		**68**	
60.5		67	
61.0		66	
61.5		65	
62.0	**33**	64	**34**
62.5	32	63	35

	Longitude		
Latitude °S	**3°W**	**0°E**	**3°E**
63.0	**31**	62	**36**
63.5	30	61	37
64.0	**29**	60	**38**
64.5	28	59	**39**
65.0	**27**	**58**	**40**
65.5	26	57	41
66.0	**25**	56	**42**
66.5	24	55	43
67.0	**23**	54	**44**
67.5	22	53	45
68.0	**21**	52	**46**
68.5	20	**51**	
69.0	**19**	**50**	
69.5	18	**49**	
70.0	**17**		
70.5			

An impression of the collected data is provided by Figs. 3.1 and 3.2. Fig. 3.1 shows the horizontal distribution of vertical profiles of potential temperature, light transmission and oxygen concentration along the Greenwich meridian. Fig. 3.2 portrays a horizontal map of the temperature at the depth of the temperature maximum.

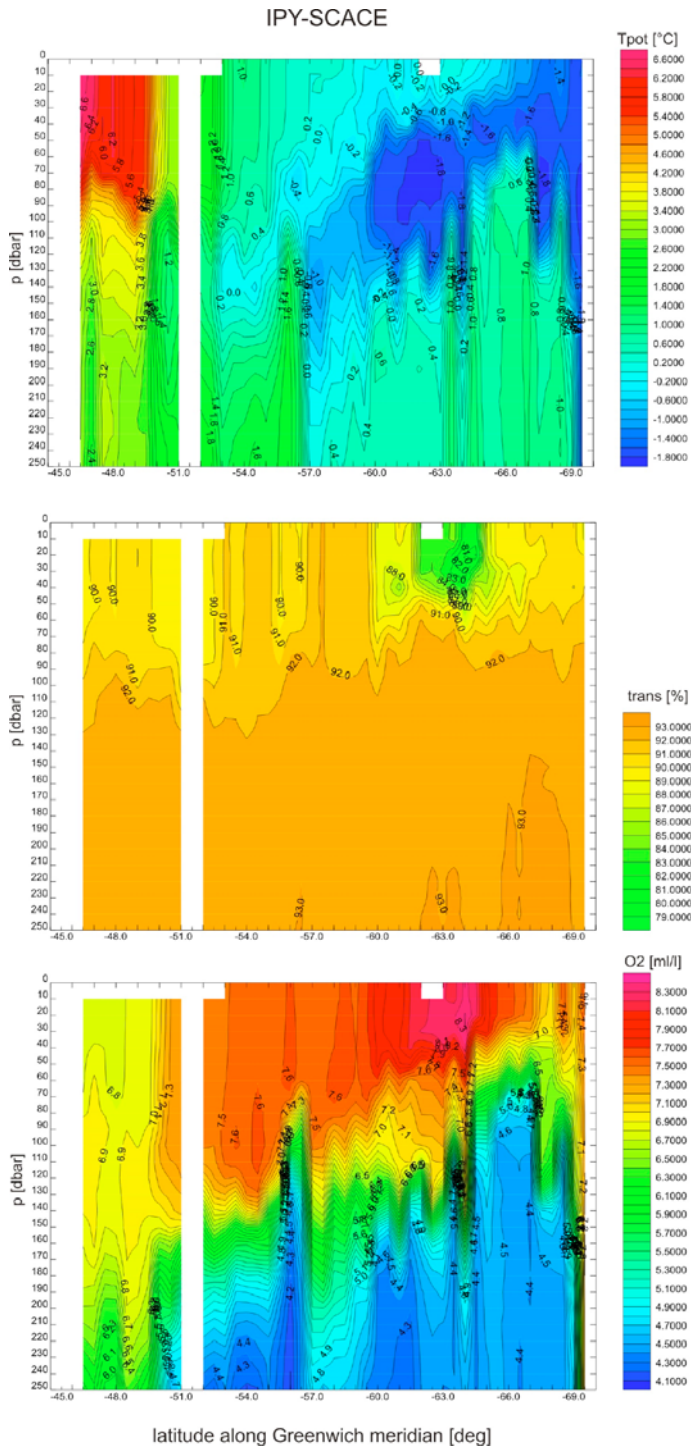

Fig. 3.1: Horizontal distribution of vertical profiles of potential temperature, light transmission and oxygen concentration along the Greenwich Meridian. The lowest values of light transmission, revealing high concentrations of phytoplankton, and highest concentrations of oxygen, indicative of high photosynthesis rates, were centered around 63°S where sea ice melt and warming stabilized the water column and created a shallow mixed layer that is generally favourable for phytoplankton primary production. This ice edge phytoplankton bloom extended over an area of approximately 700.000 km^2 as revealed by satellite remote imaging (chlorophyll concentration from the official ESA MERIS satellite data algal-1 level-2 product composed to maps by T. Dinter (Institute of Environmental Physics, Bremen) and A. Bracher (AWI, Bremerhaven); pers. comm.).

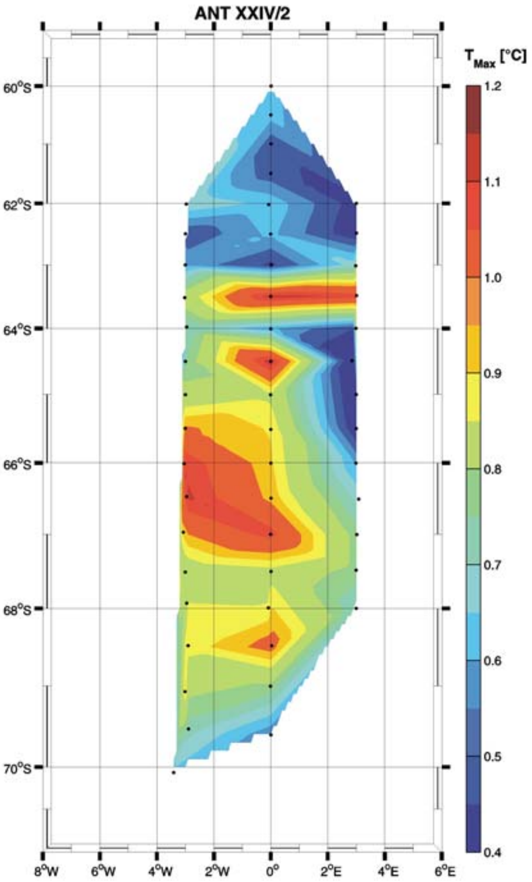

Fig. 3.2: Horizontal distribution of temperature at the temperature maximum

4. PHYSICAL OCEANOGRAPHY: MEASUREMENTS OF CURRENTS AND BACKSCATTER STRENGTH WITH THE VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER (ADCP)

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Objectives and work at sea

Vertical profiles of ocean currents down to 335 m depth were measured with a Vessel Mounted Acoustic Doppler Current Profiler (type 'Ocean Surveyor'; manufacture of RDI, 150 kHz nominal frequency), installed 11 m below the water line in the ship's keel behind an acoustically transparent plastic window for ice protection. The transducer emits/receives the acoustic signals from its flat face, which is composed of an array of about 1,000 ceramic elements, covered in urethane. These elements are arranged in a fixed pattern and are each wired to transmit a specific signal, identified by its phase. The phase shift, with which the ceramic elements emit their acoustic signals, is arranged in a way such that the signals interfere to form beams in four distinct directions, slanted at 30 degrees from the vertical. The transducer also records the echoes returned from particles in suspension in the water. Echoes reflected by particles moving relative to the ADCP return with a change in frequency. The ADCP measures this change, the so-called Doppler shift, as a function of depth to obtain water velocity at a maximum of 128 depth levels. The instrument settings for this cruise were chosen to give a vertical resolution of current measurements of 4 m in 80 depth bins and a temporal resolution of 2 min for short time averages.

Determination of the velocity components in geographical coordinates, however, requires that the attitude of the ADCP transducer head, its tilt, heading and motion is also known. Heading, roll and pitch data are read by the ADCP deck-unit from the ship's gyro platforms. The ship's velocity was calculated from position fixes obtained from the Global Positioning System (GPS) or Differential GPS if available, and was taken over from the ship's navigation system. Accuracy of the ADCP velocities mainly depends on the quality of the position fixes and the ship's heading data. Further errors stem from a misalignment of the transducer with the ship's centre-line and a constant angular offset between the transducer and the GPS antenna array, and a velocity scale factor. The ADCP data processing was done by using the CODAS3 software package (developed by E. Firing and colleagues, SOEST, Hawaii).

The ADCP also recorded the echo intensity, or backscatter strength, which will be analyzed in order to provide an estimate of zooplankton abundance. This estimate will be compared with the zooplankton abundance indicated by the dedicated Simrad EK60 zooplankton-echosounder, and abundance data derived from net catches.

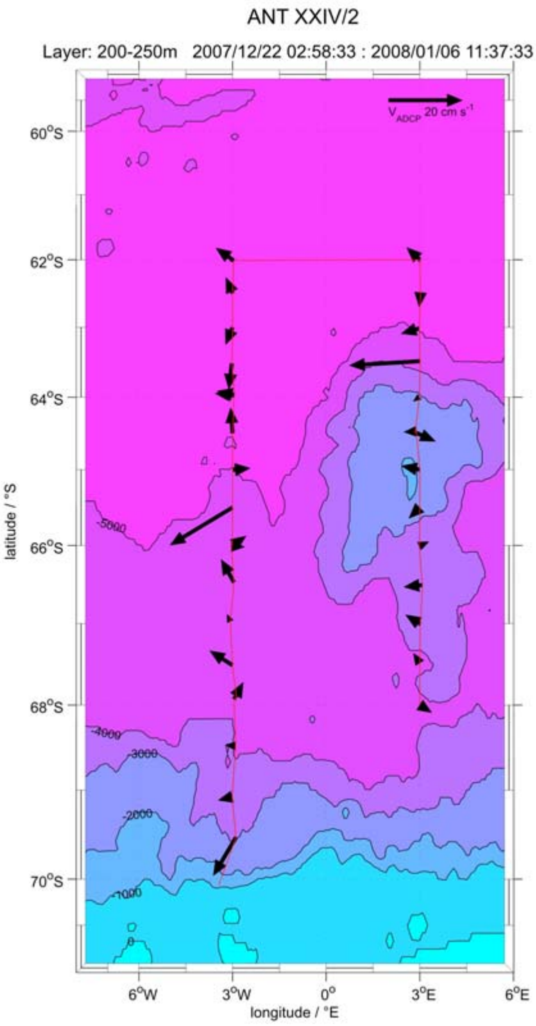

Fig. 4.1: ADCP current vectors in the depth range 200 – 250 m at hydrographic stations along the 3°W and 3°E meridians. The shown currents are not finally calibrated, hence to be considered preliminary

5. PLANKTON PARAMETERS: CHLOROPHYLL A, PARTICULATE ORGANIC CARBON, BIOLOGICAL SILICA

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Objectives and work at sea

The very basis in the food-chain in the water column is the primary producers, the phytoplankton. For all studies dealing with the distribution of higher organisms like Krill for example it is obligatory to compare between distributions of prey and predators. In this case, the prey would be the phytoplankton. There is a simple way to determine the relative concentration of phytoplankton by measuring the fluorescence of photosynthetic pigments. As chlorophyll *a* is the universal antennae pigment of all oxygenic organisms, the chlorophyll *a* content in a given amount of water is a good unit to specify phytoplankton biomass.

To measure the chlorophyll *a* content, standard methods via fluorescence were used. The depths 10, 20, 40, 60, 80, 100 and 200 m were examined along the station grids of 3°West, 0° and 3°East (Fig. 5.1, 5.2, 5.3).

Additionally, the same depths were sampled to get information about the POM (particulate organic matter), as to say, the concentration of POC/PON (particulate organic carbon/nitrogen). Following that the C:N ratio can be determined.

To measure the POC content, pre-annealed GF/F filters were used for filtration of the water samples, which were stored during the cruise in a -25°C room.

Later on at the Alfred Wegener Institute (AWI) they will be examined using standard methods via elemental analysis.

Filtration for Silica-Isotopes took also place under instruction of Mrs. de la Rocha (AWI, Bremerhaven). The filters were dried and stored in aluminium foil during the cruise. The filtrate was stored in plastic bottles. Analysis of these samples shall take place back at the AWI.

Results

Comparing the Figs. 5.1- 5.3 it is apparent that during our cruise a phytoplankton bloom was occurring along a latitude-section between 62° - 66°S.

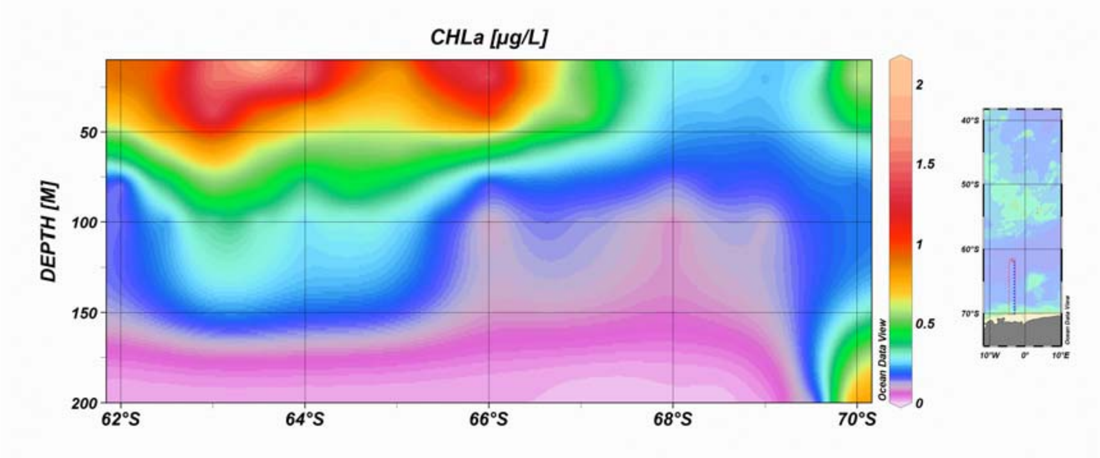

Fig. 5.1: Chlorophyll a depth-profile along the 3° West Transect extending from 62°S to 70°S

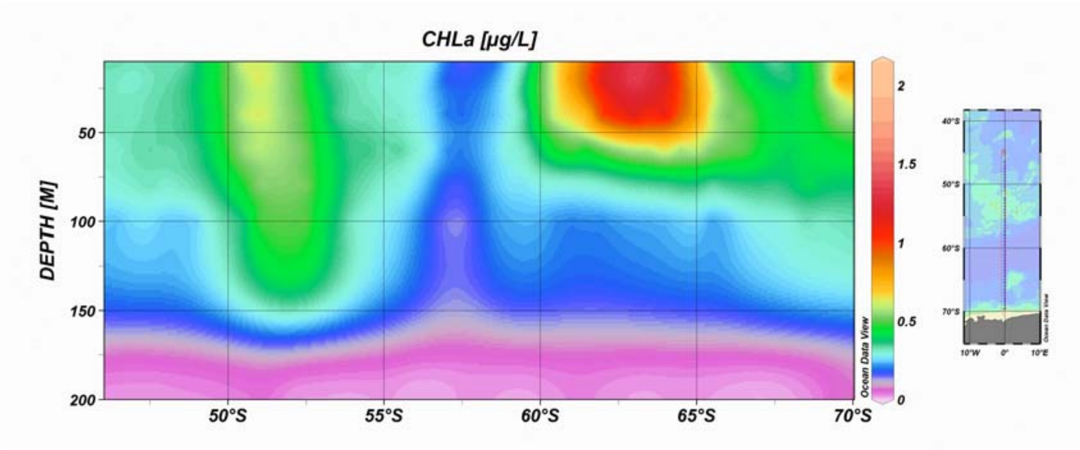

Fig. 5.2: Chlorophyll a depth-profile along the 0° Transect extending from 46°30'S to 69°36'S

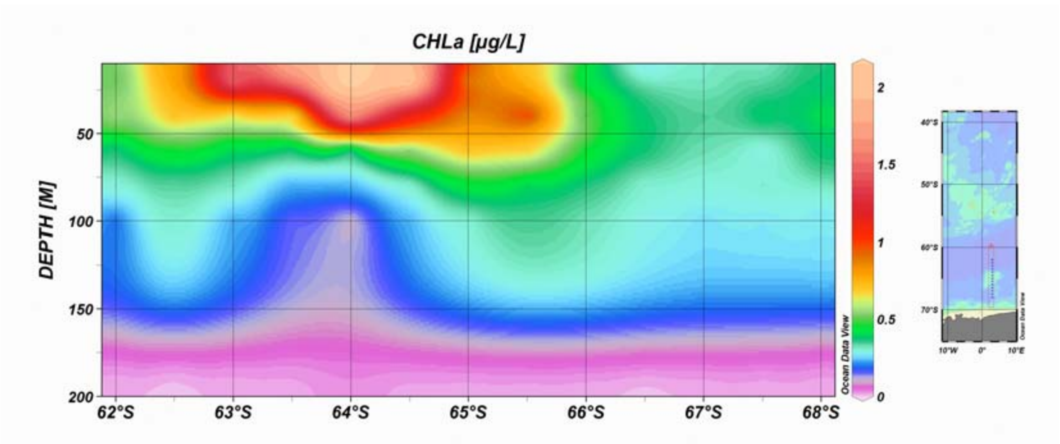

Fig. 5.3: Chlorophyll a depth-profile along the 3° East Transect extending from 62°S to 68°S

6. CONTINUOUS PLANKTON RECORDER (CPR): AUSTRALIAN ANTARCTIC DIVISION PROJECT 472

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(not on board)

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[2)] Australian Antarctic Division, Australia

Objectives

The Southern Ocean Continuous Plankton Recorder (SO-CPR) survey, which from 1997 had only involved Australia and Japan, has included Germany since 2004. This serves to address AAD's Goal 1 of maintaining the Antarctic Treaty System and enhancing Australia's influence through cooperating with Antarctic Treaty partners in the involvement in setting the direction of international scientific programmes and forums relating to Antarctic issues, e.g. international CPR survey, SCOR, SCAR, GOOS and GLOBEC.

The SO-CPR survey primarily addresses AAD's Goal 2 of protecting the Antarctic environment by providing information on the status or "health" of the Southern Ocean through the monitoring of zooplankton.

Zooplankton are sensitive to environmental parameters such as temperature, movement of currents and water quality. Due to their sensitivity, short life spans and fast growth rates plankton populations respond rapidly to environmental change, and consequently make excellent biological indicators.

The CPR programme is expected to provide information on natural variation in zooplankton patterns as well as effects of global change. Zooplankton are also the principal dietary components of many higher vertebrates, including penguins, seals and sea-birds. Therefore, changes in zooplankton distribution and abundance in the Southern Ocean are expected to have a significant effect on higher trophic levels. In turn, this will serve as a reference to help distinguish fishing impact from natural or other variation.

Consequently, the AAD has developed the CPR zooplankton monitoring programme, under the leadership of Dr. Graham Hosie. The CPR programme is a key methodology in the AAD Biology programme's objectives in addressing Goal 2 in surveying biodiversity and mapping effects of climate change. It is now also a key component of the Japanese Centre for Antarctic Environment Monitoring through collaboration with the AAD. The German Antarctic programme has now joined the SO-CPR survey with the mutual benefit of supporting their plankton studies while providing the survey with another fixed transect. The survey to date mainly relies on *Aurora Australis* for the majority of tows. These voyages cover a large area which is ideal for mapping biodiversity, but they also have variable routes and schedules according to logistic and science programme demands which can complicate attempts to assess temporal variation as distinct from spatial patterns. The Japanese icebreaker *Shirase* has provided tows along two fixed transects 110°E and 150°E at fixed times which provides useful references for the other data. The addition of the fixed transect between Cape Town and Neumayer station, sampled several times a year on *Polarstern*, has further improved our analyses, as well as improving our spatial coverage for studying patterns in the Antarctic Circumpolar Current. Additional fixed transects are also being developed with the French, New Zealand and United Kingdom Antarctic vessels. Comparisons can also be made with other oceanic areas.

By employing a CPR, surface or near-surface zooplankton can be collected at normal ship speed during a voyage. The unit is usually towed about 100 metres astern of the ship for approximately 450 nautical miles at a time. By splicing consecutive tows together one is able to produce an un-interrupted transect across the ocean, providing information on zooplankton distribution patterns, community structure, and abundance levels.

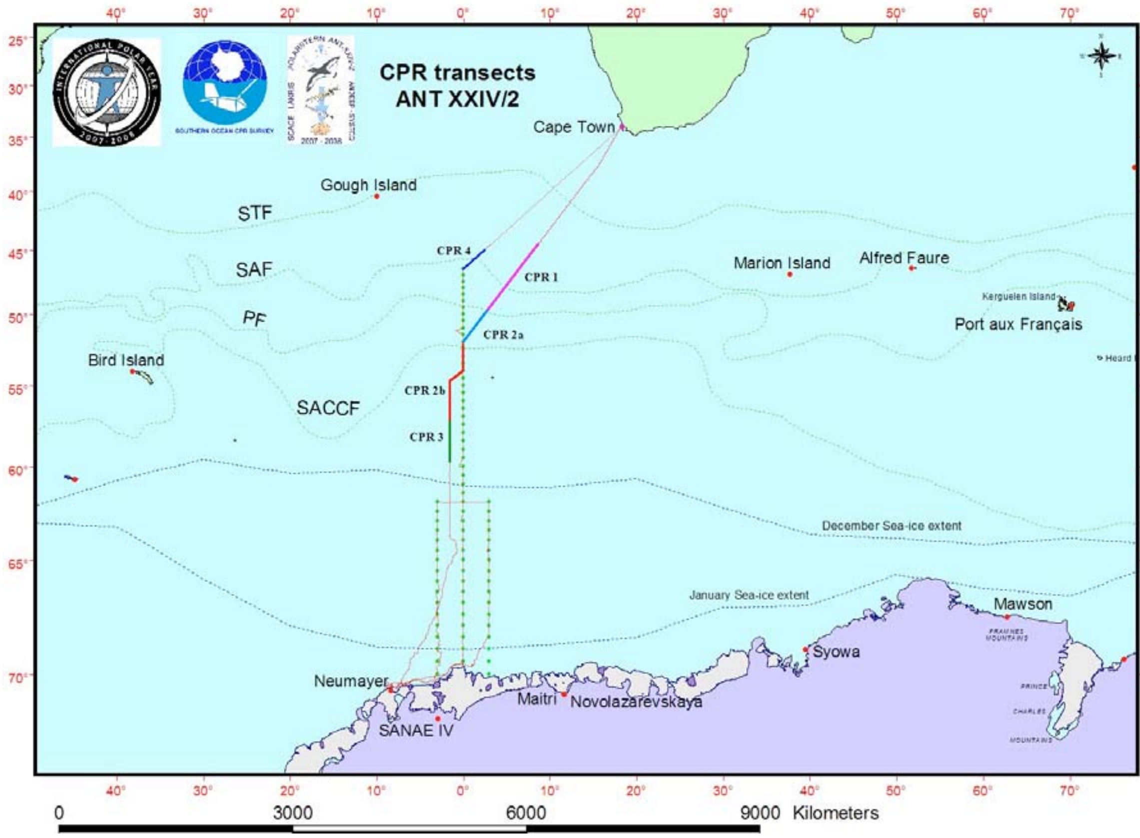

Fig. 6.1: Map showing CPR deployments during ANT-XXIV/2

Work at sea

The CPR component during ANT-XXIV/2 involved the collection of 3 samples on the southward and 1 sample on the northward legs of the Cape Town - Lazarev Sea krill survey area route (Fig. 6.1). The resulting 4 samples, a combined total distance of

1,190 nautical miles of continuous plankton recordings, will be analysed back at the laboratory at AAD headquarters in Kingston, Tasmania, Australia.

All four routine CPR tows were successfully undertaken onboard *Polarstern*. There were no problems encountered with the gear at any time.

To date, 15 routine CPR runs have been completed so far this 2007/08 season on *Aurora Australis*, with another 7 planned for the remaining 2 voyages. A further 6 CPR tows are currently being undertaken during JARE 2007/08 onboard *Shirase*, and now the addition of 4 more from ANT-XXIV/2 on *Polarstern*. The 2007/08 season will be completed with the collection of 12 more samples from *Umitaka Maru* in the southern Indian Ocean; 8 from *Tangaroa* in the southern Pacific Ocean; 4 from *Akademik Fedorov* in the Amundsen and Bellinghausen Seas; and finally 3 more from *Yuzhmorgeologiya* in the Ross Sea.

Acknowledgements

Sincere thanks again go to Uli Bathmann for his keen interest in furthering the SO-CPR programme by incorporating CPR sampling into the voyage schedule, and of course again to Master Uwe Pahl, boatswain Burkhardt Clasen and crew of *Polarstern*, for their willing assistance and faultless deployment and retrieval of gear in all weather conditions.

7. MULTINET SAMPLING DURING ANT-XXIV/2, DECEMBER - JANUARY 2007/08

John Kitchener[1)], Ulrich Bathmann[2)]

[1)] Australian Antarctic Division, Australia
[2)] Alfred-Wegener-Institut, Bremerhaven, Germany

Background and objectives

Part of an ongoing continuous multi-frequency acoustic survey is to survey the spatial distribution of *Euphausia superba* and other planktonic animals, including the possible prey organisms of krill, in relation to hydrographical processes.

Using the difference in backscattering strength with different echo-sounder frequencies, it is necessary to discriminate between distinct areas within the water column along the transects, depicted by clear shifts in backscattering signatures. To enable this, a combined data analysis of the results of different types of net hauls (e.g. RMT, Multinet, SUIT etc), hydrographical and acoustic measurements needs to be done to address the nature of such patterns in plankton distribution. This study looks at the results of the Multinet sampling.

Work at sea

During the expedition ANT-XXIV/2 throughout December 2007 to January 2008, stratified mesozooplankton samples were collected at 39 stations along 3 transects (3°W, 3°E and 0°), generally sampling at each degree in latitude. The range of all 3 transects was from 70°S to 62°S, with the exception of the Greenwich meridian transect which extended northwards until 46°30'S. The net used was a multiple opening/closing net system (Multinet, Hydro-Bios Kiel). The smaller Multinet type Midi with a mouth opening of 0.25 m^2 and five nets equipped with 100 μm meshes was used throughout. For qualitative estimates of zooplankton individuals, the water column from 500 m to the surface was sampled at 5 standard depth intervals (500 - 200, 200 - 100, 100 - 50, 50 - 25 and 25 - 0 m).

In general, each time the deployment of the Multinet was very successful without technical problems. There were, however, some considerable differences between the flow meter rates for the same depth interval between hauls. It has not been ascertained as to why this occurred.

Samples were only qualitatively analysed on board, and each major taxa allocated a percentage contribution to the overall estimated biovolume/biomass. Detailed sample analyses will occur at the Alfred Wegener Institute, post voyage.

Results

From samples collected along 3°W (Fig. 7.1) there seems to be a consistent pattern from the 500 - 100 m depth range, with small gastropods (pteropods) appearing to be quite dominant in the deeper samples. Also are copepods, and to a smaller extent chaetognaths and gelatinous zooplankton (medusae and tunicates). The upper 100 metres show a distinct delineation between samples from 68°S and 67°S. Whereas copepods, chaetognaths and pteropods were predominantly the major taxa from the southern stations, phytoplankton species became the most abundant taxa northwards from 67°S and this persisted to the end of the transect at 62°S. The total estimated biovolume/biomass of these samples were the largest recorded during this transect. Results from the chlorophyll a extractions from each CTD station also supports this trend in the plankton distribution and abundance, with profiles showing the maximum chlorophyll a at about 63°30'S (chapter 5). Transmissometer profiles also support this, with the lowest transmission also at 63°30'S (chapter 3)

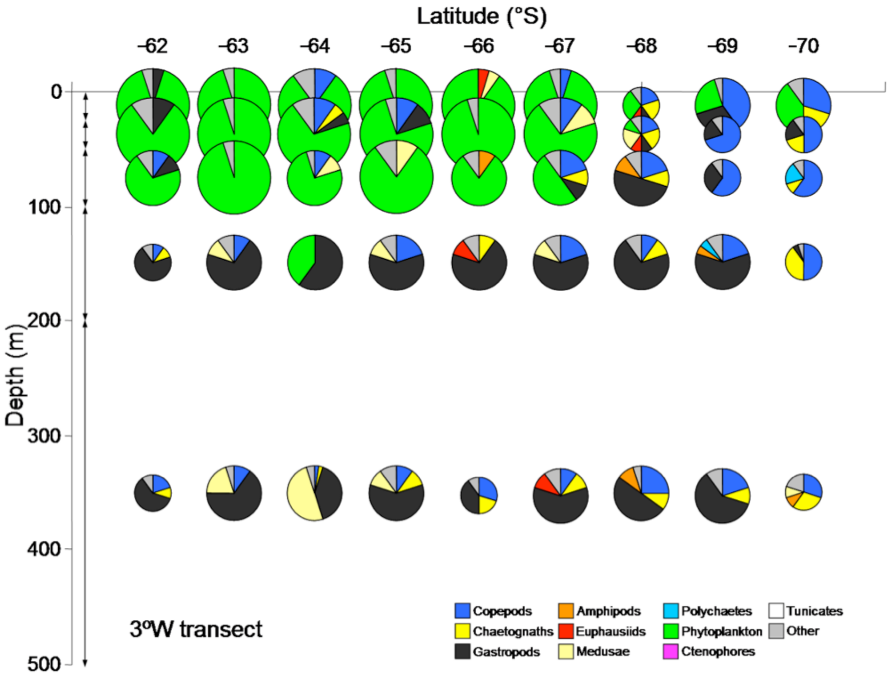

Fig. 7.1: Plankton in the top 500 m along 3°W. Species abundance is given in relative occurrence.

Due to logistical requirements, sampling was curtailed along the 3°E transect after 67°S (Fig. 7.2). Multinets again were used at every degree of latitude, with the exception of the station at 64°30'S which was moved south half a degree to coincide with Maud Rise. Again, the deeper samples (500 - 100 m) were mostly dominated by small pteropods, with copepods, chaetognaths and medusae also found in considerable quantities.

The upper 100 metres were again dominated by phytoplankton in most samples, with the exception of the southernmost station at 67°S which was heavily biased with the capture of a large ctenophore. Significant proportions of copepods were found in the northernmost station at 62°S. In general, the estimated biovolumes of samples throughout the 3°E transect were smaller than those of the 3°W transect.

The maximum chlorophyll a (chapter 5) and minimum transmission (chapter 3) occurred at 64°S. There was no Multinet at this latitude, but the trend of higher phytoplankton values around the same degrees of latitude again supports this finding similar to the 3°W transect, albeit with smaller biovolumes.

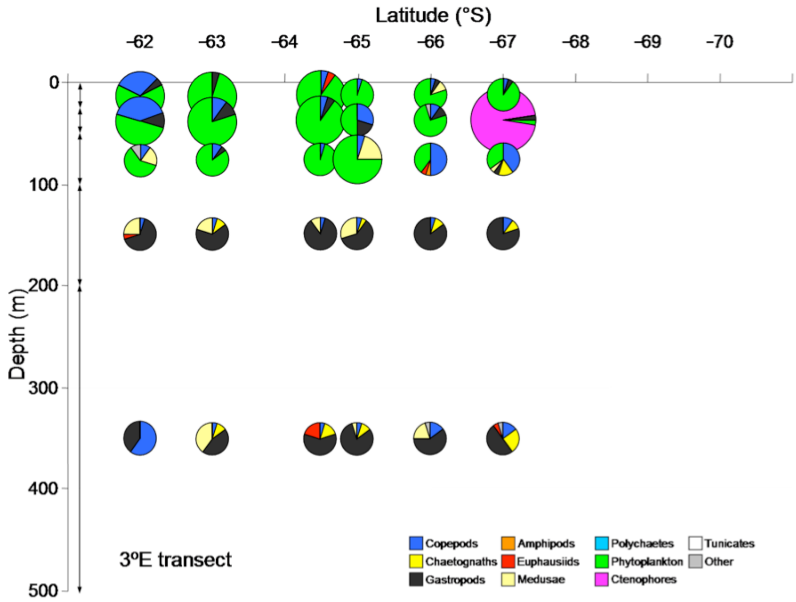

Fig. 7.2: Plankton in the top 500 m along 3°E. Species abundance is given in relative occurrence.

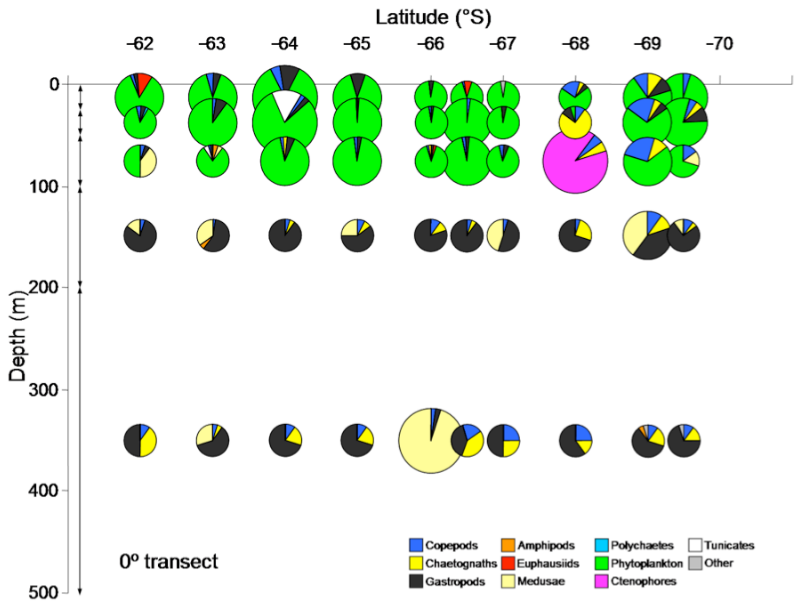

Fig. 7.3: Plankton in the top 500 m along 0° meridian (part). Species abundance is given in relative occurrence.

The 0° degree transect along the Greenwich meridian extended from the southernmost station at 69°30'S to 46°30'S in the north, the final station of the survey (Figs 7.3, 7.4, 7.5). Again, each station was conducted at every degree of latitude, with a few exceptions. Ice conditions were too severe to conduct a station at 70°S, so it was moved half a degree to the north (Fig. 7.3). Stations at 51°S to 49°S were curtailed by severe weather, so no Multinets could be used (Fig. 7.5).

As with the 3°W and 3°E transects, the deeper samples (500 - 100 m) were mostly dominated by small pteropods, with copepods and chaetognaths found in considerable quantities (Fig. 7.3). The exception was the station at 66°S, where a large medusa greatly influenced the total biovolume.

Similarly, the upper 100 metres was again dominated by phytoplankton species in most samples, with minor contributions by copepods and chaetognaths. A large ctenophore biased the 100 - 50 m sample at 68°S. In general, the estimated biovolumes of samples throughout the 0° transect were larger than those of the 3°E transect, but smaller than the 3°W transect.

Preliminary oceanographic data from this survey indicates an ice-edge algal bloom, and lower transmission at 63°S (Strass *et al.*, this cruise). The largest biovolumes of phytoplankton were sampled at 64°S, so this is a reasonable comparison. No data is available for the chlorophyll a along the 0° meridian at the time of writing.

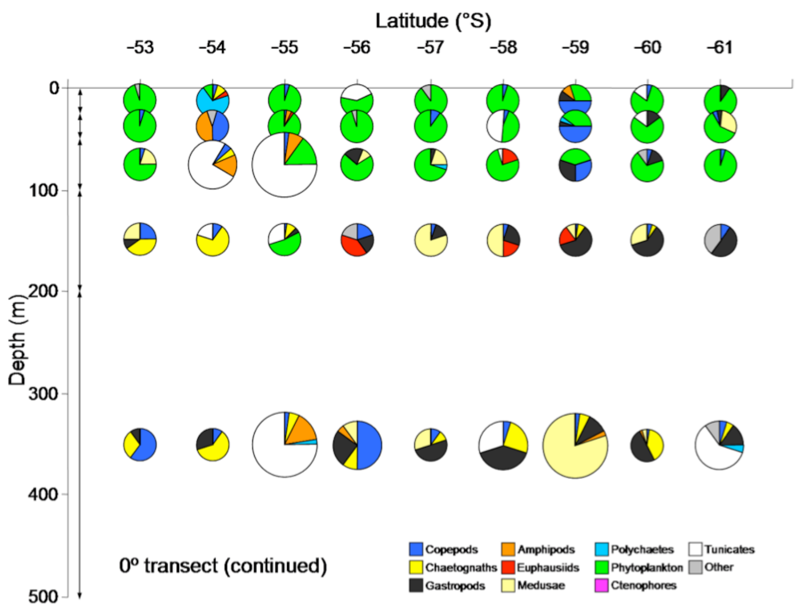

Fig. 7.4: Plankton in the top 500 m along 0° meridian (part). Species abundance is given in relative occurrence.

Fig. 7.4 depicts the Multinet station results further north along the 0° meridian from 61°S to 53°S. The composition of the plankton in the deeper layers (500 - 100 m) clearly changes throughout. Although still present, the small pteropods (Gastropoda) have given way to gelatinous zooplankton (medusae, salps). Copepods, chaetognaths, small euphausiids and amphipods are also present in considerable numbers.

Phytoplankton also forms the bulk of samples taken in the upper depth ranges (100 - 0 m). But the total estimated biovolumes are quite small compared to the previous southern section in Fig. 7.3. The presence of increasing quantities of salps is also apparent (chapter 3).

Approximately at 57°S is the northern boundary of the Weddell Gyre and the circumpolar current, as indicated by this survey's oceanographic data (Strass et al., this cruise). There is no obvious change in the zooplankton data, only possibly increasing numbers of salps to the north.

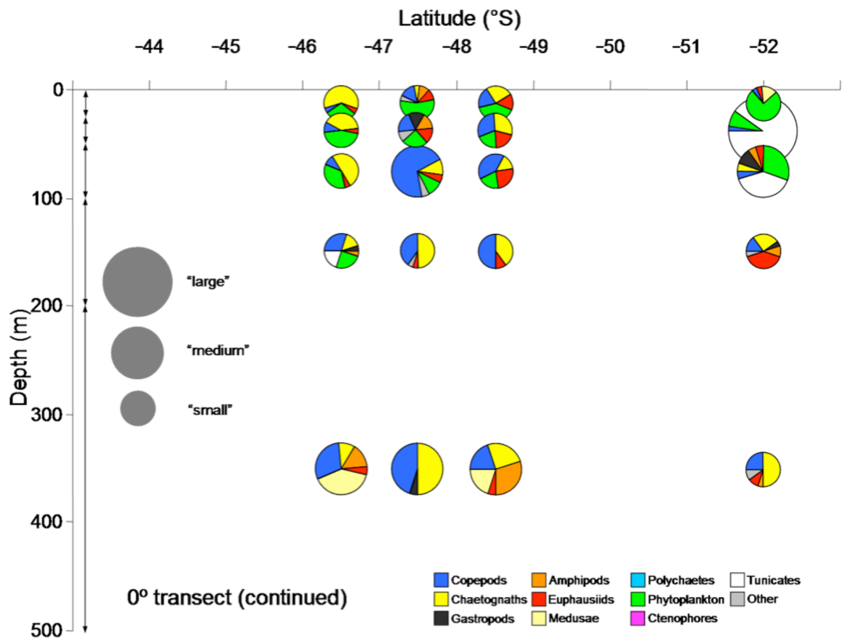

Fig. 7.5: Plankton in the top 500 m along 0° meridian (part). Species abundance is given in relative occurrence.

Fig. 7.5 shows the plankton profiles for the final Multinet stations further north along the 0° meridian from 52°S to 46°30'S. Unfortunately this section is incomplete as severe weather curtailed much of the sampling.

The composition of the plankton in the deeper layers (500 - 100 m) has changed completely from the previous section, with copepods and chaetognaths the major taxa. Gelatinous zooplankton (medusae, salps) are still present, but in lower abundances. Small euphausiids and amphipods form the rest of the important taxa.

Phytoplankton is still also present in the upper depth ranges (100 - 0 m). But its contribution to the biovolume is now quite small. Salps, dominant at 52°S have given way to a mixture of smaller species, with copepods, chaetognaths and small euphausiids the more abundant taxa.

Approximately at 49°30’S is the Polar Front. Unfortunately there are no samples around that position, but it is quite clear that the plankton composition north of the Polar Front is quite different from that to the south.

Concluding remarks

This study has served to show the preliminary results of stratified plankton distribution and abundance from the Lazarev Sea survey area, and beyond to the north, following the 0° meridian to 46°30’S. For the most part, the results seem to reflect differences within the oceanographic processes. But in some instances it is not so clear, especially north of the LAKRIS survey grid.

As the results of the plankton species abundance are only estimates of biovolume/biomass for each sample, it will not be clear until all samples are fully analysed back in the laboratories at the Alfred Wegener Institute. Although the proportion of some plankton groups may seem to be unchanged from south to north along each transect, it is extremely likely that the actual species compositions are completely different. Only detailed sample analysis will realise this, and then associations between plankton and oceanographic processes may be clearer.

8. BIOLOGY OF *OITHONA SIMILIS* (COPEPODA: CYLOPOIDA) IN THE SOUTHERN OCEAN

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Objective

Oithona similis belongs to the order of cyclopoid copepods. It is highly abundant throughout many parts of the world ocean and is supposed to be a cosmopolitan species. The work on this cruise is part of a project that challenges whether *O. similis*, a key species in three chosen study areas (Southern Ocean, Arctic Ocean and North Sea), is indeed a cosmopolitan. A further goal is a better understanding of its life cycle (or the cycles of the existing cryptic species).

Work at sea

It was possible to take samples at 17 stations throughout the three transects. *Oithona similis* is an epipelagic copepod. Therefore sampling was restricted to the upper 250 m of the water column. Samples were collected via 23 Niskin bottles mounted on a CTD and with an additionally towed multinet (mesh size: 55 µm). At each chosen depth (10, 20, 40, 60, 80, 100, 125, 150, 200, 250 m) two or three bottles were closed. The 12 l out of the Niskin bottles were directly concentrated through 20 µm gauze to a final volume of 50 ml per depth. This volume was immediately fixed in formalin for morphological identifications of species, reproduction in the field as well as feeding habits. With this method higher numbers of the first developmental stages were caught than by the multinet (used depths strata of the net: 250 - 200 m, 200 - 150 m, 150 - 100 m, 100 - 50 m, 50 - 0 m). For genetical investigations adult individuals were picked out of all multinet samples and preserved in ethanol. Additional adults were fixed in formalin for closer morphological investigations.

Outlook

The first step at the home laboratory will be the genetic investigations as they determine the further procedure. If their results hint on the existence of cryptic species in the nominal *O. similis,* the adult formalin fixed individuals will then be analysed with a focus on eventually existing differences in the morphology. If the existence of only one species is supported, the project will concentrate on the analyses of reproduction, stage distribution and gut content for this species.

9. SALP DISTRIBUTION IN THE LAZAREV SEA, DECEMBER - JANUARY 2007/08

John Kitchener[1], Sarah Herrmann[2], Evgeny Pakhomov[3] (not on board)

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[3] University of British Columbia, Canada

Background and objectives

In the Southern Ocean the pelagic tunicates, in particular the salps *Salpa thompsoni* and *Ihlea racovitzai* are very important components of the zooplankton community. Salps are of great interest as they occur at certain seasons in dense concentrations or swarms. They are a short-lived species, which exhibit rapid population growth. Salps have high grazing rates and, as they are primarily herbivores (predominately feeding upon marine phytoplankton), they must play an important role in consuming significant quantities of primary production. Where their distributions overlap with other key herbivores such as the Antarctic krill *Euphausia superba*, there must be competition for food, and this has implications for the functioning and trophic dynamics of the high Antarctic ecosystem.

Since the austral autumn of 2004, the LAKRIS project has conducted a regular survey of the Lazarev Sea (3°E to 3°W), south of 60°S. Since the first survey, a spring and winter survey followed soon after to maintain collection of data on the seasonal and interannual variability of the krill distribution and demography in high latitude areas, which are covered by sea ice for the most part of the year. Other biomass dominant zooplankton species such as salps, collected along with krill, provides an additional insight on processes influencing the high latitude Lazarev Sea ecosystem.

Work at sea

This current cruise ANT-XXIV/2 formed part of an ongoing study of salp distribution and abundance in the Lazarev Sea. Salps were collected whenever they occurred throughout a sampling grid of double oblique RMT-8 net tows between 0 and 200 m. Where possible, several salps representative of the size ranges were frozen at -80° C for later HPLC analysis. These were only taken from the routine RMT-8 trawls. The size and development stage of all aggregate and solitary salps was only done for individuals being frozen. The remaining salps from each catch were fixed in 4 % buffered formaldehyde for demographic and other biological studies back at the Alfred Wegener Institute.

Additional salps for gut fluorescence analysis were collected opportunistically from mesopelagic tows using the multiple RMT-8 (0 - 1,000 m) and SUIT nets conducted both during the grid survey and from the routine RMT-8 at a sampling station of 52°S on the Greenwich Meridian.

Gut fluorescence measurement is a method to determine the amount of chlorophyll a in the guts of the animals. As salps are filter-feeders a high amount of seawater flows through their body. The phytoplankton distributed in the seawater is being accumulated in their guts. It is common to specify the content of phytoplankton in the water column by μg chlorophyll a per litre of seawater. The same is possible for determining the chlorophyll a content in the guts of salps. The result is then divided by the length in cm of the individual. In the end the chlorophyll a content can be seen in relation to the body length or oral-atrial length of the salps, and furthermore in relation to the total chlorophyll a content in the water column which forms the feeding environment of the salps.

Immediately after capture the stomachs of ~5 salps from each size group, representative of the size range, were dissected out and placed in 10 ml of 90 % acetone for gut pigment extraction in darkness at -26°C for at least 12 hours.

Distribution and abundance of salps

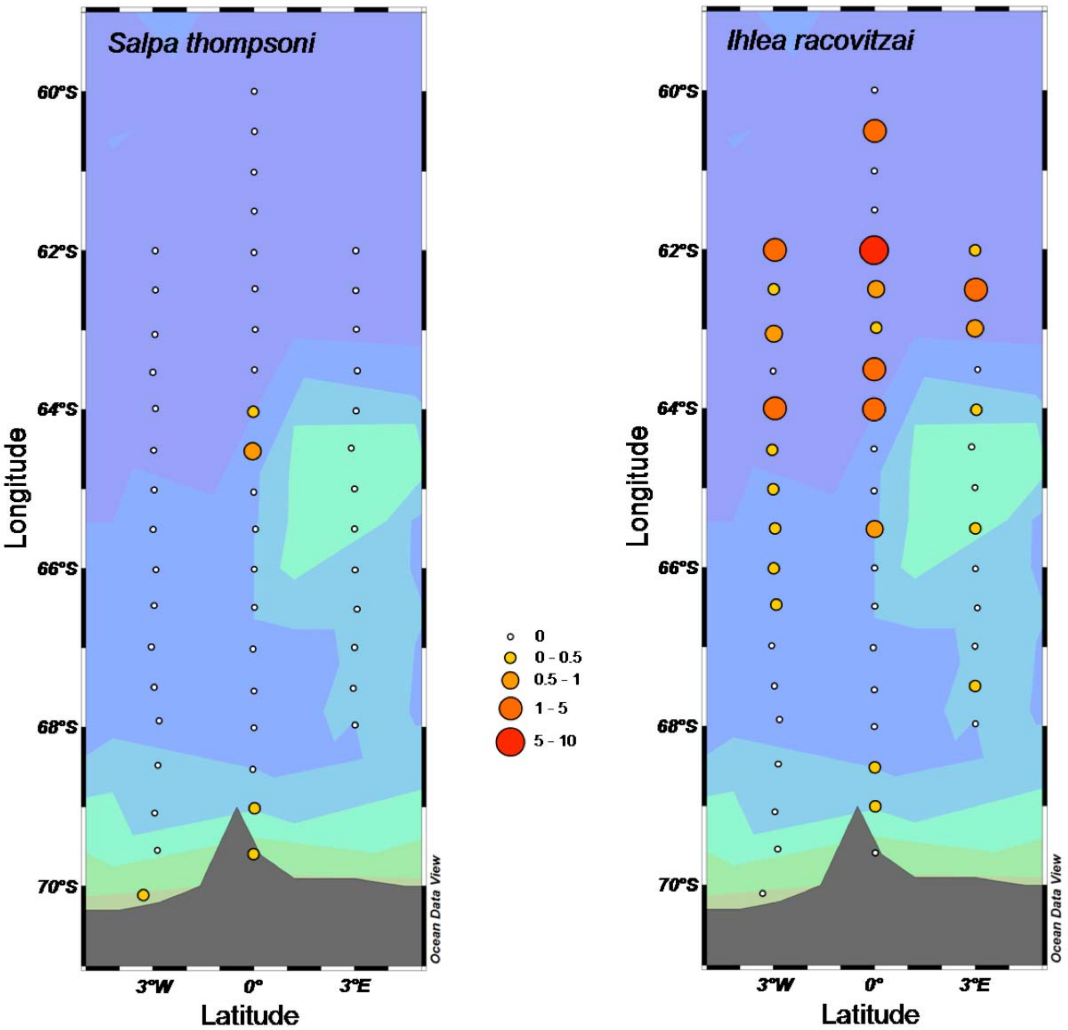

Fig. 9.1: Spatial distribution of Salpa thompsoni and Ihlea racovitzai in the Lazarev Sea, December 2007 to January 2008. Bubble size is scaled by salp densities (number of individuals per 1,000 m^3).

The occurrence of *Salpa thompsoni* was rare throughout the survey, at only 10 % of the stations. This is substantially lower than the 57 % recorded during April 2004 and again lower than 14 % during December 2005 for the same survey area. Conversely, *Ihlea racovitzai* occurred at a relatively high frequency (48 %), comparable to levels recorded during April 2004 and December 2005 of around 50 % for each. Densities at stations where specimens were caught ranged from 0.65 to 0.04 ind.1,000 m^{-3} for *S. thompsoni* and 7.23 to 0.05 ind.1,000 m^{-3} for *I. racovitzai* (Fig. 9.1). The most stations where *Salpa thompsoni* occurred were principally in the south west of the survey area. However the greatest density was recorded at a station at 64°30'S along the Greenwich meridian. *Ihlea racovitzai* was more widely distributed, with maximum densities north of ~64°S. *S. thompsoni* and *I. racovitzai* were recorded together at the same station only twice on the 0° meridian (64°S and 69°S).

Salp size and stage structure
Apart from the frozen samples, salps were not measured before they were fixed. This will be done post-voyage at AWI. Of the frozen samples, the *Salpa thompsoni* population structure was dominated by aggregate forms, with only one solitary specimen (78 mm) collected during the Lazarev Sea grid survey. The aggregate population was comprised predominantly of individuals 10 -13 mm in length, with specimens either being stage 1 or stage X. *Ihlea racovitzai* collected during the survey were all solitary animals (420 individuals), apart from 3 aggregate forms. This species was dominated by animals 20 -30 mm in length, however there was another major size class between 50 - 70 mm.

Gut fluorescence measurement

Tab. 9.1: Stations with enough salps for gut fluorescence measurement

Station	Position	Net used	Species	Size class	Sex
13-8	52°S 0°E	RMT 8	*S. thompsoni*	2,1-2,5 cm	aggregate
13-8	52°S 0°E	RMT 8	*S. thompsoni*	3,1-3,5 cm	aggregate
13-8	52°S 0°E	RMT 8	*S. thompsoni*	3,6-4,0 cm	aggregate
13-8	52°S 0°E	RMT 8	*S. thompsoni*	4,1-4,5 cm	aggregate
13-17	52°S 0°E	SUIT	*S. thompsoni*	2,1-2,5 cm	aggregate
13-17	52°S 0°E	SUIT	*S. thompsoni*	2,6-3,0 cm	aggregate
13-17	52°S 0°E	SUIT	*S. thompsoni*	3,1-3,5 cm	aggregate
13-17	52°S 0°E	SUIT	*S. thompsoni*	3,6-4,0 cm	aggregate
13-17	52°S 0°E	SUIT	*S. thompsoni*	4,1-4,5 cm	aggregate
33-1	62°S 3°W	M-RMT 8	*I. racovitzai*	2,1-2,5 cm	solitary
49-2	69°36'S 0°E	SUIT	*S. thompsoni*	1,1-1,5 cm	aggregate
60-4	64°S 0°E	SUIT	*S. thompsoni*	1,5-2,0 cm	aggregate
60-4	64°S 0°E	SUIT	*S. thompsoni*	2,1-2,5 cm	aggregate
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	1,1-1,5 cm	aggregate
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	3,1-3,5 cm	aggregate
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	3,6-4,0 cm	aggregate
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	4,1-4,5 cm	aggregate
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	4,6-5,0 cm	aggregate
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	3,1-3,5 cm	solitary
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	3,5-4,0 cm	solitary
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	4,5-5,0 cm	solitary
84-2	52°12'S 0°E	M-RMT 8	*S. thompsoni*	5,6-6,0 cm	solitary

In Table 9.1 the stations with enough salps of the different size classes for later gut fluorescence analysis are listed. The results are still in process.

Concluding remarks
This study has provided insight into the summer tunicate community of the Lazarev Sea. This season the salps were not that abundant. In particular, *Salpa thompsoni*

numbers were quite rare within the LAKRIS survey area. Even though *Ihlea racovitzai* were found in just under half the trawls, numbers of individuals were quite small.

Van Franeker et al. (chapter 12) reports that the sea ice edge for the 3^oW and 3^oE transects were approximately at 62^oS and 63^o30'S respectively. By the time the survey had commenced the 0^o meridian, the sea ice had retreated to about 67^o30'S. It is notable that only one specimen of *Salpa thompsoni* was collected throughout the first two survey transects (3^oE and 3^oW) where ice coverage was relatively high. Conversely, the lower ice coverage of the 0^o meridian transect revealed some, but not many, *S. thompsoni*. As well, most of *Ihlea racovitzai* were found within the northern half of the survey area, and mostly along the 0^o meridian. It seems that possibly the high ice coverage for this season may have contributed to the overall lower numbers of salps collected during this survey.

10. CARNIVOROUS ZOOPLANKTON IN THE MESOPELAGIC FOOD WEB OF THE SOUTHERN OCEAN

Svenja Kruse, Ulrich Bathmann Alfred-Wegener-Institut, Bremerhaven, Germany

Objectives

During this cruise the project was focused on the distribution and the abundance of deep-living carnivorous chaetognaths and amphipods, their feeding habits and their predation impact as well as their role in the carbon cycle. Special attention has been given to the depth range between 500 and 2,500 m. As expedition ANT-XXIII/6 already provided information about the winter situation this expedition should complete the existing picture of the mentioned carnivorous zooplankters in this area. Among the chaetognaths special attention has been given to the species *Eukrohnia hamata* and the two deep water species *E. bathypelagica* and *E. bathyantarctica*. In addition the amphipods *Cyllopus lucasii* and *Primno macropa* were of special interest.

Work at sea

Investigations on board *Polarstern* were done by a combination of sampling and experimental approaches. Stratified sampling was performed at 15 stations along three transects (3°W, 3°E and 0°) down to 2,000 m with a multinet. This multiple opening/closing net was equipped with five nets of 100 µm mesh size and sampled the following 5 standard depth intervals: 2,000 - 1,500 m, 1,500 - 1,000 m, 1,000 - 750 m, 750 - 500 m, 500 - 0 m. All chaetognaths were sorted out of the four deeper samples. The remaining zooplankton samples had been preserved in formaldehyde (4 %) and will be analysed quantitavely at the Alfred Wegener Institute later on. These data will complement the standard 500 m-multinet catch (compare multinet sampling by John Kitchener, chapter 7).

The chaetognaths from these samples were all determined, staged, counted and measured. Most of them, in particular the ones in good condition, were then immediately stored at –80°C for later analysis (C/N, gut content, lipids and fatty acids). Additional actively swimming specimens from depth layers between 500 and 1,000 m were kept in a cooling container at 0°C for respiration experiments (according to the Winkler-method).

The amphipods were taken from 34 RMT 8 (rectangular midwater trawl; upper 200 m) and 4 SUIT (surface under ice trawl) samples along the three transects. Among the two amphipods of main interest, *Cyllopus lucasii* was the more abundant species. Therefore specimens of both species were frozen for later anlaysis, but experiments could only be conducted with *Cyllopus lucasii*. Respiration as well as feeding experiments (with phytoplankton or zooplankton as food source) were done after a starvation period of 48 h. The produced faecal pellets were taken for measurements of the sinking velocities. The size has been measured, the CN-ratio will be investigated later on.

Four multiple RMTs were additionally deployed throughout the cruise down to depth between 1,900 and 2,500 m. This trawl consists of three pairs of nets, each of which comprises an RMT 1 (0,33 mm mesh size, 1 m^3 mouth area) and an RMT 8 (4,5 mm mesh size, 8 m^3 mouth area). By this means three depth intervals below 500 m water depth could be sampled. The intervals were variable, but we tried to choose them according to the intervals of the multinet (2,000 – 1,500 – 1,000 – 500 m). Chaetognaths and amphipods were again separated from the other zooplankton groups. Most chaetognaths were determined and counted. The quantitative analysis of the complete samples will be done in the home laboratories.

Preliminary results

Frequency of occurrence and composition of chaetognaths caught with the multinet

The first station was located on the prime meridian at 52° S, where two multinets were taken two days apart from each other (Fig. 10.1). The number of chaetognaths comprised of less than 500 individuals per 1,000 m^3 over the total depth range in both catches. The species *Eukrohnia hamata* occurred over the full depth range, but decreased in number with the depth. This was also found with *Sagitta marri* which were even missed between 1,500 and 2,000 m depth. However, the abundances of the species *Eukrohnia bathypelagica* and *Eukrohnia bathyantarctica* increased with the depth. Large chaetognaths like *Sagitta gazellae* were rarely caught with this type of net. Despite of these similarities, both catches taken at the same station looked quite different. Especially the occurrence of juvenile chaetognaths was unlike. The difference in time between the sampling as well as the drifting of the ship (i.e. geographical distinctions) may have caused this.

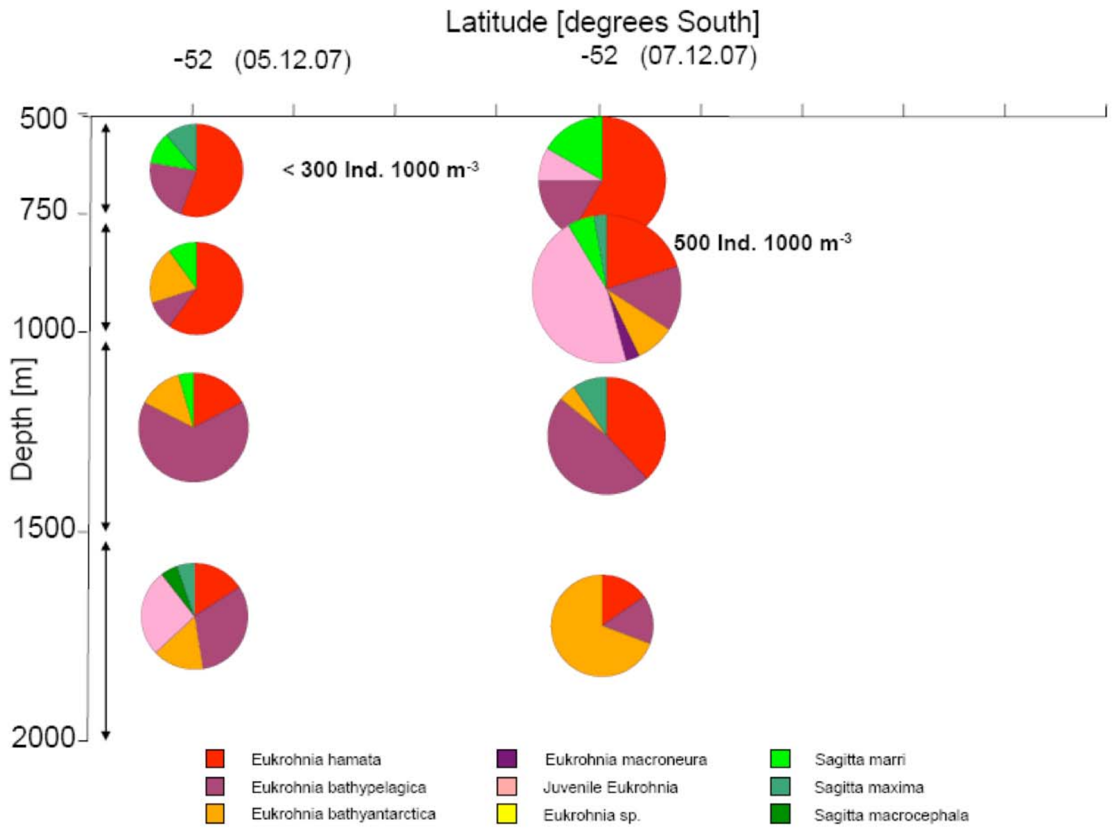

Fig. 10.1: Chaetognath abundance and composition between 500 and 2,000 m at 52°S and 0°. The circle size corresponds to the approximate number of individuals per 1,000 m^{-3}. Colours, not given in the caption, relate to different yet unidentified species.

Contrary to the two northern stations the 3°W transect (Fig. 10.2), the 3°E (Fig. 10.3) and the 0° meridian transect (Fig. 10.4) were characterised by a higher number of chaetognaths between 500 and 1,000 m water depth. The frequency of occurrence exceeded even 1,000 individuals per 1,000 m^3. This abundance was mainly based on high numbers of small juveniles between 2 and 4 mm in length. Beyond the aforementioned distribution patterns *Sagitta marri* seemed to be more abundant in the upper layer and at the southernmost station at the 3°W. Furthermore it is worth to mention that at 64° and 69°S on the 0° meridian the chaetognath frequency was comparatively low. This aspect and the general distribution patterns will be analysed with regard to the oceanographic data as soon as all chaetognaths are completely identified.

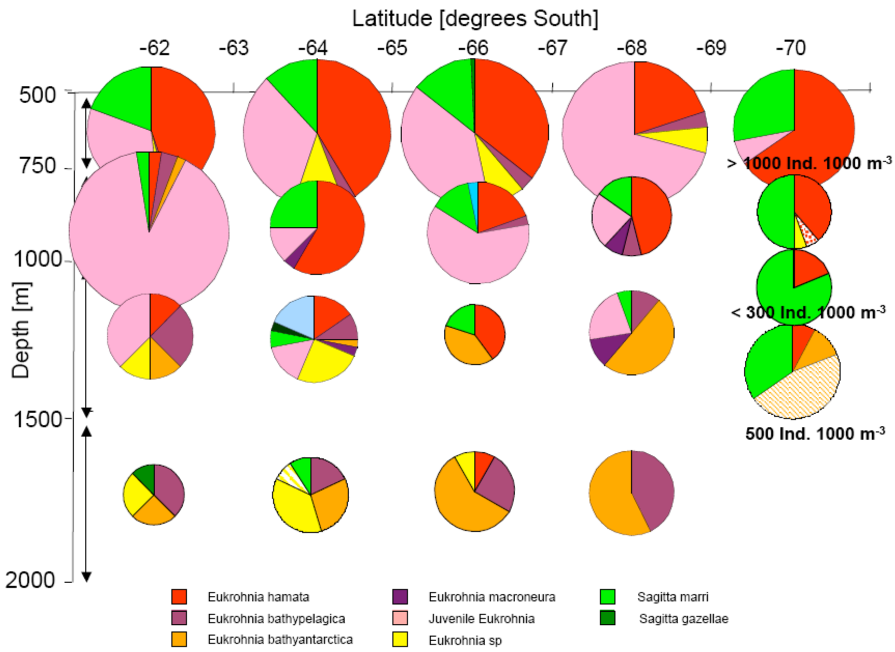

Fig. 10.2: Chaetognath abundance and composition between 500 and 2,000 m along 3°W. The circle size corresponds to the approximate number of individuals per 1,000 m^{-3}. Colours, not given in the caption, relate to different yet unidentified species.

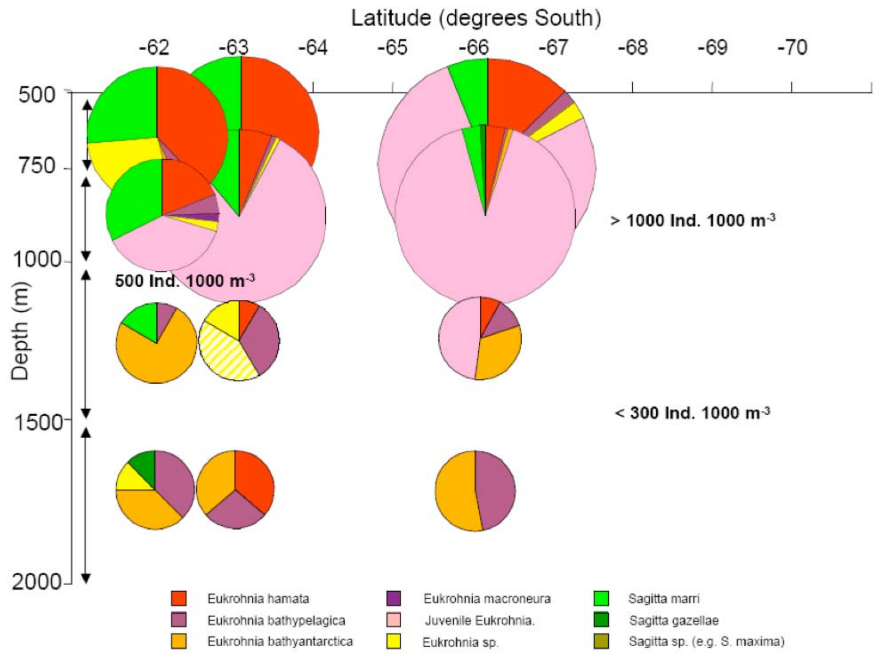

Fig. 10.3: Chaetognath abundance and composition between 500 and 2,000 m along 3°E. The circle size corresponds to the approximate number of individuals per 1,000 m^{-3}. Colours, not given in the caption, relate to different yet unidentified species.

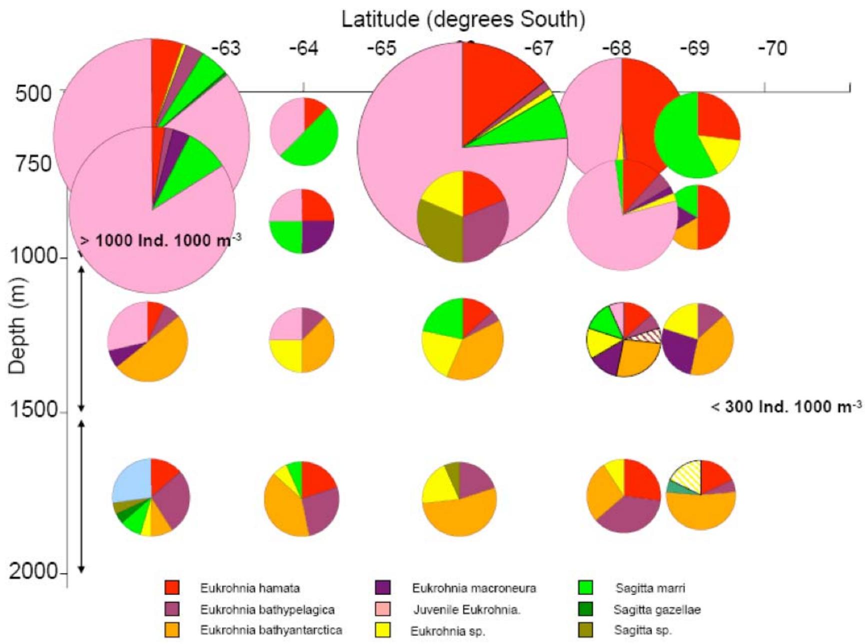

Fig. 10.4: Chaetognath abundance and composition between 500 and 2,000 m along 0° meridian. The circle size corresponds to the approximate number of individuals per 1,000 m^{-3}. Colours, not given in the caption, relate to different yet unidentified species.

11. DEMOGRAPHY OF ANTARCTIC KRILL AND OTHER EUPHAUSIACEA IN THE LAZAREV SEA IN SUMMER 2008

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Introduction and objectives

Sea ice is one of the major environmental parameters that influence the Antarctic marine ecosystem. Sea ice extent shows enormous seasonal fluctuations, ranging from 4.1 * 10^6 km^2 in summer to 21.5 * 10^6 km^2 in winter. Seasonal as well as interannual fluctuations in ice cover are likely to have an effect on the distribution, life cycle and population dynamics of Antarctic krill, *Euphausia superba*, which is the key prey species for most of the Antarctic pelagic and land-based predators. Recent research results have indicated that krill may switch from a pelagic swarming and filter feeding life in summer to a grazing behaviour on ice algae on the under-surface of sea ice. However, information is still lacking on krill distribution, abundance, growth and development of maturation and spawning in this sea ice habitat.

Due to great difficulties for research vessels to work in such ice-covered areas, quantitative studies on krill population parameters are still extremely scarce in the scientific literature. The Lazarev Sea is located in the high-latitude part of the *E. superba* range, immediately adjacent to the Antarctic continent. Antarctic water masses extend over more than 2,400 km between the continent and the Polar Front. It is also one of the regions with greatest sea ice extent of the Antarctic Ocean in winter, from the continent at 70°S to approximately 58°S, i.e. more than 1,300 km. These conditions contrasting to the well-studied Antarctic Peninsula or Scotia Sea regions, where even during winter part of the krill distribution range is free of sea ice.

Accordingly, one of the main objectives for the LAKRIS project onboard *Polarstern* was to conduct several standardized surveys in the area during different. The primary objective of the RMT-net sampling programme was to clarify krill population distribution dynamics over the year and study the effects of the advancing or retreating pack-ice on the demography and the maturation and spawning process of krill. After we successfully conducted LAKRIS studies in autumn 2004, spring 2005/06 and winter 2006, the current summer survey in 2007/08 marked the final point in this data collection series.

Work at sea

Material and Methods

From 21 December 2007 to 23 January 2008 a station grid was surveyed between 60°S and 70°S close to the continent. The planned grid consisted of three transects and 64 standard stations along 3°E, 0°, and 3°W. 52 of these stations were sampled successfully (Fig. 11.1). Two additional test stations were carried out close to Bouvet Island at approx. 52°S. Due to logistic constrains and consequently loss of time the western and eastern transects had to cut short by two degree of latitude. The stations of RMT8 net hauls are listed in table 11.2.

At the start of the survey period the area was completely covered by sea ice which extended to almost 60°S (Fig. 11.2) and which made conditions for towed net sampling difficult. The central polynya between 64 to 66°S south opened continuously during the ongoing work, and at the end of the survey the area was almost entirely free of ice cover.

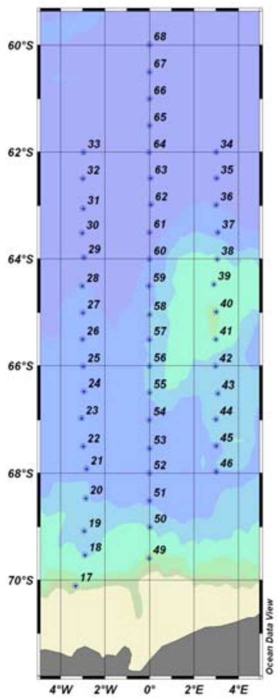


Fig. 11.1: RMT station grid in the Lazarev Sea during ANT-XXIV/2 summer cruise from 21 December 2007 to 23 January 2008

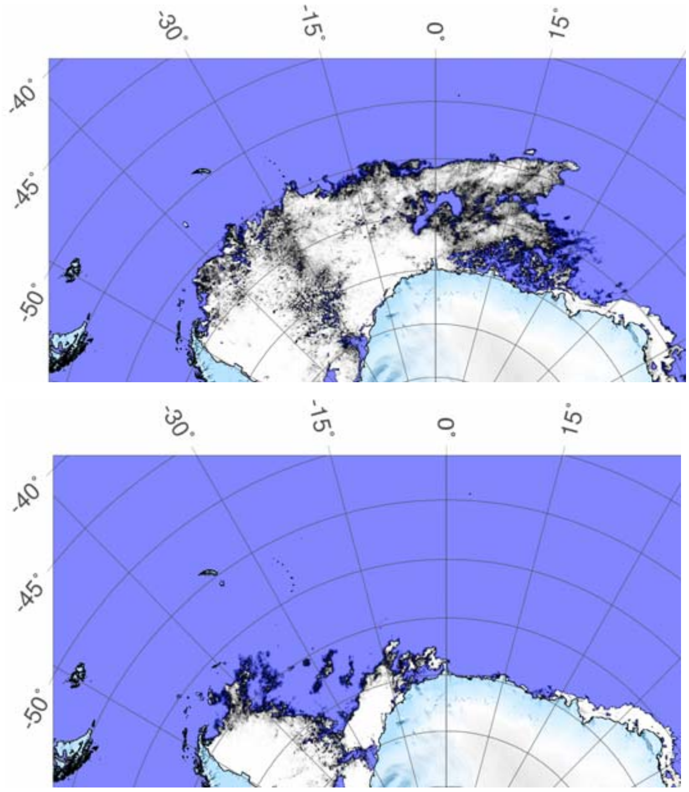


Fig. 11.2: Ice extent during the survey period a) 21 December 2007, b) 23 January 2008; ice charts from http://iup.physik.uni-bremen.de:8084/amsredata/asi_daygrid_swath/l1a/s6250/

Krill and zooplankton sampling was carried out using the standard gear RMT 1+8 (Rectangular Midwater Trawl, Baker et al 1973). When sampling in ice, a sufficient sized fairway of open water was formed behind the stern of the ship by the propeller action to allow deployment and retrieval of the net. Routine double oblique net tows were conducted from the surface down to 200 m depth. Towing speed ranged from 2 to 3 knots depending on ice conditions. The total time of the net haul from surface to maximum depth to surface was approximately 45 minutes. Mesh sizes for the large 8 m^2 net is 4.5 mm and samples from this net are primarily used for the analysis of krill and salps. The small RMT1 net has a mesh size of 0.320 mm and is used to obtain data for the smaller zooplankton fraction and early life stages of fish. The net was equipped with flowmeter and on-line depth recorder to allow the calculation of the filtered water volume and the standardization of net catches. Filtered water volumes were calculated using flow meter distance data and applying the formula given by Pommeranz et al (1982) for the effective net mouth opening.

Immediately after the tow, krill and salps were removed from the plankton catch and counted. In case of larger catches the number of krill was counted from representative subsamples. Krill were preserved in 4 % formalin seawater solution before length measurements were undertaken and sex and maturity stages were identified. Length measurements for *Euphausia superba* were carried out to the millimetre below from the anterior margin of the eye to the tip of the telson (Discovery method for total length, Siegel 1982). Maturity stages were determined according to the classification of Makarov and Denys (1981). Other euphausiid species were measured from the tip of the rostrum to the posterior end of the uropods (standard 1 length according to Mauchline 1980) and separated into males and females. The rest of the zooplankton was preserved in 4 % formalin solution for later land based sorting and analysis. All station data and the biological counts and measurements were entered into the database of the Institut für Seefischerei Hamburg. A station summary is given in the Appendix Table at the end.

Preliminary Results

Distribution and Abundance

During the summer 2007/08 survey only two out of 52 RMT samples yielded no krill. The two largest catches yielded 1980 and 1760 krill, respectively. These samples were taken in the south-eastern corner and at the northernmost end of the station grid. This numbers are relatively low compared to the number of krill caught in winter 2006 (7,400 krill in the south-eastern and 2,900 specimens in the central survey area or 2,580 krill in early summer 2005 or 94,000 specimens in autumn 2004) in a standard haul (see Fig. 11.3). A concentration of krill in some parts of the study area could not be detected. Stations with very few or no krill were scattered randomly across the area.

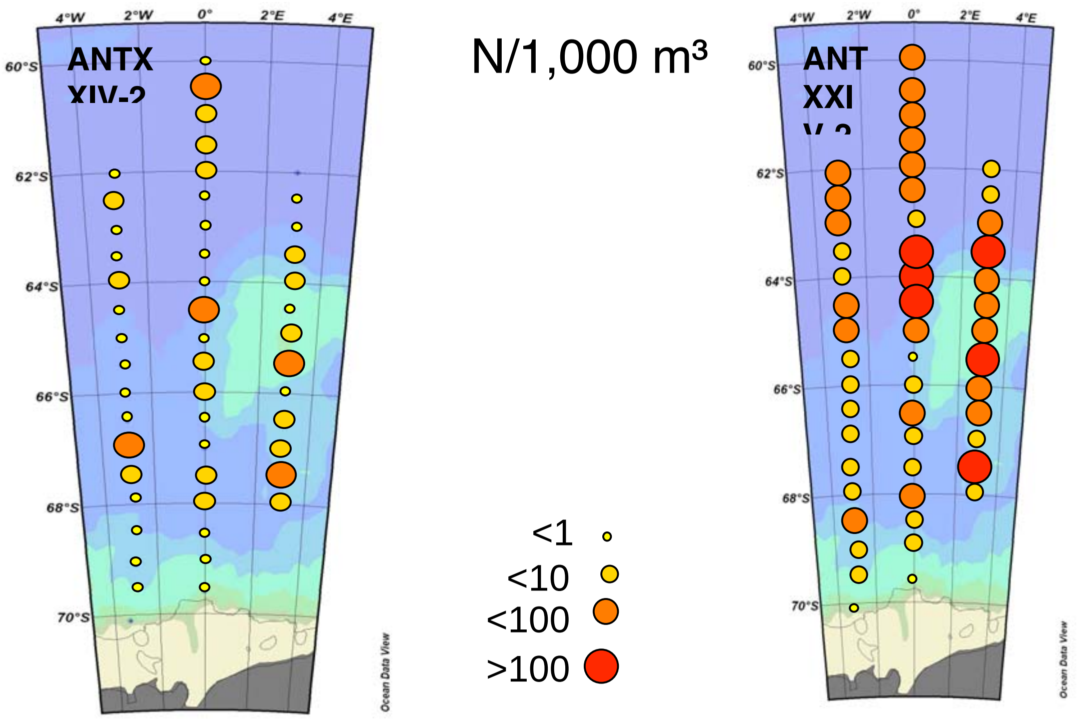


Fig. 11.3: Spatial distribution of euphausiid species given as numerical densities (N 1,000 m^{-3}) for the 200 m surface layer a. Euphausia superba *b.* Thysanoessa macrura

Krill abundance estimates for the current summer Lazarev survey results in 4.3 krill 1,000 m^{-3}, This is a significant decrease compared to the mean numerical densities for the Lazarev Sea survey compared to the preceding winter survey 2006. However, the recent results are comparable to the low results of the summer survey 2005/06 (see Tab. 11.1). Since the station grid covered more or less the same area since 2004, a regional effect can be excluded as the potential reason for the inter-survey differences. At this stage, it is unclear, whether we are observing interannual effects in stock size development caused by immigration and emigration or interannual changes caused by dramatic fluctuations in stock size.

Tab. 11.1: Krill numerical densities from the present net sampling survey in the Lazarev Sea in summer 2008 and from earlier LAKRIS cruises (winter July/August 2006, autumn April 2004 and early summer December 2005). Densities are calculated using the TRAWLCI method described by de la Mare (1994).

	2008 (summer)		2006 (winter)		2005 (summer)		2004 (autumn)	
	N 1000 m^{-3}	N m^{-2}	N 1000 m^{-3}	N m^{-2}	N 1000 m^{-3}	N m^{-2}	N 1000 m^{-3}	N m^{-2}
Mean	4.33	0.87	13.86	2.72	3.15	0.63	31.12	6.22
SE	1.709	0.219	5.54	1.108	1.054	0.211	9.032	1.806

A quantitative evaluation of the other Euphausiacea species seems to be essential, because they do overlap with Antarctic krill in the same area, and they can also occur in similar numerical densities and depending on the area in similar size classes. This may cause similar volume backscattering strength during the acoustic survey for krill biomass estimates. Therefore, it is of fundamental importance to improve our knowledge on the vertical and horizontal distribution of other euphausiids and their abundance

Another species is *Thysanoessa macrura* which is regularly found in high densities in Antarctic waters. This species was distributed across all stations of the survey grid with slightly higher densities in the north-western part of the station grid. Densities had been one order of magnitude lower in winter than in the preceding early summer 2005/06 when *Thysanoessa macrura*, but the species was back in high numbers during the current summer survey and outnumbered the density of *E. superba* five times.

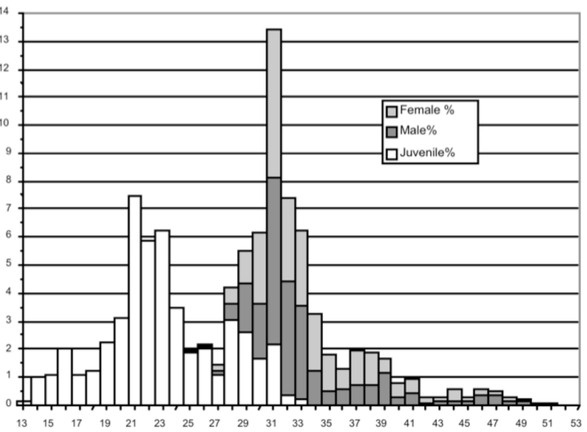
The ice-krill *Euphausia crystallorophias* is an endemic species of the neritic Antarctic coastal zone. Therefore, it was not surprising to find this species at only three stations and exclusively at the slope stations of the continent. Numbers were relatively low, because no stations were conducted on the shelf. The adult population was in the resting stage, which was to be expected, because the species is thought to have its main spawning season in December.

The species *E. frigida* and *E. triacantha* were only observed in the samples of the test stations near Bouvet Island around 52°S. During all LAKRIS expeditions *E.frigida* had only been observed once south of 60°S, i.e. in autumn 2004 between 60° and 62°S.

Size and Maturity composition

Size distribution of the Antarctic krill *Euphausia superba* was not uniform across the survey area. North of 62°S larger krill of 35 to 500 mm was characterized the stock, while south of 62° small krill dominated. These small length classes were clearly divided into two modes, which represented age classes 1+ (22 mm mode) and age class 2+ (31 mm mode).

a)



b)

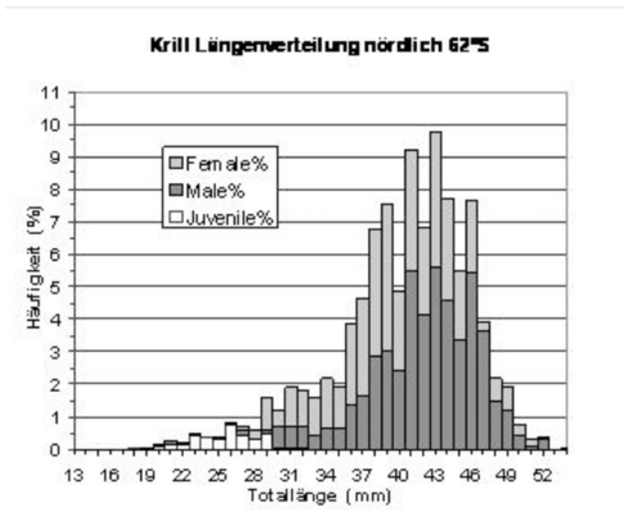


Fig. 11.4: Composite length frequency distribution of Antarctic krill Euphausia superba *a) for the area south of 62°S b) for the area north of 62°S*

Frequency of juvenile Antarctic krill was 23 %, indicating the presence of one year old krill. However, this is not a very high proportion which should be expected when a good recruitment would have taken place. Very high proportions are also given by early immature stages M2A1 und F2B. These are mostly representing the second mode in Fig. 2a and which are of the age class 2+. The composite maturity stage composition showed a clear dominance of subadult (immature) stages in general. Some males and females were found in the adult prespawning stage 3A but little more than 7 % of the population were in spawning condition.

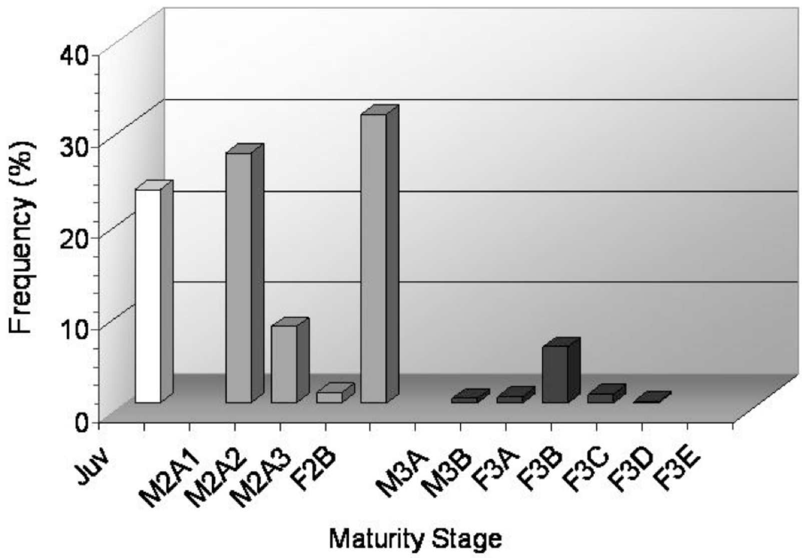


Fig. 11.5: Overall maturity stage composition of Euphausia superba during summer 2008; M = male, F = female, stage 2 = immature, stage 3 = mature, 3A pre-spawning or resting stage

Larvae

Larvae were found in RMT1 samples from all Antarctic Euphausiacea species. However, *E. triacantha* and *E. frigida* larvae were only observed at the test station near Bouvet Island. These species did not occur south of 60°S. *E. crystallorophias* larvae were limited to the southernmost stations close to the continental shelf. The stages ranged from nauplii to Calyptopis III (C3) larvae. This composition clearly indicates that spawning of *E. crystallorophias* probably started in November and was still ongoing during the survey period. Maximum densities reached more than 92 larvae m^{-2}. Larvae of *E. superba* were only found at four scattered stations. Densities were low and hardly exceeded 1 larvae m^{-2}. Naulius and metanauplius stages of *E. superba* are living in deeper water layers and are not caught by the standard RMT tows in the upper 200 m layer. Since all specimens found in our samples were C1 or

C2 stages, it can be concluded that spawning must have started in December, but because of the small amount of larvae and their early stages the spawning season had not yet peaked during the survey period.

Most commonly larvae of *Thysanoessa macrura* were found in the RMT1 samples. Larvae of this species occurred at each single station of the current study. The average density was 214 larvae m^{-2}, but maximum density was as high as 1,200 larvae m^{-2}. Larval stages consisted mainly of Calyptopis 1 and 2; oldest larvae were of Furcilia 1 stage with a maximum length of 4.5 mm. This situation was not different from the one observed during the LAKRIS 2005/06 summer season.

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Table: 11.2 Station list of RMT8 net hauls during ANT XXIV/2 survey in the Lazarev Sea

		Position		Fishing depth (m)		Time (UTC)		RMT8
Station	Date	Latitude	Longitude	Min	Max	Start	End	Filtvol (m^3)
13	20071205	520812°S	0000112°W	0	200	2007	2045	19758
14	20071207	520312°S	0000006°W	0	200	159	241	24560
17	20071221	700630°S	0031924°W	0	200	2230	2318	27385
18	20071223	693230°S	0025418°W	0	200	842	924	15795
19	20071223	690512°S	0025642°W	0	200	1850	1927	19494
20	20071224	682806°S	0025142°W	0	200	809	842	15238
21	20071225	675512°S	0024956°W	0	200	1540	1614	17009
22	20071225	673006°S	0025854°W	0	200	2243	2336	30283
23	20071226	665836°S	0030336°W	0	200	850	924	17009
24	20071226	662830°S	0025706°W	0	200	1454	1539	19422
25	20071226	660056°S	0025864°W	0	200	1857	1936	19637
26	20071227	653006°S	0030036°W	0	200	717	758	20644
27	20071227	650042°S	0025954°W	0	200	1500	1538	19134
28	20071227	643054°S	0030154°W	0	200	1913	1945	16112
29	20071228	635830°S	0025712°W	0	200	557	639	21148
30	20071228	633112°S	0030106°W	0	200	1444	1532	24169
31	20071229	630336°S	0025830°W	0	200	52	136	24736
32	20071229	622954°S	0025936°W	0	200	645	725	19422
33	20071229	620012°S	0025800°W	0	200	2040	2115	17532
34	20080101	620000°S	0025954°E	0	200	1737	1821	21402
35	20080101	622924°S	0030106°E	0	200	2315	2352	20492
36	20080102	625924°S	0025954°E	0	200	304	347	21714
37	20080102	633036°S	0030424°E	0	200	1346	1426	19784
38	20080102	640030°S	0030242°E	0	200	1917	2004	21553
39	20080103	642848°S	0025318°E	0	200	306	347	2226
40	20080104	645942°S	0025954°E	0	200	1542	1618	20370
41	20080104	653006°S	0025924°E	0	200	2049	2129	21461
42	20080104	660042°S	0025842°E	0	200	737	815	18351
43	20080105	663036°S	0030412°E	0	200	1520	1600	18781
44	20080105	665942°S	0025918°W	0	200	1931	2011	19853
45	20080106	672930°S	0025942°E	0	200	428	512	2255
46	20080106	675806°S	0030012°E	0	200	851	927	17699
49	20080117	693542°S	0000106°W	0	200	1110	1137	10816
50	20080118	690042°S	0000124°E	0	200	25	106	21471
51	20080118	683100°S	0000006°E	0	200	442	525	22065
52	20080118	680012°S	0000006°W	0	200	1144	1227	24320
53	20080118	673206°S	0000006°E	0	200	2049	2128	20341
54	20080119	670018°S	0000100°W	0	200	411	458	23876
55	20080119	662948°S	0000042°E	0	200	1037	1114	19636
56	20080119	660018°S	0000006°W	0	200	1940	2023	21500
57	20080120	653042°S	0000006°E	0	200	57	135	21476
58	20080120	650218°S	0000000°W	0	200	426	513	22583
59	20080120	643024°S	0000148°W	0	200	1638	1719	18543
60	20080120	640024°S	0000012°W	0	200	2126	2209	23789
61	20080121	633012°S	0000030°W	0	200	348	426	17817
62	20080121	625918°S	0000336°E	0	200	737	818	21534
63	20080121	622930°S	0000248°E	0	200	1943	2027	23567
64	20080122	620024°S	0000106°W	0	200	130	212	21909
65	20080122	613000°S	0000000°W	0	200	1243	1327	23710
66	20080122	610006°S	0000024°W	0	200	1812	1858	23026
67	20080122	603000°S	0000006°W	0	200	2304	2349	24879
68	20080123	595942°S	0000006°W	0	200	625	709	20706

12. MACROZOOPLANKTON AND MICRONEKTON IN THE SURFACE LAYER AND UNDER SEA ICE

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Introduction and objectives

The seasonal sea ice zone of the Southern Ocean is well known for its rich wildlife. In summer, high densities of warm blooded top predators (birds, seals, whales) concentrate at the ice edge and often increase towards the inner pack-ice, indicating considerable primary and secondary production in these areas (Van Franeker et al. 1997). Water column primary production, however, is low in ice-covered waters. In recent years, ice algae have gained increasing attention as a major source of production in the sea ice system. However, the physical and biochemical complexity of the ice environment has posed difficulties to an accurate determination of ice algal productivity so far. Another way to shed light on the energy flow in the sea ice system is to follow the food chains from higher trophic levels downwards (van Franeker et al., this volume). In order to explain feeding and prey distribution of the higher level predators in the ice-covered ocean, a good understanding of the ice-associated species community is essential. The structure and capacity of the sea ice system are not yet clearly understood. Sea ice seems to be an important factor in the ecology of larval and adult krill *Euphausia superba* (Loeb et al. 1997, Atkinson et al. 2004). Repeated reports of dense aggregations of krill directly under ice stress the importance of this habitat for the euphausiid (e.g. Brierly et al. 2002). To date, little is known to which extent krill, fish, squid or other macrofauna can be found under the sea ice. At IMARES Texel, the need to investigate the under-ice habitat in more detail led to the development of a special under-ice trawl (SUIT = Surface and Under Ice Trawl). Due to the dynamic nature of the subsurface environment, a close interaction with the water column system can be expected. Therefore it is essential to view the data collected from the surface layer in the context of physical, chemical and biological data from the entire water column down to the sea floor. The summer expedition ANT-XXIV/2 provided an excellent opportunity to collect a wide range of data in a concerted manner, forming the basis for an integrated analysis.

Work at sea

Materials & Methods

Trawling of SUIT was attempted 19 times on the regular RMT station grid and twice at one station in the Antarctic Circumpolar Current between 5 December 2007 and 22 January 2008 (Fig. 12.1). The net system consisted of a steel frame with a 2.1 x 2.1 m net opening and a 15 m long 7 mm halfmesh commercial shrimp net attached to it. The rear two meters of the net were lined with 0.3 mm mesh plankton gaze. Large floaters at the top the frame kept the net at the surface. Wheels on top of the frame allowed the net to 'roll' along the underside of ice floes. To enable sampling under undisturbed ice, an asymmetric sprout let the net shear starboard from the ship's track at a cable length of 120 m. An acoustic Doppler current profiler was used as an acoustic flow meter (AFM). The device operated with two 2 MHz measuring beams situated at an angle of 50° against each other. The AFM was capable to measure current speed at three different positions horizontally across the net opening. They were set to 60, 90 and 120 cm distance from the frame's port side during most operations. Analysis of the obtained real-time current speed data allowed the identification of the effective towing time, which was defined as the time during which the current was constantly directed into the net. The amount of water filtered [m3] was calculated as the product of effective towing time [s], average towing speed [m s-1] and net opening area (2.12 = 4.41 m^2).

Fishing was done during dark hours in 18 of the 21 completed hauls, when most plankton and nekton species were expected to approach the surface. Daytime hauls were generally excluded from analysis, except for day-night comparisons which were performed at three stations. Towing speed was 1.5 – 2 kn. Standard hauls lasted between 15 and 30 minutes towing time. During each trawl, irregularities, changes in ship speed, ice coverage [%] and ice thickness [cm] were recorded.

Animals ≥ 0.5 cm were separated to species level where possible. Displacement volume [ml] and number of individuals of each species were noted. The fractions were frozen separately for further analysis at -80°C. Taxonomic samples and the remaining small zooplankton were preserved on 4 % hexamine-buffered formaldehyde-seawater solution.

When catches were larger than 2,000 ml, they were subsampled with a plankton splitter to obtain representative subsamples for length-frequency analysis of Antarctic krill *Euphausia superba* and *Thysanoessa macrura*. The remaining sample was analysed quantitatively according to the procedure outlined above. In catches > 5,000 ml, a subsample of ca. 2,000 ml was treated as above, and the remainder was frozen immediately at -20°C. The length of euphausiids and large amphipods were measured directly after capture. When working procedure and sample size impeded immediate measurement, they were fixed in formaldehyde solution for 48 to 96 hours before measurement. Euphausiids were grouped into males, females, juveniles and gravid females. *E. superba* and amphipod length measurements were done according to the 'Discovery' method (front edge of eye to tip of telson). All other euphausiids were measured from the tip of the rostrum to the tip of the telson.

The density of animals [ind. m-2] was calculated as the number of individuals per m^2 trawled surface. Wet mass density per station [g m-2] was calculated in a similar way, assuming 1 ml = 1 g.

Coelenterates were excluded from abundance and biomass calculations because these fragile animals were susceptible to disruption when the net collected ice.

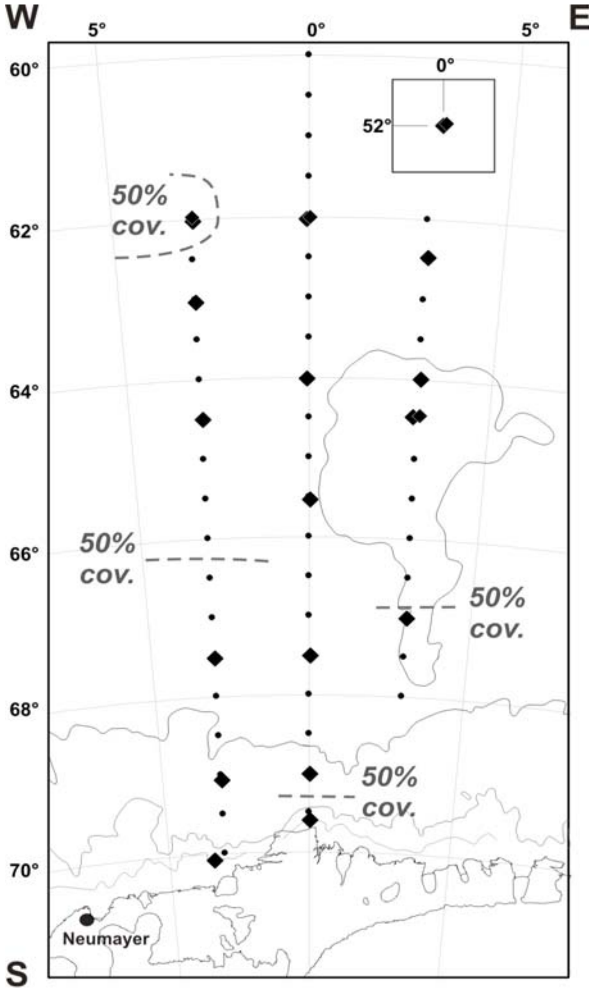

Fig. 12.1: RMT station grid (●) of ANT-XXIV/2. SUIT stations (♦) were conducted south of 62°S. An additional repeated station conducted at at 52°S 0°. Dashed line (- - -) denotes 50 % ice coverage. Note that the Prime Meridian was sampled with a delay of two weeks after the 3°W and 3°E transect. By that time, the ice had retreated considerably southwards.

Results

Species composition

Macrozooplankton / micronekton species represented a wide range of taxa, adding up to at least 40 species. The species encountered most often were Antarctic krill *Euphausia superba*, *Thysanoessa macrura*, the arrow worm *Sagitta gazellae*, the pteropod *Clio pyramidata* and the amphipod *Eusirus laticarpus*. Various species of larval and juvenile fish and squid were collected from the surface layer, among which the squid *Kondakovia longimana* and juvenile fish *Notolepis coatsi*.

Station 17 (Antarctic Circumpolar Current)

Station 17 was sampled in two consecutive nights, allowing to assess the variability of SUIT catches at one location. This station was situated at 52°S 0°, far away from the northern border of the RMT sampling grid (60°S). Species composition therefore differed from the stations sampled further south (Table 12.1, Fig. 12.2), most evidently indicated by the presence of the subantarctic euphausiid *E. frigida*. A comparison of the two hauls conducted at this location shows that the seven most abundant species were present at both occasions, dominated by *E. frigida* and *Salpa* *thompsoni* (Fig. 12.2). Both hauls differed in the composition of less abundant species, for example squid and fish larvae (Fig. 12.2).

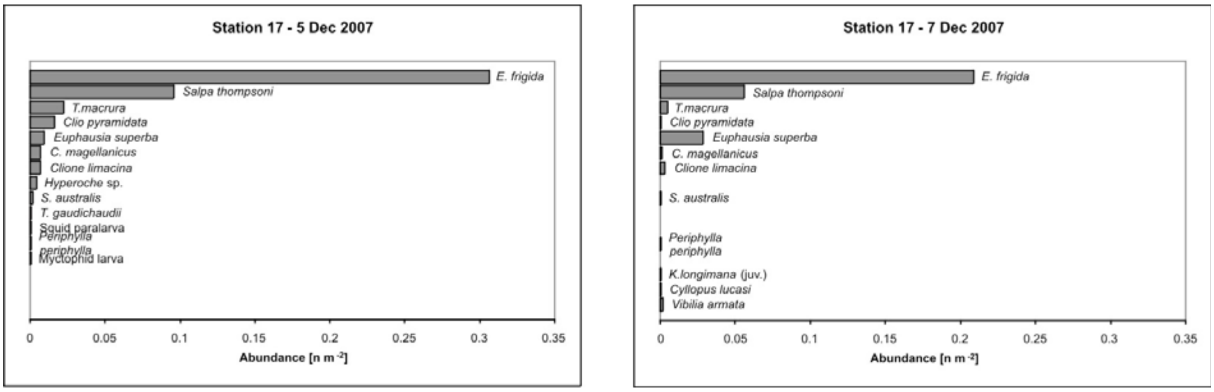

Fig. 12.2: Comparison of abundance and species composition at two repetitive hauls at the same location (Station 17, 52°S 0°). Species were ordered by abundance at the first haul.

Tab. 12.1: List of macrozooplankton species (≥ 5 mm) sampled with SUIT. Number of individuals caught (N) and the number of stations where each species occurred are provided. Species marked with an asterisk (*) exclusively occurred at station 1z (Circumpolar current)

Taxon	N	No of stations
Cnidaria		
*Periphylla periphylla**	2	2
Unid. Siphonophore	1	1
Ctenophora		
Beroe cucumis	26	6
B. forskalii	75	6
Beroe sp.	1	1
Callianira antarctica	82	11
Unid. ctenophore	9	3
Mollusca		
Clio pyramidata	1,843	17
C. piatkowskii	3	2
Clione limacina	137	15
Spongiobranchaea australis	7	3
Undid. pteropod	8	2
Kondakovia longimana (juv.)*	1	1
Unid. squid larva	7	5

Annelida (Polychaeta)		
Tomopteris carpenteri	69	11
T. septentrionalis	2	2
Vanadis antarctica	1	1
Arthropoda (Crustacea)		
Eusirus microps	31	9
E. laticarpus	480	17
Eusirus sp.	13	2
*Vibilia armata**	6	1
Cyllopus lucasi	62	6
*C. magellanicus**	22	2
Hyperia macrocephala	7	5
Hyperoche medusarum	21	8
Primno macropa	60	10
*Themisto gaudichaudii**	1	1
Euphausia superba	58,886	21
*E. frigida**	1,460	2
E. frigida furcilia*	114	1
E. crystallorophias	61	2
Thysanoessa macrura	15,529	18
T. macrura furcilia	24	3
Unid. furcilia larva	7	2
Decapod larva	10	4
Chaetognatha		
Sagitta gazellae	2,360	18
Chordata		
Salpa thompsoni	427	3
Ihlea racovitzai	9	2
Unid. salp	2	1
Notolepis coatsi (juv.)	5	3
Myctophid larva*	1	1
Artedidraco sp. larva	1	1
Channichthyid larva	1	1
Dissostichus sp. larva	1	1
Trematomus loennbergii larva	2	2
Unid. Nototheniid larva	2	1

RMT sampling grid: Distribution, abundance and wet mass

Bulk zooplankton wet mass (coelenterates excluded) was largely dominated by krill, averaging at 0.233 g m-2 and ranging between 0.003 and 1.792 g m-2 (Fig. 12.3). The most frequent and most abundant species *E. superba* was present at every station sampled with SUIT. Abundances were generally elevated in the area south of 67°S on the 3°W and 0° transects. Clearly the highest abundances were encountered on the 3°E transect, with the maximum abundance of 12 individuals per m^2 over the southern slope of Maud Rise (Fig. 12.4a). In contrast, only few krill were caught at the two stations west of Maud Rise. *T. macrura* occurred less frequently, but abundances were generally in the range of *E. superba* when they were present, showing no distinct geographical pattern (Fig. 12.4b). The third most abundant species, *Sagitta gazellae*, was more abundant in the part of the sampling area north of 64°S than to the south (Fig. 12.4c). A similar distribution pattern was apparent from *Clio pyramidata*.

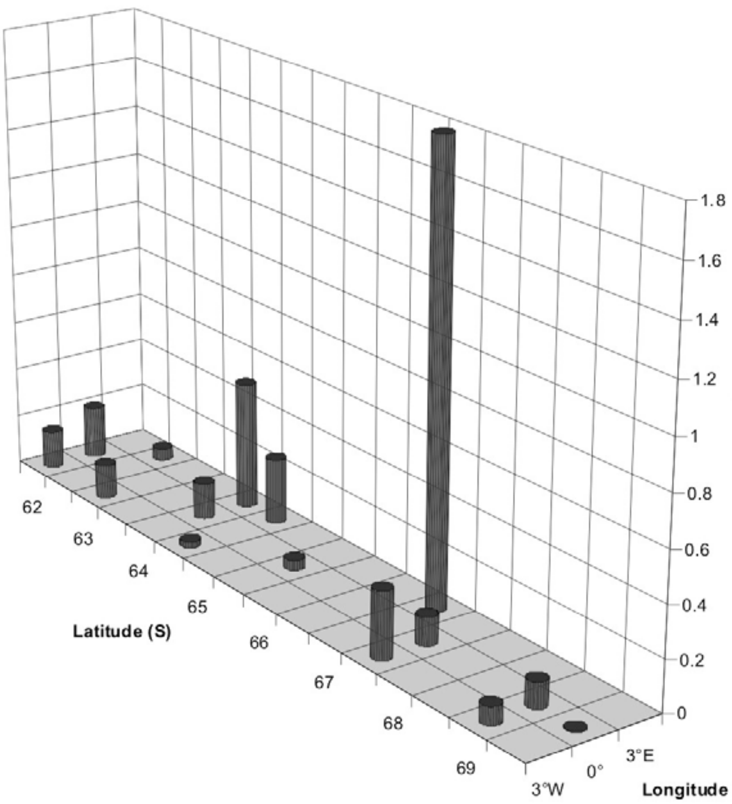

Fig. 12.3: Distribution of bulk zooplankton wet mass (coelenterates excluded)

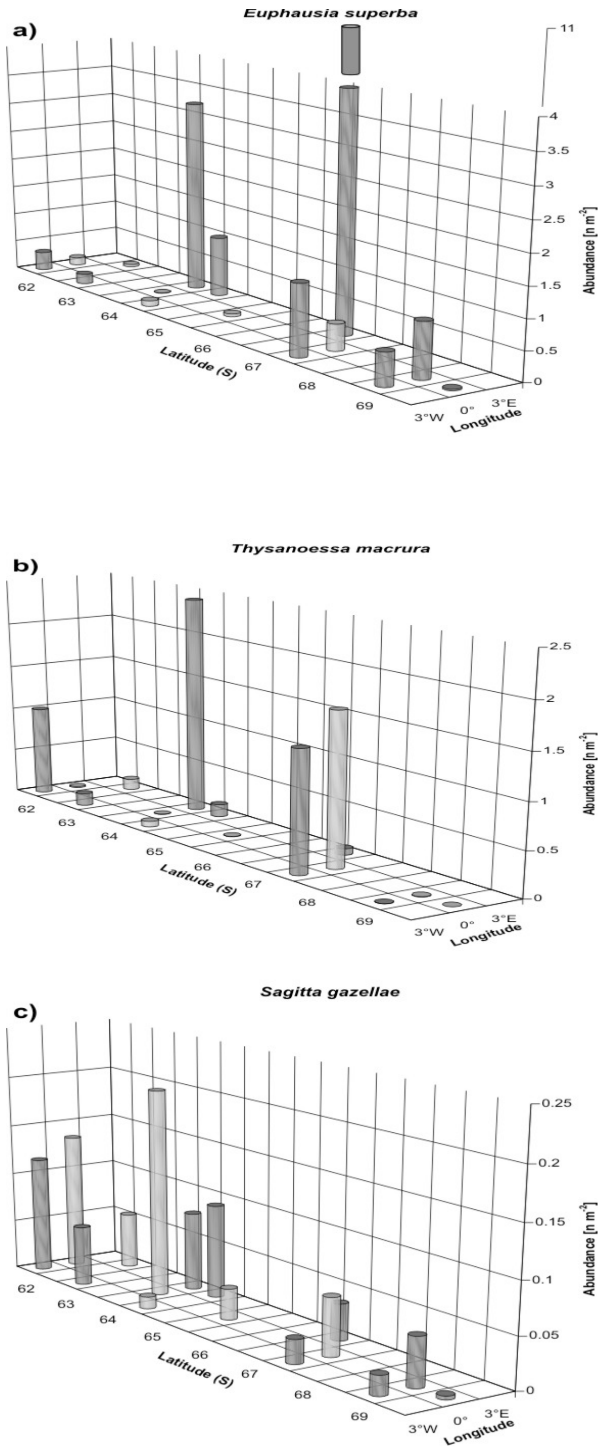

Fig. 12.4: Abundance distribution of Euphausia superba *(a),* Thysanoessa macrura *(b) and* Sagitta gazellae *(c)*

Association with sea ice

A difference was apparent between stations sampled in open water and those were the SUIT was towed along the underside of ice floes. Antarctic krill for example was more abundant under ice floes than in the surface layer of the open ocean, whereas the abundance of *T. macrura* did not differ between open water and ice stations (Fig.

12.5a). The amphipod *Eusirus laticarpus* was almost exclusively encountered under sea ice. In *Clio pyramidata*, a trend towards higher abundances in open water was apparent, whereas the abundance of *Sagitta gazellae*, similar to *T. macrura*, was comparable both under sea ice and in open water (Fig. 12.5b).

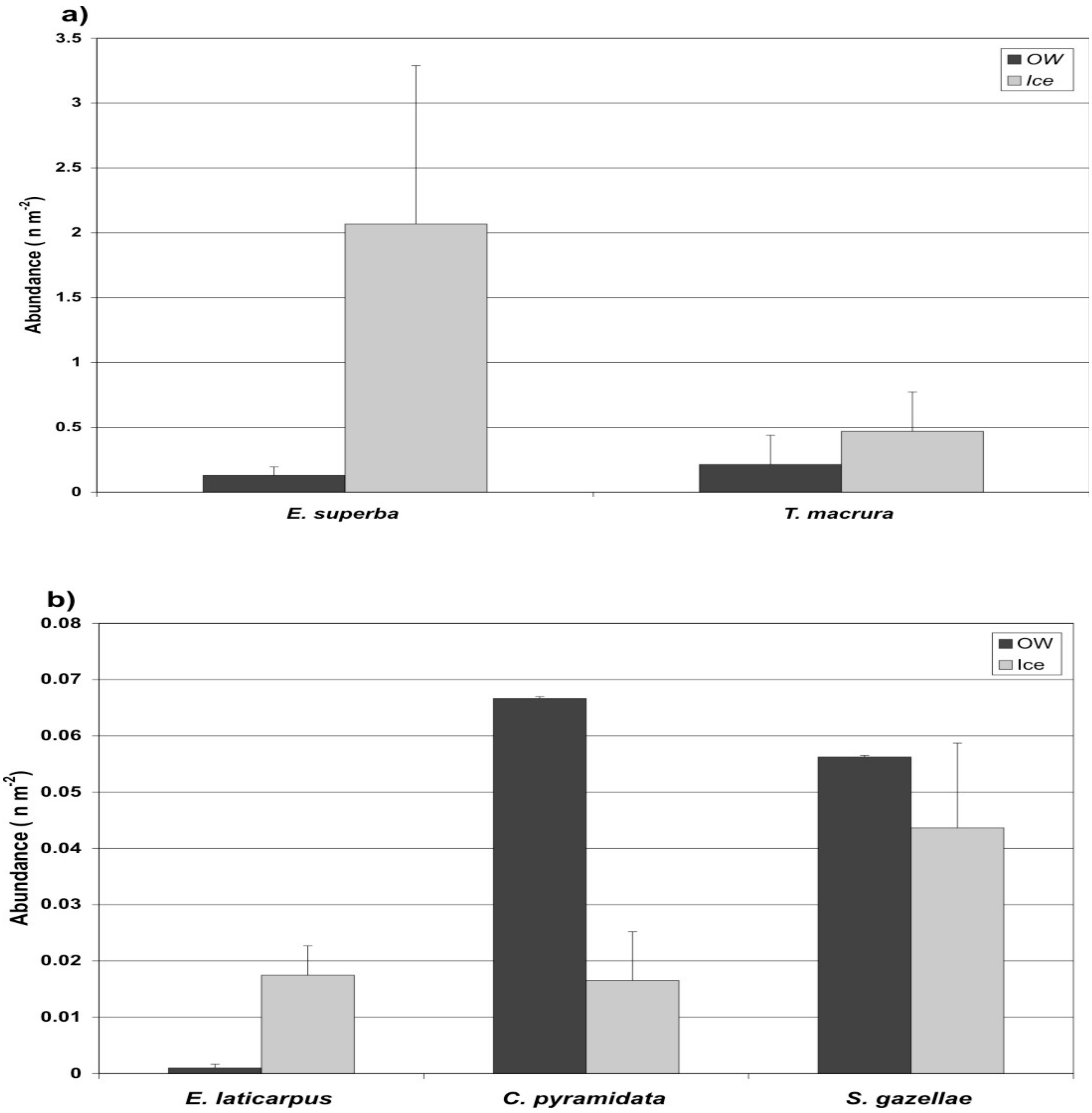

Fig. 12.5: Comparison of stations sampled under sea ice and in open water (OW): Average abundances of Euphausia superba *and* Thysanoessa macrura *(a),* Eusirus laticarpus*,* Clio pyramidata *and* Sagitta gazellae *(b). Error bars denote 75 % confidence intervals*

Day-Night comparison

On three occasions, day and night trawls were performed at the same location. At all three stations, catches differed remarkably depending on the time of day, both in quality and quantity. *E. superba* was abundant in the SUIT catches both at night and at day. Yet, abundances were highest at day at all three stations (Fig. 12.6a). The abundance of *E. laticarpus* showed no dependence of the time of day (Fig. 12.6b). *S. gazellae* exemplifies the group of species which were clearly more abundant in the surface layer during the dark hours and almost absent at daytime (Fig. 12.6c). This group includes also *T. macrura* and and *C. pyramidata*.

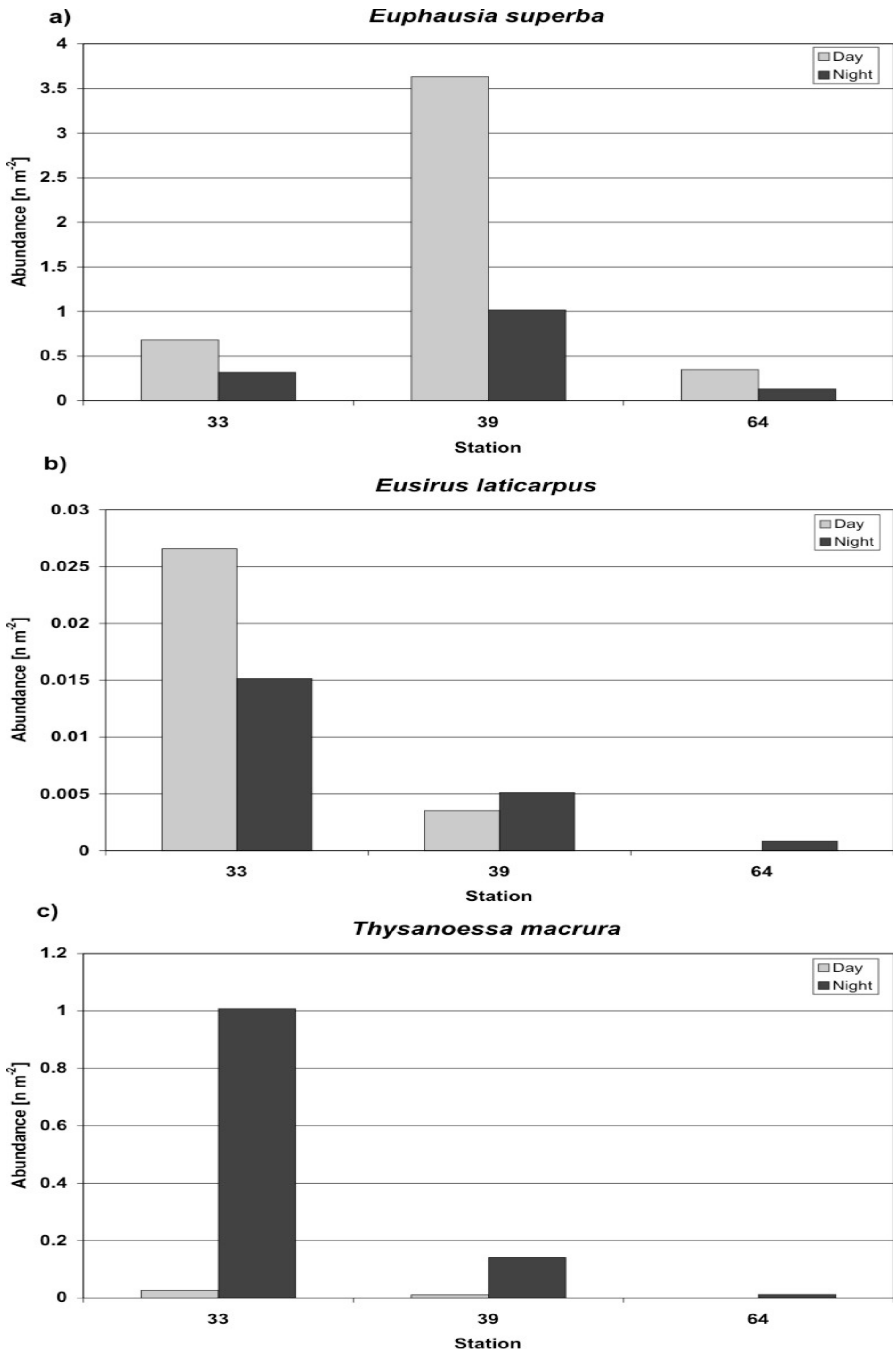

Fig. 12.6. Day-night comparison of abundant zooplankton species at three stations; a) E. superba*, b)* E. laticarpus*, c)* T. macrura

Euphausiid length distribution

The size of *E. superba* ranged between 10 and 52 mm. The length-frequency distribution showed two modes at 18 and 30 mm. The lower mode was entirely composed of juveniles which dominated the sampled population. The mode at 30 mm was equally composed of males and females. Larger animals had only a minor contribution to the size composition of Antarctic krill.

In *T. macrura*, only data from samples taken on the 3°W and the 3°E meridian could be analysed during the expedition. The size of *T. macrura* ranged from 8 to 30 mm. The sampled population was dominated by sexually differentiated animals. The Size distribution peaked at 16 mm length, with minor modes at 12 and 20 mm (only females).

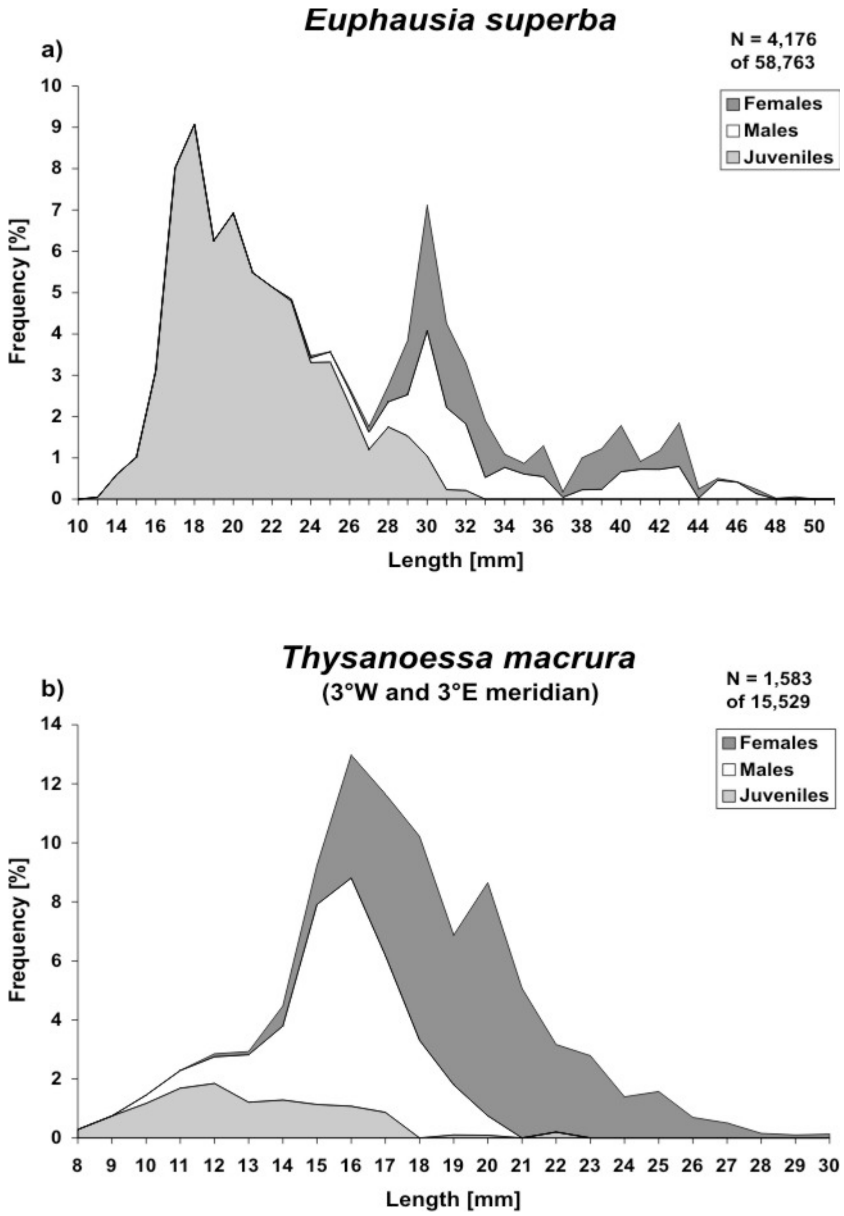

Fig. 12.7: Length-frequency distribution of post-larval Euphausia superba (a) and Thysanoessa macrura (b). For T. macrura, samples taken on the 0° meridian were not analysed for this report.

Discussion

The data collected on the Antarctic summer expedition ANT-XXIV/2 illustrate the significance of the surface layer to a wide range of macrozooplankton and micro-nekton species. The presence of sea ice apparently had a strong influence on the composition of thenear-surface community. In spite of the differences in species composition, the surface layerwas rich in macrozooplankton / micronekton, both under ice floes and in open water. Somespecies were concentrated under the ice, such as *Euphausia superba* and *Eusirus laticarpus*, indicating that ice plays a major role for these species as a habitat and foraging ground. *E. superba* was clearly more abundant under ice than in the surface layer of the open ocean, especially if one takes into account that the large confidence interval shown in Fig. 12.5a was mainly influenced by the extra-ordinary large catch at St. 44 (67°S / 3°E; Fig. 12.4a). Thenotion that krill often aggregated in thin layers not only under ice, but also at the surface inopen water is further supported by the observation of surface swarms (chapter 11). A concentration of krill under sea ice might partly explain the high abundance of Antarctic krill encountered by the SUIT in the surface / under ice layer compared to water column abundances sampled by the RMT in the area south of 62°S (Siegel et al., chapter 11).

In contrast to *E. superba*, the abundance of *Thysanoessa macrura* showed no difference between stations sampled under ice floes and those fished in open water (Fig. 12.5a). They were more efficiently caught by the RMT, indicating a more dispersed distribution over a wide depth range (chapter 11). In spite of the differences in euphausiid abundances, SUIT and RMT catches were related to each other, as exemplified by the significant positive relationships between SUIT bulk wet mass and RMT abundances of *E. superba* and *T. macrura*, respectively (Fig. 12.8 b, c).

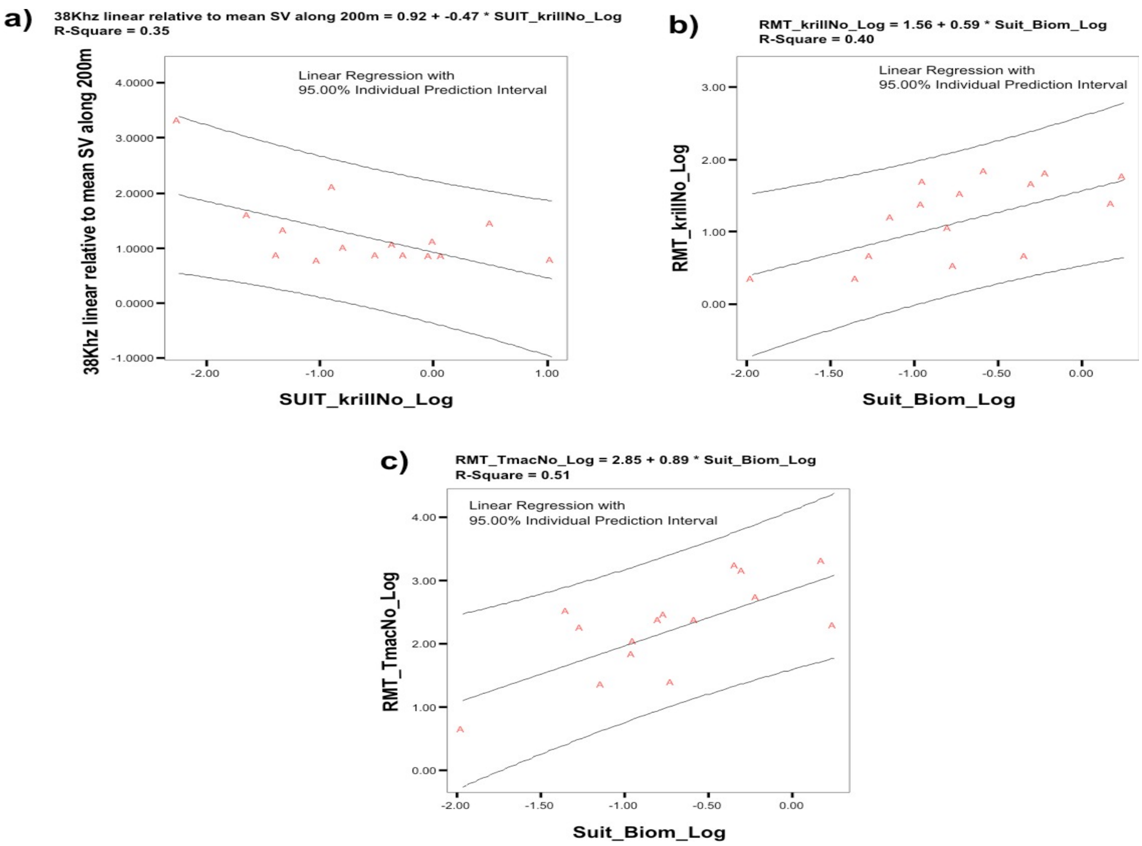

Fig. 12.8: Linear regressions of log-transformed Antarctic krill abundance from the SUIT versus SIMRAD backscatter (a: $P < 0.05$), SUIT total wet mass versus log-transformed numbers of E. superba (b: $P = 0.01$) and T. macrura (c: $P = 0.03$) caught by RMT.

The observed geographical distribution patterns must be carefully considered in the light of the two-weeks time lag between the 3°E transect and the 0° transect, which introduced an unknown seasonal component. The separation of various environmental factors according to their influence on the observed distribution patterns is difficult, and the results should thus not be interpreted in terms of mono-causal relationships. Next to sea ice and temporal developments, hydrography is an important factor influencing the distribution of species in the area of investigation. For example, the elevated abundances of *Clio pyramidata* and *Sagitta gazellae* in the northern part of the area of investigation coincided with water masses of the northern (eastward-flowing) limb of the Weddel Gyre and at the same time with the area largely devoid of sea ice. The hydrographical peculiarities of Maud Rise further complicated the situation (chapter 3). This survey's highest krill abundances both by RMT and SUIT sampling on the southern slope of Maud Rise, as well as the extremely low krill abundances encountered to the west of Maud Rise might have been related to the seamount's specific current patterns.

A pronounced diel pattern was apparent in the presence of *T. macrura*, *C. pyramidata* and *S. gazellae* in the surface layer. At the three day/night comparison stations sampled, these species were almost absent from SUIT catches during daylight hours, whereas at night they were abundant (Fig. 12.6c). Most often, such diel migration behaviour is explained as the avoidance of visual predators. Yet, at least in the two species carrying almost no pigmentation, *T. macrura* and *S. gazellae*, avoidance of harmful UV radiation could be an alternative explanation.

In contrast, *E. superba* even showed a tendency to higher abundances at day (Fig. 12.6a). Apparently, the benefit of grazing under the ice and in the phytoplankton-rich surface layer in open water was higher than the danger imposed by predation during summer. Interestingly, the opposite behaviour was observed in winter 2006, when krill only was abundant under the ice at night (Flores et al., in press). No diel pattern was observed in *Eusirus laticarpus*, indicating that the amphipod continuously stays in the ice habitat (Fig. 12.6b).

Initial comparisons of the abundances of surface / under ice macrozooplankton and the food requirements of the top predator community showed no simple overall correlation (chapter 13). Further integrated analysis of all potentially relevant biological and physical datasets is warranted to increase our understanding of the functioning of the high-Antarctic ecosystem.

Acknowledgements
We express our deepest thanks to the crew of *Polarstern* ANT-XXIV/2. Martina Vortkamp contributed a lot to the success of our work. This project was funded by the Netherlands Ministry for Agriculture, Nature and Food Quality (LNV).

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13. MARINE BIRDS AND MAMMALS IN THE LAZAREV SEA: THE SUMMER INFLUX

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Introduction and objectives

IMARES participates in AWI's multi-year LAKRIS study with a special focus on the role of the surface layer on the biology and abundance of krill and other potential prey of marine top predators. The history of this involvement is that consistent observations of elevated densities of marine birds and mammals in the seaice zone remained largely unexplained in terms of known food availability (e.g. van Franeker et al. 1997). The poorly quantified under-ice habitat was thought to potentially hold missing explanations, which led to development of the Surface and Under Ice Trawl (SUIT) research (see Flores et al. this volume).

In the Southern Ocean, top predator abundances strongly suggest that biological production in sea ice is a major driving force behind Antarctic animal population sizes and biodiversity. Understanding the sea ice related foodweb is thus critical for a proper evaluation of the potential impacts of climate change, a key issue in the research of the International Polar Year 2007-2008. The interdisciplinary approach and seasonal spread in *Polarstern*'s Lakris cruises offers an excellent framework to improve such knowledge of marine Antarctic foodwebs.

IMARES uses a top down approach in its ecosystem study which means that we start with a quantification of food requirements of the top predator community derived from detailed density surveys of birds, seals and whales. Results will be compared with catch data from the SUIT (Flores et al., this volume), the Rectangular Midwater Trawl (RMT) used in the CCAMLR krill survey (Siegel et al., this volume), acoustic surveys (Krägefsky et al. this vol.) and ultimately all biological and physical information collected. This report presents the preliminary results of predator surveys in terms of food requirements of the top predator community.

Work a sea

Methods

Two platforms, the ship and helicopter, were available for making quantitative counts of marine top predators during the Lakris expedition.

Ship-based censuses of birds and mammals were made from outdoor observation posts installed on top of the bridge of *Polarstern* (± 20 m height). The wooden observation posts have perspex windshields, a rain-hood and a small fan-heater that allowed usage in extreme conditions. The outdoor position gives an unobstructed clear view to all sides, crucial to detect all animals in the band transect and also needed to identify ship-associated birds that have to be omitted from density calculations. Birds are counted from the moving ship, in a band transect during time blocks of ten minutes. Ship-based bird censuses use band-transect methodology in which birds in flight are counted according to the so-called 'snapshot-method' (Tasker et al. 1984) in order to avoid density bias by bird movement. Ship speed and transect width can be used to convert observed numbers of animals to densities per unit of surface area for each ten-minute period. The standard width of the transect band is 300 m, taken as 150 m to each side of the ship. Under average conditions, this is considered the maximum distance to ensure detection of all individuals, even of inconspicuous species. Depending on viewing conditions such as seastate, light level and glare, the transect may be limited to one side of the ship and transect width may be adapted to a distance that maximizes detection of all individuals of different species. Special adaptation of band-width is sometimes necessary in dense and heavy ice, where the ship often follows an erratic course searching leads or cracks in the ice. As many predators aggregate in or around these leads, persisting in a narrow transect band would result in a highly (upward) biased census result. Under such conditions, the band-width of observations was widened at both sides to approximately half the floe-size between leads, to ensure that counts represent an adequate cross-section of the overall habitat.

Seal censuses are based on the same band records as used for bird observations. Band-transect counts are considered adequate for seal censuses (Laws 1980), but the Antarctic Pack Ice Seal Program (APIS) recommended line-transect methods where possible (SCAR Group of Specialists on Seals 1994). Therefore, for ship-based seal counts in ice areas, line transect data (Hiby and Hammond 1989) are currently being collected in addition to band transect observations. However, current analyses are still based on the band transect data. In the analyses hauled out seal numbers seen from the ship were corrected for diurnal patterns in haul-out behaviour. In ship-based observations, whale sightings are recorded following line-transect methods, that is noting the angle and detection distance for each observation irrespective of distance. Since the focus of the observer is on the narrow band transect, chances for detection of whales at greater distances are reduced. Our current data analysis for whales is based on simple estimated 'effective detection ranges'; finer detection curves for Minke and larger whales will gradually be developed from our dataset.

Helicopter based surveys used band-transect methods for all species groups. A dedicated observer in the front seat focused all attention ahead on a narrow band-transect which, depending on viewing conditions, ranged between 200 and 300 m width. Band width was calibrated by perpendicular overflights of *Polarstern* (118 m length). By overflying the ship over bow or stern at least twice at the start of each survey, at the chosen altitude of 250 or 300 ft and standard speed of 60 knots, reference points for transect limits could be made using interior parts of the heli. Survey-tracks were subdivided into smaller units by making GPS waypoints approximately every three to four minutes and recording data in between waypoints.

The GPS was operated by a second observer in the rear seat, at the same time making ice-records for each subsection of the survey. Observers in the rear also noted animal sightings outside of the transect band.

Analysis of survey data

Survey distance within each 10 min ship-survey was calculated from averaged ship-speeds in *Polarstern*s PODAS database system. For helicopter surveys accurate flight speed and distance covered were established using waypoints made. Surface surveyed was thus established from speed and band-transect width, allowing the calculation of densities (number of animals per km^2) for each count unit. Each count unit also has a number of environmental parameters, either noted during the counts (e.g. ice-conditions, sea-state, visibility etc) or extracted from the PODAS system (position, surface water-temperature, salinity etc.). Results of ice records are presented elsewhere in this volume.

Top predator density data have been translated to daily prey requirements, expressed as kg carbon requirement of the top predator community per km^2 per day. Calculations are based on published literature of field metabolic rates and energy contents of prey as described in Van Franeker et al. *(*1997). In addition to the quantitative counts, qualitative information was collected on the occurrence of species outside transect bands or during oceanographical stations. Such data are not used for density estimates, but assist in more complete distribution mapping of species.

Analyses in this paper are based on averages of all 10 minute ship-counts and the 'between waypoints' helicopter-counts, mostly grouped over half a degree of latitude around station positions on each transect leg. Helicopter surveys were only conducted where sea ice was present. Due to the speed of the observation platform, helicopter surveys are expected to give some underestimate of especially whale densities as diving individuals can be easily missed in fast overflight. However, seal data from heli-counts are expected to be more complete than those from the ship because all heli-surveys were conducted around midday, the peak haul-out period for ice seals. Furthermore, in contrast to the ship, the helicopter follows a straight unbiased transect line over seaice, where the ship often follows an erratic course in response to ice conditions. In a later phase, detailed comparisons of ship and helicopter results may lead to adaptations in data analyses.

Results and discussion

The long summer daylight periods for ship surveys plus the availability of helicopters resulted in good coverage of top predator surveys over the full grid area. Until the 23 of January a total of 2,094 counts was made: 1,395 ten-minute counts from the ship, and 699 'between waypoint' counts made during 28 flights with the helicopter. The surface area thus covered by top predator counts amounts to 3,061 km^2, of which 1,537 km^2 from ship and 15,24 km^2 from the helicopter. Helicopter counts were restricted to areas with sea ice.

These sample sizes include the observations during the southward voyage from Cape Town to Neumayer preceding the work in the study grid between 62°S-70°S and 3°W-

3°E. Sample sizes and surface surveyed for different transects within the study-grid area are specified in Table 13.1. Ship based counts were continued throughout the northward voyage, and will be included in later analyses.

The overall north to south distribution of food requirements of top predators (Fig 13.1) shows the usual pattern of relatively low values in warmer open ocean, occasionally sharply elevated by incidental observations of large whales. In the seasonal sea ice zone (sea ice retreated from about 60°S to 67°S) requirements are consistently higher, largely due to regular presence of seals and whales. Birds, especially penguins were relatively scarce during this voyage, likely because most species retreat to land for breeding and moulting during this period, all at considerable distance from the study grid.

Logistic commitments of *Polarstern* to support the delivery of building materials to Neumayer station caused a break in the transects in the study grid. This seriously complicates interpretation of spatial patterns of top predator distributions in the study grid between 60° to 70°S and 3°W to 3°E. Data are presented for the somewhat wider latitudes south of 60, as events a bit north of the grid were considered illustrative for results obtained within the grid. The combination of ship counts and helicopter based surveys allowed excellent coverage of all transects (Fig. 13.2A). However, in this season of very rapid changes in ice conditions, the delay between the outer transects (3°W and 3°E) and the central one along the 0° meridian seems to have had an overruling effect on observed animal densities confusing a view on basic spatial patterns (Fig. 13.2B).

As was the case during earlier winter observations, the 3°W transect showed higher densities of predators than the 3°E transect which runs over Maud Rise (Fig. 13.3B and C). However, food requirements during the delayed third and last transect moving north along the zero meridian showed no ‘matching’ intermediate pattern (Fig. 13.3D). Strongly elevated food requirements from top predators were observed, largely caused by increasing densities of crabeater seal *(Lobodon carcinophagus)* in the constantly shrinking area of sea ice in the south and increased abundance of Antarctic minke whale (*Baleanoptera bonaerensis*) in and around the open and broad marginal ice zone. In winter, minke whales concentrated far south in heavy sea ice, but it appears these animals move to the melting zones in summer, likely increased with migrating individuals. On top of this, summer arrival of large baleen whales added to sharply increased food requirements. In the rim of the sea ice, a rare observation of a blue whale (*Balaenoptera musculus*) was documented. At the northern side of the study grid, large numbers of migratory humpback whales (*Megaptera novaeangliae*) had arrived, and flocks of thousands of moulting blue petrels (*Halobaena caerulea*) further indicated rich and reliable food supply for predators. The seasonal change of seals concentrating in residual ice and arrival of migratory whales attracted by the productivity of the seasonal sea ice zone, is best seen by a comparison of the final transect along the zero meridian (Fig. 13.3D) with the initial track to Neumayer (Fig. 13.3A) about five weeks earlier which ran along 1°West until 65°S before gradually moving further southwest. In the five weeks time gap, sea ice had retreated over seven degrees of latitude and triggered a strong change in the composition of top predator community and a fourfold increase of top predator daily food requirements in the study grid (Table 13.1), clearly indicating the importance of the seasonal sea ice zone.

Among the remarkable observations, Ross seals (*Ommatophoca rossii*) need mentioning. Throughout the cruise, but particulary in the area around the 0° meridian, we observed unusually high numbers of this rarest among the ice seals. Where Bester et al. (2002) reported an already relatively high percentage of 1.7 % Ross seals in the seal populations of the Lazarev Sea, our observations add up to a more than three times higher percentage of 5.4 % in summer 2007 - 2008.

In this early stage of data processing, no scientifically accurate evaluation of relations of predator abundance with catches from various nets, acoustics or other biological or physical parameters is possible. However, a quick initial survey of data was made with preliminary SUIT data (Flores et al. this vol), RMT data (chapter 11) and echosounding information (Krägefsky et al this vol). In many but not all cases, positive correlations between predator abundance and prey abundance are visible. However, only few correlations were significant in linear regressions. Three examples of correlations between specific predator groups and krill abundance are shown in Fig. 13.4 using logaritmic data and simple linear regressions. Food requirements of petrels were positively related ($p<0.001$) to numbers of krill in the RMT net (Fig. 13.4A) and requirements of seals were positively related ($p=0.03$) to mass of krill in the SUIT net. Simrad 38 kHZ backscatter over the upper 200 m showed a near significant correlation ($p=0.052$) with food requirements of the total top predator community. Further analyses will be needed to combine prey abundance from all different indicators.

In conclusion, results of the ANT-XXIV/2 expedition confirm a major role of the seasonal sea ice in supporting Antarctic food webs. Insight into finer scale relations and processes is increasing, but still very incomplete because that requires integration of results from different sampling devices over different depth ranges and needs to deal with extremely patchy distributions and strongly variable diel migration patterns.

Additional work

- *Fishing by helicopter*

  During predator counts from from ship and heli, as in several earlier cruises, we observed “brown spots”, i.e. discolourations in the water up to may tens of meters in diameter. Although zooplankton swarming was suspected, this remained unconfirmed as close subsurface swarming of zooplankton during daylight hours would be unusual. Sampling had been impossible so far, but with the team of Heli Transair we prepared a trial with a simple 50cm diameter plankton net on a 20 m long rope deployed as sling load under the helicopter. We made one successful trial lowering the net to about 15 m subsurface in a brown spot, hauling up uniformly young krill. Learning more about the species/age composition of such patchy swarms, their size and potential biomass contribution to the zooplankton community is crucial to understand the functioning of the Southern Ocean ecosystem and interpretation of catch data from conventional sampling net studies and even the SUIT net, which will rarely ‘hit’ these swarms. Given the opportunity in future expeditions, we will look into the development of a more quantitative type of sampling net to be deployed under helicopter, as better knowledge of the 'brown spot' phenomenon fully fits our objective to assess the role of surface layer phenomena in the functioning of the Antarctic ecosystem.

- *Atka Bay Emperor Penguin colony count*
  During the first visit of *Polarstern* to Neumayer Station, conditions on 14 Dec were excellent for aerial photography of the colony of emperor penguins (*Aptenodytes forsteri*) in Atka Bucht. Chicks were distributed over eight different 'creches' that were all photographed with telelens from distance out of the helicopter. Counts of the photographic material shows that close to 11.000 chicks were present with about 1,200 attending adult birds.
- *Opportunistic diet sampling*
  In our research, birds accidentally landing on the ship are routinely measured and if possible a stomach sample is taken for diet studies. As expected in a mid-summer cruise accidental landings hardly occurred. Two Kerguelen petrels were reported on the ship, one of which took off again by itself. The other one had regurgitated its stomach content on the deck (krill). It was captured, measured and subsequently released, and the stomach content was collected.
- *Education, Outreach and Communication*
  Considerable effort was made by our group to produce 12 short videos for the Dutch IPY site (www.pooljaar.nl/poolijs) and the AWI ftp site, 9 weekly illustrated newsletters (in Dutch and German; www.jafweb.nl) and various other written and photographic contributions for general usage. During the voyage we also cooperated in a newspaper article and radio interview in the Netherlands.

Acknowledgements

We thank officers and crew of Polarstern, cruise leader Uli Bathmann and all colleagues on board for their frequent and extensive support for our project. Martina Vortkamp and Sören Krägefsky kindly assisted in providing preliminary RMT and SIMRAD data. Special thanks are expressed towards the HeliTransAir pilots and technicians. This project was funded by the Netherlands Ministry for Agriculture, Nature and Food Quality (LNV). Last but not least we are very grateful to the Alfred Wegener Institute for its open attitude to international cooperation through the sharing of costly logistic facilities.

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Tab. 13.1: Carbon requirements of marine toppredators (seabirds, seals and whales) in and just north of the study grid, in half degree latitude zones around station positions. Sample size indicated by the number of counts (integrated helicopter waypoint counts and ship 10 min counts), and the total surface of band-transect investigated.

	Transect 0 10-14 Dec 2007 1°- 8° West			**Transect 1** 21-29 Dec 2007 3° West			**Transect 2** 01-06 Jan 2008 3° East			**Transect 3** 17-23 Jan 2008 0° Meridian		
Latitude	*counts* *n*	surveyed km2	C requirement kgC/km2/day	*counts* *n*	surveyed km2	C requirement kgC/km2/day	*counts* *n*	surveyed km2	C requirement kgC/km2/day	*counts* *n*	surveyed km2	C requirement kgC/km2/day
-60.0										*10*	9.5	1.86
-60.5	*6*	6	0.49							*2*	2	3.43
-61.0	*15*	14	0.07	*8*	16	0.13				*17*	17	11.58
-61.5	*10*	12	0.37	*15*	33	4.45				*17*	17	82.84
-62.0	*16*	14	**0.16**	*26*	42	**2.52**	*16*	11	**0.00**	*10*	10	**3.13**
-62.5	*20*	19	**0.21**	*23*	38	**0.22**	*8*	7	**0.00**	*9*	9	**0.37**
-63.0	*14*	12	**0.04**	*21*	37	**0.09**	*13*	11	**0.00**	*21*	17	**3.04**
-63.5				*31*	43	**0.07**	*20*	20	**0.34**	*9*	9	**0.01**
-64.0	*14*	26	**1.01**	*23*	39	**0.19**	*22*	37	**0.07**	*7*	7	**0.02**
-64.5	*22*	39	**0.44**	*16*	14	**0.61**	*15*	32	**0.11**	*18*	17	**0.98**
-65.0	*13*	25	**0.23**	*19*	20	**0.02**	*31*	50	**0.22**	*12*	12	**1.39**
-65.5	*21*	42	**0.12**	*18*	25	**1.44**	*34*	55	**0.90**	*3*	3	**0.00**
-66.0	*16*	27	**0.80**	*24*	43	**0.13**	*12*	29	**0.07**	*15*	17	**0.01**
-66.5	*8*	15	**1.75**	*24*	37	**2.88**	*26*	38	**0.82**	*16*	15	**2.55**
-67.0	*14*	31	**0.49**	*28*	38	**2.50**	*24*	45	**0.30**	*15*	12	**1.17**
-67.5	*26*	45	**0.60**	*52*	96	**0.78**	*35*	46	**0.82**	*8*	8	**0.01**
-68.0	*35*	66	**0.19**	*38*	81	**0.25**	*28*	43	**0.76**	*18*	15	**2.47**
-68.5	*14*	27	**0.29**	*33*	63	**0.65**	*31*	61	**0.60**	*23*	24	**8.19**
-69.0	*22*	47	**0.24**	*44*	91	**0.16**	*12*	26	**0.21**	*41*	64	**2.44**
-69.5	*45*	101	**0.55**	*26*	41	**0.63**				*62*	91	**1.78**
-70.0	*69*	144	**0.43**	*21*	43	**0.59**	*15*	13	**0.01**	*11*	20	**0.96**
-70.5	*53*	117	**0.30**	*10*	11	**0.10**				*12*	11	**0.60**
S of 62°S	*422*	796	**0.46**	*477*	801	**0.77**	*342*	524	**0.33**	*310*	360	**1.62**

Tab. 13.2: General abundance data on bird and mammal species observed during ship and heli-surveys in ANT-XXIV/2. Column ship records includes all records, including birds repeatedly observed as associated to the ship or animals outside the transect area. Columns 'in ship transect' and 'in heli transect' give numbers used in density calculations.

Polarstern ANT-24-2 Bird & Mammal species list (*until 23 Jan 2008*)

part 1: BIRDS English name	*scientific name*	latitudinal range	ship records	in ship-transect	*in heli transect*
Emperor Penguin	*Aptenodytes forsteri*	-64 to -70	290	72	*115*
Adelie Penguin	*Pygoscelis adeliae*	-60 to -70	214	93	*71*
Chinstrap Penguin	*Pygoscelis antarctica*	-52 to -61	846	844	*2*
Rockhopper Penguin	*Eudyptes crestatus*	-52 to -52	1	1	
Unidentified penguin	*penguin sp.*	-49 to -69	18	13	*6*
Wandering Albatross	*Diomedea exulans*	-41 to -49	63	1	
Royal Albatross	*Diomedea epomophora*	-54 to -54	1		
Large albatross sp	*Diomedea 'large'*	-43 to -49	2		
Black-browed Albatross	*Diomedea melanophris*	-39 to -58	120	3	
White-capped Albatross	*Diomedea cauta*	-41 to -42	6	1	
Grey-headed Albatross	*Diomedea chrysostoma*	-41 to -59	35	1	
Light-mantled Sooty Albatross	*Phoebetria palpebrata*	-44 to -61	375	28	
Southern Fulmar	*Fulmarus glacialoides*	-49 to -70	292	89	
Antarctic Petrel	*Thalassoica antarctica*	-56 to -70	4457	976	*109*
Cape Petrel	*Daption capense*	-47 to -66	1046	33	*1*
Snow Petrel	*Pagodroma nivea*	-58 to -70	984	145	*180*
Northern Giant Petrel	*Macronectes halli*	-45 to -45	1		
Southern Giant Petrel	*Macronectes giganteus*	-49 to -70	116	12	*3*
Giant Petrel sp.	*Macronectes sp.*	-47 to -61	73	3	
Antarctic Prion	*Pachyptila desolata*	-49 to -65	679	100	
Unidentified Prion	*Pachyptila sp*	-41 to -47	688	257	
Blue Petrel	*Halobaena caerulea*	-47 to -61	1832	1476	
Prion or Blue P.?	*Pachyptila/Halobaena sp*	-61 to -61	800		
Great-winged Petrel	*Pterodroma macroptera*	-36 to -39	10	1	
White-headed Petrel	*Pterodroma lessonii*	-36 to -59	23	3	
Atlantic Petrel	*Pterodroma incerta*	-39 to -47	10	3	
Kerguelen Petrel	*Pterodroma brevirostris*	-49 to -65	247	93	
Soft-plumaged Petrel	*Pterodroma mollis*	-36 to -61	255	39	
Grey Petrel	*Procellaria cinerea*	-38 to -47	28	6	
White-chinned Petrel	*Procellaria aequinoctialis*	-36 to -55	98	8	
Great Shearwater	*Puffinus gravis*	-38 to -54	80	19	
Sooty Shearwater	*Puffinus griseus*	-39 to -42	3	3	
Little Shearwater	*Puffinus assimilis*	-41 to -41	7	4	
unidentified shearwater	*Puffinus sp.*	-52 to -52	1		
Wilsons Storm-petrel	*Oceanites oceanicus*	-57 to -70	36	9	*1*
Black-bellied Storm-petrel	*Fregetta tropica*	-39 to -62	182	41	
Unidentified Diving Petrel	*Pelecanoides sp.*	-41 to -49	6	4	
South Polar Skua	*Catharacta maccormicki*	-61 to -70	9		
unidentified large Skua	*Catharacta sp.*	-42 to -42	1		
Arctic Skua	*Stercorarius parasiticus*	-40 to -40	1	1	
unidentified smaller Larus	*Larus unidentified; small*	-64 to -64	1		
Arctic Tern	*Sterna paradisaea*	-39 to -69	637	361	*524*
Tern unidentified	*Sterna sp medium*	-52 to -52	2	1	

Tab.13.2: Continued (for caption see previous page)

Polarstern ANT-24-2 Bird & Mammal species list (*until 23 Jan 2008*)

part 2: MAMMALS English name	*scientific name*	latitudinal range	ship records	in ship-transect	*in heli transect*
Crabeater Seal	*Lobodon carcinophagus*	-61 to -70	171	143	*455*
Leopard Seal	*Hydrurga leptonyx*	-68 to -69	2	2	*7*
Weddell Seal	*Leptonychotes weddellii*	-67 to -70	5	4	*24*
Ross Seal	*Ommatophoca rossii*	-66 to -70	20	11	*25*
unidentified seal (Phocid)	*Phocidae sp*	-62 to -70	12	3	*2*
Minke Whale spec	*Balaenoptera sp Minke type*	-62 to -69	9	9	
Antarctic Minke Whale	*Balaenoptera bonaerensis*	-62 to -69	66	59	*20*
unidentified small whale	*Cetacean small*	-59 to -69	18	18	
Sei/Fin?Whale	*Baleanoptera sp*	-45 to -45	1	1	
Blue Whale	*Balaenoptera musculus*	-67 to -67			*1*
Humpback Whale	*Megaptera novaeangliae*	-52 to -62	132	112	
Sperm Whale	*Physeter macrocephalus*	-47 to -47	2	2	
S. Bottlenose Whale	*Hyperoodon planifrons*	-58 to -58	1	1	
Killer Whale	*Orcinus orca*	-66 to -70	36	6	

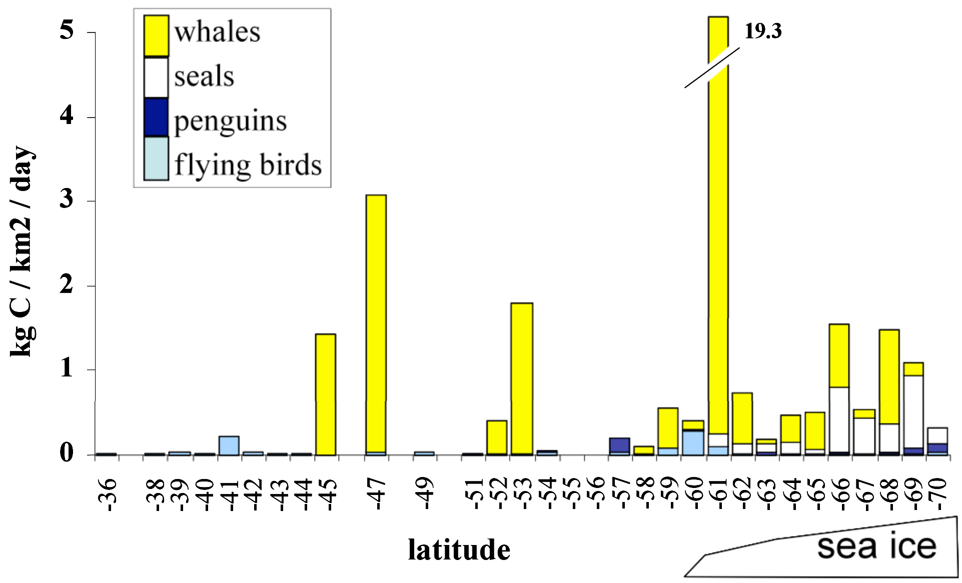

Fig.13.1: Latitudinal pattern of food requirements of top predators; all data from 29 November 2007 to 23 Jan 2008 averaged per degree of latitude. Sea ice retreated from about 60°S to 67°S during this period (n=2094 ship and helicounts over a surface area of 3061 km^2; label for latitude on x-axis omitted where no data available).

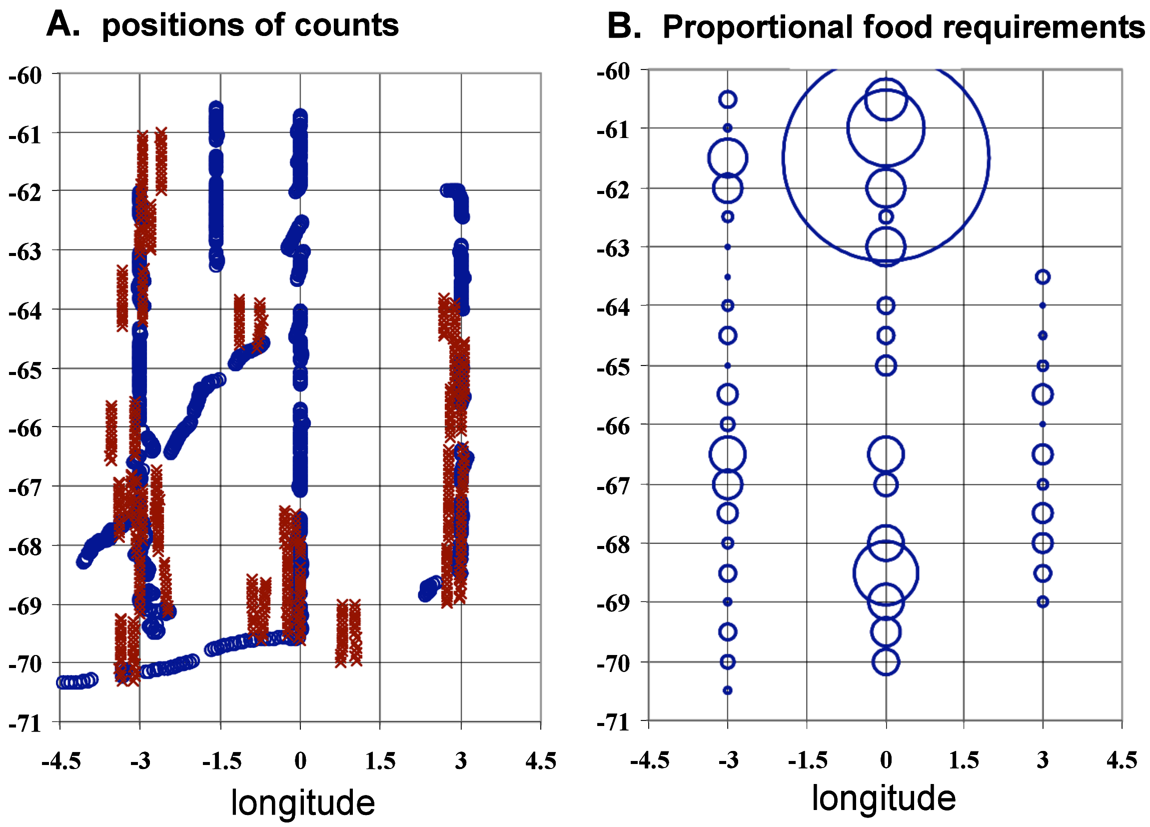

Fig. 13.2: Data coverage in the survey grid (A: shipcounts circles; helicounts crosses) and proportional food requirements of top predators during the three north south transects, with data grouped in half-degree latitude and 3 degree longitude blocks around station positions (30 x ca 35 nm; disproportionate scaling of axes for clarity of the information.

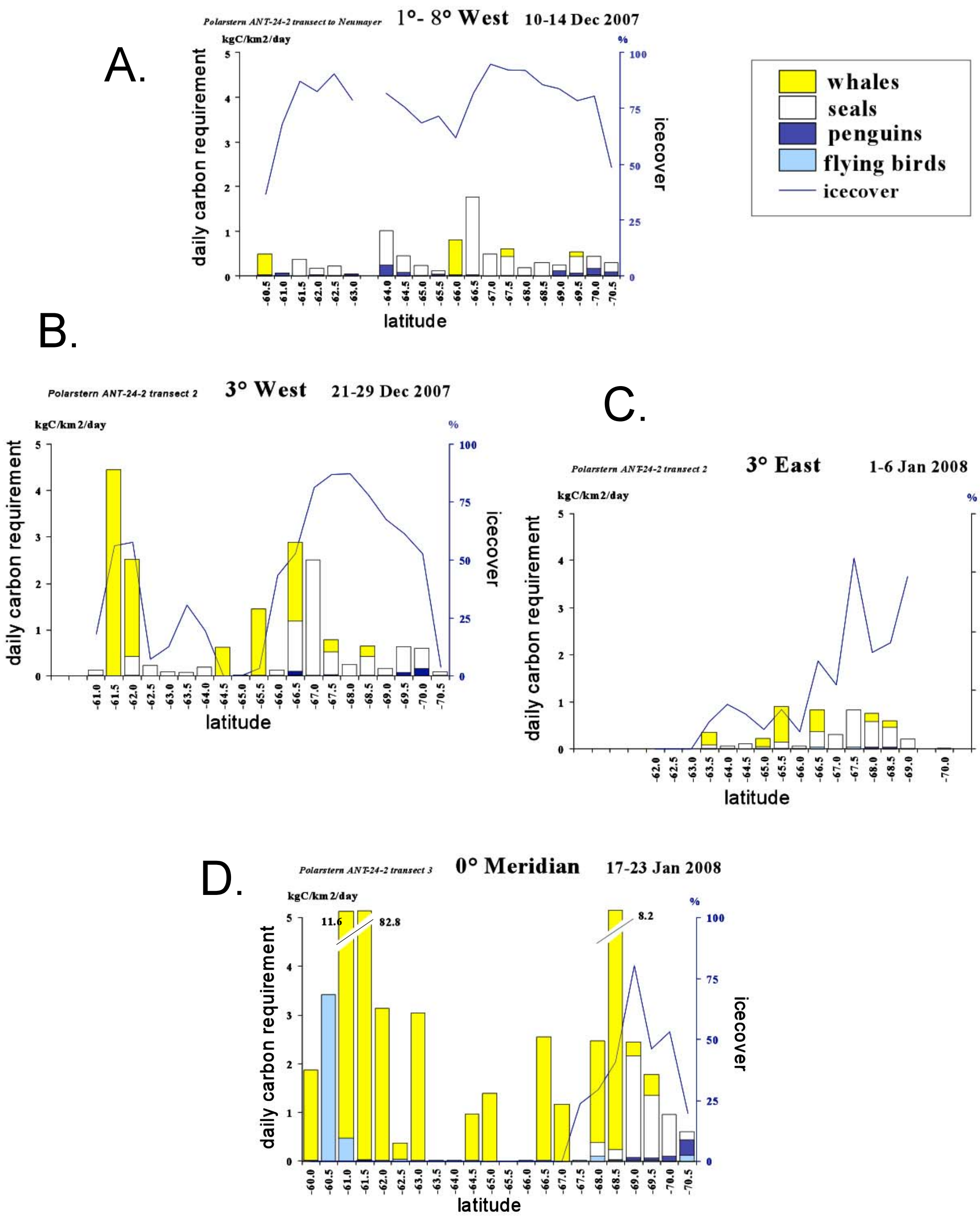

Fig. 13.3: Food requirements of top predators (as kg Carbon per km² per day) in the separate transect legs of ANT-XXIV/2 and sea ice cover at the time of observations. Transects along 3°W (B) and 3°E (C) were conducted in rapid sequence, but there is a considerable time-lag between these and the first (A) and last transect along 0° (D). Sample sizes are detailed in Table 13.1.

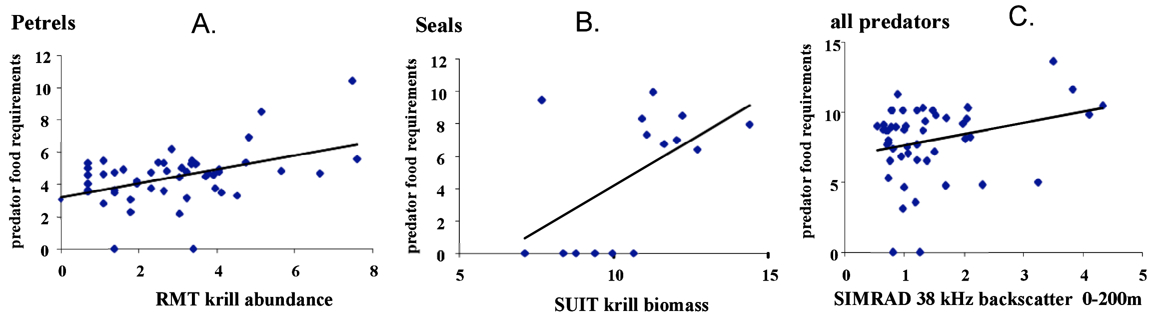

Fig. 13.4: Examples of correlation graphs of predator abundance versus prey abundance (ln transformed data with linear regression lines). A: food requirements of petrels versus number of krill in catches of RMT (p<0.001); B: food requirements of seals versus biomass of krill in catches of the SUIT (p=0.03); C: food requirements of all top predators versus Simrad 38 kZ 0 - 200 m backscatter (p-0.05).

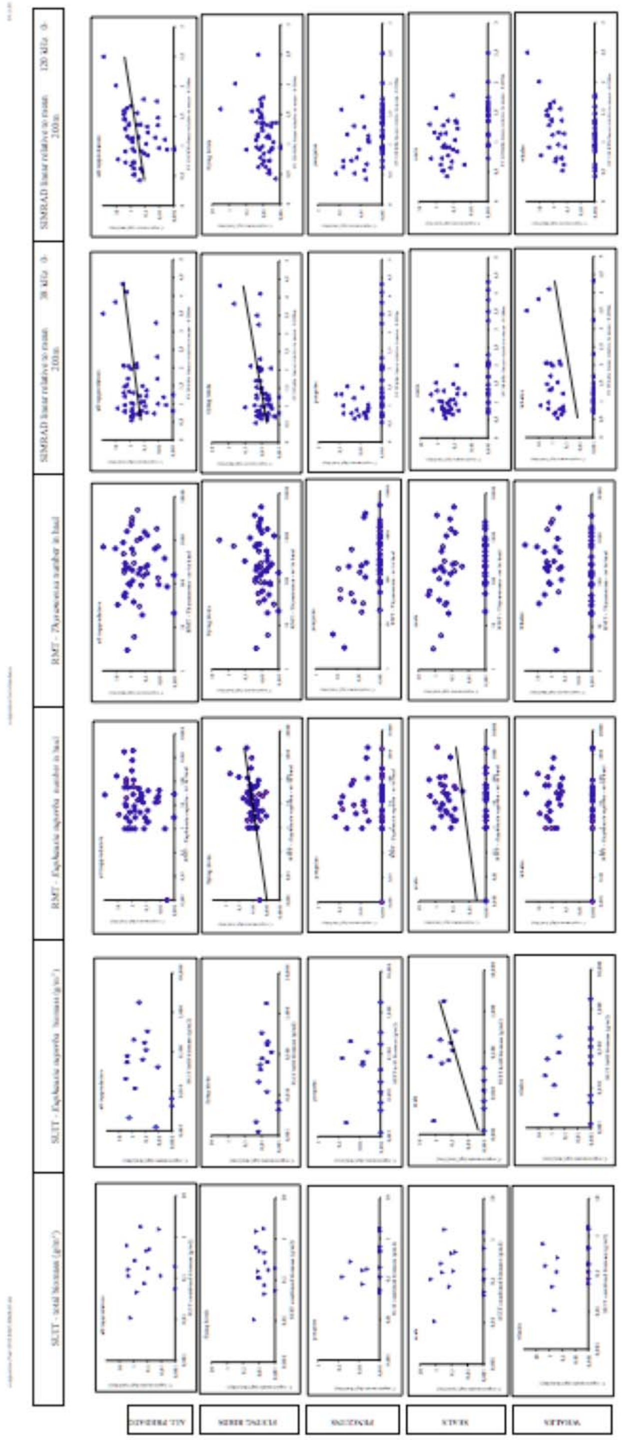

Fig. 13.5: Background data

14. ANDEEP-SYSTCO (SYSTEM COUPLING) SYSTEM COUPLING IN THE DEEP SOUTHERN OCEAN - FROM CENSUS TO ECOSYSTEM FUNCTIONING

Angelika Brandt[1], Brigitte Ebbe[2], Eberhard J. Sauter[3]

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The general scope and objectives

Vast areas of the Southern Ocean surrounding the Antarctic continental shelf are deep sea. In contrast to our knowledge of the benthos in Southern Ocean shelf areas, corresponding data from the deep sea are still scarce. However, the pioneering investigations of ANDEEP aboard the German icebreaker *Polarstern* have revealed a remarkable biodiversity in the Southern Ocean deep sea. SYSTCO builds on the precursor programme ANDEEP which was multidisciplinary but more focused on the status quo of the nearly unexplored ecosystem of the abyssal benthos in the Antarctic.

We will now build on those results and try to understand the role of deep-sea key species in the ecosystem and will try to elucidate the functioning of atmospheric, pelagic, and benthic systems of the Southern Ocean in a process oriented context. SYSTCO will help to understand the role of the Southern Ocean in global energy budgets, climate change, and the functioning of atmospheric, pelagic, and benthic systems of the Southern Ocean. The approach of exploring a new or almost untouched frontier with regard to the geographic area will be complemented by approaching a new frontier in linking major scientific disciplines. SYSTCO involves a wide variety of scientists from different disciplines, such as atmospheric sciences, planktology, physical oceanography, geology, sedimentology, and biogeochemistry for simultaneous study of a defined area to shed light on atmospheric-pelagic-benthic coupling processes (atmospheric, biological sciences, physical oceanography, sedimentology, and geology) for simultaneous study of a defined area.

SYSTCO is an ambitious programme designed to study processes in different realms of the biosphere in Antarctica and uncover how these systems are linked to each other (atmospheric-pelagic-benthic coupling processes).
Important objectives in the different realms are as follows:

Atmosphere: SYSTCO aims to unravel surface fluxes from satellite data:

Water column and plankton: SYSTCO aims to understand the influence of atmospheric processes on processes in the water column, the influence of the biogeochemistry of the surface water on primary productivity, and to describe vertical changes in the plankton community to abyssal depths.

Benthos: SYSTCO investigates the biology of abyssal key species, the role of the bottom-nepheloid layer for recruitment of benthic animals, the influence on abyssal life of the quantity and quality of food sinking through the water column, feeding ecology and trophic relationships of abyssal animals.

Seabed characteristics: SYSTCO studies the effects of topography, sedimentology and biogeochemistry of sediment and pore water on benthic life and microhabitat formation.

The benthic fauna depends on deep carbon export from the pelagic production and particle sedimentation. For that reason the project aimed to revisit a station on the way back to Cape Town in order to perform repeated measurements at the same station for an estimate of seasonal and episodic variabilities of the particle flux.

The area investigated during SYSTCO will provide a basis for future monitoring programmes, i.e., global change studies and could serve as a time-series-area which could be revisited in future.

SYSTCO is the IPY lead project #66 and it is also integrated into SCAR-EBA and CAML (Census of the Antarctic Marine Life) and CeDAMar (Census of the Diversity of Abyssal Marine Life). Data management can be guaranteed through SCAR-MarBIN to OBIS. Samples will be handled through the German Centre for Marine Biodiversity (DZMB) in Wilhelmshaven, Germany, a department of the Senckenberg Institute especially designed as a service organisation coordinating sample handling, processing, tracking, and archiving for all projects staged from German research vessels, as well as providing a database of taxonomic experts. As SYSTCO is an important field project also for the global Census of Marine Life (CoML, field projects CeDAMar and CAML), education and outreach are managed during the expedition by Dr Victoria Wadley (CAML) and Dr Brigitte Ebbe (CeDAMar).

In order to avoid duplication of the presentation of results in this cruise report, only the general aims of physical oceanography and planktology are outlined here, and references to the other chapters of the report are provided.

Physical Oceanography

The physical and oceanographic measurements of the *Polarstern* cruise ANT-XXIV/2 will form part of the IPY-project Synoptic Circum-Antarctic Climate and Ecosystem study (SCACE). The overarching goal of SCACE is to internationally collaborate in the collection of a unique data set that can serve as a benchmark for comparison of existing data for the identification and quantification of polar changes.

SCACE (for description of the project see chapter 2) contributes to SYSTCO in addressing questions such as:

- Which physical, biological and chemical processes regulate the Southern Ocean system and determine its influence on the global climate development?
- How sensitive are Southern Ocean processes and systems to natural climate change and anthropogenic perturbations?

To answer these questions a CTD was used that held additional instruments such as a chlorophyll-sensitive fluorometer to provide an indication of the abundance of phytoplankton and a transmissiometer to measure the attenuation of light. It will be attached to a carousel water sampler holding 24 bottles of 12 l volume each. The CTD water is used to measure the distributions of inorganic carbon, total alkalinity, oxygen and nutrients in the Weddell Sea and on the Antarctic shelf. The CTD measurements were accompanied by measurements of horizontal currents in the top few hundred metres. This was done by continuously recording with a vessel mounted ADCP (Acoustic Doppler Current Profiler). The ADCP is also used to detect zooplankton abundance by evaluating the backscattered echo amplitude and provides background information on processes in the water column (for further descriptions of this work chapter 4).

Investigations of the upper layer of surface water and sea ice

The ocean surface layer and its link to sea ice is of critical importance to the Antarctic food webs. A top-down survey of the food web structure is done in order to explain high predator abundance in sea ice, which is believed to be largely triggered by ice algae concentrating higher food web levels in the poorly studied upper layer of surface water. Sampling of these systems was conducted using a special net to sample fish and zooplankton residing in the upper water layer, even when directly under sea ice. The scraping off of the under ice fauna is performed using an especially constructed heavy-framed but floating net that can 'roll' along the undersurface of the sea ice, the SUIT (Surface and Under-Ice Trawl) (for more details see chapter 12).

Studies on Plankton

The physical and oceanographic measurements are complemented by a suite of chemical and biological measurements. Data of zooplankton abundance are derived from different net catches to provide insight into the biodiversity and distribution of zooplankton, including euphausiid (krill) life stages for demography studies and population dynamics (chapter 12), in the Southern Ocean surface layer of the Circumpolar Current, as well as the pelagic realm. A Continuous Plankton Recorder (CPR) was used to determine the patchiness and species composition of zooplankton. The role of carnivorous zooplankton (e.g. chaetognaths) in the mesopelagic food web of the Southern Ocean was studied on the basis of stratified sampling by a multinet (MN) at depth intervals between 2,000 - 1,500 m, 1,500 - 1,000 m, 1,000 - 750 m, 750 - 500 m, 500 - 0 m. Further material was derived from Rectangular Midwater Trawl (RMT) samples (chapters 6 - 9).

Biogeochemistry at the sediment-water interface
Biogeochemistry was done to study organic carbon (C_{org}) fluxes reaching the seafloor at the different SYSTCO locations. Moreover, interactions between geochemical microgradients and benthic organisms can be discovered using a suite of gear including Landers, microprofilers, benthic corers and sledges at the same station. Measurements of geochemical microgradients are used to describe the geochemical milieu around benthic organisms and help to explain faunal community structures with their ecological and metabolic characteristics. Further details are presented in the background of the DOMINO (Dynamics of benthic Organic Matter fluxes In polar deep-Ocean environments) project (chapter 31). DOMINO contributes to both SCACE and SYSTCO, as well as to the IPY programme ICED (Integrating Climate and Ecosystem Dynamics).

Measurement of the pore-water oxygen distribution provides a suitable tool for the determination of C_{org} fluxes through the sediment-water interface as an estimate of food input to the benthic communities. So far, only few data on C_{org} remineralization rates exist for high latitudes beyond 60° S and furthermore very little is known also about the total amount of organic carbon remineralized and fixed within surface sediments of the Southern Ocean.

In-situ microprofile measurements of small scale variabilities generated by bacteria or benthic organisms were planned to be performed by means of an autonomously working 3D deep-sea microprofiler mounted on a free falling Lander system. Besides the photographs taken, the 3D reconstruction of the pore water oxygen distribution was to be used for a geochemical habitat characterization as well as for 3D pore water modelling. These data are of great importance for benthic biologists, especially when measured around biogenic structures. *In-situ* measurements were planned to be complemented by *ex-situ* measurements of microprofiles, sediment, pore water for the determination of further geochemical parameters like C_{org}, C/N ratio as well as nutrient profiles. Sediment was sampled using a MUC (multicorer).

In addition, the sea floor surrounding the sampling and measuring locations was characterized hydroacoustically using Parasound and Hydrosweep for approximately 30 minutes before approaching a station.

Some interesting achievements of the ANDEEP-SYSTCO project are
General

- First biogeochemical *in-situ* measurement repeated after 7 weeks, to investigate the effect of a phytoplankton bloom on benthos and how surface productivity is linked to the seafloor
- First biogeochemical sampling of deep-sea stations 12 nm apart in order to look at small-scale heterogeneity in the sediment
- Worldwide southernmost *in-situ* benthic flux measurement at 69°40.4'S (Polynia station)
- First sampling through the entire water column in the Southern Ocean from surface and ice flora and fauna down to bathyal or abyssal depths (5 stations, partly incomplete)

- First sediment profiles measured simultaneously with the complete benthic community, including epibenthos and infauna
- 52° SPF is characterised by low diversity and abundance in the macrofauna, even after a slight plankton bloom in spring (revisit of stations after 7 weeks)
- Eastern Weddell Sea and Lazarev Sea are generally poorer in species and abundance of organisms in the deep sea
- Maud Rise (seamount) differs completely in taxon composition from the abyssal stations, perhaps due to the unique physical oceanographic conditions including the Taylor column influencing localised entrainment of larvae. Brooders, on the contrary, occur only as a minor fraction in the macrobenthic sample.

Fauna

- Discovery of the rare Monoplacophora *Laevipilina antarctica* close to Neumayer (northern pier) which will help to elucidate the phylogenetic position of this taxon
- High numbers of Bivalvia at Maud Rise (52 % of the macrofauna) possibly indicating high particle availability for filter feeders
- High biomass of Holothuria (in total about 15 kg, with the largest holothurian [70 cm] of 3.6 kg, possibly indicating that these mud-feeding animals have much organic matter available
- High biodiversity of Gastropoda (higher than at northernmost stations) providing interesting result for deep-sea latitudinal gradients!
- Sampling of a high number of small calcareous Porifera at northern pier and of a large carnivorous sponge (70°S Lazarev Sea in 2,100 m)
- Finding symbioses; parasitic gastropods on holothurians and crinoids, many parasitic copepods on a scale worm and on fishes
- Sampling of more than 10 specimens of Haplomunnidae, a very rare deep-sea isopod family, at Maud Rise.

Methods

- An experimental approach to the meiobenthic food-web study in the Southern Ocean deep sea to uncover the microbial carbon contribution to the diet of Nematoda
- About 750 samples for biochemistry for food-web analysis (fatty acids and stable isotopes) which is essential for the analysis of the trophic structure
- About 500 samples for isopod barcoding and 350 extractions for genetics, important for population genetics and phylogenetic analyses of selected taxa
- Many samples for genetics of polychaetes and other taxa (same background as isopods)
- Fixation of *Laevipilina* for genetics in order to solve the phylogenetic relationship of Monoplacophora
- Five deployments (4xSYSTCO) of free-falling Lander equipped with *in-situ* microprofiler for high resolution pore water oxygen profiles
- Laboratory oxygen porewater profiles measured at 5 stations *ex-situ* in MUC and GKG samples. Complementing sampling for porosity, Chlorophyll a and organic carbon content to be determined at the institute.

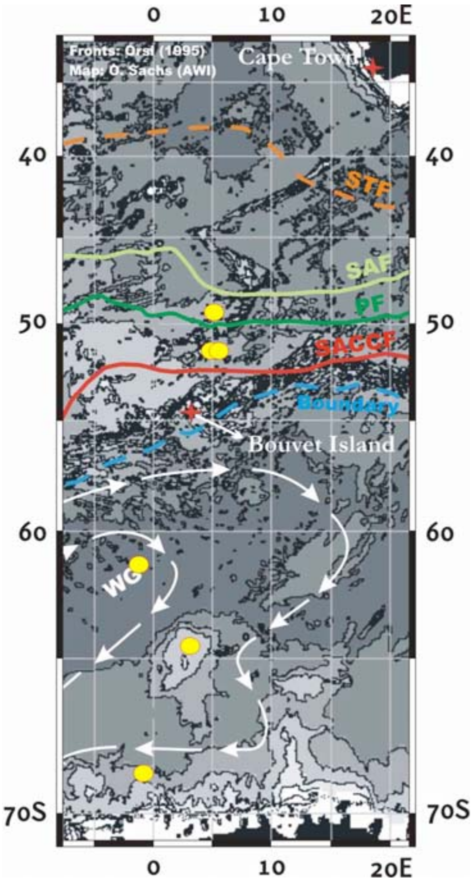

Fig. 15.1: In total 6 stations were sampled in the framework of the SYSTCO project, of these the last two ones are incomplete stations. Further details are provided in the station book as well as the chapter Benthic work – introduction to the work at sea.

15. ANDEEP - SYSTCO: WORK AT THE SEAFLOOR

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General and objectives

The following short contributions serve the purpose of the description of the benthos gear deployed during the expedition ANT-XXIV/2. It contains brief descriptions of the deployments of the gear as well as information about successful hauls and failures.

Tab. 15.1 provides a checklist for all gear being deployed at the SYSTCO stations (Fig. 15.1) (including DOMINO). For details with regard to the description of the gear deployed in the water column, please read the chapters of LAKRIS and SCACE.

Table SYSTCO stations all gear

Gear/Stations	PS 71/13	PS 71/17	PS 71/33	PS 71/39	PS 71/85	PS 71/90
CTD	√	√	√	√	√	√
MD	√	√	√	√	√	-
RMT	√	√	√	√	-	-
M-RMT	no deploym.	failure	√	√	-	-
SUIT	√	√	√	√	-	-
FFL	√	no deploym.	failure	√	-	-
A-Traps	failure	√	√	√	-	-
TVS	failure	√	√	√ (40 Min.)	-	-
MUC 1	√	√	√	√	√	√
MUC 2	√	√	**f-**MUC 3 √	√ MUC 3 √	√	-
GKG 1	√	√	failure	√	√	√
GKG 2	√	√	failure	√	-	-
EBS	√	√	failure	√	-	-
AGT	√	√	√	√	failure	

Table SYSTCO summary of methods

Fraction/Gear	CTD	Nets	MUC	GKG	EBS	AGT	RD	A-Trap	Lander
Meiobenthos			√	√	√				
Macrobenthos			√	√	√	√			
Megabenthos			√	√	√	√			
Stones				√	√	√			
Biochemistry	√	√		√	√	√			
Genetics		√		√	√	√			
Geochemistry			√						√

In the following sections the metadata for the different benthic gear deployed at the seafloor are outlined.

Free-falling lander with deep-sea microprofiler

Organic carbon fluxes to the seafloor are commonly derived from sedimentary oxygen uptake, either by chamber respiration measurements or porewater oxygen microgradients. The total oxygen uptake (TOU), as obtained by incubation experiments, normally exceeds and is to be distinguished from the diffusive oxygen uptake (DOU) obtained from microprofile measurements. Whereas TOU includes the contribution of epi- and macro- fauna to the respiration rate of the enclosed sediment section, DOU reflects the basic turnover primarily caused by microbial activities. Both TOU and DOU can be determined *ex-situ*, i.e., by shipboard sediment core incubation and laboratory measurements of pore water oxygen microprofiles, respectively. Alternatively these parameters can be determined *in-situ*, i.e. at the sea floor using deep-sea benthic chamber and microprofiler landers, respectively.

The use of microsensors for flux determination was introduced some 25 years ago. Since their *in-situ* deployment is not trivial, data coverage is still modest for temperate equatorial and upwelling regions. For the deep high latitude Atlantic and the Southern Ocean, even less published *in-situ* measurements are available so far. More data exist from laboratory measurements. However, the latter tend to over-determine benthic fluxes, mainly due to pressure and temperature artefacts occurring during sediment recovery.

Therefore, fluxes were aimed to be measured both *in-situ* and *ex-situ* in order to improve the correction approach (see chapter 16). *Ex-situ* measurements were carried out at multicorer samples with an apparently undisturbed sediment surface. In addition, measurements were performed in deeper sediment strata on box corer subsamples, in order to better constrain the oxygen depth distribution deeper down the sediment.

Free-falling lander

For *in-situ* measurements a free-falling benthic lander was used (Fig. 15.2) and equipped with either a newly developed 3D oxygen microprofiler or a 1D deep-sea microprofiler. Due to releaser problems with the fish trap of the Brussels group, fish traps were mounted on the profiler lander as well.

In contrast to winch-operated gear, a free-falling lander (FFL) is designed to work autonomously. It is deployed by releasing it into the ocean where it sinks down to the seafloor. The system stays there while carrying out its pre-programmed task. After finishing the measurement programme at the seafloor, the lander releases its bottom weights via a hydroacoustic command received from the ship and ascends to the surface for recovery. Depending on the payload, landers can be used for *in-situ* measurements, time series experiments and observations over periods of hours, days, and up to a year. Beside the advantage of avoiding sampling artefacts by *in-situ* investigation, landers save ship time as they measure autonomously: for a 16 - 24 hrs period of autonomous seafloor measurement and fish trap exposition, typically less than 30 min and 2 hours of ship time was needed, for deployment and recovery, respectively.

3D microprofiler

This profiler system was designed to allow new insights into spatial small scale variabilities caused by benthic organisms. The new device is not restricted to drive sensors vertically into the sediment but is able to displace its sensor array (up to 12 Clark type oxygen microsensors, Fig. 15.2 right) horizontally in order to measure cascades of microprofiles over a target area of ~30 x 35 cm. Together with a sequence of photographs taken in advance, during and after the measurements, this allows the 3D reconstruction of the pore water oxygen distribution for descriptive geochemical habitat characterization e.g. around biogenic structures, as well as for 3D pore water modelling.

Unfortunately, one of the three step motors of the 3D system suffered seawater intrusion during the deployment at 5300 m (Station PS71/033, Weddell Sea). As a consequence several electronic parts had to be replaced. Although this was well performed by the ship's electronic engineer, the 3D profiler could not be deployed during the second half of the cruise since the time requirement of its measurements exceeded the duration of one station. Moreover, there was no time for a test deployment to proof the pressure resistance of the used electronic spare parts. This risk could not be taken at the only repetition station (PS71/085). Thus, the rather reliable 1D system was used here instead.

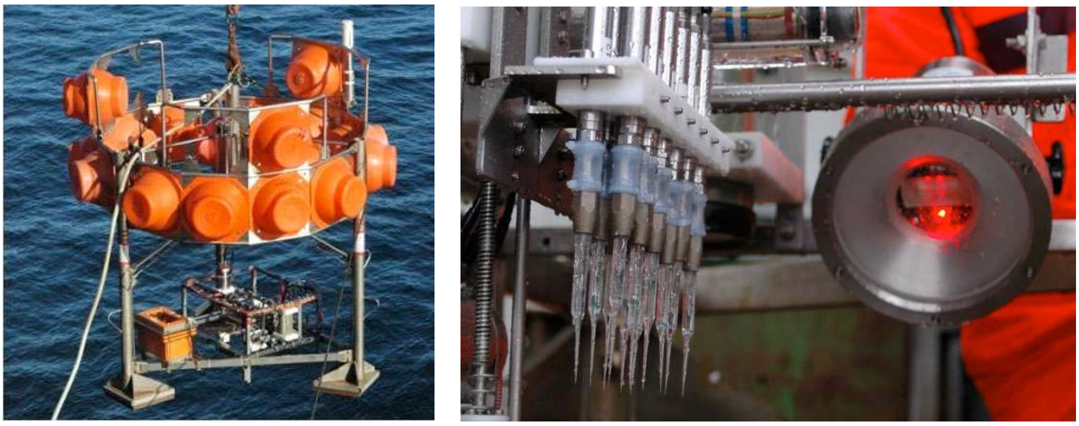

Fig. 15.2: Deployment of 3D deep-sea microprofiler lander (left), microsensor array and camera flash light with red pre-illumination diode after shipboard modification (right)

1D microprofiler

Fortunately, a 1D microprofiler (Unisense A/S) was available on this cruise as a back-up system and was used successfully at some of the stations (Fig. 15.3).

This microprofiler was equipped with up to five pressure compensated Clark type oxygen sensors that were pre-calibrated according to Sauter *et al*. (2001). During ~5 - 6 hours at the sea floor, the sensors were lowered through the water-sediment interface into the sediment with a vertical resolution of up to 0.25 mm. For porosity determination, a resistivity sensor (formation factor probe) was used.

Fig. 15.3: 1D deep-sea microprofiler module built into the lander

Table 15.1 gives an overview over the lander deployments during ANT-XXIV/2. A lander deployment was not possible at the station PS71/017 due to sea ice and at Station PS71/090 due to rough weather. Here oxygen profiles could only be measured in the laboratory on multicorer samples. Vice versa, no multicorer could be deployed at Stations PS71/047 and PS71/084.

Tab. 15.1: Lander deployments during ANT-XXIV/2

Station	Date	Time	Latitude	Longitude	Depth [m]	Comment
PS71/013-2	05.12.07	12:38	52° 0.41' S	0° 1.08' E	2990	3D, successful
PS71/033-3	29.12.07	13:22	62° 0.71' S	2° 56.88' W	5337	3D, failure
PS71/039-4	03.01.08	06:22	64° 30.19' S	2° 52.56' E	2125	1D, successful
PS71/047-1	07.01.08	06:09	69° 40.40' S	1° 2.24' E	1843	1D, successful
PS71/084-1	26.01.08	11:45	52° 12,02' S	0° 0,17' E	3004	1D, successful
PS71/085-1	26.01.08	20:56	52° 1,14' S	0° 0,07' E	2995	1D, successful

Meiofauna and sediments

The Multicorer (MUC)

The Multicorer (MUC) is a 600 kg sampling device armed with 12 plexiglass cores (diameter 9,4 cm) which are gently pushed into the sediment by heavy lead weights via a hydraulic system when the frame has landed on the sediment (Fig 15.4). Lifting of the gear causes upper and lower lids to close the liners and prevent sediment from sliding out during the heaving process.

The MUC of the Senckenberg Research Institute has successfully been deployed 14 times during the *Polarstern* ANT-XXIV/2 expedition (Tab 15.2).

Fig. 15.4: (from left to right): Deployment of the Multicorer from board Polarstern; removal of filled cores on deck; successful sediment core from station PS 71/13-12, 2963 meters depth

Tab. 15.2: Stations sampled with the Multicorer during the *Polarstern* ANT-XXIV/2 cruise. Depth is given according to the winch rope length. Core distribution: Cores for meiofauna have been sliced and stored in 4 % buffered formalin, cores for different sediment analyses have been sliced and frozen at –80°C, syringe samples of sediment have been taken for further sediment analyses, spooned sediment has been treated and frozen for fatty acid and stable isotope analyses of meiofauna organisms back in the home laboratories.

Station Code/Location	date	Lat	Long	depth [m]	sediment	core distribution
52° S						
PS71/013-12	06.12.2007	52° 2.22' S	0° 1.04' W	2963	foraminiferan/ diatom ooze	3 cores meiofauna 2 cores oxygen/sediment 2 cores sediment analyses 3 syringes sediment analyses rest spooned
PS71/013-14	06.12.2007	52° 2.25' S	0° 1.11' W	2970	foraminiferan/ diatom ooze	3 cores meiofauna 2 cores oxygen/sediment 2 cores sediment analyses 3 syringes sediment analyses rest spooned
Southernmost						
PS71/017-12	22.12.2007	70° 4.86' S	3° 22.59' W	1935	mud	3 cores meiofauna 2 cores oxygen/sediment 1 core sediment analyses 3 syringes sediment analyses

Station Code/Location	date	Lat	Long	depth [m]	sediment	core distribution
						rest spooned
PS71/017-14	22.12.2007	70° 4.80' S	3° 22.71' W	1951	mud	3 cores meiofauna
						2 cores oxygen/sediment
						2 cores sediment analyses
						3 syringes sediment analyses
						rest spooned
Central Weddell Sea						
PS71/033-10	30.12.2007	62° 0.80' S	2° 59.05' W	5323	deep-sea mud	2 cores meiofauna
						2 cores oxygen/sediment
						1 core sediment analyses
						3 syringes sediment analyses
						rest spooned
PS71/033-12	30.12.07	62° 0.65' S	3° 0.06' W	5315		u nsuccessful deployment
PS71/033-19	31.12.2007	62° 0.45' S	2° 58.70' W	5314	deep-sea mud	all cores spooned
						3 syringes sediment analyses
						rest spooned
Maud Rise						
PS71/039-10	03.01.2008	64° 28.83' S	2° 52.48' E	2116	foraminiferan sand	1 core meiofauna
						6 cores for in vitro experiment
						1 core oxygen/sediment
						1 core sediment analyses
						3 syringes sediment analyses
						rest spooned
PS71/039-12	03.01.2008	64° 28.83' S	2° 52.53' E	2123	foraminiferan sand	1 core meiofauna
						6 cores for in vitro experiment
						3 syringes sediment analyses
						rest spooned
PS71/039-14	03.01.2008	64° 28.84' S	2° 52.49' E	2119	foraminiferan sand	1 core meiofauna
						8 cores for in vitro experiment
						1 core sediment analyses
						3 syringes sediment analyses
						rest spooned
Continental Shelf						
PS71/048-4	12.01.08	70° 23.45' S	8° 18.66' W	649	very compacted sediment	unsuccessful deployment

Station Code/Location	date	Lat	Long	depth [m]	sediment	core distribution
52° S revisited						
PS71/085-5	26.01.08	52° 1.20' S	0° 0.20' E	2965	foraminiferan/	3 cores meiofauna
					diatom ooze with greenish	2 cores oxygen/sediment
					flufflayer	1 core sediment analyses
						3 syringes sediment analyses
						rest spooned
PS71/085-7	27.01.08	52° 1.53' S	0° 0.16' E	2964	foraminiferan/	3 cores meiofauna
					diatom ooze with greenish	1 core sediment analyses
					flufflayer	3 syringes sediment analyses
						rest spooned
Antarctic Convergence						
PS71/090-2	29.01.08	49° 0.95' S	0° 0.03' E	3980	foraminiferan/	1 core meiofauna
					diatom ooze	1 core oxygen, afterwards for meiofauna
						3 syringes sediment analyses
						1 core from GKG for comparison sediment

Scientists of 5 institutes and universities benefited from the MUC samples. The fauna of the cores which were sliced and fixed in formalin will be sorted at the Senckenberg Research Institute in Wilhelmshaven. Meiofauna community investigations will be carried out by K. Guilini at the University of Gent (Nematoda) and G. Veit-Köhler and A. Henche at the Senckenberg Research Institute (Copepoda). The spooned cores serve for extraction of meiofauna at the home labs for biochemical analyses. Foraminifera have been collected from these cores by D. Fontaine (University of Geneva). Cores for oxygen measurements and C-flux determinations have been taken by E. Sauter and O. Sachs (Alfred Wegener Institute for Polar and Marine Research), while additional sediment analyses will be carried out by L. Würzberg (University of Hamburg) and K. Guilini (University of Gent).

Macrofauna

The Box corer

A 0.25 m² Sandia box corer was used for quantitative macrobenthos samples. It was deployed twice at each station without subcores. The area of 0.1 m² to be sampled for the macrofauna was determined either by pushing the subcores in on deck or by inserting a metal square with a surface of 33 x 33 cm and 10 cm depth. Sediments were washed through 0.3 mm sieves – in case of many stones through stacked 0.5 mm and 0.3 mm sieves after gentle swirling in buckets. The samples were fixed in 4 % buffered formalin and later transferred to 70 % ethanol. The box corer deployments were successful at five of six stations (Tab. 15.3).

Tab. 15.3: Box cores

Station	latitude	longitude	depth	sediment	penetration depth	sample size
PS71/13-11	52°2.206'S	0°0.950'W	2958	Very fine light brown diatomaceous ooze	30 cm	2 1-l jars
PS71/13-13	52°2.225'S	0°1.000'W	2960	same	same	2 1-l jars
PS71/17-9	70°4.933'S	3°21.949'W	1947	Very fine grey clay with sand and stones	30 cm	2 1-l jars
PS71/17-13	70°5.023'S	3°20.850'W	1966	same	same	2 1-l jars
PS71/33-11	62°0.513'S	2°59.646'W	5314	Very fine homo-geneous gray-brown mud	Overpenetrated, Failure	none
PS71/33-13	62°0.596'S	2°59.335'W	5312	same	ca 40 cm, not closed, failure	none
PS71/39-11	64°28.812'S	2°52.515'E	2118	Foraminiferous ooze, light brown	35 cm	2 1-l jars
PS71/39-13	64°28.844'S	2°52.548'E	2113	same	same	2 1-l jars
PS71/85-6	52°1.48'S	0°0.18'E	2951	See PS 71/13-11	20 cm	1 1-l jar
PS71/90-3	49°1.71'S	0°0.02'E	4008	Very fine light brown diatomaceous ooze	45 cm	1 1-l jar

The Epibenthic Sledge (EBS)

The epibenthic sledge (EBS) was successfully employed at five stations (Tab. 15.4). While the epibenthic sampler extends from 27 to 60 cm above the seafloor, the suprabenthic sampler (fixed on the top of the epibenthic box; Fig. 15.5) extends from 100 to 133 cm above the bottom. A plankton net is attached to each sampler, of 0.5 mm mesh size for the epinet and supranet and 0.3 mm for the cod ends. When the sledge touches the seafloor, a shovel fixed to the box door of the epibenthic sampler opens both boxes. The doors are closed mechanically when the sledge leaves the bottom.

After lowering with 0.5 m/sec. (ship stops until the EBS reaches the ground, then the ship speed compensates for the lowering in order to lay the wire straight in front of the gear on the ground) to 1.5 cable length to water depth, the sledge was hauled over the ground for 10 min at a mean velocity of 1 knot. Afterwards the ship stopped and holstering was done at –0.5 m/sec. until the EBS had left the ground, then it was holstered with –0.7/1 m/sec. until it reached the deck of *Polarstern*. The haul distances were calculated from the time the sledge travelled on the ground while heaving (0.5 m/sec.). The tension meter of the winch indicated when the gear left the ground. Haul lengths varied from 1,209 to 3,159 m; for the comparative analysis the data will be standardised to 1,000 m hauls, equivalent to a bottom area of 1,000 m² sampled by the sledge. In total, 9,537 m² of ocean bottom was sampled. On deck the complete half of the sample was immediately transferred into pre-cooled 96 % ethanol and kept at least for 48 hours in -20°C for DNA extraction, the other half sorted for biochemistry and selected key species were frozen at -80°C. The first extractions of DNA have already been done on board. Specimens were partly sorted on board or later in the laboratory in the Zoological Museum of the University of Hamburg.

Tab. 15.4: EBS stations, depth, calculated trawling distance, start and end position. (Abbreviations: SPF = South Polar Front; LS = Lazarev Sea; WS = Weddell Sea; MR = Maud Rise)

station	region	depth (m)	Trawl. Dist. (m)	long (start)	long (end)	lat (start)	lat (end)
PS 71/13-16	SPF	2996-3000	1875	0°01.12'W	0°01.14'W	52°01.97S	52°01.80'S
PS 71/17-11	LS	1736-2114	1209	03°21.50W	03°21.40W	70°04.82S	70°04.65S
PS 71/33-16	WS	5337-5338	3159	02°58.35W	02°58.74W	62°00.37S	62°00.42S
PS 71/39-17	MR	2147-2153	1389	02°52.68E	02°53.01E	64°28.76S	64°28.68S
PS 71/85-08	SPF	2986-3003	1905	0°00.21'W	0°00.04'W	52°01.55S	52°01.57'S

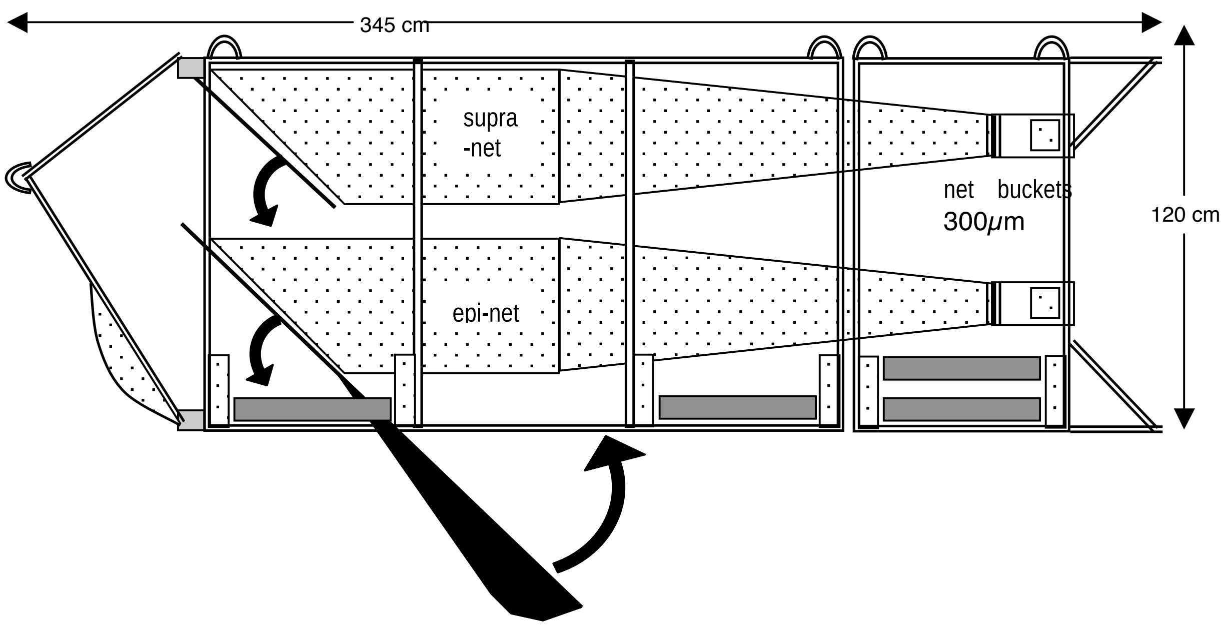

Fig. 15.5: Schematic illustration of the epibenthic sledge (Nils Brenke, University of Bochum)

Megafauna

The Agassiz Trawl (AGT)

Altogether, we employed the large Agassiz Trawl (AGT) 6 times during this expedition (Tab. 15.5); the trawls 1-5 were successful, but the AGT no. 6 failed to collect animals due to inverted nets under stormy conditions. The table below gives an overview of each of these localities as well as other relevant information concerning the AGT employments.

Tab. 15.5: AGT stations, RD-Ranschort-Dredge

AGT No./ Date:	AGT 1 6.12.07	AGT 2 22.12.07	AGT 3 30.12.07	AGT 4 4.01.08	AGT 5 12.01.08	AGT 6 29.01.08
Station no.	# 71/13-15	# 71/17-10	#71/33-14	71/39-16	71/48-1	71/90-4
Coordinates:	52°0` S, 0°0` W	70°0` S, 3,02`° W	61°0` S, 3°02` W	64°3` S, 2°05` E	70°2`S, 8°2` W	49° S, 0°0` W
Locality:	Southern Polar Front	Lazarev Sea	Central Weddell Sea	Maud Rise	Neumayer Northern Pear	Antarctic Polar Front
Depth:	3,000 m	2,180 m	5,335 m	2,150 m	600 m	4,000 m
Trawling distance calc.:	1,809 m	1,200 m	2,790 m	1,300 m	616 m	2,475 m
Inner net used:	yes	yes	yes	yes	no	yes
RD employed:	no	no	no	yes	yes	yes

The large AGT is 2.7 m in frame length, 3.6 m wide (corresponding to the width of the trawled track) and 1.2 m high; its total weight, without the net, is 500 kg. The AGT net has a mesh size of 10 mm, maximum diameter. For deep-sea stations, it has proven useful to employ a fine-meshed (500 μm) inner net to hold back the mud with many smaller animals (this inlet was an invention by Angelika Brandt, employed successfully for the first time during ANDEEP III). We used the inlet at all the SYSTCO stations, but not at the 600 m station, because the amounts of coarse material might have destroyed it. At 3 stations, the small Rauschert Dredge (RD) was employed, attached to the AGT. When employing the RD, it is very important that it is attached symmetrically by two lines to the AGT frame, because otherwise it may cause tilting, or turn over, during lowering of the AGT (as clearly seen at station #71/33-14, where we decided to pull back and remove the RD).

To prevent the trawl from tilting within the water column, or the net to fall in front of the frame entrance, the AGT must always be lowered against the current. Therefore the AGT is put into the water and lowered, while the ship is steaming against the current direction with a speed in knot of 2 x the winch velocity. Lowering is done at 1 m/sec., until the wire length equals the water depth, and then continues at 0.5 m/sec. In order to make the AGT sink down and reach the bottom, it is necessary to lay out wire corresponding to 1.5 x the water depth. The net is trawled on the bottom for 10 minutes and then retrieved at 0.5 m/sec. During the first period of heaving, while the “extra” wire is pulled back, the net is in fact still being trawled over the ocean floor. Only when the AGT leaves the bottom (which can be observed as a sudden increase of wire tension), the actual trawling time is over.

The Underwater-Camcorder

During the expedition an electronically modified digital Video Camcorder was used to document the sediment surface. The Underwater-Camcorder (Model: Nautilus Marine Service with Camcorder PANASONIC NV-GS400EG) was equipped with two 300 W spotlights (Deep-Sea Multi-SeaLife, P/N 710041601), and all parts were installed in a two meter high, pyramidal Lander-frame (DOCLT). Additionally two hundred kilograms of lead were attached to the frame to increase the weight. By using a Coax-Communication-Cable (Winch 31), the Underwater-Camcorder was powered up using a power supply unit to provide 450 - 450V with 1.1 - 1.4 A. The Underwater-Camcorder filmed, in a position 80 cm above the sediment surface, an area of approximately 85 x 45 cm². The film was saved on a 6.35 mm digital videotape, in 625 lines PAL, PCM-Digital-Take record system with 16 Bit (48 kHz/2 canal) audio quality. The tape recorded a time of 60 minutes.

The Lander-frame with the pressure chamber, including the underwater-camcorder, was lowered to the sea bottom, with at first 0.7 m/s and later at 1.0 m/s and held above the ground for three minutes, to allow a clear view of the sediment surface. After 3 minutes the Lander-frame was heaved up 10 m and followed the drift of the ship for two minutes. Then a new cycle was started, and the procedure was repeated for one hour. At this time the underwater-camcorder returned to surface.

During the expedition ANT-XXIV/2 five locations were sampled with the underwater-camcorder. Unfortunately, the first deployment (PS71/13-20) was not successful, due to a misinterpretation of the conductivity of the Coax-Communication-Cable. The last deployments (PS71/17-15, 33-17, 39-9, 48-2) were successful.

16. GEOCHEMICAL INVESTIGATIONS AT THE SEAFLOOR

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Objectives

Biological and physical processes in the surface ocean strongly control the air-sea carbon dioxide (CO_2) balance, as a key factor of the earth's climate system (Sarmiento & Le Quere, 1996). CO_2 fixation by phytoplankton via photosynthesis combined with the subsequent cycle of grazing, export to the deep, sedimentation, and remineralisation, often referred to as the "biological pump" (Sarmiento & Le Quere, 1996), represents one of the major CO_2 sinks. During this cruise these processes were investigated within the programmes SCACE and LAKRIS. In association with the ANT-XXI/4 cruise in 2004, the geochemical investigations were carried out within the DFG project DOMINO which is to be considered a module of SYSTCO linking the water column work to the benthic compartment, whose results are described in this section.

Putting the geochemical seafloor investigations into such multidisciplinary framework, the main objectives of DOMINO were:

- to characterize the geochemical milieu of the benthic environment and
- to determine organic carbon fluxes through the water/sediment interface.

The sediments of the oligotrophic Antarctic deep-sea as well as of the shelf are generally well oxygenated. Thus, the main focus is put on the determination of the porewater oxygen depth distribution, i.e., the measurement of oxygen micro profiles (as described in section 15, Lander Methods). Where possible (at stations with both lander and MUC deployment) *in-situ* and *ex-situ* profiles were measured in order to improve the correction function of Sachs *et al*. (submitted a) which permits revision of *ex-situ* measured fluxes to be corrected for pressure artefacts (temperature artefacts only play a minor role in polar regions).

Oxygen measurements are complemented by sediment investigations to obtain pigment and carbon concentrations as well as sediment porosity. In cooperation with the University of Hamburg, additional sedimentological parameters will be determined from multicorer samples.

Work at sea

Hydroacoustic seafloor survey

For about 30 - 60 minutes before reaching a SYSTCO station, the ship's HYDROSWEEP and PARASOUND systems were switched on, in order to obtain information about the seafloor topography and sediment stratification of the benthos station to be sampled. It was not intended to acquire hydroacoustic data for seismic, bathymetric or geological use. Instead, this hydroacoustic survey was performed to support the safe use and the identification of the appropriate location for the deployment of the benthos gear.

The data quality of the fish sounder Simrad EK60 (used for zooplankton observations, see section 4) was considerably disturbed by HYDROSWEEP and PARASOUND, which were therefore only switched on for minimal time periods.
Since high quality EK60 information was essential in particular during net operations, and those, dependent on a clear water column, preceded the benthos work at the SYSTCO stations, the hydroacoustic seafloor survey was performed during the EBS or AGT tows at the later stations.

Geochemical investigations

According to the description given in section 15, Lander Methods, lander deployments were prepared and carried out if ice conditions and sea state permitted. In addition, laboratory measurements were performed at multicorer samples. All sensors were calibrated prior to their deployment. Oxygen microprofiles were obtained as raw data sets from both *in-situ* and *ex-situ* measurements (*in-situ*: mV, *ex-situ*: pA values) and had to be translated to oxygen values via the following steps:

- Correction of sensor drift if necessary
- adjustment of sensor height relative to the water/sediment interface
- translation of raw signal into oxygen concentration on the basis of a two point calibration (bottom water oxygen concentration by Winkler titration, and sensor zero reading from oxygen-free water)

For the determination of organic carbon fluxes to the seafloor, at first the diffusive oxygen uptake was calculated from the porewater oxygen microgradient at the sediment surface using the software PROFILE of Berg *et al*. (1998). The oxygen uptake was then transferred to the amount of carbon aerobically respired using a modified Redfield ratio according to Anderson and Sarmiento (1994). Whereas the organic carbon flux reflects a "snapshot" of food supply at the time of measurement, oxygen penetration depth (OPD) changes much more slowly on a time scale of years, in particular in the oligotrophic deep Southern Ocean. Therefore OPD was determined as a long term measure of carbon supply to the seafloor. This was achieved by extrapolation of oxygen profiles using exponential functions and was at some stations supported by oxygen point measurements in deeper sediment strata sub-sampled from the boxcorer.

Beside the shape of the porewater oxygen depth distribution, which often reflects bioirrigation and bioturbation features, OPD is essential to characterize the oxic zone of the sediment as a habitat for benthic infauna.

In order to detect fresh material sedimentation on top of the sediment, oxygen profiles were analyzed for discontinuities and sediment samples were taken for subsequent pigment and C_{org} analysis. In the case of fluff material occurring on the sediment surface, this material (e.g. aggregates) was sampled separately and fixed in formalin (4 % formol).

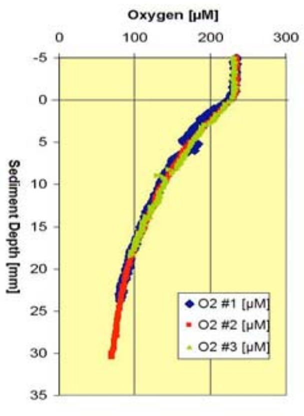
First results

The preliminary results are briefly introduced here moving from the south (close to the shelf-ice edge) towards the north (Polar Front).

Stations next to the shelf-ice edge

Station PS71/017 was the southernmost SYSTCO station close to the 3°W transect. Massive ice coverage prohibited the deployment of the free-falling lander. Investigations are based here solely on multicorer samples. As a contrasting sampling condition, the ice opened up to form a polynia at Station PS71/047. Here, the time of the echo sounder calibration was used to deploy the lander, whereas time constraints prohibited the deployment of corers. The measurements obtained from this station are to our knowledge the southernmost *in-situ* flux measurements worldwide.

Both stations are similar in water depth (1,927 and 1,843 m) and latitude (70° 4.86' S and 69° 40.40' S) but exhibit totally different carbon fluxes at the seafloor: Whereas the ice covered station showed very low fluxes around 2 mg C $m^{-2}d^{-1}$, fluxes measured in the polynia were found to be as four times as high (Fig. 16.1). OPD values corresponded well to this finding with three times higher oxygen penetration at Station PS71/017 compared to the polynia situation. This suggests that such conditions can be found repeatedly at these stations, i.e., that the polynia exhibits a typical high flux situation as found in the North East Water Polynia east of Greenland.



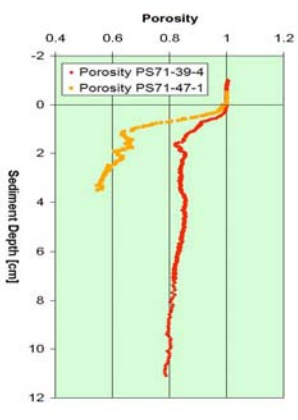


Fig. 16.1: Left: In-situ porewater oxygen profiles measured in a polynia at 69°40.40' S (Station PS71/047). Due to drop stones, microsensors broke after only a few centimetres penetration into the sediment. Right: Comparison of sediment porosity depth distribution as determined from the formation factor (via electrical resistivity of the sediment) for the Polynia and Maud Rise stations.

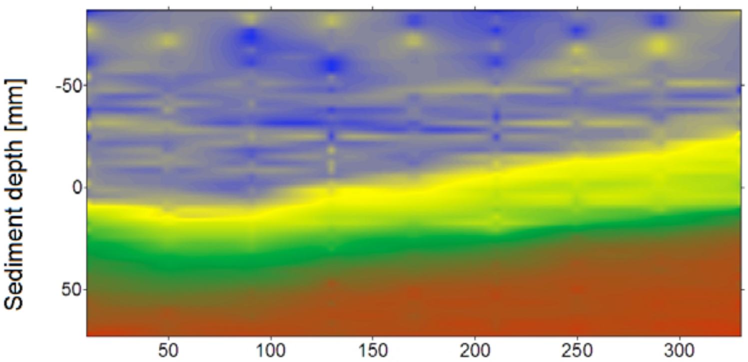
Deep Weddell Sea and Maud Rise

With moderate fluxes in the range of 3 mg C $m^{-2}d^{-1}$, the organic carbon input to the seafloor of the deep Weddell Sea (Station PS71/033) was found to be very similar to those of the Maud Rise plateau (Station PS71/039). The oxygen penetration depth estimated by profile extrapolation was almost 2 metres in the deep Weddell Sea, suggesting that the flux already reflects a spring or summer situation without rapid deep export of phytodetritus, as for example found at Station PS71/085 (see below). However, at Maud Rise sediments were also found to be oxygenated to a greater depth than expected, with an OPD value of over 50 cm. This might reflect the peculiar hydrography above this sea mount (see chapter 3 SCACE).

Repetition station at 52°S and Polar Front (49°S)

The first benthic location investigated on the way south was Station PS71/013 at 52°S. At the beginning of December, fluxes were found to be moderate to low. Fortunately it was possible to revisit this site end of January on the way back north, i.e., more than 7 weeks later. There has been to our knowledge no such previous revisit of a seafloor location in the Southern Ocean. What was suspected earlier could be proven during this cruise and could be considered a scientific highlight: at the repetition station PS71/085 fluxes were found to be elevated by a factor of 2 - 3 compared to the first visit. At both stations measurements were performed *in-situ* and are supported by additional laboratory measurements as well as by the observation of fluffy material on top of the sediment (St. PS71/085). Station PS71/013 the 3D profiler worked out well and measured 94 individual microprofiles on a target area of ~25 x 35 cm. One of the 2D porewater oxygen cross sections is shown in Fig. 16.2.

Just 10 hours prior to the repetition measurement at Station PS71/085, an *in-situ* measurement was carried out 12 nautical miles south of 52°S (Station PS71/084). At this site with comparable water depth (both stations ~3,000 m), fluxes were found to be approximately 20 % lower than at the 52°S repetition station. The somewhat lower flux as a short term signal corresponds well with a slightly deeper oxygenation of the sediment as a long term indicator for organic carbon supply. Experience shows that gradients are steep at the Front System of the ACC. Thus, we interpret this finding as an indication, that south of the Polar Front fluxes decrease towards the deep Weddell Sea as primary production exhibits smaller extrema during the blooming season. This was at the first glance contradicted by the finding at 49°S ("Polar Front", Station PS71/090) where a relatively low flux was determined. However, satellite chlorophyll a information confirms that this particular spot was characterized by lower surface production compared to other areas of the Polar Front. The correlation of surface production patterns with organic carbon fluxes to the seafloor is to be further investigated. However, the statistical approach to match these parameters in order to assess benthic fluxes from remote sensing (Sachs *et al.*, submitted b) seems to be supported by this observation.



Distance Y [mm]

Fig. 16.2: 2D porewater oxygen cross section measured in-situ at Station PS71/013. Oxygen concentration decreases according to colour transition from blue-yellow-green-red whereas the border blue-yellow indicated the sediment-water interface.

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17. MICROBIAL COMMUNITIES WITHIN DEEP ANTARCTIC SEDIMENTS

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Scientific background and objectives

In a previous study, carried out using samples from the ANDEEP 3 expedition, 16S ribosomal DNA clone library analysis was performed to assess archaeal diversity within three surficial sediment samples obtained from the bathypelagic zone (depth : 2,165 -3,406 m) of the Weddell Sea,. The nearly complete 16S rDNA gene (1,440 bp) was obtained for 146 clones; 46 phylotypes were defined. The majority of the sequences (> 99 %) formed three clusters within the Marine Group I Crenarchaeota. The most important cluster, with 78.8 % of the clones, included Candidatus Nitrosopumilus maritimus, a mesophilic archaeon able to oxidize ammonia. The most important subgroup in that cluster was the APA4-0cm subgroup (with 62.3 % of the clones). This subgroup might represent important Crenarchaeota in the functioning of the bathypelagic sedimentary ecosystems of the Weddell Sea because it dominated the clone libraries in all sampling stations, and was found in sediments separated by very large geographic distances. Only one clone grouped within the Euryarchaeota. This euryarchaeal clone could not be affiliated with any of the previously defined clusters and might represent a novel Euryarchaeal lineage.

The objective of this part of the project is to further the description of Archaeal diversity in the deep Antarctic sediments, using the same techniques, and same collaborations.

Work at sea

Sediments for bacterial analyses were sampled during box corer (GKG) operations, at 6 stations. Subcores (top 8 cm) of the sample were taken using 50 ml sterile plastic syringes. Subcores were taken away from the borders of the untouched core, in obviously undisturbed areas. Samples were processed immediately in the dry laboratory on *Polarstern*, using all precautions to avoid bacteriological contamination. Cryotubes were filled with sediment of the subcores and deep-frozen in liquid N_2 (-196°C) until the end of the cruise, when samples were transferred to the cold storage room (-30°C) for preservation.

Preliminary results

5 samples of each subcore were collected at six different benthic stations of the cruise (PS 71/13, PS 71/17, PS 71/33, PS 71/39, PS 71/85 and PS 71/90), bringing a total of 30 samples.

18. PROTISTS - BENTHIC FORAMINIFERA OF THE DEEP SOUTHERN OCEAN: DIVERSITY AND BIOGEOGRAPHY

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Objectives

Foraminifera are a significant and often visually conspicuous component of the deep-sea and high-latitude benthic fauna. In addition to the geologically important and well-known calcareous foraminifera, deep-sea and high-latitude assemblages include substantial numbers of soft-shelled, mostly single-chambered species, most of which are undescribed. These organisms include the organic-walled allogromiids, finely agglutinated saccamminids and the large, delicately agglutinated komokiaceans, of which the phylogenetic origin remains a mystery and deserves further studies.

Literature records, combined with our own studies on Antarctic fauna, suggest that many foraminiferal morphospecies have wide geographical ranges in the deep sea. However, it is not certain whether all of these morphospecies constitute single taxonomic entities at the molecular level, over their entire geographical ranges. Furthermore, the hypothesis of genetic variation rates being lower within deep-species than the shallow ones has to be investigated.

Finally, sampling of phytodedritus, mudballs, or komoki specimens will be used to analyze whether they could represent hotspots of deep-sea micro-diversity, as previous observations seem to indicate.

Living benthic foraminiferans were collected from 52°S latitude of the Greenwich meridian (South Polar Front), Lazarev Sea, Weddell Sea, Maud Rise and Atka Bay, in depths from 600 to 5,000 meters.

The species collected during this expedition will be compared with similar morphospecies collected from Antarctica during previous sampling campaigns (Weddell Sea and McMurdo Sound). The comparison will combine molecular analyses of ribosomal RNA gene sequences with conventional morphology-based species descriptions to determine whether or not genetic divergence has occurred between widely separated populations of the same morphospecies. The description of some of the many new species collected during this expedition is also an important objective, which will improve our knowledge of benthic foraminiferal and gromiid biodiversity.

Methods

The foraminifera were isolated from surface sediment samples (0 - 5 cm) collected by multicorer (3 cores), boxcorer (20x10cm) and additionally sediment collected by different trawls deployed during this cruise, the Agassiz Trawl, the Epibenthic Sledge and the Rauschert Dredge.

The sediment was sieved on 1-mm, 0.5-mm, and 0.1-mm meshes and stored at -2°C. Specimens of living foraminifera were then isolated under a dissecting microscope. The isolated foraminifera were identified, photographed with a digital camera and either immediately processed for DNA extraction, frozen in -80°C freezer, dried or fixed in 98° ethanol. The fixed material will form the basis of the morphological part of our study.

Additionally, at each site, samples of total sediment were collect and immediately frozen at -80°C. These samples will be used for total environmental DNA analyses.

Preliminary Results

During the course of the expedition, a total of 7 stations was sampled, yielding 699 DNA extracts, 958 frozen specimen samples, 93 samples of frozen sediment for total environmental DNA analysis, 1339 dried test and 6 preserved specimens in ethanol (Table 18.1, 18.2).

A total of 99 morphospecies was identified, in addition to a number of unidentified, mostly single-chambered (monothalamous) species.

The number of specimens sampled, isolated, extracted, dried and fixed has far exceeded initial expectations of this sampling campaign and will guarantee a successful comparison of this material with previously sampled Antarctic specimens. In addition, the samples will advance our knowledge of monothalamous Foraminifera through new species descriptions and finally provide the basic data that will enable us to carry out further studies focussing on a better understanding of the origin and evolution of the komokiaceans.

Tab. 18.1: summary of work carried out during ANT-XXIV/2
(n/a = data unavailable at the time of writing)

Stations	52°2 S / 0°1 W	70°35 S / 9°2 W	70°5 S / 3°21 W	62° S / 2°59 W	64°28 S / 2°52 W	70°23 S / 8°18 W	52°2 S / 0°1 W
Dates	06.12.2007	17.12.2007	22.12.2007	30.12.2007	03.01.2008	12.01.2008	28.01.2008
Species	47	27	54	40	45	31	n/a
DNA Extracts	84	15	119	186	209	86	n/a
Frozen Specimen Samples	166	79	404	312	95	76	n/a
Preserved Speci-mens	128	45	428	202	391	145	n/a
Frozen Sediment	35	0	30	36	14	0	n/a

Table 18.2: species sampled during ANT XXIV/2 for both molecular and morphological investigation. Species identifications are subject to changes after further examination in the home laboratory.
E = extracted DNA / F = frozen sample / D = dried specimen

Stations	**52°2 S / 0°1 W**	**70°35 S / 9°2 W**	**70°5 S / 3°21 W**	**62° S / 2°59 W**	**64°28 S / 2°52 W**	**70°23 S / 8°18 W**
Amas de Globigerina	F				E	
Ammobaculites sp.			D	D		
Ammolagena clavata	F, D	E	F	E		
Bathyallogromia weddellensis-like	E, F		E, F	E, F		
Bathysiphon argenteus			F	E, F		
Bathysiphon flavidus				E		
Bulimina aculeata	D		E, D		D	
Cassidulinoides porrectus	D					
Cibicides lobatulus			D			E, D
Cibicides refulgens						E, D
Cibicides sp.	D	D	D	D		D
Cibicides sp. (dispars?)	D					D
Cibicides variabilis			D		E, D	E
Cibicides wuellestorfi	E, D		E, D			
Clavulina communis			D		E, D	
Cornuspiroides foliaceus					D	
Cornuspira involens			D			
Cribrostomoides scitulus			D	E, D		
Cribrostomoides sp. (?)	D				E, D	D
Cribrostomoides sp. t.2	D			D	E, D	
Cribrostomoides sp. t.3	D		D	D	E, D	
Cribrostomoides sp. t.4					E	
Crithionina hispida	F			F		
Cyclammina cancellata					E, D	
Cyclogira involvens					D	D
Dendrophira sp. (arborescens?)	F					
Epistominella exigua	D		E, D			
Fissurina sp.	D		D			D
Globigerina sp.	E, D		E, D		E, D	D
Globocassidulina biora		D				
Globocassidulina sp.						
Gromia sp.			F		F	F
Hippocrepinella sp.	F	F		E		
Hormosina globulifera			E, F	E, D		
Hormosina normani						
Hormosina sp. (?)						E, D
Hyperammina elongata				E		
Hyperammina sp. ou Rhabdammina sp.	E, F		E			E
Hyperammina subnodosa		E	E		E	
Jaculella sp.	F					
Keramosphaera				E, D		
Komokiaceans		F	F	F	F	F
Lagena sp. (gracillima?)	F		D		D	

Continuation: Table 18.2: species sampled during ANT XXIV/2 for both molecular and morphological investigation. Species identifications are subject to changes after further examination in the home laboratory.

E = extracted DNA / F = frozen sample / D = dried specimen

Stations	52°2 S / 0°1 W	70°35 S / 9°2 W	70°5 S / 3°21 W	62° S / 2°59 W	64°28 S / 2°52 W	70°23 S / 8°18 W
Lagena laevis			D		D	
Lagena sp.					D	D
Lagenammina sp.	F, D		E, F, D	E	E	
Lenticula gibba			D		D	
Marginulina obesa			D		D	
Miliolinella subrotunda				E, D	D	
Nemogullmia sp.	F		F	E, F	F	F
Nonion sp.			D			
Nothrabdammina sp.		F	F, D			
Oolina sp.	D					
Oridorsalis umbonatus	E, D	D				
Pelosina sp.		E				
Phytodetritus	F		F	F	F	
Psammosphaera sp.		E, F	E, F	E	E	D
Psammosphaera sp. t.2		E, F				E
Psammosphaera sp. t.3						E, D
Psammosphaera sp. t.4						
Pseudowebbinella geesi	F			E	E	E
Pullenia bulloides	D					
Pullenia subcarinata	D					
Pyrgo sp.			D		E, D	D
Pyrgo sp. (murrhyna?)	D		D		E, D	
Pyrgo sp. (williamsoni?)	D	D				
Recurvoides sp. (?)						
Recurvoides sp. t.1 (?)			D			
Recurvoides sp. t.2 (?)			D			
Reophax cylindricus	E					
Reophax distans			E, D			
Reophax gutifer (?)				E		
Reophax hoeglundi	E	E, F	E, D			E, D
Reophax nodulosus	D	E	E, D	E, D	E, D	
Reophax nodulosus t.1			E			
Reophax nodulosus t.2	E		E			
Reophax oviculus	E		E			
Reophax pilulifer				E		
Reophax distans						
Reophax sp. (?)		D	E	E	E, D	
Reophax sp. (spiculifxr?)		F				
Rhabdammina cornuta		F				
Rhabdammina ou Rhizammina	F					
				D		

Continuation: Table 18.2: species sampled during ANT XXIV/2 for both molecular and morphological investigation. Species identifications are subject to changes after further examination in the home laboratory.

E = extracted DNA / F = frozen sample / D = dried specimen

Stations	**52°2 S / 0°1 W**	**70°35 S / 9°2 W**	**70°5 S / 3°21 W**	**62° S / 2°59 W**	**64°28 S / 2°52 W**	**70°23 S / 8°18 W**
Rhabdammina sp. (linearis?)	E	F, D	D			
Rhizammina sp. (algaeformis?)	F			D	E	
Saccammina sp.		E				
Saccammina sphaerica						
Saccorhiza ramosa	F					
Silver saccamid		E	F	E, F	F	
Textularia porrecta			E, D			D
Tholosina sp.		F	E, F			
Trifarina earlandii			D			
Triloculina tricarinata					D	
Trochammina sp.	D		D			
Undet				F		
Undet allogromid	E		F	E	E, F	E
Undet crithionid		F				
Undet milioliid			D	D	F, D	D
Undet rotalid	D			D		
Undet textulariid	D		E, D	E, D		D
Vaginulina sp.			D		D	
Vaginulinopsis sublegumes					D	
Vanhoeffenella sp.			F		F	E, F
Virgulina sp.			D		D	D
Webbinella sp.	E		F			

19. METAZOAN MEIOFAUNA - THE LINK BETWEEN STRUCTURAL AND FUNCTIONAL BIODIVERSITY OF THE MEIOFAUNA COMMUNITIES IN THE ANTARCTIC DEEP SEA

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Objectives

Meiofauna can significantly contribute to the regulation of benthic turnover and serve as food for secondary consumers. The role of meiofauna in the deep Antarctic ocean as trophic link between sedimented organic matter and higher level consumers is a question that will be investigated in this study. The contribution of the meiofauna to the C-flow through benthic deep-sea sediments has to be addressed in relation to their biodiversity. In order to unravel the link between meiofaunal biodiversity and function, it is essential to reveal the interactions in the benthic food web and the trophic position of different meiofauna taxa and functional groups at locations with contrasting food supply. Many studies have illustrated the high biodiversity of small benthic taxa in the deep sea. However it remains unclear what drives this high local biodiversity. For many systems, a relation with productivity of the system has been hypothesized but correlation with water depth and other associated environmental factors often hampers unravelling the link between biodiversity and food input. At the Southern Polar Front, strong water mass and primary productivity gradients exist. A repeated sampling on the front and sampling southwards would allow an estimate of the variation in local biodiversity in relation to changing productivity levels.

Biomarkers such as stable isotopes and fatty acids can be traced throughout food webs and thus are suitable for the understanding of trophic positions and food resource selectivity of marine species. Detailed analyses of fatty acid, fatty alcohol and wax ester compositions can elucidate similarities between taxa and reveal indications of feeding behaviour and food sources. The advantage of applying lipid compositions to feeding studies is that trophic lipid markers integrate longer time periods than conventional methods. Feeding experiments verified the concept of trophic marker lipids, using algae and copepods of known lipid composition. But generally, benthic species have relatively low lipid contents as compared to herbivorous zooplankton species and do not rely on depot lipids in the same way. Often fatty acids of the available food sources dominate the fatty acid composition of the species, masking potentially taxon-specific patterns and emphasising the intensity of the pelago-benthic coupling. Therefore stable isotope ratios $\delta^{13}C$ and $\delta^{15}N$

have to be used as an additional tool which can contribute to the determination of food sources and selectivity in meiofauna organisms, even at species level.

This and the linking to total meiofaunal standing stocks in the Antarctic deep-sea sediments, which are highly dependent on the degree of organic matter input and consequently the surface primary production, will be a crucial contribution to the generalised energy-flux model and food web study - a common objective of the ANDEEP-SYSTCO cruise.

Work at sea

Samples were taken with the multiple corer (MUC). From every MUC deployment 1 to 3 sediment cores were sliced down to 20 cm (0 - 1 cm, 1 - 2 cm, 2 - 3 cm, 3 - 4 cm, 4 - 5 cm, 5 - 7 cm, 7 - 10 cm, 10 - 15 cm, 15 - 20 cm). The sediment slices were preserved in 4 % buffered formaldehyde/seawater solution and stored for meiofauna community analysis. Our sampling method enables us not only to compare different regions but also to study the vertical distribution profile of the meiobenthos in the sediment. From one core per deployment, syringe subsamples were taken for granulometry, organic carbon and pigment analyses. The organic carbon and pigment samples were stored at -30°C. Furthermore a minimum of 4 cores per deployment were used to scoop off the upper 5 cm of sediment. This material was immediately sieved in the lab with filtered seawater over stacked sieves (1 mm, 500 μm, 100 μm and 32 μm). We retained the 500 μm, 100 μm and 32 μm fractions and stored them at -80°C. Back at the laboratory, the nematodes and copepods will be extracted for biochemical analyses (fatty acids and stable isotopes).

Preliminary results

During the course of the expedition a total of 6 deep-sea stations was sampled, yielding 25 cores which were sliced for meiofaunal community analysis, 24 samples for biochemical analysis and 12 x 3 subsamples for additonal granulometry, organic carbon and pigment analysis.

Back at the laboratory, the nematodes and copepods from the formalin fixed samples will be extracted from the sediment, identified and counted for analyzing the communities and diversity at the different locations. Stable isotope and fatty acid analyses will be performed on the nematodes and copepods picked out from the frozen samples and identified to the lowest taxonomic level possible, in order to identify the relative importance of the different food sources and the potential selectivity. Nevertheless, very high numbers of these animals are necessary for these analyses.

Co-operation with Laura Würzberg (University of Hamburg) as well as Eberhard Sauter and Oliver Sachs (Alfred Wegener Institute for Polar and Marine Research) will ensure linking of our data to sediment parameters and oxygen profiles.

20. AN EXPERIMENTAL APPROACH TO THE MEIOBENTHIC FOOD-WEB STUDY IN THE SOUTHERN OCEAN DEEP SEA: WHAT IS THE MICROBIAL CARBON CONTRIBUTION TO THE DIET OF NEMATODA?

Katja Guilini, Ann Vanreusel (not on board) | Gent University, Gent, Belgium

Objectives

In addition to the analyses on the meiofauna community and the biochemical background values, an experiment was planned in which the trophodynamic and functional aspects of the dominant metazoan benthos taxon, the Nematoda, were the main focus. Owing to their ubiquitous presence, nematodes are assumed to play an important role in the benthic food web. However, little is known on their trophic status and functioning in deep-sea sediments. Although previous studies showed that the nematode standing stock in deep-sea sediments is closely linked to the degree of organic matter input and consequently the surface primary production, their response to seasonally varying deposition of phytodetritus seems often delayed in time. Instead of an increase in densities at the surface of the sediments, there also seem to be subsurface maxima in densities. Although limited to date, evidence for a microbial related feeding activity rather than using fresh phytodetritus as food source is growing. In order to test the uptake rate and potential preference for microbial related food sources an *ex-situ* enrichment experiment with several ^{13}C labeled substrates was performed. Back at the laboratory, these results together with the natural biomarker analysis (stable isotopes and fatty acids) of selected taxa will unravel an integrated view on of the degree of selectivity and food preferences of nematodes for particular components of the deep-sea ecosystem.

Work at sea

Methods

At the approximately 2,120 m deep Maud Rise station, 20 sediment cores were gathered during 3 MUC deployments for the *ex-situ* experiment. The 100-mm diameter cores were subsampled on deck with 67-mm diameter cores, incubated in a cold room at *in-situ* temperature (0.5°C) and oxygenated. Shortly after, ^{13}C labelled substrates were injected in the upper 5 cm of the sediment. There were four treatments (acetate, bicarbonate, glucose and bacteria grown on degrading diatoms) and one control which was sampled according to a time series (day 2, day 4, day 8 and day 12). The control samples were checked for living nematodes and preserved in 4 % buffered formaldehyde, while the treatment samples for biochemical analysis were stored at -20°C. Additionally, DNA extractions of the bacterial communities in the sediment were performed. This was done for the different treatments at several sampling days from the time series. Due to a collaboration with Eberhard Sauter and Oliver Sachs (AWI) established during the campaign, oxygen profiles could be measured in several cores over the time series.

Preliminary results

The experiment was completed on day 12. At each time step living nematodes were found in the control samples, however, not quantified. The oxygen profiles measured in the samples over the time series indicate different ongoing processes in the upper layers of the sediment according to the treatment. However we will only be able to interpret these profiles after we have performed the biochemical and DNA analyses back in the laboratory. The experimental results will enable us to quantify the uptake and incorporation of microbial carbon by nematodes.

21. MACROFAUNA – BIODIVERSITY, ECOLOGY AND ZOOGEOGRAPHY OF PERACARID CRUSTACEANS AND POLYCHAETA

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[3)] Ruhr Universität Bochum, Germany

Objectives

During SYSTCO, the biodiversity and ecology including feeding biology of peracarid crustaceans (with focus on the Isopoda), and polychaetes were investigated using an epibenthic sledge. The results will be compared with data from the ANDEEP expeditions. Quantitative and qualitative samples were taken at five stations between 1,736 and 5,338 m in different water masses and environments with different topographical and sedimentary conditions. These catches covered a trawled area of 9,537 m². For further details please see benthic work - introduction to work at sea.

Very little is known about the ecology and role of deep-sea fauna in the trophodynamic coupling and nutrient cycling in oceanic ecosystems. This project examines the trophic structure and functioning of the abyssal macrobenthic community of the Southern Atlantic Ocean, focusing specifically on the role of the Isopoda and Polychaeta including

1) general feeding biology,
2) bentho-pelagic coupling,
3) the reproduction of abundant species, and
4) population genetics of selected abundant species.

Epibenthic sledge samples from three previous *Polarstern* expeditions (ANDEEP I-III) and new epibenthic sledge and sediment core samples taken during this expedition will be analysed. A variety of methods will be used including gut content analysis, functional morphology of target species as well as biochemical measurements. The latter include analyses of lipid classes, fatty acid biomarkers, and examination of stable isotopic signatures of epifaunal animals and surrounding sediments.

The results will be compared and combined with the findings of research groups examining other aspects of the Southern Ocean foodweb and biogeochemistry of the sediment. Combining the comprehensive datasets concerning diversity and colonisation patterns available from ANDEEP I-III and this study focusing on foodweb dynamics allows us, for the first time, to better understand the trophodynamic role of deep-sea fauna in the ecology of the South Atlantic and Southern Ocean.

The high diversity of the Southern Ocean Isopoda was shown by Brandt *et al*. (2007). To this constraint, the difficulty of obtaining DNA-friendly samples from the deep sea has to be added. Our results from previous expeditions show that DNA quality strongly depends on the fixation method used and a stable cooling chain while taking deep-sea samples. Successful genetic work with isopods can only be performed with fresh material, sorted and extracted on board. To develop the most efficient analytical procedures, we want to improve DNA quality. Thus, we started a series of experiments as an approach for DNA quality improvement. High quality DNA is important to gain clear genetic signals (sequences) for phylogenetic studies.

Parallel to the aim to elucidate the phylogeny of different asellote isopod families (e.g. Desmosomatidae Sars, 1897; Macrostylidae Hansen, 1916), we are attempting DNA barcoding on deep-sea isopods for the first time. The barcoding approach in collaboration with the *Canadian Centre of DNA Barcoding* (CCDB) contributes to the SYSTCO objectives in using barcoding alongside traditional taxonomic methods to investigate key species and their role in the benthos of the Southern Ocean.

DNA barcoding is a standardized approach to identifying species by comparing small sequences of DNA. Target sequence is CO I. The early goals of DNA barcoding focus on the assembly of reference libraries of barcode sequences for known species. Working with deep-sea material, our research focuses on unknown or undescribed species. Molecular barcoding can hint at the existence of new taxa, but cannot replace their formal description. Our aims are to link morphological descriptions with barcodes and to establish a storage of the voucher specimens together with the DNA samples.

Work at sea

We started our analyses with the ethanol fixed samples from the ANDEEP I-III expeditions and determined abundant abyssal species as background information for the cruise. We also did first analyses of the mouthparts and foregut (including the gut contents) and some morphometric measurements on isopods in the laboratory before we started with the expedition, in order to obtain some ideas on the general feeding biology of abundant species (e.g. suspension feeders, deposit feeders, scavengers, predators, etc.). On board we started with gut content analyses of bigger organisms like fish and holothurians to check which of the species found fed on crustaceans or more specifically on isopods.

During this expedition (ANT-XXIV/2) we sampled at 6 of 7 planned stations for SYSTCO in total. Two stations were incomplete. The first station we took on our way south from Cape Town was revisited seven weeks later on our way back to Cape Town (see Fig. 15.1). This station at 52°S was the only station revisited, contrary to our original intention to revisit two stations. Five of the six stations included epibenthic sledge samples, which will serve as a basis for the above-described biochemical and gut content analysis.

Half of the epibenthic sledge material was immediately fixed in precooled 96 % ethanol and stored at least for 48 hours at –20°C, later at 0° C. Sorting was started after 48 hours on board and sorted samples were stored in the cooling chamber. During the cruise as much as possible was sorted on ice and kept cool. For DNA extraction QIAGEN Kits with slightly modified protocols were used. Alongside the QIAGEN extraction, we prepared “barcoding racks” (each yielding 96 tubes) from the CCDB (4 racks) and the Smithsonian Institution (1 rack) for automatic extraction and sequencing, which are stored at -20°C until they arrive at the laboratory. Each isopod specimen used had voucher status, a digital picture and an individual number. The other half of the sample was used for biochemistry.

Selected specimens from epibenthic sledge (EBS) samples were frozen at –80°C for later biochemical analysis. From all specimens, voucher pictures were taken. From the isopods not used for the biochemical treatment, up to three appendages were dissected before freezing for extraction of DNA on board and later genetic analysis.

For biochemical analyses, a total of 750 specimens of different taxa were picked from various benthic gears (EBS, benthic trawl, Rauschert Dredge, Box corer) and frozen at -80°C (Table 21.1). The characterisation of lipid reserves will provide a useful tool in the interpretation of ecological niches and can help to identify different feeding strategies as well as the organism’s energy status. Fatty acid signatures will be used to infer trophic levels and spatial and temporal differences in diets, both within and among species. Furthermore, measurement of stable isotopes ^{15}N und ^{13}C will help to identify the trophic position of target species within the food web.

Tab. 21.1: Number of specimens per taxon taken for biochemical analyses

Polychaeta	188
Bivalvia	99
Amphipoda	98
Isopoda	93
Pisces	56
Holothuroidea	40
others	39
Cumacea	37
Decapoda	29
Copepoda	16
Pycnogonida	15
Solenogastres	12
Tanaidacea	7
Ostracoda	7
Gastropoda	7
Sipunculida	2
Nemertina	2
Cephalopoda	2
Polyplacophora	2

From the MUC, a total of 12 sediment cores was taken for further investigation of several biochemical parameters in cooperation with Prof. Michaelis (Geobiochemistry, University of Hamburg). These data will be compared with findings of different properties of the water column obtained by other groups participating in this cruise. Additionally, bottom water was filtrated at each benthic station and will also be analysed for biochemical characteristics.

Preliminary results and discussion

All macrobenthic taxa were sorted from the EBS and counted at higher taxon level (see Fig. 21.1 as an example of three stations). Crustacea and Polychaeta were worked up to order or family level, briefly outlined as follows.

Numbers of individuals per peracarid taxa from SYSTCO stations are summarised in Table 21.2 (raw data). Isopoda are the most abundant taxon at all stations sampled with the epibenthic sledge. Station 33 - 16 yielded only a very small amount of specimens and was treated as a failure here, station 85 - 05 (the station being revisited) has not been worked up on board for reasons of time constraints. The abundance values fall into the range reported from previous Southern Ocean deep-sea expeditions (Brandt et al. 2004, 2007a; Brökeland et al. 2007).

Tab. 21.2: Peracarid individuals sorted from ANDEEP III stations taken with the EBS (+ = sample will be sorted and analysed in Hamburg)

stations	depth	Isopoda	Amphipoda	Cumacea	Tanaidacea	Mysidacea
13-16	3000	60	16	9	18	8
17-11	2114	153	126	63	31	7
33-16	5338	- failure	- failure	- failure	- failure	- failure
39-17	2153	71	24	6	19	17
85-05	3002	+	+	+	+	+

If the general composition of taxa is addressed, numbers of specimens/1,000 m increase from station 13 to 17 and 39 (Fig. 21.1). Peracarid taxa comprised about 20 % of the first two stations, while at station 39 at Maud Rise these represented only a minor fraction of the sample, as most of the organisms belonged to the Bivalvia (55 %). Interestingly, also most of the animals being sampled with the epibenthic sledge at Maud Rise are species with free spawning larvae, while very few are brooders, which have a reduced gene flow and therefore can not easily reach an isolated seamount like Maud Rise. Maud Rise generally differs completely in taxon composition from the abyssal stations, perhaps due to the unique physical oceanographic characteristics including the Taylor column causing localised entrainment of larvae.

Isopoda comprised 46 % of all peracarid taxa sampled with the EBS, followed by Amphipoda (26 %), Cumacea (12 %), Tanaidacea (11 %) and Mysidacea (5 %) (Fig. 21.2). These differences in abundance are also documented in Fig. 21.3, which demonstrates that Isopoda, Amphipoda and Cumacea occurr most frequently at station 17, the southernmost station at about 2,100 m depth in the Lazarev Sea. Fig. 21.4 illustrates the differences of Peracarid taxa per station and documents that only at station 17 on the lower slope closer to the continent, Amphipoda are about as frequent as Isopoda. This is not astonishing, as this taxon thrives on the continental shelf. However, with increasing depth, Isopoda become more important and our samples support this general hypothesis.

With regard to isopod family composition, the Desmosomatidae were more important than Munnopsidae followed by Haploniscidae. During the recent ANDEEP expeditions Munnopsididae were the most frequent Isopoda sampled in the deep Southern Ocean (Malyutina & Brandt 2007).

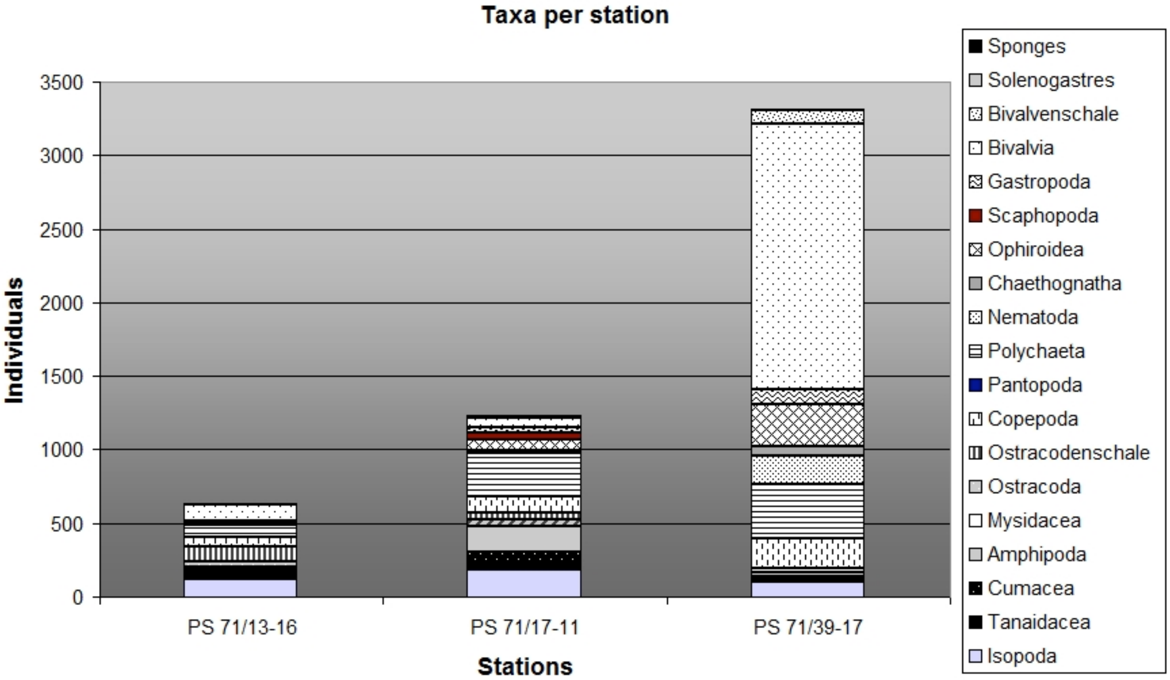

Fig. 21.1: Macrobenthic composition at three SYSTCO stations

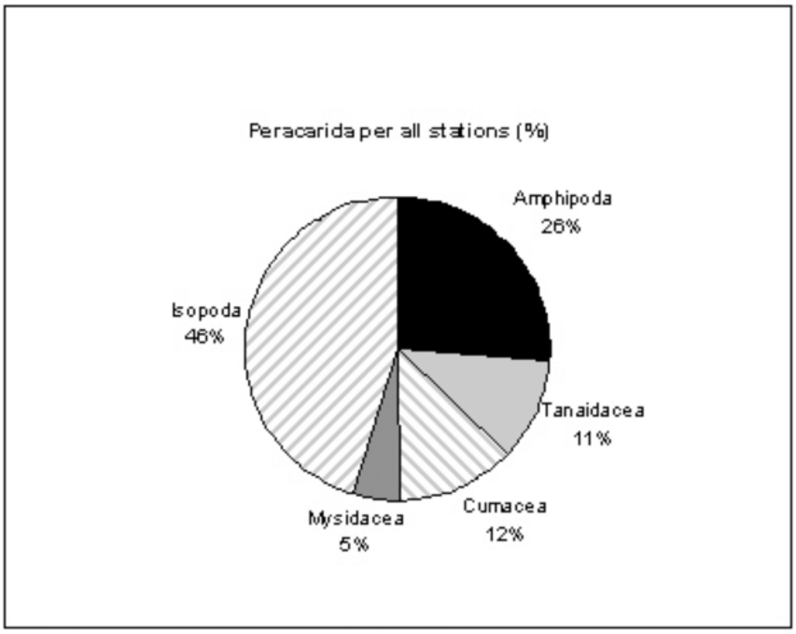

Fig. 21.2: Peracarid composition at all analysed SYSTCO stations

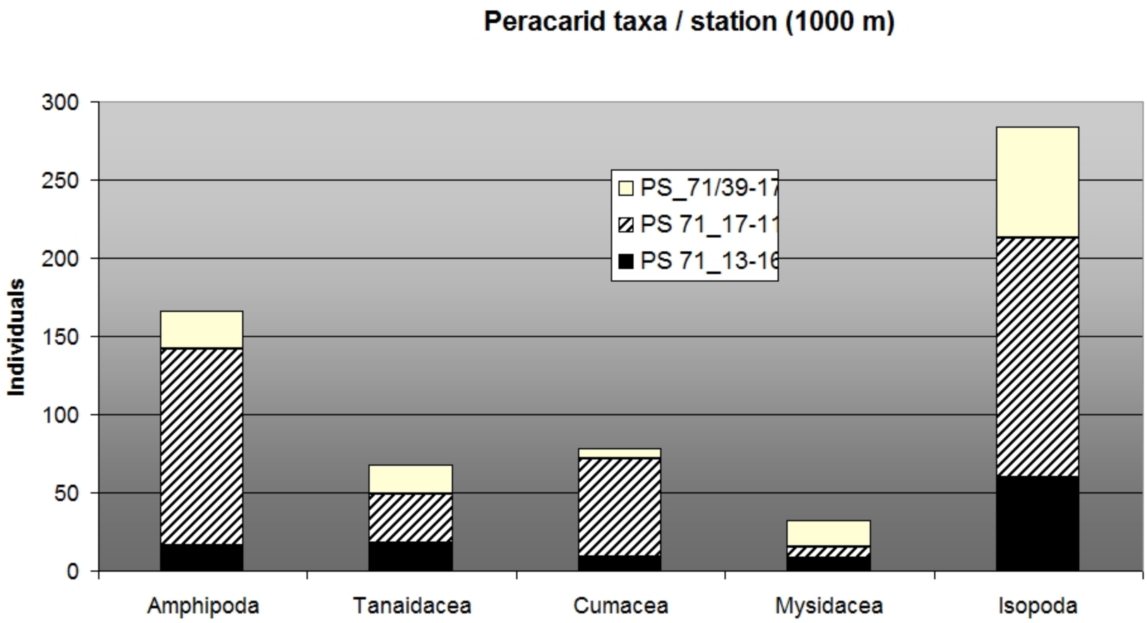

Fig. 21.3: Taxa of Peracarida distributed at three SYSTCO stations sorted (normalised to 1,000 m hauls)

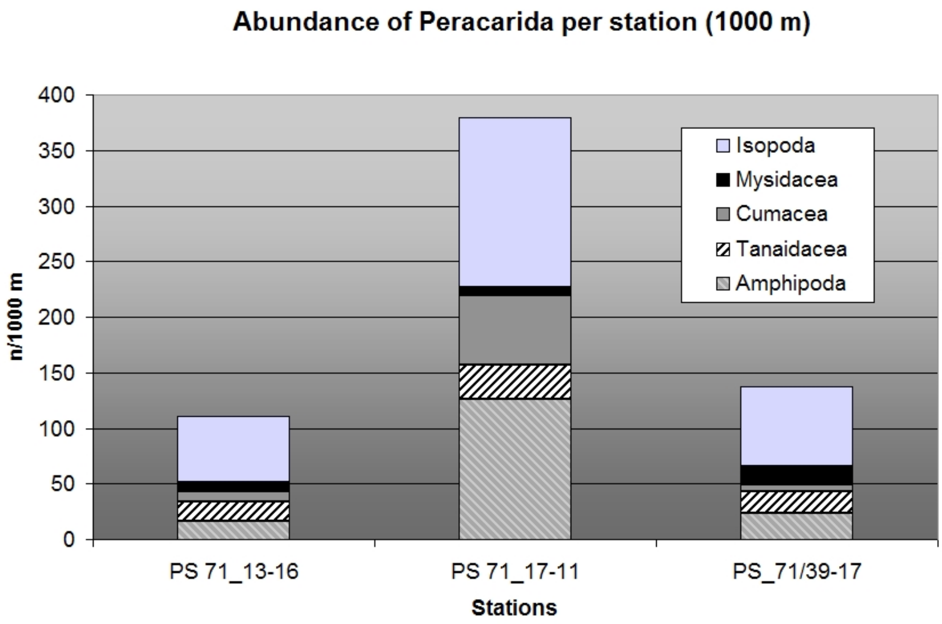

Fig. 21.4: Peracarid taxa per station (normalised to 1,000 m hauls)

During ANT-XXIV/2 we collected data for over 540 isopod specimens (Fig. 21.5) belonging to 15 isopod families. The deep stations below 2,000 m depth (PS 71/13-15 and 16; PS 71/17-10 and 11, PS 71/39-16 and 17) yielded approximately 50 species in eight asellote families.

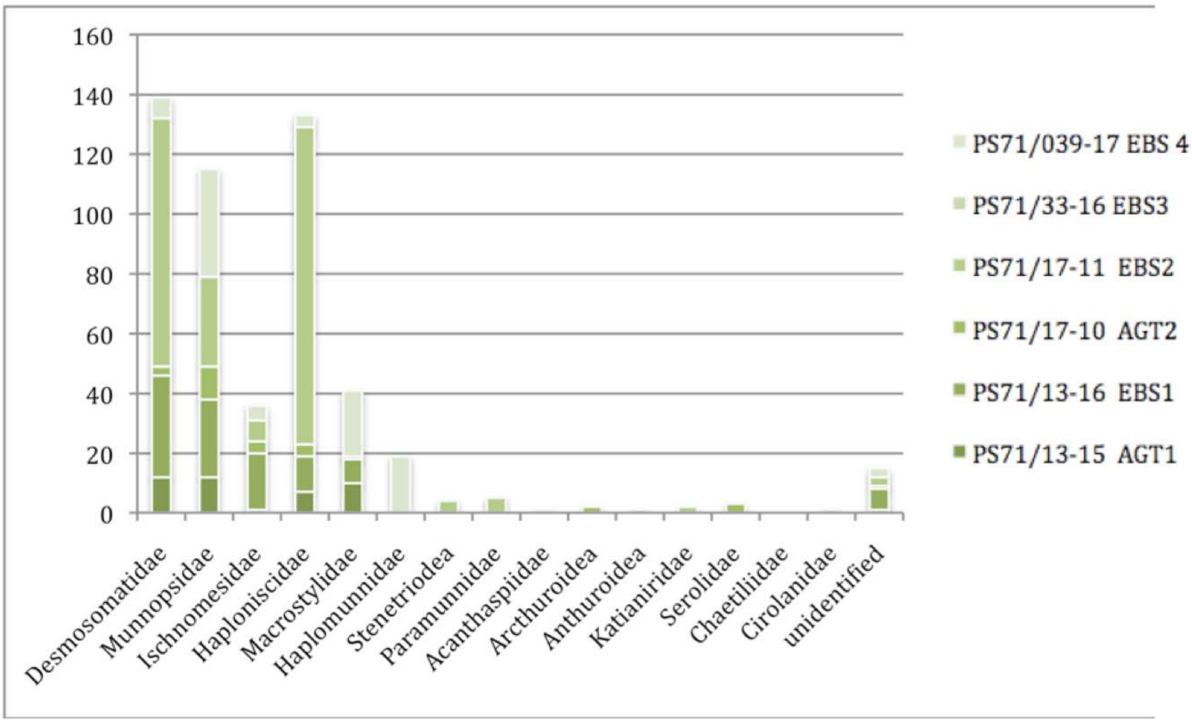

Fig. 21.5: Number of individuals in each isopod family at the stations sorted on board

Asellote isopods are one of the most important and abundant macrofaunal groups in the deep sea. A high number of undescribed species (more than 80 % of collected species are new) and low numbers of specimens per species is typical for abyssal plains. The question to answer is: how reliably can barcode data assign specimens to species (known and unknown)?

An overview of the total numbers of polychaete individuals per family from EBS samples is given in Table 21.3. Thirty-five families were distinguished in only four stations. Spionidae and Ampharetidae were the most abundant families, whereas, contrary to ANDEEP samples, the Trichobranchidae and Terebellidae were very rare. A clear difference in the family composition of different sites is not yet apparent at this stage of analysis. Also answers addressing possible reasons for the observed community structure can initially be given after identification of species and correlation with environmental factors.

Tab. 21.3: Polychaetes from EBS catches

families	13-16	17-11	33-16	39-17	total
Acrocirridae	1	0	0	0	**1**
Ampharetidae	12	59	1	18	**90**
Amphinomidae	0	1	0	0	**1**
Capitellidae	0	2	1	2	**5**
Chrysopetalidae	1	0	0	1	**2**
Cirratulidae	5	10	0	0	**15**
Dorvilleidae	0	0	0	3	**3**
Euphrosinidae	0	1	0	0	**1**
Fauveliopsidae	1	40	1	0	**42**
Flabelligeridae	3	1	0	15	**19**
Glyceridae	0	8	1	24	**33**
Hesionidae	3	11	0	4	**18**
Lumbrineridae	0	4	1	25	**30**
Maldanidae	6	22	0	14	**42**
Nephtyidae	1	4	0	0	**5**
Nereididae	0	2	0	2	**4**
Opheliidae	2	21	0	9	**32**
Orbinidae	0	1	0	3	**4**
Oweniidae	0	1	0	0	**1**
Paraonidae	0	0	1	3	**4**
Pholoididae	0	2	0	12	**14**
Phyllodocidae	0	0	0	2	**2**
Polygordiidea	0	0	0	4	**4**
Polynoidae	4	7	0	0	**11**
Polyodontidae	0	0	0	11	**11**
Sabellariidae	1	0	0	0	**1**
Sabellidae	7	4	0	4	**15**
Scalibregmatidae	3	6	0	10	**19**
Sigalionidae	1	0	1	0	**2**
Sphaerodoridae	0	2	0	0	**2**
Spionidae	29	56	0	121	**206**

families	13-16	17-11	33-16	39-17	total
Syllidae	0	11	0	0	**11**
Terebellidae	0	4	0	1	**5**
Tomopteridae	0	0	0	1	**1**
Trichobranchidae	0	3	0	2	**5**
total	**80**	**283**	**7**	**291**	**661**

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22. INDICATIONS FOR CRYPTIC SPECIATION IN THE SOUTHERN OCEAN AMPHARETIDAE AND TRICHOBRANCHIDAE (ANNELIDA, POLYCHAETA)

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Objectives

During the former ANDEEP I-III projects, the deep Weddell Sea has proven to host a highly diverse polychaete fauna. However, species accumulation plots have shown that the number of species recorded for the Southern Ocean deep sea is far below the expected level. Also, the forces that drive the composition of the polychaete fauna at different areas are merely subject to speculation so far. The SYSTCO programme therefore offered the chance to enlarge our knowledge about the number of species inhabiting the deep Southern Ocean and correlate these findings to parameters measured throughout the complete water column, giving insight into possible coupling processes for the first time (see chapter 15).

The analysis of distribution patterns of polychaete species from the Southern Ocean has shown that the polychaete fauna is not isolated. Rather, many species have wide distribution ranges (Schüller & Hilbig, 2007). About 25 % of all species found during ANDEEP I-III are considered cosmopolitan species. Additionally, eurybathy seems to be very common among Southern Ocean polychaetes (Hilbig, 2004). In the context of the background of the discovery of cryptic speciation among many invertebrate species world wide (e.g., Bleidorn et al., 2006, Held, 2003, Linse et al., 2007) and with help of molecular genetics, this apparent distribution pattern can be studied in greater detail and may have to be revised. As model taxa to find indications for cryptic speciation among Southern Ocean polychaetes, the families Ampharetidae and Trichobranchidae were chosen. Both families include species with wide vertical and global distribution ranges. Their taxonomy is poorly resolved and world-wide records of one species might be due to misidentification. However, the Ampharetidae especially are among the most abundant and diverse families in the deep sea. A thorough knowledge of this group is therefore essential for biodiversity analyses in the deep sea. The Trichobranchidae include with *Terebellides stroemii* probably the best known cosmopolitan species in polychaete science. Although Williams (1984) has already discovered two different morphological variations, further investigations about its cosmopolitan status have not been carried out to date

Work at sea

Methods

During this cruise polychaete samples from three different gears (EBS, AGT, Rauschert dredge) were sorted to family level as preparation for later biodiversity analyses. Part of the material was sorted alive and frozen for biochemical analyses;

their numbers are not included in the subsequent results. While the numbers of all remaining individuals from EBS samples were documented, the numbers of the AGT samples only include those from the 500 μm fraction. The material of the Rauschert dredge was only sorted for genetic analyses and not enumerated. For genetic analyses the Ampharetidae and Trichobranchidae of all samples were identified to species level when possible. DNA extractions using the QIAamp® DNA Mini Kit (Qiagen) with a slightly modified standard protocol were done for three ampharetid species (*Ampharete kerguelensis, Amphicteis vestis, Amphicteis gunneri*) and one trichobranchid species (*Terebellides stroemii*). For the extractions only posterior body parts were taken, still allowing a detailed morphological comparison of the specimens in the future.

Results and outlook

During this cruise over 1,000 polychaete specimens were observed. The on-board identification to species level for the Ampharetidae and Trichobranchidae resulted in eight clearly distinguished ampharetid species and two trichobranchid species. All species were only represented in low numbers, limiting the number of extractions done during this cruise. In total DNA was extracted from 33 specimens (10 *A. kerguelensis*, 18 *A. vestis*, 1 *A. gunneri*, 4 *T. stroemii*), two coming from AGT samples, three from the Rauschert dredge and the remaining from the EBS. As a next step, these extractions will be used for 16S rDNA sequencing. For comparison, further specimens of these species from former cruises to different areas in the Southern Ocean, and as far as available, specimens from northern hemisphere sites will be treated likewise. The sequences will be used to conduct a combined morphological and genetic comparison of populations of these species from different areas and depths, to find first indications for cryptic speciation among Southern Ocean polychaetes.

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23. BIODIVERSITY, PHYLOGENY AND TROPHODYNAMICS OF AMPHIPOD CRUSTACEANS IN THE ANTARCTIC DEEP SEA

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Scientific background and objectives

Peracarid crustaceans, and in particular Amphipoda, are known to be by far the most speciose animal group in the Antarctic coastal and shelf communities, with a high percentage of endemic species. About 600 amphipod species have been recorded so far in the Southern Ocean *s.s.*, mostly at shelf depths. The Antarctic deep sea remained virtually unknown until the ANDEEP I-III cruises in 2002 and 2005 revealed an overwhelming diversity and abundance of amphipod crustaceans in various deep-sea basins of the Atlantic sector. In terms of abundance, the ANDEEP I-III results showed that Amphipoda contributed up to 32 % of the large peracarid material collected by the epibenthic sledge (EBS), just after Isopoda (38 %) which are the usual dominant group in the deep sea. This is in sharp contrast with other deep-sea samples, where amphipods were usually much less abundant. In terms of species richness, the ANDEEP cruises collected about 200 species – mostly new – compared with only 72 Antarctic species previously known below 1,000 m.

Investigations on the trophic role of the rich and diverse amphipod taxocoenosis of the Antarctic shelf have revealed a rather large diversity of trophic types according to the results of detailed gut content analyses, confirmed by stable isotopes and fatty acid analyses. How far the trophic structure of the deep sea amphipod communities is similar to the shelf communities remains to be investigated.

Pioneering molecular studies (16s rRNA, 18s rRNA and CO1 data) on polar submergence in Antarctic isopods indicated several invasions into the deep sea from the Antarctic shelf, all of which occurred independently and may be related to the glaciation history in Antarctica. How far these trends may apply to amphipod crustaceans remains to be investigated. Can phylogenetic links be established between shelf and deep sea amphipod fauna and the origin of some World deep-sea taxa traced in the Antarctic shelf or in the deep Weddell Sea?

The present project will contribute to the ANDEEP-SYSTCO general aim by focusing on three main objectives:

Patterns and processes of amphipod biodiversity

- To pursue by a combined morphological and molecular approach the characterization of the composition of the amphipod fauna of the Antarctic deep sea and its relations with the Antarctic shelf fauna and the world abyssal fauna.
- To contribute taxonomical material, photographic records, distribution and ecological data to the ongoing "Synopsis of the Amphipoda of the Southern Ocean".

Ecomorphological and trophic characterization

- To document the ecological and ecomophological traits (abundance, habitats, mode of life, size spectrum, etc.) of the Antarctic deep sea amphipod taxocoenoses on latitudinal and bathymetrical scales, in comparison with the Antarctic shelf fauna and the Atlantic deep-sea fauna.

- To characterize by digestive tract and stable isotope analyses the trophodiversity and the trophodynamic role of the Antarctic deep-sea amphipods in comparison with the shelf communities (as far as collected material will allow).

Molecular phylogeny and phylogeography

- To investigate the phylogeny and phylogeography of selected amphipod taxa (mostly Lysianassoidea) through parallel molecular and morphological approaches in an attempt to understand the colonisation history of deep sea taxa.

Work at sea

Benthic amphipods were collected using different gears: Agassiz trawl (AGT), Epibenthic sledge (EBS), autonomous baited traps (AT), and Rauschert dredge (RD. Tab.23). About 90 % of the amphipod collected during this cruise were sorted to species level. For each species sorted, a 50 % sample was fixed in cooled ethanol for further molecular studies and the other fraction was fixed in 4 % formalin for further morphological studies and proper identification.

Preliminary results

A total of 4502 individuals of amphipods were collected during this cruise.

Tab. 23.1: The number of individuals collected in each station, by every gear along with the depth at which these gears were deployed.

Station	Depth	Gear	Number of individuals
- PS 71/13	2990 m	AGT	20
	2995 m	EBS	24
	(+/-) 3000 m	Amphi trap	3
- PS 71/16	486 m	RD	165
- PS 71/17	2084 m	AGT	6
	2051 m	EBS	104
- PS 71/33	(+/-) 5300 m	Amphi trap	393
- PS 71/39	(+/-) 2150 m	Amphi trap	2104
- PS 71/47	1554 m	Amphi trap	723
- PS 71/48	602 m	AGT	146
	602 m	RD	813
- PS 71/90	(+/-) 4000 m	RD	1
			Total: 4502

24. PRELIMINARY REPORT ON AGT CATCHES DURING ANT-XXIV/2

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Objectives

The deployment of the large Agassiz trawl at the benthic deep-sea stations was an integral part of the SYSTCO programme. Our objective was to collect data on the diversity and distribution of mainly the megafauna and to collect, fixate and freeze sufficient material from representative taxa for genetic and biochemical investigations, which will be performed in our home laboratories. The purpose is to obtain a better understanding of the ecological role of important benthic animal taxa and the trophodynamic coupling in the deep sea (Brandt et al. 2007). Furthermore, we aim to approach the reconstruction of the phylogenetic and geographic history of benthic key taxa in the Southern Ocean deep sea (e. g. Conradi 2007, Janussen 2007).

Work at sea

Methods

After the trawl had been retrieved, the net was emptied into baskets and inspected for the first obvious animals. Then the catch was washed on deck in running sea water through sieves with mesh sizes of 5 mm, 1 mm, and 0.5 mm. For AGT 1, an additional 0.3 mm sieve was used but then considered inefficient and not used for subsequent trawls. While washing, animals were picked out and the residues were kept for checking and later sorting under the binocular microscope. For each dominant megafauna taxon in terms of biomass, the wet weight was measured before the material was fixed or frozen for further investigations, such as molecular biology and biochemistry. The wet weights of the 5 dominant taxa for each station and their contributions to the total biomass are shown in the Table 24.1. In the lab, the catches were further sorted into major taxonomic groups, and distributed among the responsible specialists on board. During the course of this expedition, further sorting of mainly the macrofauna from the fine sediment fractions took place; only residue samples of AGT 5 are not yet fully sorted. Taxonomic identifications of the different taxa were done by the specialists on board. Therefore, our preliminary data are of very different quality depending on whether or not a specialist of the taxon on board was able to deliver detailed identifications of taxa. Thus, the numbers of species and specimens are based on counting for molluscs, polychaetes, sponges, isopods, and for other Crustacea from AGT 1 and 2, while partly on estimations for the other groups. Fig. 24.1 shows our very preliminary evaluation of some major taxa from the AGT catches nos. 1 - 5. A short description of each of the AGT stations and the catches is given below.

Results and Discussion

During this expedition, 5 of 6 AGT deployments were successful in the sense that the trawl collected animals and, in most cases, also sediment from the ocean floor. The AGT no. 6 failed to collect animals due to an inverted net under stormy conditions. The AGTs nos. 1 - 4 were bathyal or abyssal benthic deep-sea stations, which had been planned for SYSTCO from the very beginning (see SYSTCO introduction). AGT no. 5, near Neumayer Northern Pier in 600 m water depth, was chosen mainly because of the need for the *Polarstern* to do logistic work for Neumayer, where we had to stay for ten days in the beginning of January. Water depths of our AGT stations thus ranged between 600 m and 5,335 m (Table 24.1), and correspondingly the effective trawling distances varied between c. 616 m and 2,790 m from the shallowest to the deepest station. Further details concerning the methods of AGT deployment are provided in the chapter “Methods: Agassiz Trawl”.

#71/13-15, AGT 1: Depth 3,000 m, trawled distance 1,809 m, deployed with inner net. Sediment: About 100 liters of diatom ooze to foraminiferan sand, few stones. **Megafauna**: Porifera, few: 4 very small demosponges, 1 small hexactinellid (but many isolated spicules from hexactinellid sponges). Cnidaria: a few seapens (*Umbellula*), zooantharians and hexacorals. Mollusca: 1 large cephalopod (squid), common scaphopods (54 empty shells). Tentaculata: Some Bryozoa. Crustacea: a few large amphipods (Ischnomesidae sp., *Accolathura gigantissima*, *Syneurycope* sp.); Echinodermata: abundant ophiurids, some large holothurians and some asteroids. Chordata: 1 fish; 1 ascidian. **Macrofauna** (as identified later from the 300 μm and 500 μm residues fractions): bivalves abundant (8 spp., 227 specimens), gastropods 16 spp., polychaetes 17 spp., Crustacea: Isopoda, 18 spp., other Crustacea, 25 spp.

In summary, a rich macrofauna, but the megafauna was neither very diverse nor abundant.

 # PS 71/17-10, AGT 2: Depth 2,180 m, trawled distance 1,200 m, deployed with inner net. Sediment: About 75 liters of silty clay with many stones (basalt). **Megafauna**: Porifera: 2 hexactinellid spp., 2 demosponges (1 big carnivore sponge, *Chondrocladia* cf. *albatrossi*). Cnidaria: Some scypho-medusae. Mollusca: Some scaphopods (empty), 1 octopus, 1 big Solenogaster. Tentaculata: abundant bryozoans (7 spp., 156 specimens). Mollusca: Abundant *Nematocarcinus* (2 spp., 382 specimens). Echinodermata: Abundant holothurians (10 spp., 231 specimens, 2 of them very large ones), also common were echinoids (2 spp., 62 specimens), crinoids (3 spp., 47 specimens) and asteroids. Chordata: Some Ascidiacea and fishes (3/12). **Macrofauna**: bivalves 5 spp., gastropods 4 spp., polychaetes (22 spp., 104 specimens). Isopoda, 15 spp., other Crustacea, 20 spp.

In summary, at this station, the megafauna was rather diverse and abundant. The macrofauna was similar to that of AGT 1.

#PS 71/33-14, AGT 3: Depth 5335 m, trawled distance 2790 m, deployed with inner net. Sediment: about 650 liters of very pure and soft clay, few stones. It contained many, but small foraminiferans. **Megafauna**: Porifera: 2 hexactinellid spp., 1 demosponge sp. (the carnivore *Cladorhiza* sp.). Cnidaria: 2 medusae, 1 sea pen. Crustacea: Few *Nematocarcinus*. Echinodermata: Many Holothurians (4 spp., 229 specimens), common ophiurids and asteroids, few echinoids. **Macrofauna**: Gastropoda: 12 spp., Bivalvia 3 spp. (not all determined, so far). Polychaeta, 24 spp. 130 specimens, Isopoda, 6 spp., other Crustacea, 9 spp.

In summary, apart from the holothurians, which comprise almost 90 % of the weighed biomass, the megafauna was comparably poor at this station; especially if considering the long trawling distance and the large amount of sediment. The macrofauna, where Mollusca and Polychaeta are concerned, was rather rich; Crustacea comparably poor (e. g. the Isopoda, compared with AGT 1 and 2). However, this was the deepest station, and the sediment was extremely soft; so as we would expect, it is mainly colonized by soft bottom dwellers and burrowing animals.

#PS 71/39-16, AGT 4: Depth 2150 m, trawled distance 1300 m, deployed with inner net. Sediment: About 35 liters foraminiferan sand with many stones; very clean catch, no sieving on deck necessary, but unfortunately due to a mistake, part of the sediment was lost before sieving. **Megafauna**: Porifera: Polymastiidae very common on the stones: *Tentorium* and *Polymastia*, 4 spp. (mostly small specimens, probably juveniles). Cnidaria: some scyphozoan medusae, hydrozoan polyps and 1 actinian. Polychaeta: some large scale worms. Crustacea: few *Nematocarcinus*, 1 large isopod. Chelicerata: some pycnogonids. Cnidaria: Abundant ophiorids (3 spp., 135 specimens), some echinoids and some large holothurians (4 spp. 30 specimens). Chordata: fishes (3 spp., 13 specimens, 2 were washed out as the AGT was heaved on deck). **Macrofauna**: bivalves common, but apparently only 3 spp., gastropods: 2 spp. Crustacea: 9 spp.

In summary, in spite of a considerable amount of hard substrate (stones), the megafauna, including the sessile, of this station is comparably poor with low diversity. The macrofauna is extremely poor (especially the Crustacea and Polychaeta). Of the bivalves and poriferans, we found many specimens, but only few species. This may point towards few colonization events, which brought a few species to Maud Rise, where they remained fairly isolated; corresponding to the relatively isolated current system described from this locality (for details, see chapter contribution by Volker Strass "Physical Oceanography", this volume).

#71/48-1, AGT 5: Depth 600 m, trawled distance 616 m, deployed without inner net. Sediment: Hard bottom covered by sessile animals (mainly poriferans and their spicule mats), also foraminiferans, but no soft sediment. **Megafauna**: This was a "sponge ground", i.e. poriferans comprised 80 % of the weighed biomass. Especially some of the hexactinellid specimens (*Rossella racovitzea* and *R. nuda*) were large (about 50 cm in height). Both Hexactinellida and Demospongiae of this catch are very diverse and abundant, with 30 spp. (conservative estimate) and several hundreds specimens. Furthermore, very abundant Calcarea (this is a very interesting find) were found, counting for only 1 - 2 spp., but about 100 specimens, which were rather large (4 - 8 cm).). Cnidaria: mainly hexacorals (11/109) on stones. Mollusca: 1 cephalopod sp. (*Pareledone sp.*). Tentaculata: brachiopods and bryzoans (about 4/100 specimens). Chelicerata: abundant pycnogonids (2/57). Echinodermata: ophiuroids (spp./specimens: 4/488), crinoids (4/400), holothurians (4/68) and asteroids (2/69). Chordata: ascidians (2/82), and some fish (4/13). **Macrofauna**: abundant polychaetes (34/120), bivalves (7/100) and gastropods (7/50), polyplacophorans (1/9), 1 monoplacophoran (a special and rare find). Crustacea: Isopoda (8/46), Amphipoda (6/146), other Crustacea, 10 spp.

In summary, this was the richest and most diverse catch during this expedition. This is partly due to the fact that this was not a deep-sea but a shelf station, where there is much more biomass than in the deep-sea. However, in 2005 we had a station at 1,040 m (ANDEEP III, PS67/074-7) depth which was for many taxa the richest and most diverse station during the ANDEEP programme (Linse *et al*. 2007). This area is very well investigated and known for its biodiversity, but still new highlights are discovered, such as the rare monoplacophoran and the "mass occurrence" of calcareous sponges.

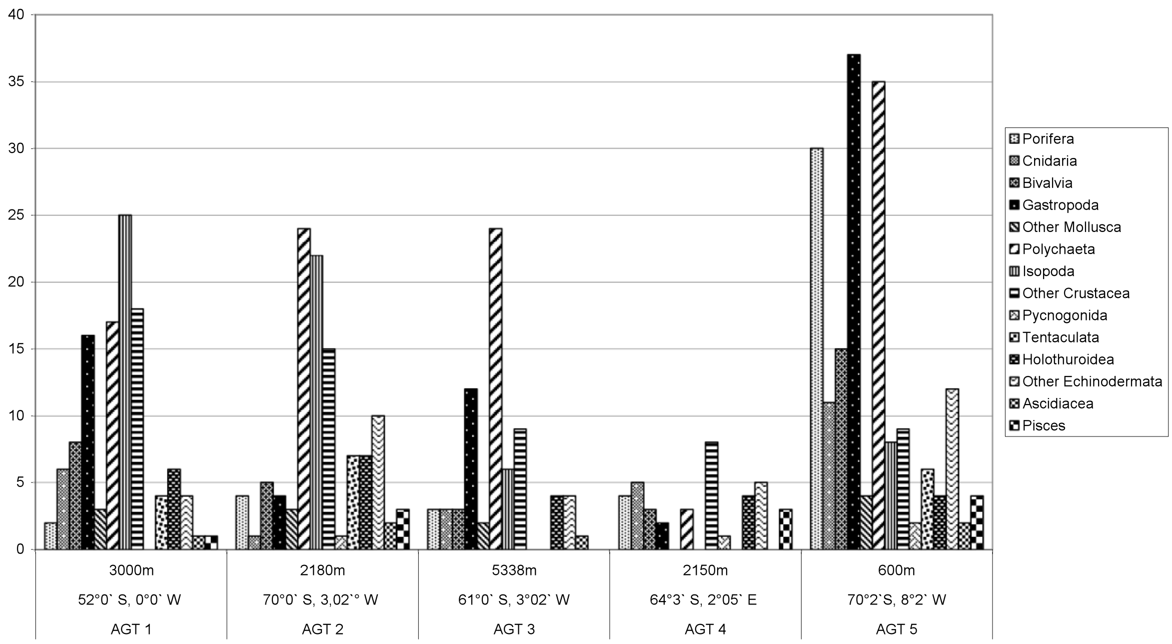

Fig. 24.1: Numbers of species of major taxa sampled at AGT stations 1 - 5

Tab. 24.1: The contributions of the 5 dominant taxa for each AGT station to the biomass in total wet weight, and in %.

AGT station	**#71/13-15, AGT**	**# 71/17-10AGT**	**#71/33-14, AGT**	**#71/39-16, AGT**	**#71/48-1, AGT**
Coordinates	**52°0`S, 0°0`W**	**70°0`S, 3°02`W**	**61°0`S, 3°02`W**	**64°3`S, 2°05`E**	**70°2`S,8°2`W**
Depth	**3000 m**	**2180 m**	**5335m**	**2150 m**	**600 m**
Porifera	-	-	-	-	25570g/ 80,1%
Cnidaria	10g/ 0,4 %	-	-	240g/ 1,5%	-
Polychaeta	25g/ 0,9%	-	-	-	-
Caridea	-	3700g/ 22,6	70g/ 1,2%	-	-
Pycnogonida	-	-	-	20g/ 0,1%	-
Cephalopoda	500g/ 19,3%	-	-	-	-
Holothurioidea	2000g/ 77,4%	8450g/ 52,0%	5200g/ 89,8%	14613g/ 89,0%	500g/ 1,6%
Ophiuroidea	50g/ 2,0%	-	245g/ 4,2%	-	-
Echinoidea	-	1490g/ 9,0%	-	845g/ 5,1%	-
Asteroidea	-	-	230g/ 4,0%	-	-
Crinoidea	-	200g/ 1,2%	-	-	1180g/ 3,7%
Ascidacea	-	-	40g/ 0,8%	-	2145g/ 6,7%
Pisces	-	2470g/ 15,2%	-	700g/ 4,3%	2530g/ 7,9%
Sum	2585g/ 100%	16310g/ 100%	5785g/ 100%	16418g/ 100%	31925g/ 100%

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25. PRELIMINARY REPORT ON THE PORIFERA (SPONGES) CAUGHT DURING THE ANT-XXIV/2, ANDEEP-SYSTCO

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Objectives

For the Porifera research (the detailed work programme is described in Janussen, 2007), the main objectives, within the framework of the SYSTCO expedition, were as follows:

1. Increase of the knowledge gained during the ANDEEP programme on the biodiversity of sponges in the deep Southern Ocean (SO).
2. To collect and fixate fresh material from representative key taxa for genetics, in order to investigate the phylogenetic relationships of SO deep-sea sponges in comparison with representatives from other deep oceans and from the shelf.
3. To obtain sufficient material of representative taxa for isotope and other biochemical analyses, in order to gain a better understanding of the functional ecology of sponges in the deep SO food web.

Results and discussion

During ANT-XXIV/2, we collected all together about 50 Porifera species from 25 families (conservative estimates). Of these species, 30 belong to the Demospongiae, 10 to the Hexactinellida and 1 or 2 to the Calcarea. As usual, sponges were collected mainly by the AGT, some by EBS and a few by GKG. At 3 stations, the Rauschert dredge was successfully deployed, either by itself (RD1) or attached to the AGT (RD2, RD3, RD4). Next to the AGT, this small dredge caught most of the sponges during this expedition, but interestingly for the Porifera the catches of the RD are not significantly different from those of the AGT (for other taxa, e. g. the Crustacea, the results are different, see contribution by Henry Robert on the Amphipoda, this volume). Obviously, the fine-meshed (500 μm) inner net, which we applied as inlet within the normal net at most AGT stations, was equally efficient as the RD net in holding back especially the smaller sponges. A detailed taxonomic list of the Porifera collected during this expedition and an overview of their distribution are given below (Table 25.1, Fig. 25.1).

Generally, the catches from the SYSTCO deep-sea stations were rather poor in sponges, compared with those of the ANDEEP II and III expedtions (Janussen & Tendal 2007). The richest station, both in total numbers and in diversity was AGT 5 (#71/48-1), which was not a deep-sea station and not originally planned for the SYSTCO expedition (see Janussen et al. “AGT catches”, this volume).

Brief description of sponge catches from the AGT stations 1 - 5:

AGT 1, #71/13, 52°S, 3000 m: the poorest station in terms of sponges: 3 tiny, probably demosponges, and 1 hexactinellid fragment.

AGT 2, # 71/17, Lazarev Sea, 2180 m: this station was richer: 3 complete demosponges of 3 spp. and 7 fragments from 1 or 2 hexactinellids were collected. One of the demosponges from the AGT was a comparably large specimen of the carnivore sponge, *Chodrocladia* cf. *albatrossi.* With its 6 cm in length, it is almost a giant compared with most specimens of the family Cladorhizidae collected during the ANDEEP cruises, which were mostly tiny specimens, a few mm only, and were collected mainly by EBS. With this large specimen of *Chondrocladia*, we now finally obtained sufficient biomass to fixate parts of the sponge in RNA-Later for genetics and also freeze a good portion for analysis of the stable isotopes.

AGT 3, #1/33-14, Central Weddell Sea, 5330 m: this station was the deepest, and a typical abyssal station, providing only few true deep-sea sponges: 4 specimens of carnivore *Cladorhiza* sp. and 2 hexactinellid fragments. The *Cladorhiza* specimens were rather long, 4 - 5 cm, but also very thin and did not provide much biomass; furthermore they were penetrated by clay sediment and are probably not suitable for biochemistry.

AGT 4, #1/39-16, Maud Rise, 2,150 m: a station rather rich in sponges, but of low diversity: we collected 17 specimens of 4 spp. belonging to the two genera *Polymastia* and *Tentorium* of the family Polymastiidae, all encrusting on stones. Many of these sponges are only a few mm big, and probably juveniles. The Polymastiidae is one of the Porifera families that show very wide distribution, both geographically and bathymetrically. For this reason, it was chosen among the key taxa for phylogenetic and zoogeographical comparisons of Antarctic sponges with representatives from other oceans (Janussen & Wörheide, unpubl.). Because the catch contained very little sediment, some of the larger specimens were suitable for biochemistry.

AGT 5, #1/48-1, near Neumayer northern pier, 600 m: not surprisingly, the major part of the sponges collected are from this locality, which was a shelf station. Nevertheless, the large amounts of very pure samples, containing almost no sediment, are very useful and necessary for our originally planned genetic and biochemical investigations, which are well-integrated within the SYSTCO programme. The Porifera comprise 80 % of the biomass of the weighed dominant taxa of this station (see Janussen et al. “AGT catches”, this volume). Altogether, we collected 40 spp. of Porifera from 24 families (conservative estimate), which must be considered a high diversity, both on species and at higher taxonomic levels. About 21 of the families represented here belong to the class Demospongiae, 1 to the Calcarea and apparently only 2 (Rossellidae and Farreidae) to the Hexactinellida. For the latter, this is a normal situation, because in the Southern Ocean, the diversity of Hexactinellida increases from the shelf down to the bathyal, where it reaches its maximum at depths between 1,000 - 2,000 m (Janussen et al. 2004, Janussen & Tendal 2007). Most of the Demospongiae of this expedition were found at #71/48-1, except the deep-sea family Cladorhizidae which was absent at this station. As one of the highlights, we collected a high number (~75 specimens, 300 g wet weight) of calcareous sponges, comparably large in body size (4 - 6 cm long). Usually, the sponge class Calcarea is considered to be rare in the Southern Ocean and is restricted to depths considerably shallower than 600 m. Therefore, this "mass occurrence" of Antarctic calcarean sponges is truly exceptional.

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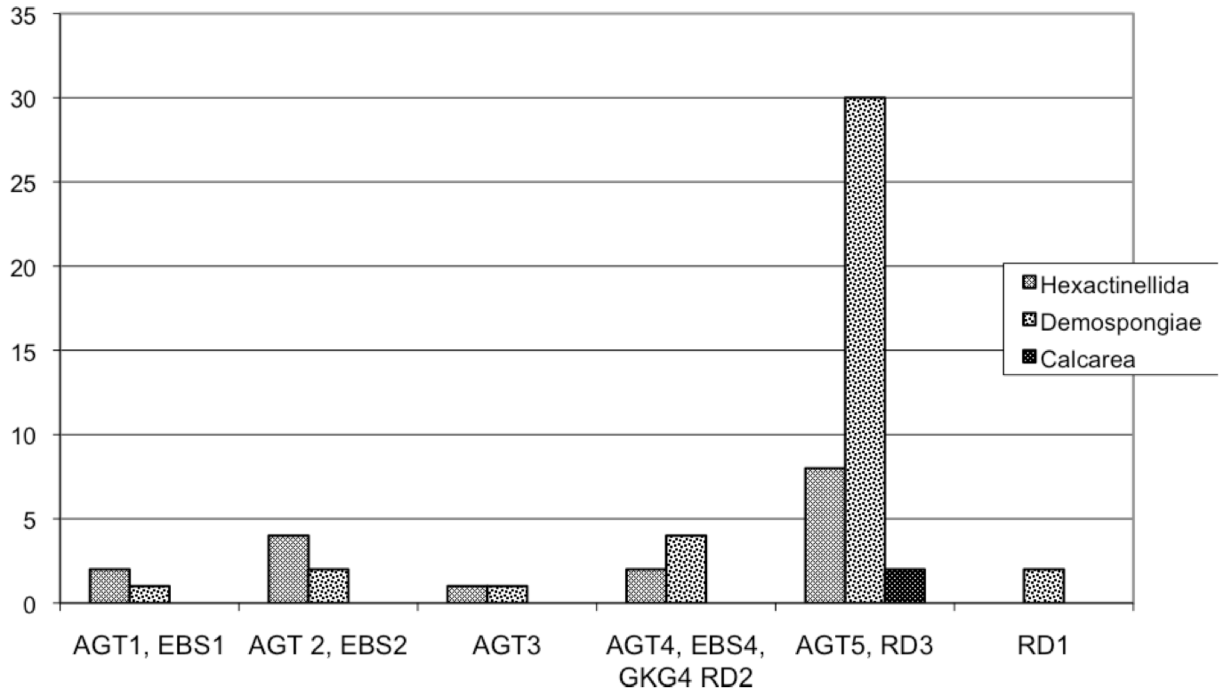

Fig. 25.1: Numbers of species from the 3 Porifera classes caught at the SYSTCO benthos stations

Table 25.1: Poriferan taxa caught on stations by different gears during the ANT XXIV-2 SYSTCO-Expedition. The table shows the numbers of specimens of each taxon distributed at the stations.

Station no. **Sponges-catching gears**	**#71/16, RD1**	**#71/13, AGT1, EBS1**	**#71/17 AGT1, EBS2**	**#71/33-14 AGT3**	**#71/39-16 AGT4, RD2, EBS4, GKG4**	**#71/48-1 AGT5, RD3**	**#71/90-4 AGT6, RD4**
Coordinates	**70° 4`S, 9°3`W**	**52°S, 00°` W**	**70°S, 3°` W**	**61°` S, 3°` W**	**64°3`S, 2°` E**	**70°2`S,8°2`W**	**49°S, 00°W**
Locality	**Neumayer, northern pear**	**Southern Polar Front**	**Lazarev Sea**	**Central Weddell Sea**	**Maud Rise**	**Neumayer, off northern pear**	**Antarctic Polar Front**
Depth, approximately **Taxon/ specimens no.**	**500m**	**3000m**	**2180m**	**5330m**	**2150m**	**600m**	**3990m**
Demospongiae:							
Tiny demosp. sp.1 (problematic), v11		3					
Incrust. Dem. sp. (problematic), v6		4			3		
Demospongiae 2spp.,. v4, v5	2						
Yellow soft Dem. sp., v50, fragm.						1	
Small bush-like Dem. sp. on stones, v53						2	
Incrusting, firm, whiteish Dem. sp., v55						1	
Firmer grey Dem. sp., v56						1	
"Transparent" grey Dem., v.60						1	
Poecilosclerida: With "bubbly" cortex, v40a more brittle, v40b more soft						7	
"Bubbly"-cortex, yellowish, v63						1	
Cladorhizidae: v.7 *Chondrocladia cf. albatrossi*			1				
Cladorhiza sp.), v. 15, 15b				4			
Halichondrida (?): *Tedania* sp., v44						c. 50	
Halichondriidae: v.8 cf. *Halichondria* sp.			1				
Axinellidae(?) sp. Large fan-shaped Dem., thicker-walled, fragm., v51						4	
Smaller, fan-shaped Dem., thinner-walled, v52						4	
Hadromerida: Polymastiidae *Polymastia* sp. 1, (flat encrusting), v.23					1		
Polymastia cf. *invaginata*, v.25, v.18, v.20, v.27					9		
Polymastia sp., v.49, v.64, v22, v29,			1		1	3	
Tentorium sp. 1, tiny, v. 24 v.46, v.57, v.13, v.19, v.21, v.28					6	c.10	
Tentorium sp. 2, v47, 58(?)						2	
Tentorium sp. 3, v48, 59(?)						2	

Continuation: Table 25.1: Poriferan taxa caught on stations by different gears during the ANT XXIV-2 SYSTCO-Expedition. The table shows the numbers of specimens of each taxon distributed at the stations.

Station no. Sponges-catching gears	**#71/16, RD1**	**#71/13, AGT1, EBS1**	**#71/17 AGT1, EBS2**	**#71/33-14 AGT3**	**#71/39-16 AGT4, RD2, EBS4, GKG4**	**#71/48-1 AGT5, RD3**	**#71/90-4 AGT6, RD4**
Coordinates	**70°4`S, 9°3`W**	**52°S, 00°` W**	**70°S, 3°` W**	**61°` S, 3°` W**	**64°3`S, 2°` E**	**70°2`S,8°2`W**	**49°S, 00°W**
Locality	**Neumayer, northern pear**	**Southern Polar Front**	**Lazarev Sea**	**Central Weddell Sea**	**Maud Rise**	**Neumayer, off northern pear**	**Antarctic Polar Front**
Depth, approximately Taxon/ specimens no.	**500m**	**3000m**	**2180m**	**5330m**	**2150m**	**600m**	**3990m**
Demospongiae:							
Tetractinellidae: *Tetilla* sp., v38, v. 54						4	
Very small *Tetilla* sp., and *Stylocordyla* (?) sp., v71						11	
Tetractinellida sp., fragm. v6	1						
Demospongiae spp., v. 65, v67						c. 85	
Calcarea sp., v.41, v. 67						c. 75	
Hexactinellida:							
Rossellidae: v.6a, v.9 *Bathydorus* sp. 1 (fragm.)			6				
Bathydorus sp.2(?) (fragm.), V.11			1				
Bathydorus sp.3(?), v12		1					
Large *Rossella racovitzae*, fragm. v32, v. 37, v68 6 dead specimens						9	
Juv. *R. rasovitzae*, v42, v61						6	
Large *Rossella nuda*, v33, v36, v69						2	
Rossella levis, v.35						2	
Rossella spp., v. 39, v.70						c. 30	
Hexactinellida spp., v. 65						c. 30	
Hexactinosida: *Farrea* sp. Dead skeleton fragm., + no.			1			1	
Farreidae sp. (fragm.), v.10			2				
Lyssacinosan sp. 1 v.16				1			
Lyssacinosan sp. 2(?) v.17				1			
Lyssacinosan sp. 3 (?),v.2		1					
Lyssacinosan sp. 4, 5 (frag. EBS)			2				
Hexactinellid sp., fragment					1		
Hexactinellid sp.juv., on spics					1		
Hexactinellida spp., v.65 v67						c. 35	

26. DIVERSITY OF THE SOUTHERN OCEAN DEEP-SEA ANTHOZOAN FAUNA

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Objectives

Anthozoans are commonly one of the major components in benthic sessile communities in terms of both abundance and diversity (Arntz 1997; Arntz *et al*. 1997; Gili *et al*. 1999). They offer a good substrate (e.g. refuge, feeding) to many benthic mobile animal groups such as crustaceans, polychaetes, and echinoderms. The Antarctic fauna of anthozoans is still poorly known (Winston 1992, Clark & Johnston 2003), and most of our knowledge comes from the continental shelf. The deep-sea fauna is much less explored and perhaps not as diverse as that living on the shelf, but undescribed genera and species are continuously discovered (e.g. López-González & Gili 2000, 2001; López-González *et al*. 2002; López-González & Williams 2002; Rodríguez & López-González 2001, 2002, 2003). Since most parts of the Southern Ocean refer to deep waters, current estimates of the total number of Antarctic and Subantarctic Anthozoan species are still very imprecise, no more than 50 % of all species. Furthermore, several unreliably described species and genera should be revised, preferably using newly collected material in combination with the type specimens deposited in museums.

Three main hypotheses have been suggested to explain the origin of recent Antarctic benthic communities: derivation from indigenous fauna components, immigration from the deep sea, or recent dispersal from neighbouring shallow-water areas (Crame 1989, 1994, Clarke 1990, Clark & Crame 1989, 1992). According to preliminary results of the anthozoan fauna from previous EASIZ, ANDEEP and LAMPOS cruises, the Antarctic alcyonaceans apparently include elements derived from all three hypotheses (López-González & Gili 2001), while pennatulaceans are mainly immigrants from the deep sea of surrounding oceans (e.g. *Umbellula*, *Kophobelemnon*) and secondarily from shallow waters (e.g. *Pennatula*) (López-González & Williams 2002).

Because of this our objectives are focused on looking for the presence of possible boundaries in the distribution of anthozoans at different taxonomic levels (family, genus, species) in the Southern Antarctic deep sea. Likewise we attempt to evaluate the potential origin of the Antarctic anthozoan fauna according to the known distribution of genera and species in this and other biogeographical areas. The finding of any undescribed species might eventually assist with a better understanding of the relationship between Antarctica and other deep-sea bottoms and continental shelf areas in the past and present. Finally, we aim to complete the scarce information about anthozoan reproductive biology and to provide adequately fixed material for the bank of tissues useful for further molecular studies, both already initiated since the EASIZ II and III in 1998 and 2000, respectively.

Work at sea

Methods

During this cruise anthozans were searched for in all Agassiz trawl (AGT), Epibenthic sledge (EBS) and Rauschert dredge (RD) catches (Table 26.1).

All colonies and individual specimens, including discernable fragments of them, were sorted, labelled, and when possible photographs were taken to obtain information about the colour patterns of the different species while still alive. A considerable amount of ethanol-fixed residues from AGT station no. 5 still await sorting; it is expected to contain numerous smaller anthozoans or fragments.

Anthozoans were fixed for morphological studies (histology, anatomy, etc.) in buffered 6 % formaldehyde in sea water (pH 8 - 9), some selected specimens of fragments were fixed in 96 % ethanol for further molecular analysis. Some hexacorals were relaxed before fixation by adding menthol crystals on the surface of the sea water. Depending on their size, some sea anemones were fixed also injecting 40 % formaldehyde. Once in the laboratory, all specimens will be preserved in 70 % ethanol.

Preliminary results and discussion

The anthozoan material collected during ANT-XXIV/2 was obtained from 5 AGT, 2 RD and 1 EBS hauls. We found anthozoans almost at all geographical stations (the last AGT was not successful due to the weather conditions) but not in all the benthic gears used for each station.

A total of 102 individuals/colonies were identified, although some of them were only present in a fragmentary state, (e.g. gorgonians). These specimens belong to 30 morphospecies, some of which were identified on board to species level, although most are awaiting further morphological studies in the laboratory, (e.g., histological sections, light and electron microscopy). Fourteen species belong to the Octocorallia, and 16 to the Hexacorallia. The octocoral classification used here, which is considered to be the most natural currently available, considers only three orders: Helioporacea, Alcyonacea, and Pennatulacea; only the last two are present in the Southern Ocean. Among the octocoral species there were 6 pennatulaceans, and 8 alcyonaceans (4 soft coral, and 4 gorgonian species). The hexacoral species consisted of 9 actiniarians, 5 scleractiniarians and 2 zoanthideans.

Tab. 26.1: Summary of the anthozoan species and specimens collected in each station by the corresponding gear during ANTXXIV/2. The shelf stations are marked in bold face.

GEAR	AGT	RD	AGT	EBS	AGT	AGT	**AGT**	**RD**
N° STATION	PS 71-13-15	**PS 71-16-01**	PS 71-17-10	PS 71-17-11	PS 71-33-14	PS 71-39-16	**PS 71-48-01**	**PS 71-48-01**
DEPTH(m)	2997.6	**486.3**	2084.7	1736	5336.7	2150.4	**601.8**	**601.8**
Actinernus n.sp.	0	**0**	0	0	0	0	**5**	**1**
Actiniaria *sp.1*	0	**0**	1	0	0	0	**0**	**0**
Actiniaria sp.2	0	**0**	1	0	0	0	**0**	**0**
Actiniaria sp.3	0	**0**	0	0	0	0	**2**	**0**
Actinostolidae sp.1	0	**0**	0	0	0	1	**0**	**0**
Alcyonium sp.1	0	**0**	0	0	0	0	**1**	**0**
Alcyonium sp.2	0	**0**	0	0	0	0	**1**	**0**
Amphianthus sp.1	0	**0**	4	0	0	0	**0**	**0**
Amphianthus sp.2	0	**0**	0	0	0	0	**3**	**0**
Amphianthus sp.3?	0	**0**	0	0	0	0	**1**	**0**
Epizoanthus sp.1	0	**0**	1	0	0	0	**0**	**0**
Epizoanthus sp.2	0	**0**	0	0	0	0	**2**	**0**
Flabellum sp.1	0	**0**	0	0	0	0	**0**	**1**
Flabellum sp.2	0	**0**	0	0	0	0	**1**	**0**
Fungiacyathus sp.	0	**1**	0	0	0	0	**6**	**0**
Galatheanthemum profundale	0	**0**	0	0	19	0	**0**	**0**
Glyphoperidium bursa	0	**0**	1	0	0	0	**0**	**0**
Inflatocalyx infirmata	0	**0**	0	0	0	0	**2**	**0**
Kophobelemnon sp.1	1	**0**	0	0	0	0	**0**	**0**
Primnoisis sp.?	0	**0**	0	0	0	0	**5**	**0**
Scleractinia sp.1	0	**0**	0	0	0	0	**2**	**0**
Sphaeralcyon sp.1	0	**0**	0	0	0	0	**2**	**0**
Thouarella sp.1	0	**0**	0	0	0	0	**19**	**3**
Thouarella sp.2	0	**0**	0	0	0	0	**6**	**0**
Thouarella sp.3	0	**0**	0	0	0	0	**3**	**0**
Umbellula lindahli	0	**0**	0	0	0	0	**2**	**0**
Umbellula magniflora	0	**0**	0	1	0	0	**0**	**0**
Umbellula sp.1	0	**0**	0	0	2	0	**0**	**0**
Umbellula sp.2	0	**0**	0	0	0	0	**1**	**0**
Umbellula thomsoni	0	**0**	0	0	1	0	**0**	**0**
Number of species	1	**1**	5	1	3	1	**18**	**3**
Number of specimens	1	**1**	8	1	22	1	**64**	**5**

Discussion

The deep stations sampled on this cruise include a range from 2,000 m to 5,300 m depth. To compare abundances and species richness, we should only focus on AGT stations because of their similar sampling effort. We observed a much higher abundance at the deepest station (5,300 m) compared to the shallower ones. The frequency of deep-sea anthozoans thus appears to be not correlated with depth. This could be due to the usually patchy distribution of some benthic species, in this case mainly produced by the soft-bottom dwelling actiniarian *Galatheanthemum profundale.* The same is true for the species richness.

Other factors such as the availability of adequate bottom substrates or potential latitudinal gradients need to be considered as well. The distance to the continent may play an important role in the way of providing food into the bottom (Gili *et al*. 2001).

In summary, the shallowest stations show higher species richness (18 spp. in stn. 48 - 01), while the most speciose of the deeper ones only reaches five species (stn. 17 10).

For the actiniarian species, *Galatheanthemum profundale* and *Glyphoperidium bursa*, the collected material should be considered as a deeper record in the Southern Ocean and for *G. bursa* the deepest.

With regard to the knowledge of zoanthideans, only one genus, *Parazoanthus*, was previously known from that area, and seemed to be restricted to the shelf, associated with gorgonians. During the last deep-sea cruise, ANDEEP III in 2002, species belonging to the genus *Epizoanthus* were found. Now two more specimens of the latter genus have been collected. This genus has not been found in the different shallow (shelf) water Antarctic research programmes. Our findings confirm the presence of the genus *Epizoanthus* in the deep Southern Ocean, revealing an immigration from the surrounding oceanic basins.

- During ANDEEP I, members of the genus *Thouarella* were collected down to 3000 m depth. No *Thouarella* could be found in any of the deep stations during this cruise, while 35 specimens were obtained from the shelf station PS71/48-01 at 600 m. We certainly need a more intensified sampling to conclude properly on distributional patterns, but we can already suspect that *Thouarella* shows a patchy distribution, not only with latitude, but also with depth. Furthermore, its presence outside Antarctic and Subantarctic regions, as well as some anatomical features (branching patterns, distribution of sclerites on the polyps, etc…) could suggest that this genus is an ancient component that mainly diversifies in Subantarctic waters.
- Results from previous deep-sea cruises showed a constant anthozoan species/group composition at depths around 4000 m and 5000 m. The only species occurring in such depths were *Galatheanthemum profundale* (Actiniaria), Antipatharia gen.1 (Antipatharia), and *Umbellula thomsoni* (Pennatulacea). Interestingly, none of these species are present in Antarctic or Subantarctic shelf areas. During this cruise we collected two of them (*G. profundale* and *U. thomsoni*) in the deepest station at 5300 m only, confirming the presence of a homogeneous faunal composition in abyssal depths.

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27. GASTROPODA OF THE DEEP SOUTHERN OCEAN - RESULTS FROM AGT CATCHES DURING ANDEEP-SYSTCO

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Objectives

Molluscs generally are among the most common and diverse phyla in the deep sea. Within the framework of ANDEEP, former expeditions allowed first insights into the biodiversity of trenches and abyssal plains off the Antarctic Peninsula, the Scotia Arc and across the Weddell Sea. Our previous results on gastropods showed a surprising overall species diversity, but great heterogeneity between the areas with regard to species numbers and abundance. In contrast to earlier assumptions, an abyssal Antarctic gastropod fauna exists that is not just an impoverished shelf fauna but contains a high amount of apparently unique faunal elements. Its origin and relationships were unknown because adjacent deep-sea areas were virtually unexplored. Also the reproductive biology and ecology of southern deep-sea molluscs is unknown, and, thus, their role in abyssal food webs and their dependence and influence on special deep-sea environments. During ANDEEP-SYSTCO, we aimed to fill a gap within our inventory by collecting in several deep water areas between South Africa and Antarctica. Besides uncovering gradients in diversity, abundance and faunal composition we hoped to shed some light on the biology and ecological interactions of molluscs and other organisms. The present report gives a preliminary list of gastropods found in the AGT catches so far.

Work at sea

Methods

For AGT collecting methods and a short description of the catches see Janussen *et al*. (Preliminary report on AGT catches during ANT-XXIV/2; this volume). Note that at the deep sea stations nos. 1-4 an inner net with a mesh size of 0.5 mm was used, while at the shelf station (AGT 5) the mesh size was approx. 1 cm. Gastropods were sorted out of the catches quantitatively, on deck by eye and then from finer fractions down to 0.5 mm under the dissecting microscope. All AGT catches have been completely revised, except for no. 5, of which about 20 liters of mixed biogenic residues remain to be sorted. Most gastropods were preserved in 95 % ethanol, while some selected specimens were deep frozen for later biochemical or stable isotope analyses, or relaxed in an isotonic solution of $MgCl_2$ prior to fixation in either 70 % ethanol or 4 % formalin-seawater.

Results and Discussion

We sorted and pre-identified gastropods from five AGT-stations of ANDEEP-SYSTCO at approximately 600 to 5335 m depth. To date we have found 324 specimens belonging to 67 species (Table 27.1). Most of the 30 families were represented by single or just a few species. The most diverse families are the Buccinidae (8 spp.), followed by Naticidae (5 spp.), and Turridae, Marginellidae, and Eulimidae (4 spp. each). The most abundant species were *Lissotesta strebeli* (137 spms.), *Melanella* sp. 3 (27 spms.), and *Puncturella conica* (23 spms.). 55 species were represented by 1 - 3 individuals only.

Several new biological observations have been made. *Puncturella conica* frequently sits on a still unidentified ascidian, probably using it as an adequate substrate. Four species of Eulimidae, three of them unidentified and potentially new, were found parasitizing on holothurian hosts. Females of *Melanella* sp. 2 were deeply buried into the sea cucumbers' body wall.

With 129 specimens of 37 species, the not yet fully sorted shelf station is richer than the deep- sea stations (Fig. 27.1). Comparing the deep-sea stations, most gastropods were found at the deepest station (AGT 3; 5,338 m) in the central Weddell Sea. This is mainly due to *Lissotesta strebeli* which was very abundant locally (109 specimens). Most species (16) were collected at the second deepest station, in the abyssal plain of the Agulhas Basin (AGT 1; almost 3,000 m). Standardized values (specimens and species per 1,000 m trawling distance) confirm the shelf station to be considerably richer than deeper stations (Fig. 27.2), as it was expected. Values of gastropod species richness in the deep stations range between 1.54 and 8.84, thus approximately one order of magnitude less than on the shelf (60.1). Surprisingly, the bathyal stations AGT nos. 2 (Lazarev Sea) and 4 (Maud Rise) seem to be the poorest with regards to gastropods (Fig. 27.2). Considering the bathyal and abyssal stations only, there is no linear correlation between the number of gastropod specimens and species collected by the AGT with depth. However, such comparisons based on AGT catches have to be treated with great caution. Most Southern Ocean gastropods are small sized and they are certainly underrepresented in the shelf catch where larger mesh sizes were used; furthermore, sorting is still ongoing. Delicate shells are easily smashed within large AGT catches containing stones or gravel, such as in the apparently poor catches taken from the slope of the Lazarev Sea and from Maud Rise. Also volumes of material available for sieving and sorting differed greatly between the catches, ranging from 35 liters in AGT 4 to approximately 650 liters in AGT 3 (see Janussen et al., chapter 25). Data from epibenthic sledge, multicorer and box corer samples will be required for drawing conclusions on gastropod abundances and diversity.

Table 27.1: Gastropoda collected by the AGT on ANDEEP-SYSTCO. The shelf station not yet fully sorted is marked with grey.

Taxon / Station	**PS 71/13-15 (AGT 1)**	**PS 71/17-10 (AGT 2)**	**PS 71/33-14 (AGT 3)**	**PS 71/39-16 (AGT 4)**	**PS 71/48-01 (AGT 5)**	Total specimens
Depth (m)	2990-2996 m	2085-2163 m	5337-5338 m	2143-2151 m	595-602 m	
Scissurellidae						
Anatoma euglypta (Pelseneer, 1903)		2			1	3
Fissurellidae						
Puncturella conica (d'Orbigny, 1841)					23	23
Lepetidae						
Bathylepeta linseae Schwabe, 2006		5				5
Iothia coppingeri (Smith, 1881)		1				1
Trochidae						
Antimargarita dulcis (Smith, 1907)					5	5
Brookula sp.	6					6
Margarites refulgens (Smith, 1907)					2	2
Submargarita sp.	1					1
Submargarita macknighti Dell, 1990			3			3
Turbinidae						
Leptocollonia innocens (Thiele, 1912)					5	5
Lissotesta strebeli (Thiele, 1912)	1		109	9	18	137
Liotella endeavourensis Dell, 1990	2					2
Choristellidae						
Choristella agulhasae (Clarke, 1961)			7			7
Skeneidae						
Cirsonella extrema Thiele, 1912					1	1
Seguenziidae						
Seguenzia sp.	2		3			5
Newtoniellidae						
Cerithiella sp.	1					1
Cerithiella sp.					3	3
Turritellidae						
Turritellopsis latior Thiele, 1912			1			1
Rissoidae						
Onoba gelida (Smith, 1907)					2	2
Onoba turqueti (Lamy, 1905)					1	1
Capulidae						
Capulus subcompressus Pelseneer, 1903		4				4
Torellia insignis (Smith, 1915)					1	1
Torellia mirabilis (Smith, 1907)					5	5
Velutinidae						
Marseniopsis sp.					1	1
Eulimidae						
Hemiaclis katrinae Engl, 2004			1			1
Melanella sp. 1			3			3
Melanella sp. 2				5*		5
Melanella sp. 3					27	27

Continuation:Table 27.1: Gastropoda collected by the AGT on ANDEEP-SYSTCO. The shelf station not yet fully sorted is marked with grey.

Taxon	Station	**PS 71/13-15 (AGT 1)**	**PS 71/17-10 (AGT 2)**	**PS 71/33-14 (AGT 3)**	**PS 71/39-16 (AGT 4)**	**PS 71/48-01 (AGT 5)**	Total specimens
	Depth (m)	2990-2996 m	2085-2163 m	5337-5338 m	2143-2151 m	595-602 m	
Naticidae							
Bulbus benthicolus Dell, 1990						3	3
Falsilunatia fartilis (Watson, 1881)						2	2
Naticidae sp. 1		1					1
Naticidae sp. 2		1					1
Kerguelenatica delicatula (Smith, 1902)				1			1
Buccinidae							
Buccinidae sp.		1					1
Buccinidae sp. 1						1	1
Chlanidota sp.						1	1
Pareuthria plicatula Thiele, 1912						1	1
Parabuccinum polyspeirum (Dell, 1990)		1					1
Proneptunea rossiana Dell, 1990						1	1
Prosipho crassicostatus (Melvill & Standen, 1907)						1	1
Prosipho nodosus Thiele, 1912						1	1
Volutidae							
Harpovoluta charcoti (Lamy, 1910)						2	2
Marginellidae							
Volvarina hyalina (Thiele, 1912)						1	1
Cancellariidae							
Nothadmete sp.		1					1
Nothoadmete antarctica (Strebel, 1908)						1	1
Turridae							
Aforia magnifica (Strebel, 1908)						2	2
Belaturricula ergata (Hedley, 1916)						2	2
Belaturricula turrita (Strebel, 1908)						1	1
Oenopota striatula (Thiele, 1912)		2					2
Orbitestellidae							
Microdiscula vanhoeffeni Thiele, 1912						1	1
Omalogyridae							
Omalogyra burdwoodiana (Strebel, 1908)						1	1
Limacinidae							
Limacina helicina (Phipps, 1774)				1		1	2
OPISTHOBRANCHIA *SP.*				1			1
Opisthobranchia sp. 1						1	1
Cephalaspidea sp. 1		2					2
Cephalaspidea sp. 2		1					1
Cephalaspidea sp. 3		1					1
Cephalaspidea sp. 4				1			1
Acteonidae							
Acteon antarcticus Thiele, 1912				1			1

Continuation:Table 27.1: Gastropoda collected by the AGT on ANDEEP-SYSTCO. The shelf station not yet fully sorted is marked with grey.

Taxon	Station	**PS 71/13-15 (AGT 1)**	**PS 71/17-10 (AGT 2)**	**PS 71/33-14 (AGT 3)**	**PS 71/39-16 (AGT 4)**	**PS 71/48-01 (AGT 5)**	Total specimens
	Depth (m)	2990-2996 m	2085-2163 m	5337-5338 m	2143-2151 m	595-602 m	
Philinidae							
Philine antarctica (E. A. Smith, 1902)		3					3
Cylichnidae							
Cylichna gelida (Smith, 1907)				4			4
Diaphanidae							
Toledonia elata Thiele, 1912						1	1
Toledonia globosa Hedley, 1916						1	1
Toledonia punctata Thiele, 1912				6			6
Scaphandridae							
Scaphandridae sp.						2	2
Pleurobranchidae							
Tomthompsonia antarctica (Thiele, 1912)						2	2
Aegiretidae							
Aegires albus Thiele, 1912						3	3
Dorididae							
Austrodoris cf. *kerguelenensis* (Bergh, 1884)						1	1
Total: 67 spp.		27	12	142	14	129	324

* specimens are deeply buried in the tissue of holothurians. More individuals are likely to be found when carefully revising more potential hosts.

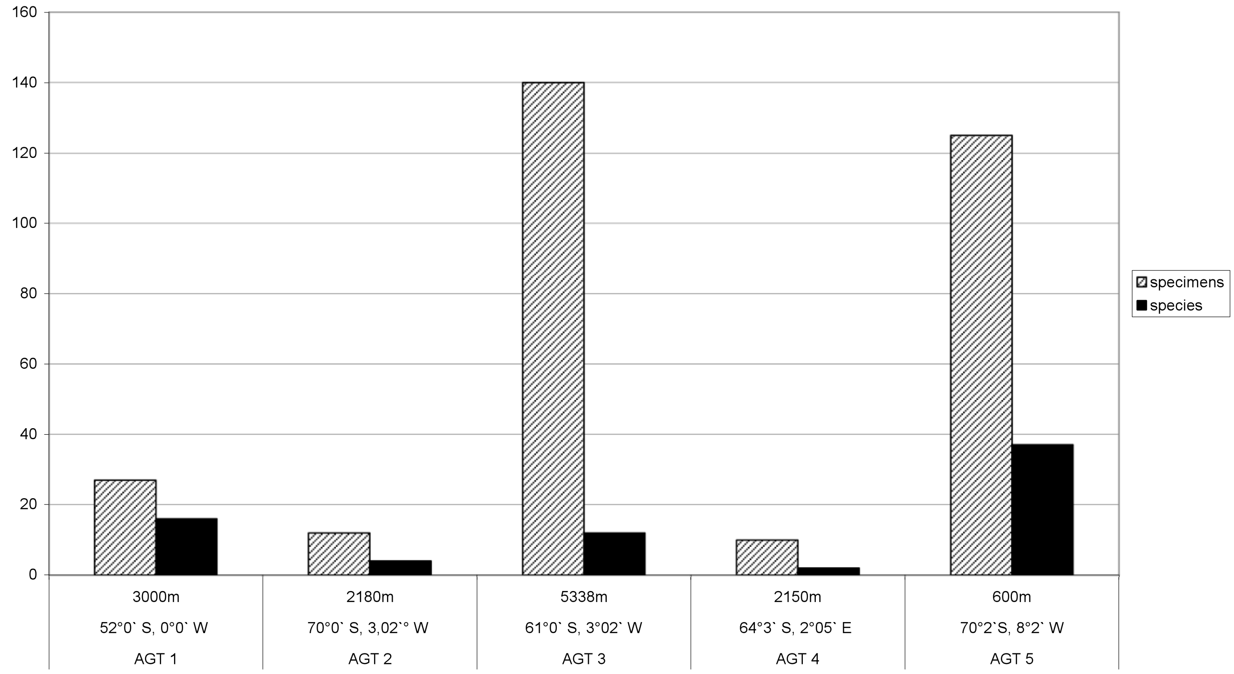

Fig. 27.1: Gastropod specimens and species collected at the 5 AGT stations (AGT 5 not yet fully sorted!)

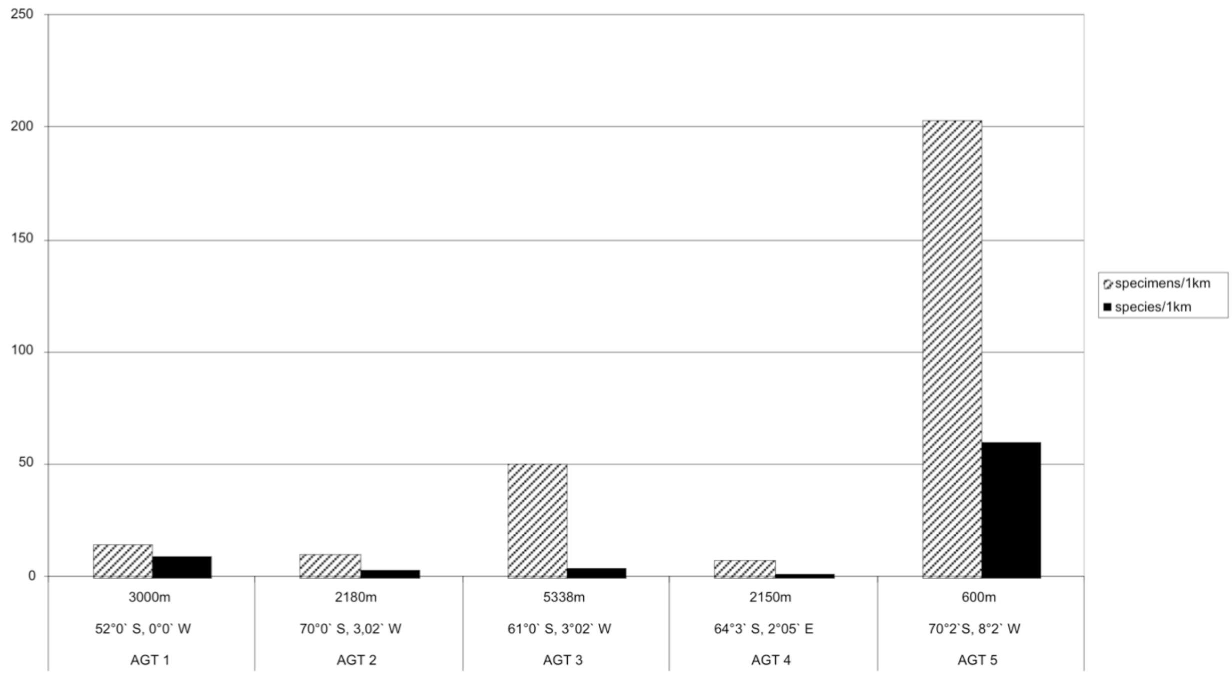

Fig. 27.2: Gastropod specimens and species collected at the 5 AGT stations (AGT 5 not yet fully sorted!), values standardized to 1,000 m trawling distance

28. BIOGEOGRAPHY OF ASTEROIDS

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Scientific background and objectives

The Antarctic fauna is generally described as characterized by its high level of specific endemism, and a relatively low level of generic endemism. Since the isolation of Antarctica, the benthic fauna of the Southern Ocean has been subject to environmental parameters considered as extreme. As an example, glaciation cycles and iceberg scouring largely influence diversity and distribution of the Antarctic benthos. Antarctic asteroids are generally considered as being widely distributed (circumpolar), having a high degree of endemism and a large bathymetric range. To the best of our knowledge, few studies have addressed this question, although asteroids are an ecologically successful group, being well represented in the Antarctic.

A preliminary study has already been carried out using sea stars collected during a previous expedition (ANDEEP III) and by integrating the data obtained with data from other campaigns (*Walter Herwig*, EPOS). The objective is to aggregate the largest quantity of data possible in order to understand interactions resulting from the actual distribution of the Southern Ocean sea stars, using objective presence/absence data.

The preliminary study has shown that among the families considered, the Asteriidae (Forcipulatida) displayed the richest specific biodiversity. Results have also confirmed previous observations on eurybathy, and have refined the available knowledge. The study of specific richness in the different sectors considered in the study has established the east of the Weddell Sea and the southern branch of the Scotia Arc as regions where the sea star fauna is particularly diversified.

While the general analysis has shown that there is little chance that new species are discovered above 1,000 m depth, results have shown that most of the species considered in the study are rarely reported. The results seem to be very different when considering the deep sea (below 1,000 m), which has been far less sampled.

Sampling sea stars during the ANDEEP-SYSTCO will allow completion of the very scattered picture we have on Southern Ocean sea star biodiversity, in the regions which have been less sampled, the Southern Ocean deep sea. It is also intended to utilize genetic tools, in order to support the biogeographic information available.

Work at sea

Asteroids and ophiuroids were collected from the Agassiz trawl and the Rauschert dredge. Every specimen was sorted to species level and fixed in 70 % ethanol.

Preliminary results

Including the station (PS 71/16 and PS 71/48), a total of 144 Asteridae and 814 Ophiuridae have been collected during this cruise. Table 28.1 shows the numbers of individuals collected at each station and by the different gears.

Tab. 28.1: Numbers of individuals collected at each station and by different gears

Station	Depth	Gear	Number of individuals of	
			Asteroidea	Ophiuroidea
PS 71/13	2990 m	AGT	7	32
PS 71/16	486 m	RD	1	21
PS 71/17	2084 m	AGT	22	27
PS 71/33	5336 m	AGT	27	36
PS 71/39	2150 m	AGT	0	135
PS 71/48	602 m	AGT	69	488
	602 m	RD	18	75
		Total:	**144**	**814**

29. BIODIVERSITY AND EVOLUTION OF ECHINOIDS

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Scientific background and objectives

A conspicuous and important component of the benthic community is the cidaroid echinoids (colloquially known as pencil-spine sea urchins). The cidaroid assemblage of the Southern Ocean belongs to the subfamily Ctenocidarinae and comprises approximately 21 extant species within 5 genera. In spite of the suitability of this taxon for studying major biological factors in the Southern Ocean, problems with the systematics of the group require investigation. In the process, many data relating to the evolution of benthic Antarctic fauna can be uncovered. Among the ctenocidarines, the status of taxa at every rank is uncertain. The confusion surrounding the systematics of this group is due in part to a lack of consistent, well-delineated features that can be used to unequivocally identify some species. Morphological techniques, along with advanced molecular analyses of several genes will be used to elucidate the systematics of this group. This will provide, for the first time, well supported data to construct a comprehensive phylogenetic tree. By studying phylogenetic trees one can map the events that signify environmental change, such as alterations in biogeographic and bathymetric distributions, and in reproductive behaviour.

Although the full ranges of these species are poorly known, many have a circumpolar distribution: a remarkable feat for species without dispersive larvae. Generally, the production of pelagic larvae is a common mode of development for benthic organisms of the Southern Ocean. However, there are a number of speciose clades that protect their brood. The ctenocidarines are one such clade. Brood-protection has been reported in 13 ctenocidarine species to date and is suspected in the remaining species. How so many brood protecting taxa, such as these urchins, have come to be so diverse in the Southern Ocean compared to the other areas of the world oceans, is unknown. It has been proposed that the unique oceanographic conditions of the Southern Ocean, afforded by the opening of Drake Passage initiating the Antarctic Circumpolar Current (ACC), have contributed to the radiation of these clades. Indeed, a larger number of brood-protecting benthic invertebrate species are found in the region of the Scotia Arc than in surrounding areas. Through the analysis of the morphological and molecular phylogenetic trees elucidated for this group, and careful calibration for an accurate timeline, we will be able to reconstruct their evolutionary history. Support for the theory will be gained if the majority of genera are 23 million years old or younger, i.e. if the radiation of this group occurred mainly after the final isolation of Antarctica and the initiation of the ACC.

The cruise track of ANDEEP SYSTCO has covered poorly sampled areas and, therefore, will greatly enhance the morphology-based taxonomy and distribution, as well as the molecule-based phylogeny, components. The sampling of these areas, particularly the abyssal biome, will greatly expand the biodiversity data already collated on all the Antarctic echinoids; not just of the cidaroids but also of the other six echinoid families, both regular and irregular, that occur in the Southern Ocean.

Work at sea

Echinoids were collected from the Agassiz trawl and the Rauschert dredge. Every specimen was sorted to the species level and fixed in 70 % ethanol.

Preliminary results

In total, 142 Echinoids were collected during this cruise (including the non-SYSTCO stations, PS 71/16 and PS 71/48); 121 Regularia and 21 Irregularia (Table 29.1).

Tab. 29.1: Number of regular and irregular echinoids by gear and station

Station	Depth	Gear		Number of individuals	
				Regularia	Irregularia
PS 71/13	2990 m	AGT		2	0
PS 71/16	486 m	RD		6	0
PS 71/17	2084 m	AGT		58	4
PS 71/33	5336 m	AGT		0	0
PS 71/39	2150 m	AGT		10	2
PS 71/48	602 m	AGT		34	9
	602 m	RD		11	6
			Total:	121	21

30. PRELIMINARY RESULTS OF SEABED VIDEO IMAGES

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Objectives

Seafloor images were obtained as a supplement to the benthos gear, adding to the information on the life at the ocean bottom from other gear, such as the EBS, AGT and GKG.

Methods

The underwater camcorder was deployed four times as explained in the chapter on benthic work – introduction to the work at sea.

Preliminary results

A first analysis of the image-frames and video material allowed an approximate specification of the sediment consistency and a simple characterization of the relative abundance of epifauna. The general results of the analysis of the video images are summarised in Table 30.1.

Tab. 30.1: Results of the analysis of the video and picture-frame material of the four successful deployments of the underwater-camcorder during ANT-XXIV/2

	date	area	depth	Trk. Dist. [m]	usable minutes	frames total / frames used	Sediment	Stones	Schill	visible Macrofauna (>5cm) total	Macrofauna / minute	relative Dist. [m]	relative Abundance [m]
TVS II PS71/17-15	22.12.07	Continental Slope	1960 - 2044	870	12.9'	8/3	soft 80-95%	5-20%		128	9.8	187	0.7
TVS III PS71/33-17	31.12.07	Central Weddel Sea	5349 - 5344	222	3.0'	3/2	very soft 100%			1	0.33	11	0.1
TVS IV PS71/39-9	03.01.08	Maud Rise	2117 - 2120	370	12,8'	10/5	coarse ~98%	1-2%		18	1.3	79	0.1
TVS V PS71/48-2	12.01.08	nearby Northern Pier	594-616	481	18.9'	5/5	condensed ~55%	~45%	~5%	291	15.4	151	1.9

Most conspicuous is the fact that at the Stations PS71/17-15 and PS71/33-17 on the shelf and on the continental slope, respectively, the sediment contains a high number of drop-stones. These stones allow non-digging, sessile animals to colonize this habitat. Consequently the biodiversity at those stations is much higher than at stations without stones, as the sampling stations PS71/39-9 and PS71/48-2 showed. Furthermore, depending on a presumably higher input of nutrients close to the coast, the biomass was much higher at Station PS71/17-15 on the shelf and at PS71/33-17 on the continental slope than at the stations in the open ocean (PS71/39-9 and PS71/48-2). This is clearly visible by analyzing the relative abundance of the macrofaunal animals (Fig. 30.1).

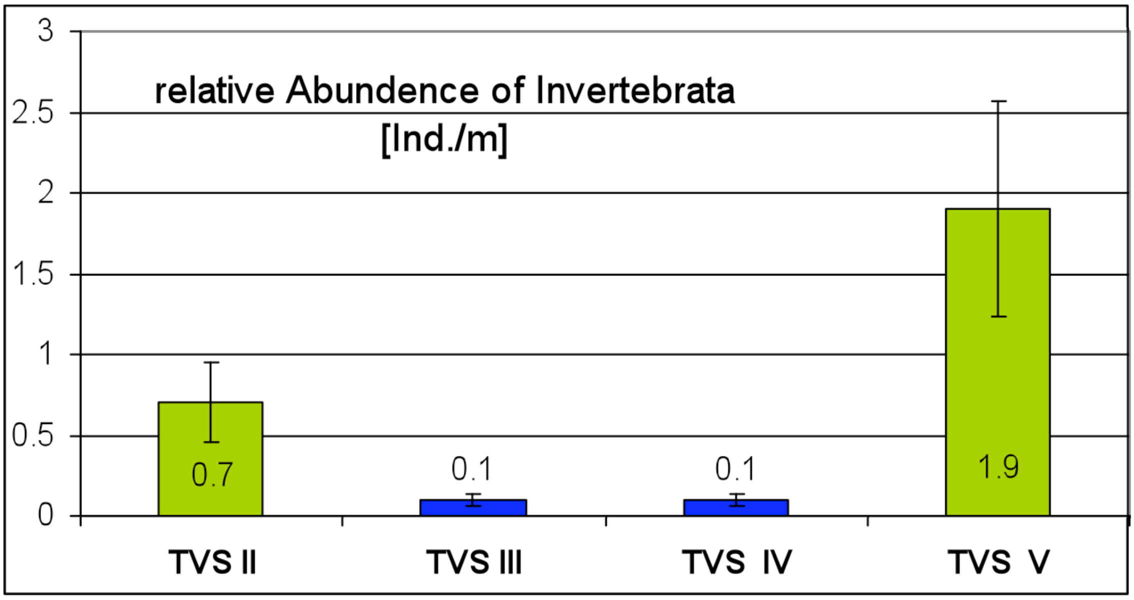

Fig. 30.1: Relative abundance of the visible macrofauna per minute, calculated for the relative distance of the underwater-camcorder track in meters

It is important to note that the error rate is high due to the subjective nature of an analysis based on the interpretation of pictures (frames).

Nevertheless, video surface observation is very useful to identify geomorphologic structures and the frequency of biological activities. The visual perception of the sea bottom stimulates our thoughts about the processes at the sediment-water interface in a manner that corers, grabs and net catches can not replace. The technology of remote monitoring of the deep-sea floor allows us a better understanding of the complexity of sediment dynamics.

31. DOMINO - DYNAMICS OF BENTHIC ORGANIC MATTER FLUXES IN POLAR DEEP-OCEAN ENVIRONMENTS

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Being part of the ICED umbrella (Integrating Climate and Ecosystem Dynamics) and closely associated to the IPY projects ANDEEP-SYSTCO (ANtarctic benthic DEEP-sea biodiversity: colonization history and recent community patterns - SYSTem COupling) and SCACE (Synoptic Circum-Antarctic Climate-processes and Ecosystem study), DOMINO links water column processes such as particle export and the fate of this food supply to the polar deep-sea communities at the seafloor. The DFG-funded project (Priority Program Antarctic Research) focuses on the determination of organic carbon fluxes onto deep-sea sediments of the Southern Ocean, their spatial distribution as well as their temporal dynamics. Such fluxes to the seafloor comprise a carbon sink at the lower end of the ocean's biological pump which binds atmospheric CO_2 to biomass and partly exports it to depth. Although playing a key role in this respect, there are so far only few data available for the Southern Ocean. DOMINO aims to improve the data coverage by high quality *in-situ* measurements (for methodology, see chapter 14, 15) and will at the same time foster the multidisciplinary linkage to planktology, oceanography, and benthos biology by the project's close linkage to SYSTCO, SCACE and LAKRIS.

The ANT-XXIV/2 expedition ties up to the ANT-XXI/4 cruise in 2004 during which benthic fluxes were measured on a north-south transect through the ACC front system to the Weddell Sea. Scientific publications, discussions and workshops in the aftermath of ANT-XXI/4 helped to coordinate the planning of the much more multidisciplinary IPY cruise ANT-XXIV/2, and to adjust the field programmes of SCACE, LAKRIS, DOMINO and SYSTCO. In this concert, DOMINO was to act as a "geochemical interface" between water column and benthos investigations. Due to time constraints, one element of the programme could not be worked out: The near-bottom water column (bottom-next 2 metres) was planned to be sampled at the SYSTCO stations by means of a special bottom water sampler (Sauter et al., 2005) for the description of gradients in dissolved substances, particles and microorganisms. This sampler was not deployed at all during the cruise.

However, despite the mentioned difficulties, a number of research highlights could be achieved during this cruise: Amongst others, the DOMINO-related results can be summarized as follows (for a more detailed description of preliminary results see chapter 16):

- Close to the shelf ice, benthic fluxes were found to be low under the exceptionally heavy sea ice but significantly elevated after the opening of a polynia.
- During the cruise the southernmost *in-situ* flux measurement was carried out at 69°40'S.
- At least one of the originally planned repetition stations could be investigated and allowed for new insights into the dynamics of seasonal benthic food supply and the activities of benthic infauna. Whereas the benthic organic carbon input was found to be 3 times higher end of January than at the begin of December, an additional station 12 nautical miles south of this repetition station showed a 20 % lower mean flux.
- The preliminary comparison of benthic fluxes with the development of sea surface chlorophyll (from remote sensing data) suggests a linkage between these parameters.
- As an overall result, this cruise revealed, that our knowledge of the pelago-benthic coupling in the Southern Ocean is still poor. Continued efforts and an integrated approach including water column as well as benthic investigations is necessary to reveal the role of the benthic compartment in respect to carbon export, reworking and fixation, respectively, and to assess the ecological importance of the Southern Ocean's sea-floor habitats for system functioning.

Reference

Sauter, E. J., Schlüter, M., Wegner, J., Labahn, E. (2005). A routine device for high resolution bottom water sampling. Journal of Sea Research, 54, 204-210.

32. EDUCATION AND OUTREACH REPORT - POLARSTERN ANT-XXIV/2

Victoria Wadley[1)], Brigitte Ebbe[2)]

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The initial objective of the Education and Outreach (E&O) campaign on *Polarstern* ANT-XXIV/2 was to publicise the scientific results of the voyage. This objective was subsequently broadened, to include the logistic activities. Projects of the International Polar Year (IPY), including the three on *Polarstern* ANT-XXIV/2**,** have agreed to include the education of young scientists ("the next generation of polar researchers") and outreach to the general public. E&O campaigns for 18 biodiversity voyages during the IPY, including *Polarstern* ANT-XXIV/2, are being coordinated by the Census of Antarctic Marine Life (CAML) in association with the IPY. The campaign was implemented on board by scientists with media experience and specialist training, in addition to their research duties. All participants on the voyage contributed to the campaign in a cooperative spirit.

The E&O activities are grouped into those before the voyage, while at sea, and at the end of the voyage. Communications at sea are limited by the high cost of emails and lack of internet access. As a consequence, important aspects of the campaign were planned for the weeks immediately after the voyage. The AWI Press Office provided advice and support, including an .ftp site accessible by partner organisations to feed their websites.

Before the voyage a Memorandum of Understanding was signed by a responsible person at each participating institution. This document outlined the objectives and scope of the campaign and the roles of the contributors, most importantly the Voyage Leader to approve all material. A meeting at AWI on 4 October 2007 clarified the approach and provided connection with the successful press coverage of biodiversity research on *Polarstern* ANT-XXIII/8. English was the main language used, with translation to German, Dutch and French as appropriate.

While at sea the scope of the E&O campaign was presented to all scientists at an evening lecture early in the voyage. A daily activity report for the Census of the Diversity of Abyssal Marine Life (CeDAMar) website was coordinated by Brigitte Ebbe, using text (in both English and German) and photos from contributing scientists. Victoria Wadley wrote a weekly biodiversity report for the CAML website about the animals and sampling gear, accompanied by photos and videos. Equipe Cousteau and Census of Marine Life (CoML) posted material from the campaign.

Jan van Franeker coordinated a regular series of short videos by the Surface and Under Ice Trawl (SUIT) team for the official Dutch IPY website, which were shared through the AWI ftp server, and contributed articles, photos and video material for general usage. On a more personal level, the Dutch team produced weekly illustrated newsletters in Dutch and German Partner websites including IPY.

Through CAML, *Polarstern* communicated with E&O campaigns on the vessels *Ivan Papanin*, *Aurora Australis*, *G.O. Sars, L'Astrolabe, Umitaku Maru* and *Tangaroa* which were at sea at the same time on IPY biodiversity voyages. Reports to participating institutions were submitted as required. The IPY office and the Scientific Committee on Antarctic Research (SCAR) were updated regularly on developments. Standard protocols were adopted for photo metadata, including acknowledgement of authors and their institutions.

Karoline Stürmer wrote an article published in the *Frankfurter Allgemeine* about the voyage's logistic support for the construction of Neumayer III. Michael Schröder wrote for a Munich newspaper about his discovery of a rare monoplacophoran, significant for molluscan phylogenetics. Various articles were written for local newspapers in Germany and the Netherlands and a telephone interview was given on Dutch national radio. A press release was prepared to announce *Time* magazine's selection of a deepsea Antarctic biodiversity *Nature* paper in the Top Ten science results of 2007; four of the authors were on the *Polarstern voyage*.

During the voyage, the E&O team presented the results of the campaign and thanked all participants. Many scientists expressed interest in continuing the activities as part of their projects, using the freely-shared resources (text, photos, videos) collected during the campaign. As an example, one of the daily reports was selected as the introduction for a childrens' book. The students on board increased their awareness of how to communicate their results to a wider audience.

At the end of the voyage posters, talks and video material on the voyage's highlights were prepared for a press conference in Capetown on 5 February, attended by Minister Schavan and 150 guests. It is hoped that these E&O products will foster cooperation between South African and German research institutions through messages tailored to viewpoints of politicians, media and decision makers. Furthermore, the presentations will support in an understandable way the scientists' bid for additional shiptime to make up for the time losses due to logistic responsibilities of *Polarstern*. The E&O highlights will be archived for publicity by CoML/IPY at the end of the IPY in March 2009. The effectiveness and impact of the campaign, including website hits, will be assessed in the weeks after the voyage.

List of partner websites
Alfred Wegener Institute for polar and marine research www.awi.de
Biodiversity reports for the CAML website www.caml.aq
Daily blogs to CeDAMar www.cedamar.org and www.deepsea-research.de
Equipe Cousteau coordinating 18 biodiversity voyages at www.cousteau.org
Census of Marine Life international marine biodiversity coordination www.coml.org
The Dutch IPY website is www.pooljaar.nl in which page www.pooljaar.nl/poolijs/ refers especially to the *Polarstern* ANT-XXIV/2 participation; Dutch/German newsletters posted on www.jafweb.nl

33. WEATHER

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The expedition ANT-XXIV/2 started in Cape Town in the evening of 28 November, just after sunset. Frequency distributions of wave heights, wind directions and wind forces for Dec 07 and Jan 08 are presented in Figs. 33.1, 33.2 and 33.3, respectively. The first two days were dominated by a subtropical high pressure system with SE-winds decreasing from 7 Bft near the coast to 4 Bft on the open sea. During the following days *Polarstern* crossed the west drift and several deep cyclones with their frontal systems passed the track causing stormy winds. The first storm occurred on 1 December, a further one on 3 December and a third one on 7/8 December. The synoptic situation of these three storms was quite similar and was defined by a cyclone with a well marked trough on the rear side. At each time a maximal wind speed of 8 - 9 Bft and waves of 7 - 9 m were observed when the trough passed. On 9/10 December a high pressure ridge extended to the south and by its moving to the southeast the wind shifted from southwest to northwest and decreased to 4 Bft. At the late evening of the 9 December the sea ice limit was reached at 60°S.

From 11 to 13 December the weather was dominated by a low pressure system that moved along 60°S to the east. The winds changed their direction from northwest to northeast with 3 - 4 Bft and light snowfall occurred when the occlusion passed through. Behind this eastwards-moving cyclone a high pressure ridge built up and after a passage through quite heavy ice *Polarstern* arrived in the early afternoon in the Atka-Bay. The unloading had to take place on the sea ice of the Atka-Bay Due to the fast ice it wasn't possible to go alongside the shelf ice edge. Therefore the unloading had to take place on the sea ice of the Atka-Bay.These operations took almost two days, and fair weather with weak southerly winds dominated till 17 December. Between the anticyclone over the Antarctic continent and a cyclone moving along 62°S weak southerly winds persisted, sometimes even calm.

From 18 to 21 December an extensive storm cyclone moved from the South Sandwich Islands to the southeast. With its flat trough, which reached to the eastern Weddell Sea, it caused mainly weak winds with changing directions. The unloading of the fuel for Neumayer was finished at midday of 19 December.

On 22 December another storm cyclone moved from Bouvet Islands to the southeast and filled up. *Polarstern* was on the southern edge of this low, so the winds of 4 Bft shifted slowly from east to southeast and later to south.

On 24 December a ridge of high pressure built up over the Lazarev Sea and dominated the weather until 27 December. Below a pronounced inversion there were an extended layer of low level clouds and southwesterly winds of 3-4 Bft which shifted to the northwest on 26 December. From 28 to 30 December *Polarstern* was between an occluded low near South Sandwich Islands and a high over the Lazarev Sea, what caused northeasterly winds 4-5 Bft. They shifted gradually to southeast and later to southwest.

For the turn of the year cyclonic weather conditions prevailed. A low pressure system over the Weddell Sea passed Cape Norvegia and travelled on to the Lazarev Sea. After its coldfront went through westerly winds 6 Bft set in, shifting to southwest on New Year. In only few or even no ice waves built up to 2 - 2,5 m.

On 2 January a secondary cyclone over the Weddell Sea moved to the Lazarev Sea and its occlusion front brought some snowfall and freezing drizzle. The northwesterly wind increased to 5 Bft. Already on the next day a ridge followed and the decreasing winds shifted from southwest to east. On 4 and 5 January on the southern edge of a low on 57°S 7°W moving to the southeast an easterly current of 5 - 6 Bft developed, with embedded showers of snow and snow grains. A ridge of high pressure caused on 6 and 7 January southeasterly winds of 3 - 4 Bft, shifting later to west. Extended stratocumulus clouding prevailed. On 8 January the scientific work was stopped and *Polarstern* sailed back to the Atka Bay for supporting the freighter *Naja Arctica*. On the southern edge of an extended low over the Weddell Sea an easterly current caused wind speeds of 5 - 6 Bft. On 9 and 10 January a ridge of high pressure over the Lazarev Sea brought sunny weather and southerly winds around 4 Bft. From 11 to 13 January cyclonic weather dominated. An intense low pressure system developed west of South Georgia and moved to the eastern Weddell Sea. On the southern edge of this cyclone there were easterly winds of 8 Bft over the Atka Bay on the 12/13 January. Already on the 14 January the wind shifted to southeast on the back of the low and later decreased to 4 Bft. And it was also quite sunny due to the dry air that was advected from the continent.

A ridge of high pressure formed over the eastern Weddell Sea and shifted very slowly to the Lazarev Sea, where it became more and more flat. Therefore weak southwesterly winds prevailed, temporary it was almost calm. Most of the time it was cloudy, occasionally some showers of snow occurred.

From 20 to 22 January a small cyclone moved slowly from the eastern Weddell Sea to the Lazarev Sea. In the moist and unstable air convective clouds formed and also some showers of snow. The moderate winds came first from northwest, later from southwest. From 23 to 25 January a small cyclone moved from the South Sandwich Islands to the southeast and influenced the weather during the station work. The highest wind speed during the passage of this low was observed on 24 January when a northwesterly wind of 7 - 8 Bft occurred.

On 26 January a low pressure system developed over the Weddell Sea and moved, under further intensifying to a storm, until 29 January to 63°S 10°E, where it became stationary then. *Polarstern* was on the northern flank of the storm low in a westerly current. On 27 January the wind speed increased to 9 Bft and a wave height of 8 m was observed (Fig. 33.1). The wind remained between 7 and 8 Bft until the morning of 29 January, and then it decreased to 6 Bft and the waves to 6 m.

On 30 January a cyclone travelled in a westerly current from the South Sandwich Islands to the southeast and its circulation enclosed more and more *Polarstern*. The northwesterly wind increased to 6 - 7 Bft. At the evening the last iceberg of this cruise was observed (47°S 0°W). On 31 January the cold front that belonged to the low passed eastwards and brought some showers of rain and northwesterly winds of 7 Bft, temporary up to 8 Bft.

On 1 and 2 February a westerly current existed between 40°S and 50°S. An embedded low moved to the east and first a westerly, later a northwesterly wind increased to 5 - 6 Bft (sea 2 - 3 m). On 2 February the weak tail of its coldfront passed in the evening *Polarstern* accompanied by showers of rain and by westerly winds of 7 - 8 Bft. Behind the cold front an anticyclone over the South Atlantic extended to the southeast on the next day and caused stabilization and drying of the air mass. The southwesterly wind decreased slowly during the day from 8 Bft to 5 Bft. On 4 February, when *Polarstern* entered Cape Town, a strong southeasterly wind blew.

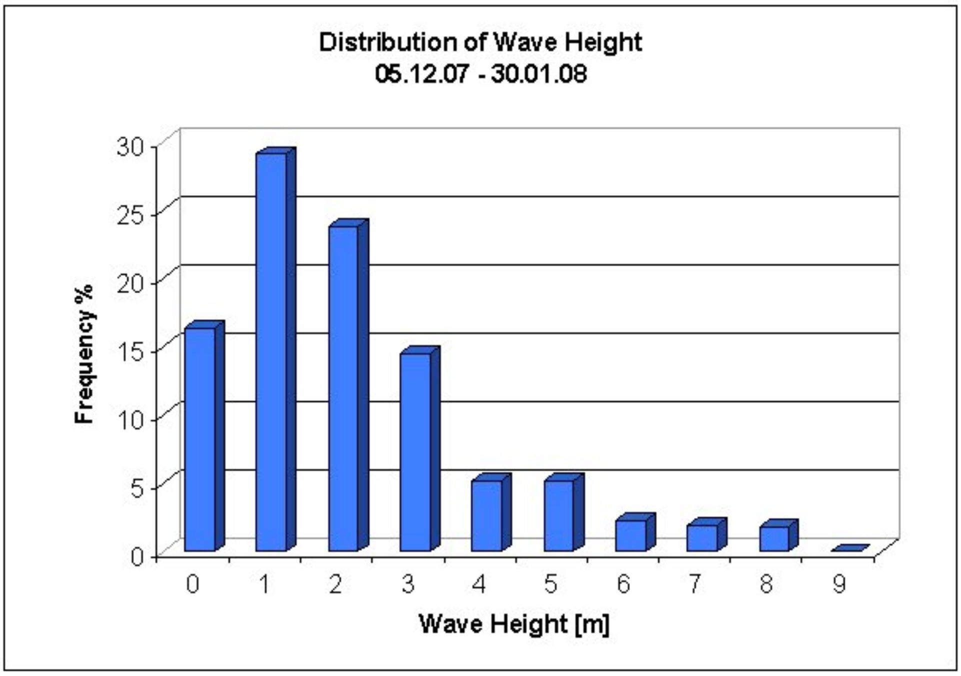

Fig. 33.1: Frequency distribution of wave heigt in Dec 07 and Jan 08

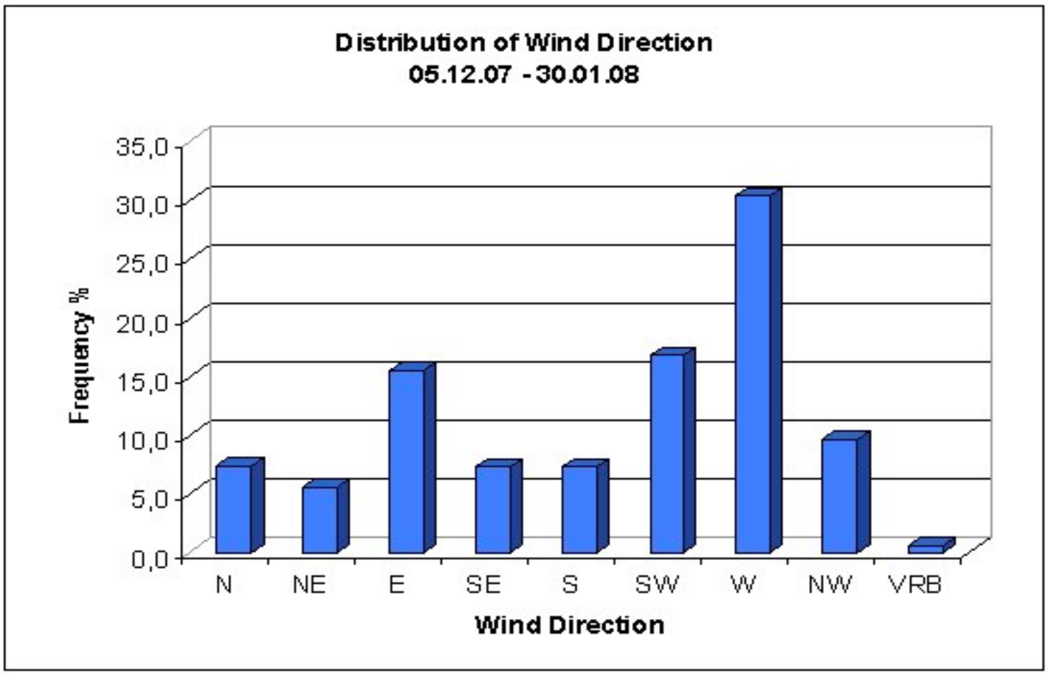

Fig. 33.2: Frequency distribution of wind direction in Dec 07 and Jan 08

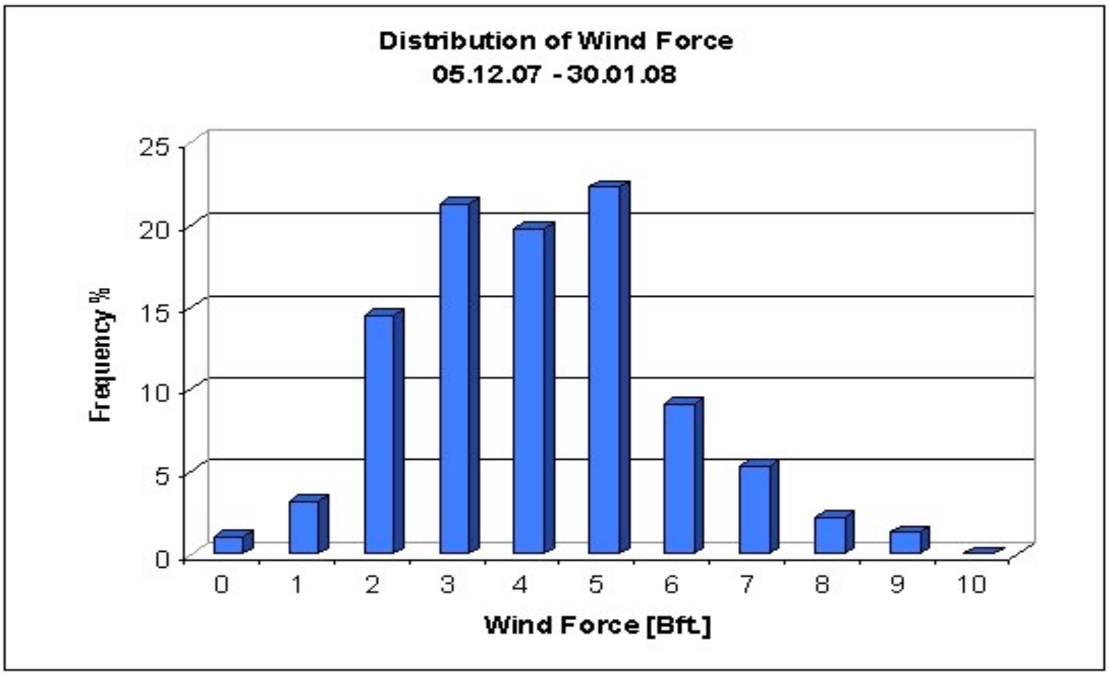

Fig. 33.3: Frequency distribuition of wind force in Dec 07 and Jan 08

34. SEA ICE CONDITIONS DURING POLARSTERN EXPEDITION ANT-XXIV/2, DECEMBER 2007 – JANUARY 2008

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[2)]Deutscher Wetterdienst Hamburg, Germany

Introduction

Sea ice conditions are a major determinant in marine biology, physics and chemistry and therefore of direct relevance to all studies conducted during the *Polarstern* ANT-XXIV/2 expedition. Regular updates on the ice situationfrom satellite information was provided during the daily weather forecasts on board. Summer 2007 - 2008 in the Weddell and Lazarev Seas was characterized by unusual heavy, extended and persistent sea ice. This made progress slow for *Polarstern* on its first southward transect to Neumayer Station. Persistent fast ice also necessitated a second journey to the station in the second week of January to break out a harbour in the fast ice to allow unloading of the freighter *Naja Arctica* at the cliffs of the shelf ice.

The seasonal melting of sea ice in the Lazarev Sea is not only characterized by a north south retreat but also by a strong east to west retreat. Melting often starts in a polynia to the west of Maud Rise which rapidly widens. This pattern of rapid southward and eastward retreat of the sea ice in the Lazarev Sea is clear from a comparison of the satelite images of 21 Dec and 29 Dec 2007, starting and end date of the first research transect moving north from 70° to 60° South along 3° West. Satellite images shown in Fig. 34.1 are produced by Bremen University (Spreen et al., 2006) from microwave radiometers with a spation resolution of 6 x 4 km and thus lack resolution at low ice concentrations. Furthermore, the speed of melting complicates the assessment of actual ice conditions around *Polarstern* at its station positions from satelite images. Detailed ice records are a standard component of the predator survey programme (van Franeker et al., this volume) and allow fine scale additional information for momentary ice conditions around station positions

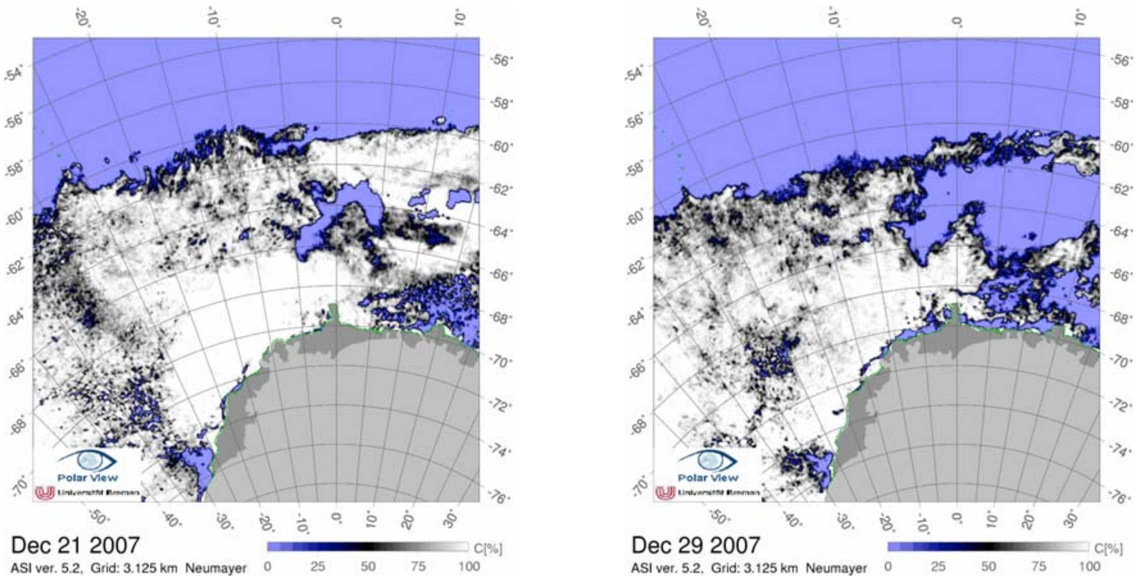

Fig. 34.1: Rapid changes in sea ice conditions during the ANT-XXIV/2 transect along 3°West, from 21 to 29 December 2007

Work at sea

Methods

The observation units for top predator surveys and associated information are ten minute counts for ship-based observations and 'waypoint counts' for censuses conducted from the helicopter. For details see Van Franeker et al. (this volume). With each ship and helicopter count, an assessment was made of the average ice conditions within the surveyed transect band of usually 300 m wide. The surface area thus assessed is usually less than 1 km^2 in a ship count and between 2 and 3 km^2 in a helicount. As a minimum in both survey types, the average ice cover (% of surface) and the size of dominant floes (diameter in meters) is recorded. Some more details are recorded in the ship observations, among which the number of icebergs within horizon distance. Within horizon distance is defined as 'waterline of berg visibly below horizon with the bare eye'. In practise this means bergs within a circular distance of approximately 6 to 7 nm. Evidently this is a rough indicator of iceberg abundance, also depending on visibility. Icebergs are relevant as they can have strong impact on water physics and chemistry, and thus biology.

As with top predator data, ice information from individual counts from helicopter and ship, was averaged over sections of half a degree of latitude, i.e. from 15 nm south to 15 nm north of each station position. Thanks to the combination of ship and helicopter surveys, coverage of all transects was virtually complete. Iceberg data are lacking when a section was covered by only heli surveys. Since observations were made from the ship itself or heliflights in direct surroundings, the records give an accurate picture of ice conditions at the time of station work.

Results

The averaged results for all transects, including the initial southward leg to Neumayer ("transect 0") are shown in Table 34.1. For details on number of observations and surface area surveyed at each position, see Table 34.1 in the top predator report by Van Franeker et al (this volume). The initial transect to Neumayer ran along the 1° West longitude until about 65°S and then changed to a southwestern course to 70°S-8°W. The sea ice edge at this initial transect was situated a bit south of 60°S. Other approximate sea ice edge positions are apparent from the table. In all situations, sea ice edges were very 'loose' starting with belts and open ice fields over considerable distances. Data for transect 1 along 3° West show good correlation with the satellite pictures in Fig. 34.1 with the exception that the satellite images show 'open' water where in reality still loose sea ice was present with low concentrations. As a consequence, the satellite image shows a larger polynia to the west of Maud Rise than was actually observed.

Tab. 34.1: Average ice conditions around ANT-XXIV/2 station positions, December 2007 to January 2008, recorded during top predator surveys from ship and helicopter. For sample sizes and areas surveyed see Van Franeker et al. (this volume: Table 13.1). The bottom row provides overall average transect data for the study grid south of 62°S.

	Transect 0			Transect 1			Transect 2			Transect 3		
	10-14 Dec 2007 1°- 8° West			21-29 Dec 2007 3° West			01-06 Jan 2008 3° East			17-23 Jan 2008 0° Meridian		
Latitude	average icecover %	average floesize m	average nr of icebergs	average icecover %	average floesize m	average nr of icebergs	average icecover %	average floesize m	average nr of icebergs	average icecover %	average floesize m	average nr of icebergs
-60.0										0	0	8.4
-60.5	37	8	1.7							0	0	9.0
-61.0	68	8	0.6	18	6					0	0	10.2
-61.5	87	15	0.0	56	8					0	0	8.2
-62.0	**83**	**16**	**0.0**	**58**	**10**	**0.0**	**0**	**0**	**0.3**	**0**	**0**	**5.3**
-62.5	**91**	**25**	**0.0**	**7**	**3**	**1.0**	**0**	**0**	**0.5**	**0**	**0**	**0.4**
-63.0	**79**	**27**	**0.0**	**13**	**5**	**0.9**	**0**	**0**	**0.0**	**0**	**0**	**0.9**
-63.5				**31**	**14**	**0.7**	**12**	**6**	**0.0**	**0**	**0**	**1.0**
-64.0	**82**	**293**		**20**	**10**	**1.6**	**19**	**12**	**0.0**	**0**	**0**	**1.0**
-64.5	**76**	**429**	**1.4**	**0**	**1**	**0.6**	**15**	**13**		**0**	**0**	**0.5**
-65.0	**69**	**90**	**0.4**	**0**	**1**	**0.3**	**8**	**12**	**0.8**	**0**	**0**	**0.0**
-65.5	**72**	**188**	**0.0**	**3**	**10**	**0.6**	**17**	**10**	**0.0**	**0**	**0**	**0.0**
-66.0	**62**	**75**	**0.0**	**43**	**47**	**0.5**	**7**	**8**		**0**	**0**	**0.4**
-66.5	**82**	**419**	**0.0**	**53**	**281**	**0.0**	**37**	**14**	**0.0**	**0**	**0**	**0.0**
-67.0	**95**	**911**		**81**	**634**	**0.0**	**27**	**17**	**0.4**	**0**	**0**	**0.7**
-67.5	**92**	**1071**	**0.0**	**87**	**581**	**0.0**	**81**	**18**	**0.0**	**24**	**7**	**0.0**
-68.0	**92**	**1029**	**0.0**	**87**	**626**	**0.6**	**41**	**20**	**0.0**	**29**	**10**	**0.0**
-68.5	**86**	**1057**	**0.0**	**78**	**514**	**1.0**	**45**	**316**	**1.4**	**41**	**402**	**1.7**
-69.0	**84**	**755**	**1.0**	**67**	**639**	**1.9**	**73**	**2217**	**2.0**	**80**	**957**	**4.1**
-69.5	**78**	**672**	**0.5**	**61**	**560**	**1.0**				**46**	**115**	**3.4**
-70.0	**81**	**729**	**0.8**	**53**	**557**	**4.0**	**15**	**22**	**3.7**	**53**	**4574**	**4.0**
-70.5	**48**	**1235**	**4.2**	**4**	**7**	**4.6**				**20**	**14**	**4.0**
S of 62°S	**79**	**531**	**0.5**	**41**	**250**	**1.1**	**25**	**168**	**0.7**	**16**	**338**	**1.5**

Acknowledgements

Officers and crew of Polarstern and pilots and technicians of Heli Transair are gratefully acknowledged for their support to the top predator observation programme. The research project by IMARES is funded by the Netherlands Ministry for Agriculture, Nature and Food Quality (LNV). We thank the to the Alfred Wegener Institute for its open attitude to international cooperation through the sharing of costly logistic facilities.

References

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35. ACOUSTIC SURVEY OF THE HORIZONTAL AND VERTICAL DISTRIBUTION OF KRILL, ZOOPLANKTON AND NEKTON

Sören Krägefsky, Ulrich Bathmann — Alfred-Wegener-Institut, Bremerhaven, Germany

Objectives

Antarctic krill, *Euphausia superba*, is an important species in the Antarctic food web and plays an important role in the biochemical cycling in the Southern Ocean. Antarctic krill provides an important food source for whales, seals, penguins, squids, fish and birds.

There is a potential for large increase in krill fishery in the coming years due to the development in krill-processing technology and an increasing demand (Kock et al. 2007). Today, most krill is processed to produce fish food.

The distribution of krill is highly uneven, and despite long lasting research, estimates of the total krill biomass and production is still very uncertain (Atkinson et al., 2009). Acoustic measurements allow to study the distributional pattern of krill in large survey areas, and were used for survey krill abundance and distribution in the Lazarvev Sea. The Lazerev Sea is part of the area 48.6 of the Convention of the Conservation of Antarctic Marine Living Resources (CCAMLR), which, so far, has a small spatial and temporal coverage with krill measurements.

Work at sea

The distribution and abundance of krill, zooplankton and nekton were surveyed continuously with multifrequency acoustic measurements, using a Simrad EK60 at frequencies 38, 70 120 and 200 kHz. A calibration of the system was performed on 08 - 09.01.2008 with standard target spheres. During the survey, a pulse duration of 1,024 ms was used for all frequencies. Raw data was recorded down to a depth of 1,000 m, at a ping rate of 1 ping every 2 - 3 seconds. The acoustic survey comprised four main meridional transects across the Lazarev Sea (Fig. 35.1), with a time lag between single transects due to logistic tasks during the expedition. The noise content of the acoustic record varies, among others, subject to the actual ice coverage encountered along the transects.

Preliminary results

Preliminary data exploration suggests that advection and seasonal vertical displacement of animals may have contributed to changing backscattering signature over the course of the survey.

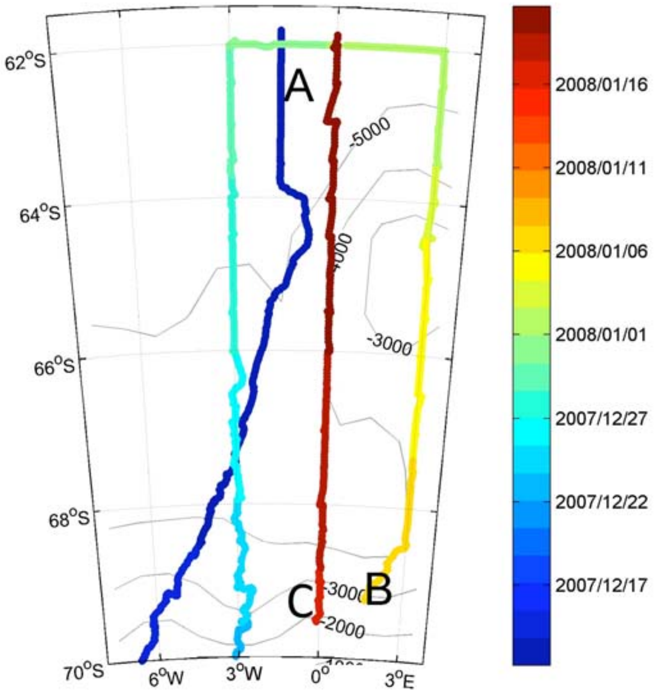

Fig. 35.1: Main transects of the acoustic survey. Colour code of transect lines indicate the date. Measurements along the transects were performed from A:10.12.2007 – 13.13.2007, B: 23.12.2007 – 06.01.2008, C: 17.01.2008 – 22.01.2008.

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Kock, K-H., Reid, K., Croxall, J. and Nicol, Stephen (2007) Fisheries in the Southern Ocean: an ecosystem approach. Phil. Trans. R. Soc. B 362: 2333-2349

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION LIST

A.1 BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Adresse /Address
AAD	Australian Antarctic Division Department of the Environment and Water Resources 203 Channel Highway 7050 Kingston, Tasmania Australia
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 12 01 61 27515 Bremerhaven Germany
DFZ	Universidad de Sevilla Departamento Fisiologia Animal y Zoologia Facultad de Biologia Avenida Reina Mecedes Spain
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard Nocht Str. 76 20359 Hamburg Germany
DZMB	German Centre of Marine Biodiversity Senckenberg Institute Südstrand 44 46382 Wilhelmshaven Germany

	Adresse /Address
FIS	Senckenberg Forschungsinstitut und Naturmuseum Senckenberganlage 25 60325 Frankfurt Germany
HeliTransair	Heli Transair GmbH Flugplatz 63329 Egelsbach Germany
I.R.Sc.N.B.	Institut Royal des Sciences Naturelles de Belgique (I.R.Sc.N.B./K.B.I.N.) Département des Invertébrés Laboratoire de Carcinologie Rue Vautier, 29 B-1000 Brussels / Belgium
IMARES	IMARES Marine and Coastal Zone Research PO Box 167 1790AD Den Burg (Texel) The Netherlands
LAEISZ	Reederei F. Laeisz GmbH Brückenstr. 25 27568 Bremerhaven Germany
LMU, Uni München	Ludwig Maximilians-Universität München (LMU) Biozentrum, Department Biologie II, Systematische Zoologie Großhaderner Str. 2 D-82152 Planegg-Martinsried Germany
OPTIMARE	Optimare Sensorsyteme AG Am Luneort 15A 27572 Bremerhaven Germany

	Adresse /Address
RUB	Ruhr Universität Bochum Zoologie Universitätsstr. 150 44780 Bochum Germany
UiB	University of Bergen Allégaten 55 5007 Bergen Norway
Uni HB	Marine Zoologie Universität Bremen Postfach 33 04 40 28334 Bremen Germany
Uni Geneva	University of Geneva 30, Quai Ernest Ansermet Genève 4, 1211 Switzerland
U Gent	Gent University Biological Department / Marine Biology Krijgslaan 281 – Building S8 Gent, 9000 Belgium
ZIM, Uni HH	Zoological Institute and Zoological Museum University of Hamburg Martin-Luther-King-Platz 3 20146 Hamburg Germany
Uni L.	University of Liverpool Department of Earth and Ocean Sciences 4 Brownlow Street Liverpool L69 3GP, UK United Kingdom

	Adresse /Address
UTC	University of Cape Town Rondebosch 7701 South Africa
v.T.I.	Johann Heinrich von Thünen-Institut Institut für Seefischerei Herrn Dr. Gerd Kraus Palmaille 9 22767 Hamburg Germany

A.2 FAHRTTEILNEHMER / PARTICIPANTS

Fahrtleiter/Chief Scientist: Ulrich Bathmann
Cape Town – Cape Town

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
Bathmann	Ulrich	AWI	Biologist chief scientist
Brandt	Angelika	ZIM, Uni HH	Biologist
Brauer	Jens	HeliTransair	Technician
Brenke	Nils	DZMB	Biologist
Brix	Saskia	DZMB	Biologist
Brown	Kelly	UiB	Chemist
Büchner	Jürgen	HeliTransair	Pilot
Dorssen	Michiel van	IMARES	Biologist
Ebbe	Brigitte	DZMB	Biologist
Edinger	Jens	v.T.I.	Student
Ewe	Daniela	AWI	Student
Feij	Bram	IMARES	Ornithologist
Flores	Hauke	IMARES	Biologist
Fontaine	Delia	Uni Geneva	Biologist
Franeker	Jan van	IMARES	Biologist
Friedt	Wolfgang	HeliTransair	Pilot
Guilini	Katja	U Gent	Biologist
Haraldsson	Matilda	v.T.I.	Student
Hauck	Judith	UiB	Chemist
Heckmann	Markus	HeliTransair	Technician
Henche	Annika	DZMB	Biologist
Herrmann	Sarah	AWI	Biologist
Hofmann	Oliver	UiB	Student
Janussen	Dorte	FIS	Biologist
Kitchener	John	AAD	Biologist
Krägefsky	Sören	AWI	Biologist

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
Kramer	Lydia	ZIM, Uni HH	Biologist
Kruse	Svenja	AWI	Biologist
Leach	Harry	Uni Liverpool	Physicist
Maßmann	Silvia	AWI	Student
Meijboom	Andre	IMARES	Biologist
Neill	Craig	UiB	Chemist
Müller	Eugen	DWD	Meteorologist
Sonnabend	Hartmut	DWD	Technician
Olischläger	Mark	AWI	Student
Pey	Frank	UiB	Chemist
Richter	Falk	AWI	Student
Riehl	Torben	ZIM, Uni HH	Biologist
Robert	Henri	I.R.Sc.N.B.	Scientist
Sachs	Oliver	AWI	Geologist
Sauter	Eberhard	AWI	Geochemist
Schrödl	Michael	LMU, Uni München	Biologist
Schüller	Myriam	RUB	Biologist
Schwabe	Enrico	LMU, Uni München	Biologist
Strass	Volker	AWI	Physicist
Stürmer	Karoline	v.T.I.	Biologist
Veith-Köhler	Gritta	DZMB	Biologist
Vortkamp	Martina	v.T.I.	Technician
Wadley	Victoria	AAD	Biologist
Wend	Britta	AWI	Biologist
Witte	Timo	OPTIMARE	Physicist
Würzberg	Laura	ZIM, Uni HH	Biologist
Zapata Guardiola	Rebeca	DFZ	Biologist

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Pahl, Uwe	Master
2.	Grundmann, Uwe	1. Offc.
3.	Ziemann, Olaf	Ch. Eng.
4.	Bratz, Herbert	2. Offc.
5.	Fallei, Holger	2. Offc.
6.	Hering, Igor	2. Offc.
7.	Kapieske, Uwe	Doctor
8.	Koch, Georg	R. Offc.
9.	Kotnik, Herbert	2. Eng.
10.	Schnürch, Helmut	2. Eng.
11.	Westphal, Henning	2. Eng.
12.	Holtz, Hartmut	ElecEng.
13.	Dimmler, Werner	ELO
14.	Feiertag, Thomas	ELO
15.	Fröb, Martin	ELO
16.	Rehe, Lars	ELO
17.	Clasen, Burkhard	Boatsw.
18.	Neisner, Winfried	Carpenter
19.	Burzan, Gerd-Ekkeh.	A.B.
20.	Hartwig-Lab. , Andreas	A.B.
21.	Kreis, Reinhard	A.B.
22.	Kretzschmar, Uwe	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada Martinez, S.	A.B.
25.	Schröder, Norbert	A.B.
26.	Schultz, Ottomar	A.B.
27.	Beth, Detlef	Storek.
28.	Dinse, Horst	Mot-man
29.	Fritz, Günter	Mot-man
30.	Kliem, Peter	Mot-man

No.	Name	Rank
31.	Krösche, Eckard	Mot-man
32.	Watzel, Bernhard	Mot-man
33.	Fischer, Matthias	Cook
34.	Tupy, Mario	Cooksmate
35.	Völske, Thomas	Cooksmate
36.	Dinse, Petra	1. Stwdess
37.	Wöckener, Martina	Stwdess/Kr.
38.	Deuß, Stefanie	2. Stwdess
39.	Hu, Guo Yong	2. Steward
40.	Schmidt, Maria	2. Stwdess
41.	Streit, Christina	2. Stwdess
42.	Sun, Yong Sheng	2. Stwdess
43.	Yu, Chung Leung	Laundrym.
44.	Henning, Marcus	Apprent.
45.	Seifert, Bruno	Apprent.

A.4 STATIONSLISTE / STATION LIST PS071

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
012-1	05.12.2007	11:45		0° 0.00' N	0° 0.00' E	0	CPRon deck
013-1	05.12.2007	12:18		52° 0.12' S	0° 0.10' E	0	TRAPFsurface
013-2	05.12.2007	12:38		52° 0.41' S	0° 1.08' E	0	LANDERsurface
013-3	05.12.2007	13:07		52° 2.20' S	0° 0.99' W	0	MNsurface
013-3	05.12.2007	13:25		52° 2.16' S	0° 0.98' W	0	MNat depth
013-3	05.12.2007	13:46		52° 2.19' S	0° 1.01' W	0	MNon deck
013-4	05.12.2007	13:58		52° 2.16' S	0° 0.99' W	0	CTD/ROsurface
013-4	05.12.2007	14:07		52° 2.15' S	0° 1.01' W	0	CTD/ROsurface
013-4	05.12.2007	14:22		52° 2.17' S	0° 1.08' W	0	CTD/ROon deck
013-5	05.12.2007	14:27		52° 2.16' S	0° 1.08' W	0	MNsurface
013-5	05.12.2007	15:39		52° 2.19' S	0° 1.16' W	2996	MNat depth
013-5	05.12.2007	16:48		52° 2.23' S	0° 0.96' W	0	MNon deck
013-6	05.12.2007	17:00		52° 2.21' S	0° 0.98' W	0	CTD/ROsurface
013-6	05.12.2007	18:00		52° 2.24' S	0° 1.00' W	2996	CTD/ROat depth
013-6	05.12.2007	18:39		52° 2.21' S	0° 1.08' W	0	CTD/ROInformation
013-6	05.12.2007	19:22		52° 2.21' S	0° 1.05' W	0	CTD/ROon deck
013-7	05.12.2007	19:27		52° 2.23' S	0° 1.04' W	0	MNsurface
013-7	05.12.2007	19:38		52° 2.22' S	0° 1.04' W	0	MNat depth
013-7	05.12.2007	19:57		52° 2.29' S	0° 1.05' W	0	MNon deck
013-8	05.12.2007	20:07		52° 2.31' S	0° 1.20' W	0	RMTsurface
013-8	05.12.2007	20:22		52° 2.24' S	0° 1.90' W	0	RMTBegin Trawling
013-8	05.12.2007	20:44		52° 2.10' S	0° 3.01' W	0	RMTEnd of Trawl
013-8	05.12.2007	20:44		52° 2.10' S	0° 3.01' W	0	RMTheave
013-8	05.12.2007	20:48		52° 2.13' S	0° 3.05' W	0	RMTon deck
013-9	05.12.2007	21:09		52° 2.60' S	0° 1.49' W	0	SUITsurface
013-9	05.12.2007	21:25		52° 3.10' S	0° 0.92' W	0	SUITstart trawl
013-9	05.12.2007	21:52		52° 3.17' S	0° 1.65' W	0	SUITstop trawl
013-9	05.12.2007	22:13		52° 3.17' S	0° 1.42' W	0	SUITon deck
013-10	05.12.2007	22:46		52° 2.22' S	0° 0.86' W	0	CTD/ROsurface
013-10	05.12.2007	23:54		52° 2.21' S	0° 1.02' W	2996	CTD/ROat depth
013-10	06.12.2007	01:17		52° 2.22' S	0° 0.98' W	0	CTD/ROon deck
013-11	06.12.2007	01:27		52° 2.21' S	0° 0.96' W	0	GKGsurface
013-11	06.12.2007	02:26		52° 2.23' S	0° 1.03' W	2996	GKGat sea bottom
013-11	06.12.2007	03:33		52° 2.18' S	0° 1.07' W	0	GKGon deck
013-12	06.12.2007	03:41		52° 2.17' S	0° 1.16' W	0	MUCsurface
013-12	06.12.2007	04:38		52° 2.22' S	0° 1.04' W	3000	MUCat sea bottom
013-12	06.12.2007	05:35		52° 2.23' S	0° 0.98' W	0	MUCon deck
013-13	06.12.2007	05:42		52° 2.21' S	0° 0.98' W	0	GKGsurface
013-13	06.12.2007	06:37		52° 2.21' S	0° 1.08' W	2996	GKGat sea bottom
013-13	06.12.2007	07:41		52° 2.21' S	0° 1.07' W	0	GKGon deck
013-14	06.12.2007	07:47		52° 2.21' S	0° 1.03' W	0	MUCsurface
013-14	06.12.2007	08:44		52° 2.25' S	0° 1.11' W	2997	MUCat sea bottom
013-14	06.12.2007	09:39		52° 2.24' S	0° 1.24' W	0	MUCon deck
013-15	06.12.2007	10:16		52° 3.42' S	0° 3.93' E	0	AGTsurface
013-15	06.12.2007	11:24		52° 2.53' S	0° 0.60' E	2990	AGTAGT on ground
013-15	06.12.2007	12:07		52° 2.19' S	0° 0.76' W	2998	AGTstart trawl

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
013-15	06.12.2007	12:17		52° 2.17' S	0° 1.05' E	2997	AGTStop Trawl
013-15	06.12.2007	13:07		52° 2.16' S	0° 1.09' E	2996	AGTAGT off ground
013-15	06.12.2007	14:55		52° 2.32' S	0° 0.82' E	0	AGTon deck
013-2	06.12.2007	15:17		52° 0.72' S	0° 1.18' E	0	LANDERreleased
013-2	06.12.2007	16:11		52° 0.40' S	0° 1.09' E	0	LANDERon Deck
013-16	06.12.2007	18:46		52° 2.98' S	0° 0.76' W	0	EBSsurface
013-16	06.12.2007	20:37		52° 2.90' S	0° 0.89' W	2996	EBSon ground
013-16	06.12.2007	21:34		52° 1.98' S	0° 1.12' W	2998	EBSstart trawling start winch stop
013-16	06.12.2007	21:44		52° 1.81' S	0° 1.16' W	3000	EBSend trawling start hoisting
013-16	06.12.2007	22:35		52° 1.76' S	0° 1.24' W	2998	EBSfrom the bottom
013-16	06.12.2007	23:58		52° 1.52' S	0° 1.24' W	0	EBSon deck
013-17	07.12.2007	00:45		52° 3.21' S	0° 0.78' W	0	SUITsurface
013-17	07.12.2007	00:49		52° 3.20' S	0° 0.75' W	0	SUITslipped
013-17	07.12.2007	00:53		52° 3.06' S	0° 0.80' W	0	SUITstart trawl
013-17	07.12.2007	01:18		52° 2.39' S	0° 0.96' W	0	SUITstop trawl
013-17	07.12.2007	01:23		52° 2.32' S	0° 0.94' W	0	SUITon deck
013-17	07.12.2007	01:36		52° 2.49' S	0° 0.75' W	0	SUITon deck
013-18	07.12.2007	01:59		52° 3.22' S	0° 0.12' W	0	RMTsurface
013-18	07.12.2007	02:14		52° 2.76' S	0° 0.61' W	0	RMTheave
013-18	07.12.2007	02:43		52° 1.92' S	0° 1.43' W	0	RMTon deck
013-19	07.12.2007	03:02		52° 2.17' S	0° 1.07' W	0	MNsurface
013-19	07.12.2007	04:13		52° 2.19' S	0° 1.13' W	0	MNat depth
013-19	07.12.2007	05:21		52° 2.17' S	0° 1.10' W	0	MNon deck
013-20	07.12.2007	05:40		52° 2.18' S	0° 1.12' W	0	VIDEOin water
013-20	07.12.2007	06:43		52° 2.16' S	0° 1.08' W	2997	VIDEOstart profile
013-20	07.12.2007	07:39		52° 2.07' S	0° 1.22' W	2997	VIDEOend profile
013-20	07.12.2007	08:39		52° 2.16' S	0° 1.23' W	2996	VIDEOon deck
013-1	07.12.2007	09:09		52° 0.14' S	0° 0.35' E	2977	TRAPFHydrophon to the water
013-1	07.12.2007	09:14		52° 0.18' S	0° 0.53' E	2978	TRAPFInformation
013-1	07.12.2007	09:15		52° 0.19' S	0° 0.56' E	2978	TRAPFHydrophon out of the water
013-1	07.12.2007	09:28		52° 0.16' S	0° 0.33' E	0	TRAPFHydrophon to the water
013-1	07.12.2007	09:35		52° 0.21' S	0° 0.54' E	0	TRAPFreleased
013-1	07.12.2007	09:37		52° 0.22' S	0° 0.60' E	0	TRAPFHydrophon out of the water
013-1	07.12.2007	10:30		52° 0.27' S	0° 0.48' E	0	TRAPFAborted, trap not afloat
014-1	07.12.2007	11:50		52° 7.70' S	0° 0.01' W	0	CPRinto water
014-1	09.12.2007	08:10		57° 15.36' S	1° 34.01' W	0	CPRon deck
015-1	09.12.2007	08:16		57° 16.25' S	1° 34.01' W	0	CPRinto water
015-1	09.12.2007	22:59		0° 0.00' N	0° 0.00' E	0	CPRheave
015-1	09.12.2007	23:02		59° 43.64' S	1° 34.01' W	0	CPRon deck
016-1	17.12.2007	17:24		70° 35.29' S	9° 3.15' W	485	RDsurface
016-1	17.12.2007	17:50		70° 35.29' S	9° 2.89' W	486	RDstart dredging
016-1	17.12.2007	18:06		70° 35.35' S	9° 2.31' W	489	RDHoisting
016-1	17.12.2007	18:18		70° 35.35' S	9° 2.27' W	488	RDstop dredging
016-1	17.12.2007	18:45		70° 35.31' S	9° 2.31' W	488	RDon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
017-1	21.12.2007	21:15		70° 5.88' S	3° 20.93' W	0	RMTsurface
017-1	21.12.2007	21:34		70° 6.23' S	3° 19.77' W	0	RMTBegin Trawling
017-1	21.12.2007	21:48		70° 6.46' S	3° 19.21' W	0	RMTEnd of Trawl
017-1	21.12.2007	22:00		70° 6.51' S	3° 19.22' W	0	RMTon deck
017-2	21.12.2007	22:26		70° 6.43' S	3° 19.74' W	0	RMTsurface
017-2	21.12.2007	22:47		70° 6.89' S	3° 18.21' W	0	RMTBegin Trawling
017-2	21.12.2007	23:16		70° 6.68' S	3° 15.36' W	0	RMTEnd of Trawl
017-2	21.12.2007	23:21		70° 6.65' S	3° 15.08' W	0	RMTon deck
017-3	22.12.2007	00:10		70° 4.92' S	3° 25.58' W	0	SUITsurface
017-3	22.12.2007	00:17		70° 4.71' S	3° 24.88' W	0	SUITstart trawl
017-3	22.12.2007	00:43		70° 4.32' S	3° 22.85' W	0	SUITstop trawl
017-3	22.12.2007	01:06		70° 4.26' S	3° 22.99' W	0	SUITon deck
017-4	22.12.2007	01:35		70° 4.21' S	3° 23.86' W	0	MNsurface
017-4	22.12.2007	01:44		70° 4.15' S	3° 23.98' W	0	MNat depth
017-4	22.12.2007	02:00		70° 4.10' S	3° 24.20' W	0	MNon deck
017-5	22.12.2007	02:09		70° 4.09' S	3° 24.26' W	0	CTD/ROsurface
017-5	22.12.2007	03:01		70° 3.97' S	3° 24.67' W	0	CTD/ROat depth
017-5	22.12.2007	03:50		70° 3.89' S	3° 25.08' W	0	CTD/ROon deck
017-6	22.12.2007	03:56		70° 3.85' S	3° 25.06' W	0	MNsurface
017-6	22.12.2007	04:50		70° 3.68' S	3° 25.54' W	2264	MNat depth
017-6	22.12.2007	05:41		70° 3.52' S	3° 25.68' W	0	MNon deck
017-7	22.12.2007	05:53		70° 3.56' S	3° 25.52' W	0	MNsurface
017-7	22.12.2007	06:10		70° 3.52' S	3° 25.56' W	0	MNat depth
017-7	22.12.2007	06:32		70° 3.41' S	3° 25.79' W	0	MNon deck
017-8	22.12.2007	06:42		70° 3.39' S	3° 25.78' W	0	CTD/ROsurface
017-8	22.12.2007	06:51		70° 3.36' S	3° 25.83' W	0	CTD/ROat depth
017-8	22.12.2007	07:05		70° 3.31' S	3° 25.92' W	0	CTD/ROon deck
017-9	22.12.2007	07:34		70° 4.94' S	3° 21.94' W	1946	GKGsurface
017-9	22.12.2007	08:11		70° 4.91' S	3° 22.02' W	1950	GKGat sea bottom
017-9	22.12.2007	08:50		70° 4.92' S	3° 22.05' W	0	GKGon deck
017-10	22.12.2007	09:24		70° 5.40' S	3° 24.93' W	0	AGTsurface
017-10	22.12.2007	10:10		70° 4.78' S	3° 21.09' W	2085	AGTAGT on ground
017-10	22.12.2007	10:40		70° 4.58' S	3° 19.66' W	2190	AGTstart trawl
017-10	22.12.2007	10:50		70° 4.48' S	3° 19.20' W	2163	AGTStop Trawl
017-10	22.12.2007	10:50		70° 4.48' S	3° 19.20' W	2163	AGTStart hoisting
017-10	22.12.2007	11:22		70° 4.31' S	3° 19.11' W	0	AGTAGT off ground
017-10	22.12.2007	12:43		70° 3.86' S	3° 19.38' W	0	AGTon deck
017-11	22.12.2007	13:32		70° 5.14' S	3° 23.37' W	0	EBSsurface
017-11	22.12.2007	14:37		70° 5.13' S	3° 23.50' W	1724	EBSon ground
017-11	22.12.2007	15:25		70° 4.83' S	3° 21.50' W	2051	EBSstart trawling winch stop
017-11	22.12.2007	15:34		70° 4.66' S	3° 21.37' W	2091	EBSend trawling start hoisting
017-11	22.12.2007	16:05		70° 4.64' S	3° 22.21' W	2063	EBSfrom the bottom
017-11	22.12.2007	17:02		70° 4.36' S	3° 23.38' W	0	EBSon deck
017-12	22.12.2007	17:39		70° 4.93' S	3° 22.19' W	0	MUCsurface
017-12	22.12.2007	18:11		70° 4.86' S	3° 22.59' W	1927	MUCat sea bottom
017-12	22.12.2007	18:41		70° 4.77' S	3° 23.24' W	0	MUCon deck
017-13	22.12.2007	19:08		70° 5.02' S	3° 20.79' W	0	GKGsurface
017-13	22.12.2007	19:39		70° 4.97' S	3° 21.54' W	1977	GKGat sea bottom
017-13	22.12.2007	20:13		70° 4.96' S	3° 21.78' W	0	GKGon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
017-14	22.12.2007	20:20		70° 4.97' S	3° 21.76' W	0	MUCsurface
017-14	22.12.2007	20:53		70° 4.80' S	3° 22.71' W	1960	MUCat sea bottom
017-14	22.12.2007	21:26		70° 4.75' S	3° 23.31' W	0	MUCon deck
017-15	22.12.2007	22:13		70° 4.93' S	3° 22.57' W	0	VIDEOin water
017-15	22.12.2007	23:08		70° 4.68' S	3° 23.38' W	1973	VIDEOstart profile
017-15	23.12.2007	00:02		70° 4.38' S	3° 24.02' W	0	VIDEOend profile
017-15	23.12.2007	00:40		70° 4.17' S	3° 24.53' W	0	VIDEOon deck
018-1	23.12.2007	07:36		69°32.09' S	2° 53.04' W	0	CTD/ROsurface
018-1	23.12.2007	07:57		69°32.22' S	2° 53.35' W	0	CTD/ROat depth
018-1	23.12.2007	08:25		69°32.27' S	2° 53.95' W	0	CTD/ROon deck
018-2	23.12.2007	08:41		69°32.61' S	2° 54.56' W	0	RMTsurface
018-2	23.12.2007	08:59		69°32.50' S	2° 52.96' W	0	RMTBegin Trawling
018-2	23.12.2007	09:23		69°32.19' S	2° 50.80' W	0	RMTEnd of Trawl
018-2	23.12.2007	09:28		69°32.15' S	2° 50.52' W	0	RMTon deck
019-1	23.12.2007	15:15		69° 5.50' S	2° 55.51' W	0	RMTsurface
019-1	23.12.2007	15:46		69° 5.45' S	2° 58.44' W	0	RMTBegin Trawling
019-1	23.12.2007	16:06		69° 5.48' S	3° 0.49' W	0	RMTEnd of Trawl
019-1	23.12.2007	16:17		69° 5.45' S	3° 1.38' W	0	RMTon deck
019-2	23.12.2007	16:36		69° 5.43' S	3° 1.70' W	3640	RELto Water
019-2	23.12.2007	17:17		69° 5.40' S	3° 1.83' W	0	RELat Deep
019-2	23.12.2007	17:23		69° 5.39' S	3° 1.84' W	0	RELreleased
019-2	23.12.2007	17:52		69° 5.34' S	3° 1.91' W	0	RELreleased
019-2	23.12.2007	18:06		69° 5.28' S	3° 1.87' W	0	RELreleased
019-2	23.12.2007	18:23		69° 5.26' S	3° 1.90' W	0	RELon Deck
019-3	23.12.2007	18:50		69° 5.02' S	2° 56.76' W	0	RMTsurface
019-3	23.12.2007	19:05		69° 4.98' S	2° 58.35' W	0	RMTBegin Trawling
019-3	23.12.2007	19:25		69° 4.86' S	3° 0.12' W	0	RMTEnd of Trawl
019-3	23.12.2007	19:29		69° 4.84' S	3° 0.40' W	0	RMTon deck
019-4	23.12.2007	19:42		69° 4.82' S	3° 0.48' W	0	CTD/ROsurface
019-4	23.12.2007	20:54		69° 4.71' S	3° 0.68' W	3639	CTD/ROat depth
019-4	23.12.2007	22:23		69° 4.32' S	3° 0.58' W	0	CTD/ROon deck
019-5	23.12.2007	22:29		69° 4.28' S	3° 0.56' W	0	MNsurface
019-5	23.12.2007	22:47		69° 4.21' S	3° 0.54' W	0	MNat depth
019-5	23.12.2007	23:08		69° 4.14' S	3° 0.54' W	0	MNon deck
019-6	23.12.2007	23:21		69° 3.89' S	3° 0.99' W	0	SUITsurface
019-6	23.12.2007	23:30		69° 3.64' S	3° 0.23' W	0	SUITstart trawl
019-6	23.12.2007	23:54		69° 3.29' S	2° 58.66' W	0	SUITstop trawl
019-6	24.12.2007	00:08		69° 3.23' S	2° 58.49' W	0	SUITon deck
020-1	24.12.2007	06:48		68°29.23' S	2° 54.24' W	0	CTD/ROsurface
020-1	24.12.2007	07:10		68°29.18' S	2° 54.30' W	0	CTD/ROat depth
020-1	24.12.2007	07:46		68°28.98' S	2° 54.25' W	0	CTD/ROon deck
020-2	24.12.2007	08:10		68°28.14' S	2° 51.72' W	0	RMTsurface
020-2	24.12.2007	08:22		68°28.12' S	2° 52.64' W	0	RMTBegin Trawling
020-2	24.12.2007	08:41		68°28.46' S	2° 53.79' W	0	RMTEnd of Trawl
020-2	24.12.2007	08:45		68°28.43' S	2° 53.89' W	0	RMTon deck
021-1	25.12.2007	08:06		67°56.10' S	2° 58.31' W	0	MNsurface
021-1	25.12.2007	08:15		67°56.08' S	2° 58.26' W	0	MNat depth
021-1	25.12.2007	08:31		67°56.05' S	2° 58.14' W	0	MNon deck
021-2	25.12.2007	08:40		67°56.03' S	2° 58.06' W	0	CTD/ROsurface
021-2	25.12.2007	10:00		67°55.82' S	2° 57.14' W	4152	CTD/ROat depth
021-2	25.12.2007	11:20		67°55.62' S	2° 55.87' W	0	CTD/ROon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
021-3	25.12.2007	11:27		67°55.60' S	2° 55.77' W	0	MNsurface
021-3	25.12.2007	12:36		67°55.42' S	2° 54.62' W	0	MNat depth
021-3	25.12.2007	13:45		67°55.23' S	2° 53.40' W	0	MNon deck
021-4	25.12.2007	13:52		67°55.21' S	2° 53.28' W	0	MNsurface
021-4	25.12.2007	14:12		67°55.17' S	2° 52.96' W	0	MNat depth
021-4	25.12.2007	14:32		67°55.12' S	2° 52.62' W	0	MNon deck
021-5	25.12.2007	14:40		67°55.11' S	2° 52.49' W	0	CTD/ROsurface
021-5	25.12.2007	14:49		67°55.09' S	2° 52.38' W	0	CTD/ROat depth
021-5	25.12.2007	15:05		67°55.06' S	2° 52.15' W	0	CTD/ROon deck
021-6	25.12.2007	15:40		67°55.26' S	2° 49.78' W	0	RMTsurface
021-6	25.12.2007	15:52		67°55.08' S	2° 50.65' W	0	RMTheave
021-6	25.12.2007	15:53		67°55.05' S	2° 50.73' W	0	RMTBegin Trawling
021-6	25.12.2007	16:13		67°55.00' S	2° 52.21' W	0	RMTEnd of Trawl
021-6	25.12.2007	16:16		67°55.00' S	2° 52.23' W	0	RMTon deck
022-1	25.12.2007	20:25		67°31.04' S	3° 0.22' W	0	CTD/ROsurface
022-1	25.12.2007	20:50		67°30.94' S	3° 0.18' W	0	CTD/ROat depth
022-1	25.12.2007	21:16		67°30.86' S	3° 0.21' W	0	CTD/ROon deck
022-2	25.12.2007	21:35		67°30.86' S	3° 0.94' W	0	SUITsurface
022-2	25.12.2007	21:44		67°30.61' S	3° 0.98' W	0	SUITstart trawl
022-2	25.12.2007	22:04		67°30.04' S	3° 1.32' W	0	SUITstop trawl
022-2	25.12.2007	22:22		67°30.06' S	3° 1.22' W	0	SUITon deck
022-3	25.12.2007	22:41		67°30.16' S	2° 58.70' W	0	RMTsurface
022-3	25.12.2007	23:03		67°29.88' S	3° 1.13' W	0	RMTBegin Trawling
022-3	25.12.2007	23:35		67°29.59' S	3° 4.44' W	0	RMTEnd of Trawl
022-3	25.12.2007	23:40		67°29.58' S	3° 4.53' W	0	RMTon deck
023-1	26.12.2007	05:02		66°58.38' S	3° 4.45' W	0	CTD/ROsurface
023-1	26.12.2007	06:26		66°58.37' S	3° 4.49' W	4486	CTD/ROat depth
023-1	26.12.2007	07:51		66°58.42' S	3° 4.40' W	0	CTD/ROon deck
023-2	26.12.2007	07:59		66°58.42' S	3° 4.37' W	0	MNsurface
023-2	26.12.2007	08:16		66°58.42' S	3° 4.24' W	0	MNat depth
023-2	26.12.2007	08:37		66°58.41' S	3° 3.96' W	0	MNon deck
023-3	26.12.2007	08:49		66°58.62' S	3° 3.26' W	0	RMTsurface
023-3	26.12.2007	09:08		66°58.00' S	3° 4.01' W	0	RMTBegin Trawling
023-3	26.12.2007	09:23		66°57.41' S	3° 4.68' W	0	RMTEnd of Trawl
023-3	26.12.2007	09:28		66°57.37' S	3° 4.73' W	0	RMTon deck
024-1	26.12.2007	13:59		66°28.77' S	2° 57.41' W	0	CTD/ROsurface
024-1	26.12.2007	14:21		66°28.66' S	2° 57.37' W	0	CTD/ROat depth
024-1	26.12.2007	14:47		66°28.59' S	2° 57.19' W	0	CTD/ROon deck
024-2	26.12.2007	14:52		66°28.57' S	2° 57.15' W	0	RMTsurface
024-2	26.12.2007	15:11		66°28.37' S	2° 55.61' W	0	RMTheave
024-2	26.12.2007	15:42		66°27.98' S	2° 53.03' W	0	RMTon deck
025-1	26.12.2007	18:57		66° 0.89' S	2° 58.90' W	0	RMTsurface
025-1	26.12.2007	19:12		66° 0.84' S	3° 0.13' W	0	RMTheave
025-1	26.12.2007	19:13		66° 0.83' S	3° 0.21' W	0	RMTBegin Trawling
025-1	26.12.2007	19:35		66° 0.72' S	3° 2.01' W	0	RMTEnd of Trawl
025-1	26.12.2007	19:39		66° 0.69' S	3° 2.25' W	0	RMTon deck
025-2	26.12.2007	19:50		66° 0.61' S	3° 2.90' W	0	MNsurface
025-2	26.12.2007	19:59		66° 0.62' S	3° 2.96' W	0	MNat depth
025-2	26.12.2007	20:17		66° 0.61' S	3° 2.92' W	0	MNon deck
025-2	26.12.2007	20:25		66° 0.62' S	3° 2.96' W	0	CTD/ROsurface
025-2	26.12.2007	21:57		66° 0.61' S	3° 2.69' W	4785	CTD/ROat depth

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
025-2	26.12.2007	23:31		66° 0.61' S	3° 2.20' W	0	CTD/ROon deck
025-4	26.12.2007	23:39		66° 0.61' S	3° 2.15' W	0	MNsurface
025-4	26.12.2007	23:57		66° 0.56' S	3° 2.01' W	0	MNat depth
025-4	27.12.2007	00:17		66° 0.57' S	3° 1.70' W	0	MNon deck
025-5	27.12.2007	00:29		66° 0.50' S	3° 1.57' W	0	MNsurface
025-5	27.12.2007	01:33		66° 0.38' S	3° 0.94' W	0	MNat depth
025-5	27.12.2007	02:41		66° 0.21' S	3° 0.48' W	0	MNon deck
025-6	27.12.2007	02:49		66° 0.18' S	3° 0.41' W	0	CTD/ROsurface
025-6	27.12.2007	02:57		66° 0.15' S	3° 0.34' W	0	CTD/ROat depth
025-6	27.12.2007	03:13		66° 0.11' S	3° 0.26' W	0	CTD/ROon deck
026-1	27.12.2007	06:20		65°29.95' S	3° 0.19' W	0	CTD/ROsurface
026-1	27.12.2007	06:41		65°30.01' S	3° 0.25' W	0	CTD/ROat depth
026-1	27.12.2007	07:07		65°30.10' S	3° 0.35' W	0	CTD/ROon deck
026-2	27.12.2007	07:16		65°30.16' S	3° 0.53' W	0	RMTsurface
026-2	27.12.2007	07:32		65°30.33' S	3° 1.89' W	0	RMTheave
026-2	27.12.2007	07:34		65°30.35' S	3° 2.07' W	0	RMTBegin Trawling
026-2	27.12.2007	07:56		65°30.63' S	3° 3.72' W	0	RMTEnd of Trawl
026-2	27.12.2007	08:00		65°30.67' S	3° 3.92' W	0	RMTon deck
027-1	27.12.2007	11:10		65° 0.07' S	2° 59.98' W	0	CTD/ROsurface
027-1	27.12.2007	12:45		65° 0.19' S	2° 59.96' W	5047	CTD/ROat depth
027-1	27.12.2007	14:12		65° 0.48' S	3° 0.07' W	0	CTD/ROon deck
027-2	27.12.2007	14:16		65° 0.51' S	3° 0.07' W	0	MNsurface
027-2	27.12.2007	14:33		65° 0.61' S	3° 0.06' W	0	MNat depth
027-2	27.12.2007	14:54		65° 0.73' S	3° 0.01' W	0	MNon deck
027-3	27.12.2007	15:00		65° 0.72' S	2° 59.97' W	0	RMTsurface
027-3	27.12.2007	15:14		65° 0.26' S	3° 0.02' W	0	RMTheave
027-3	27.12.2007	15:40		64°59.37' S	3° 0.03' W	0	RMTon deck
028-1	27.12.2007	19:13		64°30.92' S	3° 1.92' W	0	RMTsurface
028-1	27.12.2007	19:25		64°30.64' S	3° 1.29' W	0	RMTheave
028-1	27.12.2007	19:26		64°30.62' S	3° 1.24' W	0	RMTBegin Trawling
028-1	27.12.2007	19:45		64°30.22' S	3° 0.28' W	0	RMTEnd of Trawl
028-1	27.12.2007	19:49		64°30.17' S	3° 0.14' W	0	RMTon deck
028-2	27.12.2007	20:04		64°30.14' S	3° 0.03' W	0	CTD/ROsurface
028-2	27.12.2007	20:26		64°30.22' S	3° 0.08' W	0	CTD/ROat depth
028-2	27.12.2007	20:55		64°30.15' S	2° 59.61' W	0	CTD/ROon deck
028-3	27.12.2007	21:00		64°30.09' S	2° 59.45' W	0	SUITsurface
028-3	27.12.2007	21:09		64°29.88' S	2° 59.07' W	0	SUITstart trawl
028-3	27.12.2007	21:33		64°29.34' S	2° 58.01' W	0	SUITstop trawl
028-3	27.12.2007	21:47		64°29.24' S	2° 57.77' W	0	SUITon deck
029-1	28.12.2007	01:47		63°58.52' S	2° 57.17' W	0	CTD/ROsurface
029-1	28.12.2007	03:29		63°58.55' S	2° 57.07' W	5190	CTD/ROat depth
029-1	28.12.2007	05:05		63°58.62' S	2° 57.27' W	0	CTD/ROon deck
029-2	28.12.2007	05:22		63°58.60' S	2° 57.30' W	0	MNsurface
029-2	28.12.2007	05:31		63°58.60' S	2° 57.32' W	0	MNat depth
029-2	28.12.2007	05:49		63°58.61' S	2° 57.38' W	0	MNon deck
029-3	28.12.2007	05:58		63°58.60' S	2° 57.35' W	0	RMTsurface
029-3	28.12.2007	06:13		63°58.31' S	2° 56.24' W	0	RMTheave
029-3	28.12.2007	06:14		63°58.30' S	2° 56.18' W	0	RMTBegin Trawling
029-3	28.12.2007	06:37		63°57.94' S	2° 54.86' W	0	RMTEnd of Trawl
029-3	28.12.2007	06:42		63°57.90' S	2° 54.73' W	0	RMTon deck
029-4	28.12.2007	06:52		63°58.05' S	2° 55.40' W	0	MNsurface

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
029-4	28.12.2007	07:08		63°58.07' S	2° 55.58' W	0	MNat depth
029-4	28.12.2007	07:29		63°58.05' S	2° 55.72' W	0	MNon deck
029-5	28.12.2007	07:38		63°58.04' S	2° 55.79' W	0	MNsurface
029-5	28.12.2007	08:45		63°58.03' S	2° 56.28' W	0	MNat depth
029-5	28.12.2007	09:52		63°58.00' S	2° 56.20' W	0	MNon deck
029-6	28.12.2007	10:01		63°57.99' S	2° 56.17' W	0	CTD/ROsurface
029-6	28.12.2007	10:09		63°57.98' S	2° 56.14' W	0	CTD/ROat depth
029-6	28.12.2007	10:22		63°57.96' S	2° 56.10' W	0	CTD/ROon deck
030-1	28.12.2007	13:45		63°31.23' S	3° 1.41' W	0	CTD/ROsurface
030-1	28.12.2007	14:06		63°31.25' S	3° 1.42' W	0	CTD/ROat depth
030-1	28.12.2007	14:35		63°31.23' S	3° 1.28' W	0	CTD/ROon deck
030-2	28.12.2007	14:43		63°31.23' S	3° 1.22' W	0	RMTsurface
030-2	28.12.2007	15:01		63°31.13' S	2° 59.69' W	0	RMTheave
030-2	28.12.2007	15:35		63°31.10' S	2° 56.85' W	0	RMTon deck
031-1	28.12.2007	19:25		63° 0.03' S	3° 0.02' W	0	CTD/ROsurface
031-1	28.12.2007	21:03		63° 0.06' S	3° 0.00' W	5274	CTD/ROat depth
031-1	28.12.2007	22:40		62°59.98' S	2° 59.97' W	0	CTD/ROon deck
031-2	28.12.2007	23:02		63° 1.80' S	3° 0.40' W	0	SUITsurface
031-2	28.12.2007	23:10		63° 1.99' S	2° 59.92' W	0	SUITstart trawl
031-2	28.12.2007	23:42		63° 2.81' S	2° 58.82' W	0	SUITstop trawl
031-2	28.12.2007	23:55		63° 2.97' S	2° 58.79' W	0	SUITon deck
031-3	29.12.2007	00:04		63° 3.31' S	2° 58.36' W	0	MNsurface
031-3	29.12.2007	00:22		63° 3.43' S	2° 58.18' W	0	MNat depth
031-3	29.12.2007	00:43		63° 3.52' S	2° 58.00' W	0	MNon deck
031-4	29.12.2007	00:53		63° 3.64' S	2° 58.57' W	0	RMTsurface
031-4	29.12.2007	01:09		63° 3.14' S	2° 59.07' W	0	RMTheave
031-4	29.12.2007	01:42		63° 2.34' S	3° 0.49' W	0	RMTon deck
032-1	29.12.2007	05:45		62°30.05' S	2° 59.81' W	0	CTD/ROsurface
032-1	29.12.2007	06:06		62°30.00' S	2° 59.86' W	0	CTD/ROat depth
032-1	29.12.2007	06:36		62°29.94' S	2° 59.82' W	0	CTD/ROon deck
032-2	29.12.2007	06:44		62°29.95' S	2° 59.73' W	0	RMTsurface
032-2	29.12.2007	07:00		62°30.22' S	2° 58.75' W	0	RMTheave
032-2	29.12.2007	07:01		62°30.24' S	2° 58.69' W	0	RMTBegin Trawling
032-2	29.12.2007	07:23		62°30.57' S	2° 57.51' W	0	RMTEnd of Trawl
032-2	29.12.2007	07:28		62°30.61' S	2° 57.37' W	0	RMTon deck
033-1	29.12.2007	11:27		61°59.89' S	2° 58.87' W	0	RMTsurface
033-1	29.12.2007	11:48		62° 0.12' S	2° 57.89' W	0	RMTBegin Trawling
033-1	29.12.2007	12:18		62° 0.51' S	2° 56.54' W	0	RMTEnd of Trawl
033-1	29.12.2007	12:34		62° 0.69' S	2° 56.33' W	0	RMTon deck
033-2	29.12.2007	12:50		62° 0.69' S	2° 56.49' W	0	MNsurface
033-2	29.12.2007	12:59		62° 0.70' S	2° 56.59' W	0	MNat depth
033-2	29.12.2007	13:16		62° 0.70' S	2° 56.81' W	0	MNon deck
033-3	29.12.2007	13:22		62° 0.71' S	2° 56.88' W	0	LANDERsurface
033-4	29.12.2007	13:28		62° 0.68' S	2° 56.97' W	0	CTD/ROsurface
033-4	29.12.2007	15:07		62° 0.69' S	2° 58.01' W	5337	CTD/ROat depth
033-4	29.12.2007	16:40		62° 0.84' S	2° 58.11' W	0	CTD/ROon deck
033-5	29.12.2007	16:46		62° 0.84' S	2° 58.12' W	0	MNsurface
033-5	29.12.2007	17:52		62° 0.89' S	2° 57.87' W	0	MNat depth
033-5	29.12.2007	19:00		62° 0.70' S	2° 57.75' W	0	MNon deck
033-6	29.12.2007	19:09		62° 0.66' S	2° 57.75' W	0	CTD/ROsurface
033-6	29.12.2007	19:17		62° 0.66' S	2° 57.74' W	0	CTD/ROat depth

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
033-6	29.12.2007	19:32		62° 0.63' S	2° 57.73' W	0	CTD/ROon deck
033-7	29.12.2007	19:45		62° 0.54' S	2° 57.79' W	0	MNsurface
033-7	29.12.2007	20:03		62° 0.50' S	2° 57.78' W	0	MNat depth
033-7	29.12.2007	20:04		62° 0.49' S	2° 57.78' W	0	MNHoisting
033-7	29.12.2007	20:23		62° 0.40' S	2° 57.85' W	0	MNon deck
033-8	29.12.2007	20:40		62° 0.24' S	2° 58.01' W	0	RMTsurface
033-8	29.12.2007	20:44		62° 0.36' S	2° 58.04' W	0	RMTheave
033-8	29.12.2007	20:56		62° 0.74' S	2° 58.13' W	0	RMTEnd of Trawl
033-8	29.12.2007	20:56		62° 0.74' S	2° 58.13' W	0	RMTheave
033-8	29.12.2007	21:20		62° 1.40' S	2° 58.24' W	0	RMTon deck
033-9	29.12.2007	21:34		62° 1.36' S	2° 58.26' W	0	SUITsurface
033-9	29.12.2007	21:41		62° 1.40' S	2° 57.92' W	0	SUITstart trawl
033-9	29.12.2007	22:05		62° 1.52' S	2° 56.60' W	0	SUITstop trawl
033-9	29.12.2007	22:21		62° 1.46' S	2° 56.33' W	0	SUITon deck
033-10	29.12.2007	22:48		62° 1.14' S	2° 58.38' W	0	MUCsurface
033-10	30.12.2007	00:01		62° 0.80' S	2° 59.05' W	5337	MUCat sea bottom
033-10	30.12.2007	01:23		62° 0.52' S	2° 59.60' W	0	MUCon deck
033-11	30.12.2007	01:27		62° 0.53' S	2° 59.64' W	0	GKGsurface
033-11	30.12.2007	02:35		62° 0.50' S	2° 59.96' W	5339	GKGat sea bottom
033-11	30.12.2007	03:56		62° 0.59' S	3° 0.20' W	0	GKGon deck
033-12	30.12.2007	04:02		62° 0.59' S	3° 0.20' W	0	MUCsurface
033-12	30.12.2007	05:13		62° 0.65' S	3° 0.06' W	5338	MUCat sea bottom
033-12	30.12.2007	06:33		62° 0.61' S	2° 59.47' W	0	MUCon deck
033-13	30.12.2007	06:40		62° 0.60' S	2° 59.38' W	0	GKGsurface
033-13	30.12.2007	07:47		62° 0.48' S	2° 58.85' W	5337	GKGat sea bottom
033-13	30.12.2007	09:09		62° 0.19' S	2° 58.32' W	0	GKGon deck
033-14	30.12.2007	10:37		61°57.12' S	2° 50.55' W	0	AGTsurface
033-14	30.12.2007	10:42		61°57.19' S	2° 50.87' W	0	AGTInformation
033-14	30.12.2007	10:44		61°57.20' S	2° 50.94' W	0	AGTsurface
033-14	30.12.2007	12:58		62° 0.08' S	2° 57.72' W	5337	AGTAGT on ground
033-14	30.12.2007	13:44		62° 0.64' S	2° 59.33' W	5338	AGTstart trawl
033-14	30.12.2007	13:54		62° 0.74' S	2° 59.62' W	5338	AGTStop Trawl
033-14	30.12.2007	15:26		62° 0.60' S	2° 59.56' W	5338	AGTAGT off ground
033-15	30.12.2007	16:20		62° 0.53' S	2° 59.62' W	0	RELto Water
033-15	30.12.2007	16:23		62° 0.52' S	2° 59.62' W	0	RELat Deep
033-15	30.12.2007	16:24		62° 0.52' S	2° 59.62' W	0	RELreleased
033-15	30.12.2007	16:27		62° 0.51' S	2° 59.62' W	0	RELon Deck
033-15	30.12.2007	16:52		62° 0.45' S	2° 59.55' W	0	RELto Water
033-15	30.12.2007	17:04		62° 0.40' S	2° 59.60' W	0	RELat Deep
033-15	30.12.2007	17:06		62° 0.41' S	2° 59.61' W	0	RELreleased
033-15	30.12.2007	17:16		62° 0.42' S	2° 59.68' W	0	RELon Deck
033-14	30.12.2007	18:47		62° 0.60' S	2° 59.78' W	0	AGTon deck
033-3	30.12.2007	18:58		62° 0.63' S	2° 58.53' W	0	LANDERreleased
033-3	30.12.2007	20:17		62° 0.71' S	2° 56.83' W	0	LANDERInformation
033-3	30.12.2007	20:39		62° 0.47' S	2° 57.10' W	0	LANDERInformation
033-3	30.12.2007	20:40		62° 0.47' S	2° 57.09' W	0	LANDERon Deck
033-16	30.12.2007	21:09		61°59.73' S	2° 55.84' W	0	EBSsurface
033-16	31.12.2007	00:14		61°59.57' S	2° 55.81' W	5337	EBSon ground
033-16	31.12.2007	01:47		62° 0.37' S	2° 58.35' W	5337	EBSstart trawling winch stop
033-16	31.12.2007	01:57		62° 0.42' N	2° 58.74' E	5338	EBSend

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
033-16	31.12.2007	03:32		62° 0.47' S	2° 58.68' W	5339	trawling start hoisting EBSfrom the bottom
033-16	31.12.2007	05:15		62° 0.46' S	2° 58.95' W	0	EBSon deck
033-17	31.12.2007	05:33		62° 0.47' S	2° 58.92' W	0	VIDEOin water
033-17	31.12.2007	07:23		62° 0.49' S	2° 58.81' W	5338	VIDEOstart profile
033-17	31.12.2007	08:19		62° 0.56' S	2° 58.82' W	5337	VIDEOend profile
033-17	31.12.2007	09:56		62° 0.65' S	2° 57.14' W	5336	VIDEOon deck
033-18	31.12.2007	10:04		62° 0.61' S	2° 56.82' W	0	SUITsurface
033-18	31.12.2007	10:10		62° 0.62' S	2° 57.08' W	0	SUITstart trawl
033-18	31.12.2007	10:37		62° 0.72' S	2° 58.32' W	0	SUITstop trawl
033-18	31.12.2007	10:50		62° 0.82' S	2° 58.55' W	0	SUITon deck
033-19	31.12.2007	11:06		62° 0.41' S	2° 58.69' W	0	MUCsurface
033-19	31.12.2007	12:12		62° 0.45' S	2° 58.70' W	5338	MUCat sea bottom
033-19	31.12.2007	13:40		62° 0.67' S	2° 57.56' W	0	MUCon deck
034-1	01.01.2008	10:01		62° 0.05' S	3° 0.20' E	0	MNsurface
034-1	01.01.2008	10:11		61°60.00' S	3° 0.14' E	0	MNat depth
034-1	01.01.2008	10:12		61°60.00' S	3° 0.13' E	0	MNHoisting
034-1	01.01.2008	10:27		61°59.96' S	3° 0.08' E	0	MNon deck
034-2	01.01.2008	10:35		61°59.97' S	3° 0.10' E	0	CTD/ROsurface
034-2	01.01.2008	12:18		62° 0.00' S	3° 0.03' E	5378	CTD/ROat depth
034-2	01.01.2008	14:10		62° 0.02' S	3° 0.00' E	0	CTD/ROon deck
034-3	01.01.2008	14:16		62° 0.02' S	3° 0.00' E	0	MNsurface
034-3	01.01.2008	15:20		61°60.00' S	2° 59.97' E	0	MNat depth
034-3	01.01.2008	16:24		62° 0.00' S	3° 0.03' E	0	MNon deck
034-4	01.01.2008	16:29		61°59.99' S	3° 0.05' E	0	CTD/ROsurface
034-4	01.01.2008	16:37		61°60.00' S	3° 0.02' E	0	CTD/ROat depth
034-4	01.01.2008	16:48		61°60.00' S	2° 59.98' E	0	CTD/ROon deck
034-5	01.01.2008	16:52		62° 0.00' S	2° 59.97' E	0	MNsurface
034-5	01.01.2008	17:10		62° 0.04' S	2° 59.96' E	0	MNat depth
034-5	01.01.2008	17:30		62° 0.01' S	2° 59.94' E	0	MNon deck
034-6	01.01.2008	17:37		62° 0.06' S	2° 59.83' E	0	RMTsurface
034-6	01.01.2008	17:55		62° 0.50' S	2° 58.71' E	0	RMTheave
034-6	01.01.2008	17:56		62° 0.53' S	2° 58.65' E	0	RMTBegin Trawling
034-6	01.01.2008	18:19		62° 1.01' S	2° 57.46' E	0	RMTEnd of Trawl
034-6	01.01.2008	18:25		62° 1.03' S	2° 57.49' E	0	RMTon deck
033-16	30.12.2007	21:09		61°59.73' S	2° 55.84' W	0	EBSsurface
033-16	31.12.2007	00:14		61°59.57' S	2° 55.81' W	5337	EBSon ground
033-16	31.12.2007	01:47		62° 0.37' S	2° 58.35' W	5337	EBSstart trawling winch stop
033-16	31.12.2007	01:57		62° 0.42' N	2° 58.74' E	5338	EBSend trawling start hoisting
033-16	31.12.2007	03:32		62° 0.47' S	2° 58.68' W	5339	EBSfrom the bottom
033-16	31.12.2007	05:15		62° 0.46' S	2° 58.95' W	0	EBSon deck
033-17	31.12.2007	05:33		62° 0.47' S	2° 58.92' W	0	VIDEOin water
033-17	31.12.2007	07:23		62° 0.49' S	2° 58.81' W	5338	VIDEOstart profile
033-17	31.12.2007	08:19		62° 0.56' S	2° 58.82' W	5337	VIDEOend profile
033-17	31.12.2007	09:56		62° 0.65' S	2° 57.14' W	5336	VIDEOon deck
033-18	31.12.2007	10:04		62° 0.61' S	2° 56.82' W	0	SUITsurface
033-18	31.12.2007	10:10		62° 0.62' S	2° 57.08' W	0	SUITstart trawl
033-18	31.12.2007	10:37		62° 0.72' S	2° 58.32' W	0	SUITstop trawl
033-18	31.12.2007	10:50		62° 0.82' S	2° 58.55' W	0	SUITon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
033-19	31.12.2007	11:06		62° 0.41' S	2° 58.69' W	0	MUCsurface
033-19	31.12.2007	12:12		62° 0.45' S	2° 58.70' W	5338	MUCat sea bottom
033-19	31.12.2007	13:40		62° 0.67' S	2° 57.56' W	0	MUCon deck
034-1	01.01.2008	10:01		62° 0.05' S	3° 0.20' E	0	MNsurface
034-1	01.01.2008	10:11		61° 60.00' S	3° 0.14' E	0	MNat depth
034-1	01.01.2008	10:12		61° 60.00' S	3° 0.13' E	0	MNHoisting
034-1	01.01.2008	10:27		61° 59.96' S	3° 0.08' E	0	MNon deck
034-2	01.01.2008	10:35		61° 59.97' S	3° 0.10' E	0	CTD/ROsurface
034-2	01.01.2008	12:18		62° 0.00' S	3° 0.03' E	5378	CTD/ROat depth
034-2	01.01.2008	14:10		62° 0.02' S	3° 0.00' E	0	CTD/ROon deck
034-3	01.01.2008	14:16		62° 0.02' S	3° 0.00' E	0	MNsurface
034-3	01.01.2008	15:20		61° 60.00' S	2° 59.97' E	0	MNat depth
034-3	01.01.2008	16:24		62° 0.00' S	3° 0.03' E	0	MNon deck
034-4	01.01.2008	16:29		61° 59.99' S	3° 0.05' E	0	CTD/ROsurface
034-4	01.01.2008	16:37		61° 60.00' S	3° 0.02' E	0	CTD/ROat depth
034-4	01.01.2008	16:48		61° 60.00' S	2° 59.98' E	0	CTD/ROon deck
034-5	01.01.2008	16:52		62° 0.00' S	2° 59.97' E	0	MNsurface
034-5	01.01.2008	17:10		62° 0.04' S	2° 59.96' E	0	MNat depth
034-5	01.01.2008	17:30		62° 0.01' S	2° 59.94' E	0	MNon deck
034-6	01.01.2008	17:37		62° 0.06' S	2° 59.83' E	0	RMTsurface
034-6	01.01.2008	17:55		62° 0.50' S	2° 58.71' E	0	RMTheave
034-6	01.01.2008	17:56		62° 0.53' S	2° 58.65' E	0	RMTBegin Trawling
034-6	01.01.2008	18:19		62° 1.01' S	2° 57.46' E	0	RMTEnd of Trawl
034-6	01.01.2008	18:25		62° 1.03' S	2° 57.49' E	0	RMTon deck
035-1	01.01.2008	21:29		62° 28.28' S	3° 2.56' E	0	SUITsurface
035-1	01.01.2008	21:34		62° 28.44' S	3° 2.32' E	0	SUITstart trawl
035-1	01.01.2008	22:00		62° 29.07' S	3° 1.44' E	0	SUITstop trawl
035-1	01.01.2008	22:11		62° 29.17' S	3° 1.32' E	0	SUITon deck
035-2	01.01.2008	22:19		62° 29.20' S	3° 1.30' E	0	CTD/ROsurface
035-2	01.01.2008	22:41		62° 29.23' S	3° 1.32' E	0	CTD/ROat depth
035-2	01.01.2008	23:07		62° 29.37' S	3° 1.23' E	0	CTD/ROon deck
035-3	01.01.2008	23:14		62° 29.41' S	3° 1.20' E	0	RMTsurface
035-3	01.01.2008	23:29		62° 29.86' S	3° 0.58' E	0	RMTBegin Trawling
035-3	01.01.2008	23:56		62° 30.61' S	2° 59.42' E	0	RMTon deck
036-1	02.01.2008	03:05		62° 59.41' S	2° 59.94' E	0	RMTsurface
036-1	02.01.2008	03:21		62° 59.93' S	2° 59.40' E	0	RMTheave
036-1	02.01.2008	03:53		63° 0.85' S	2° 58.46' E	0	RMTon deck
036-2	02.01.2008	04:00		63° 0.76' S	2° 58.68' E	0	MNsurface
036-2	02.01.2008	04:18		63° 0.80' S	2° 58.71' E	0	MNat depth
036-2	02.01.2008	04:38		63° 0.82' S	2° 58.72' E	0	MNon deck
036-3	02.01.2008	04:45		63° 0.83' S	2° 58.71' E	0	CTD/ROsurface
036-3	02.01.2008	06:27		63° 0.89' S	2° 58.84' E	5358	CTD/ROat depth
036-3	02.01.2008	07:59		63° 0.86' S	2° 58.63' E	0	CTD/ROon deck
036-3	02.01.2008	08:06		63° 0.85' S	2° 58.66' E	0	MNsurface
036-3	02.01.2008	09:10		63° 0.74' S	2° 58.55' E	0	MNat depth
036-3	02.01.2008	09:11		63° 0.74' S	2° 58.55' E	0	MNHoisting
036-3	02.01.2008	10:17		63° 0.66' S	2° 58.34' E	0	MNon deck
037-1	02.01.2008	13:46		63° 30.68' S	3° 4.36' E	0	RMTsurface
037-1	02.01.2008	14:01		63° 30.39' S	3° 3.26' E	0	RMTheave
037-1	02.01.2008	14:28		63° 29.78' S	3° 1.68' E	0	RMTon deck
037-2	02.01.2008	14:44		63° 29.29' S	3° 0.58' E	0	CTD/ROsurface

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
037-2	02.01.2008	15:07		63° 29.31' S	3° 0.45' E	0	CTD/ROat depth
037-2	02.01.2008	15:32		63° 29.30' S	3° 0.29' E	0	CTD/ROon deck
038-1	02.01.2008	19:16		64° 0.57' S	3° 2.76' E	0	RMTsurface
038-1	02.01.2008	19:35		64° 0.19' S	3° 1.39' E	0	RMTheave
038-1	02.01.2008	19:36		64° 0.17' S	3° 1.31' E	0	RMTBegin Trawling
038-1	02.01.2008	20:01		63° 59.81' S	2° 59.57' E	0	RMTEnd of Trawl
038-1	02.01.2008	20:05		63° 59.78' S	2° 59.36' E	0	RMTon deck
038-2	02.01.2008	20:17		63° 59.73' S	2° 59.14' E	0	CTD/ROsurface
038-3	02.01.2008	20:34		63° 59.72' S	2° 59.15' E	0	HNsurface
038-3	02.01.2008	20:57		63° 59.72' S	2° 59.19' E	2831	HNon deck
038-2	02.01.2008	21:16		63° 59.73' S	2° 59.17' E	2831	CTD/ROat depth
038-2	02.01.2008	22:12		63° 59.79' S	2° 58.90' E	0	CTD/ROon deck
038-4	02.01.2008	22:28		63° 59.68' S	3° 1.17' E	0	SUITsurface
038-4	02.01.2008	22:36		63° 59.57' S	3° 1.76' E	0	SUITstart trawl
038-4	02.01.2008	23:02		63° 59.24' S	3° 3.33' E	0	SUITstop trawl
038-4	02.01.2008	23:15		63° 58.97' S	3° 3.77' E	0	SUITon deck
039-1	03.01.2008	03:05		64° 28.83' S	2° 53.42' E	0	RMTsurface
039-1	03.01.2008	03:22		64° 29.10' S	2° 52.26' E	0	RMTheave
039-1	03.01.2008	03:51		64° 29.53' S	2° 50.09' E	0	RMTon deck
039-2	03.01.2008	04:00		64° 29.44' S	2° 50.73' E	0	MNsurface
039-2	03.01.2008	04:10		64° 29.44' S	2° 50.84' E	0	MNat depth
039-2	03.01.2008	04:27		64° 29.46' S	2° 50.84' E	0	MNon deck
039-3	03.01.2008	04:33		64° 29.47' S	2° 50.86' E	0	CTD/ROsurface
039-3	03.01.2008	05:16		64° 29.47' S	2° 50.91' E	2141	CTD/ROat depth
039-3	03.01.2008	05:58		64° 29.44' S	2° 50.97' E	0	CTD/ROon deck
039-4	03.01.2008	06:22		64° 30.19' S	2° 52.56' E	2125	LANDERsurface
039-5	03.01.2008	06:43		64° 28.63' S	2° 52.31' E	0	MNsurface
039-5	03.01.2008	07:01		64° 28.66' S	2° 52.30' E	0	MNat depth
039-5	03.01.2008	07:22		64° 28.68' S	2° 52.32' E	0	MNon deck
039-6	03.01.2008	07:36		64° 28.73' S	2° 52.24' E	0	RMTsurface
039-6	03.01.2008	09:22		64° 32.02' S	2° 48.07' E	2099	RMTBegin Trawling
039-6	03.01.2008	09:23		64° 32.04' S	2° 48.05' E	2099	RMTheave
039-6	03.01.2008	11:26		64° 34.11' S	2° 46.79' E	0	RMTon deck
039-7	03.01.2008	12:43		64° 26.96' S	3° 3.27' E	0	SUITsurface
039-7	03.01.2008	12:50		64° 27.03' S	3° 2.82' E	0	SUITstart trawl
039-7	03.01.2008	13:11		64° 27.06' S	3° 1.29' E	0	SUITstop trawl
039-7	03.01.2008	13:23		64° 26.96' S	3° 0.91' E	0	SUITon deck
039-8	03.01.2008	13:53		64° 28.61' S	2° 53.02' E	0	CTD/ROsurface
039-8	03.01.2008	14:01		64° 28.58' S	2° 53.03' E	0	CTD/ROat depth
039-8	03.01.2008	14:15		64° 28.58' S	2° 52.96' E	0	CTD/ROon deck
039-9	03.01.2008	14:26		64° 28.56' S	2° 52.95' E	0	VIDEOin water
039-9	03.01.2008	15:14		64° 28.28' S	2° 53.08' E	2160	VIDEOstart profile
039-9	03.01.2008	16:10		64° 28.08' S	2° 53.11' E	2163	VIDEOend profile
039-9	03.01.2008	16:49		64° 28.10' S	2° 53.06' E	0	VIDEOon deck
039-10	03.01.2008	17:10		64° 28.85' S	2° 52.37' E	0	MUCsurface
039-10	03.01.2008	17:39		64° 28.83' S	2° 52.48' E	2151	MUCat sea bottom
039-10	03.01.2008	18:13		64° 28.83' S	2° 52.54' E	0	MUCon deck
039-11	03.01.2008	18:18		64° 28.81' S	2° 52.52' E	0	GKGsurface
039-11	03.01.2008	18:47		64° 28.80' S	2° 52.52' E	2152	GKGat sea bottom
039-11	03.01.2008	19:24		64° 28.82' S	2° 52.49' E	0	GKGon deck
039-12	03.01.2008	19:28		64° 28.82' S	2° 52.47' E	0	MUCsurface

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
039-12	03.01.2008	19:57		64° 28.83' S	2° 52.53' E	2151	MUCat sea bottom
039-12	03.01.2008	20:32		64° 28.85' S	2° 52.55' E	0	MUCon deck
039-13	03.01.2008	20:42		64° 28.85' S	2° 52.55' E	0	BCsurface
039-13	03.01.2008	21:10		64° 28.87' S	2° 52.49' E	2150	BCat sea bottom
039-13	03.01.2008	21:46		64° 28.85' S	2° 52.51' E	2151	BCon deck
039-14	03.01.2008	21:53		64° 28.84' S	2° 52.46' E	0	MUCsurface
039-14	03.01.2008	22:21		64° 28.84' S	2° 52.49' E	2151	MUCat sea bottom
039-14	03.01.2008	22:56		64° 28.91' S	2° 52.37' E	0	MUCon deck
039-15	03.01.2008	23:22		64° 27.86' S	2° 51.39' E	0	SUITsurface
039-15	03.01.2008	23:29		64° 28.05' S	2° 51.81' E	0	SUITstart trawl
039-15	03.01.2008	23:48		64° 28.69' S	2° 52.61' E	0	SUITstop trawl
039-15	04.01.2008	00:00		64° 28.85' S	2° 52.66' E	0	SUITon deck
039-16	04.01.2008	00:30		64° 29.85' S	2° 48.42' E	0	AGTsurface
039-16	04.01.2008	01:21		64° 29.05' S	2° 51.40' E	2143	AGTAGT on ground
039-16	04.01.2008	01:45		64° 28.87' S	2° 52.35' E	2150	AGTstart trawl
039-16	04.01.2008	01:56		64° 28.79' S	2° 52.74' E	2151	AGTStop Trawl
039-16	04.01.2008	02:30		64° 28.79' S	2° 52.84' E	2151	AGTAGT off ground
039-16	04.01.2008	03:47		64° 28.83' S	2° 52.84' E	2150	AGTon deck
039-17	04.01.2008	04:17		64° 29.13' S	2° 51.08' E	2147	EBSsurface
039-17	04.01.2008	05:35		64° 29.09' S	2° 51.21' E	2148	EBSon ground
039-17	04.01.2008	06:14		64° 28.77' S	2° 52.69' E	2152	EBSstart trawling winch stop
039-17	04.01.2008	06:24		64° 28.69' S	2° 53.01' E	2153	EBSend trawling start hoisting
039-17	04.01.2008	07:00		64° 28.66' S	2° 53.14' E	2153	EBSfrom the bottom
039-17	04.01.2008	07:41		64° 28.69' S	2° 53.11' E	0	EBSon deck
039-18	04.01.2008	08:38		64° 30.16' S	2° 52.55' E	0	RELto Water
039-18	04.01.2008	08:48		64° 30.16' S	2° 52.56' E	0	RELat Deep
039-4	04.01.2008	08:50		64° 30.16' S	2° 52.54' E	0	LANDERreleased
039-18	04.01.2008	08:57		64° 30.17' S	2° 52.52' E	0	RELreleased
039-18	04.01.2008	09:05		64° 30.19' S	2° 52.53' E	0	RELon Deck
039-4	04.01.2008	09:19		64° 30.21' S	2° 52.57' E	0	LANDERInformation
039-4	04.01.2008	09:38		64° 30.18' S	2° 52.98' E	0	LANDERon Deck
040-1	04.01.2008	13:15		64° 59.96' S	2° 59.98' E	0	CTD/ROsurface
040-1	04.01.2008	14:03		65° 0.01' S	2° 59.90' E	2410	CTD/ROat depth
040-1	04.01.2008	14:49		64° 59.99' S	2° 59.96' E	2411	CTD/ROon deck
040-2	04.01.2008	14:57		64° 59.89' S	2° 59.90' E	0	MNsurface
040-2	04.01.2008	15:16		64° 59.85' S	2° 59.77' E	0	MNat depth
040-2	04.01.2008	15:36		64° 59.80' S	2° 59.85' E	0	MNon deck
040-3	04.01.2008	15:42		64° 59.79' S	2° 59.92' E	0	RMTsurface
040-3	04.01.2008	16:02		64° 59.48' S	3° 1.56' E	0	RMTheave
040-3	04.01.2008	16:03		64° 59.47' S	3° 1.64' E	0	RMTBegin Trawling
040-3	04.01.2008	16:18		64° 59.23' S	3° 2.76' E	0	RMTEnd of Trawl
040-3	04.01.2008	16:21		64° 59.20' S	3° 2.87' E	0	RMTon deck
041-1	04.01.2008	19:51		65° 30.12' S	3° 0.00' E	0	CTD/ROsurface
041-1	04.01.2008	20:13		65° 30.16' S	2° 59.73' E	0	CTD/ROat depth
041-1	04.01.2008	20:41		65° 30.15' S	2° 59.47' E	0	CTD/ROon deck
041-2	04.01.2008	20:50		65° 30.14' S	2° 59.46' E	0	RMTsurface
041-2	04.01.2008	21:06		65° 30.05' S	3° 0.74' E	0	RMTBegin Trawling
041-2	04.01.2008	21:27		65° 29.89' S	3° 2.59' E	0	RMTEnd of Trawl
041-2	04.01.2008	21:32		65° 29.86' S	3° 2.84' E	0	RMTon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
042-1	05.01.2008	01:05		66° 0.09' S	2° 59.12' E	0	MNsurface
042-1	05.01.2008	01:14		66° 0.12' S	2° 58.98' E	0	MNat depth
042-1	05.01.2008	01:31		66° 0.12' S	2° 59.02' E	0	MNon deck
042-2	05.01.2008	01:38		66° 0.13' S	2° 59.10' E	0	CTD/ROsurface
042-2	05.01.2008	02:48		66° 0.12' S	2° 59.18' E	3351	CTD/ROat depth
042-2	05.01.2008	03:55		66° 0.09' S	2° 59.63' E	0	CTD/ROon deck
042-3	05.01.2008	03:59		66° 0.08' S	2° 59.59' E	0	MNsurface
042-3	05.01.2008	05:10		66° 0.20' S	2° 59.17' E	0	MNat depth
042-3	05.01.2008	06:18		66° 0.41' S	2° 58.88' E	0	MNon deck
042-4	05.01.2008	06:24		66° 0.45' S	2° 58.86' E	0	CTD/ROsurface
042-4	05.01.2008	06:32		66° 0.49' S	2° 58.81' E	0	CTD/ROat depth
042-4	05.01.2008	06:44		66° 0.55' S	2° 58.80' E	0	CTD/ROon deck
042-5	05.01.2008	06:50		66° 0.59' S	2° 58.82' E	0	MNsurface
042-5	05.01.2008	07:08		66° 0.66' S	2° 58.80' E	0	MNat depth
042-5	05.01.2008	07:28		66° 0.75' S	2° 58.67' E	0	MNon deck
042-6	05.01.2008	07:36		66° 0.77' S	2° 58.64' E	0	RMTsurface
042-6	05.01.2008	07:51		66° 0.80' S	2° 59.90' E	0	RMTheave
042-6	05.01.2008	07:52		66° 0.81' S	3° 0.00' E	0	RMTBegin Trawling
042-6	05.01.2008	08:14		66° 0.88' S	3° 1.59' E	0	RMTEnd of Trawl
042-6	05.01.2008	08:19		66° 0.88' S	3° 1.69' E	0	RMTon deck
043-1	05.01.2008	12:10		66° 29.42' S	2° 59.69' E	0	RMTsurface
043-1	05.01.2008	12:45		66° 30.13' S	3° 2.44' E	0	RMTBegin Trawling
043-1	05.01.2008	13:43		66° 30.88' S	3° 5.18' E	0	RMTEnd of Trawl
043-1	05.01.2008	13:55		66° 30.89' S	3° 5.34' E	0	RMTon deck
043-2	05.01.2008	14:21		66° 30.79' S	3° 5.24' E	0	CTD/ROsurface
043-2	05.01.2008	14:43		66° 30.73' S	3° 4.93' E	0	CTD/ROat depth
043-2	05.01.2008	15:12		66° 30.69' S	3° 4.57' E	0	CTD/ROon deck
043-3	05.01.2008	15:21		66° 30.64' S	3° 4.28' E	0	RMTsurface
043-3	05.01.2008	15:36		66° 30.77' S	3° 5.40' E	0	RMTheave
043-3	05.01.2008	16:02		66° 30.91' S	3° 7.34' E	0	RMTon deck
044-1	05.01.2008	19:30		66° 59.75' S	2° 59.35' E	0	RMTsurface
044-1	05.01.2008	19:47		67° 0.12' S	3° 0.48' E	0	RMTheave
044-1	05.01.2008	19:48		67° 0.14' S	3° 0.54' E	0	RMTBegin Trawling
044-1	05.01.2008	20:10		67° 0.52' S	3° 1.81' E	0	RMTEnd of Trawl
044-1	05.01.2008	20:16		67° 0.54' S	3° 2.03' E	0	RMTon deck
044-2	05.01.2008	20:25		67° 0.53' S	3° 2.04' E	0	CTD/ROsurface
044-2	05.01.2008	21:25		67° 0.31' S	3° 0.92' E	3232	CTD/ROat depth
044-2	05.01.2008	22:24		67° 0.16' S	2° 59.96' E	0	CTD/ROon deck
044-3	05.01.2008	22:30		67° 0.14' S	2° 59.80' E	0	MNsurface
044-3	05.01.2008	22:46		67° 0.09' S	2° 59.54' E	0	MNat depth
044-3	05.01.2008	23:04		67° 0.05' S	2° 59.36' E	0	MNon deck
044-4	05.01.2008	23:14		67° 0.14' S	2° 59.40' E	0	SUITsurface
044-4	05.01.2008	23:21		67° 0.33' S	2° 59.72' E	0	SUITstart trawl
044-4	05.01.2008	23:44		67° 1.01' S	3° 0.71' E	0	SUITstop trawl
044-4	05.01.2008	23:57		67° 1.18' S	3° 0.45' E	0	SUITon deck
045-1	06.01.2008	03:32		67° 29.37' S	2° 59.75' E	0	CTD/ROsurface
045-1	06.01.2008	03:53		67° 29.41' S	2° 59.71' E	0	CTD/ROat depth
045-1	06.01.2008	04:18		67° 29.46' S	2° 59.58' E	0	CTD/ROon deck
045-2	06.01.2008	04:27		67° 29.53' S	2° 59.75' E	0	RMTsurface
045-2	06.01.2008	04:44		67° 29.98' S	3° 1.00' E	0	RMTheave
045-2	06.01.2008	04:45		67° 30.00' S	3° 1.07' E	0	RMTBegin Trawling

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
045-2	06.01.2008	05:10		67° 30.56' S	3° 2.56' E	0	RMTEnd of Trawl
045-2	06.01.2008	05:15		67° 30.64' S	3° 2.74' E	0	RMTon deck
046-1	06.01.2008	08:51		67° 58.13' S	3° 0.26' E	0	RMTsurface
046-1	06.01.2008	09:06		67° 58.61' S	3° 0.26' E	0	RMTBegin Trawling
046-1	06.01.2008	09:25		67° 59.24' S	3° 0.16' E	0	RMTEnd of Trawl
046-1	06.01.2008	09:30		67° 59.35' S	3° 0.13' E	0	RMTon deck
042-4	05.01.2008	06:44		66° 0.55' S	2° 58.80' E	0	CTD/ROon deck
042-5	05.01.2008	06:50		66° 0.59' S	2° 58.82' E	0	MNsurface
042-5	05.01.2008	07:08		66° 0.66' S	2° 58.80' E	0	MNat depth
042-5	05.01.2008	07:28		66° 0.75' S	2° 58.67' E	0	MNon deck
042-6	05.01.2008	07:36		66° 0.77' S	2° 58.64' E	0	RMTsurface
042-6	05.01.2008	07:51		66° 0.80' S	2° 59.90' E	0	RMTheave
042-6	05.01.2008	07:52		66° 0.81' S	3° 0.00' E	0	RMTBegin Trawling
042-6	05.01.2008	08:14		66° 0.88' S	3° 1.59' E	0	RMTEnd of Trawl
042-6	05.01.2008	08:19		66° 0.88' S	3° 1.69' E	0	RMTon deck
043-1	05.01.2008	12:10		66° 29.42' S	2° 59.69' E	0	RMTsurface
043-1	05.01.2008	12:45		66° 30.13' S	3° 2.44' E	0	RMTBegin Trawling
043-1	05.01.2008	13:43		66° 30.88' S	3° 5.18' E	0	RMTEnd of Trawl
043-1	05.01.2008	13:55		66° 30.89' S	3° 5.34' E	0	RMTon deck
043-2	05.01.2008	14:21		66° 30.79' S	3° 5.24' E	0	CTD/ROsurface
043-2	05.01.2008	14:43		66° 30.73' S	3° 4.93' E	0	CTD/ROat depth
043-2	05.01.2008	15:12		66° 30.69' S	3° 4.57' E	0	CTD/ROon deck
043-3	05.01.2008	15:21		66° 30.64' S	3° 4.28' E	0	RMTsurface
043-3	05.01.2008	15:36		66° 30.77' S	3° 5.40' E	0	RMTheave
043-3	05.01.2008	16:02		66° 30.91' S	3° 7.34' E	0	RMTon deck
044-1	05.01.2008	19:30		66° 59.75' S	2° 59.35' E	0	RMTsurface
044-1	05.01.2008	19:47		67° 0.12' S	3° 0.48' E	0	RMTheave
044-1	05.01.2008	19:48		67° 0.14' S	3° 0.54' E	0	RMTBegin Trawling
044-1	05.01.2008	20:10		67° 0.52' S	3° 1.81' E	0	RMTEnd of Trawl
044-1	05.01.2008	20:16		67° 0.54' S	3° 2.03' E	0	RMTon deck
044-2	05.01.2008	20:25		67° 0.53' S	3° 2.04' E	0	CTD/ROsurface
044-2	05.01.2008	21:25		67° 0.31' S	3° 0.92' E	3232	CTD/ROat depth
044-2	05.01.2008	22:24		67° 0.16' S	2° 59.96' E	0	CTD/ROon deck
044-3	05.01.2008	22:30		67° 0.14' S	2° 59.80' E	0	MNsurface
044-3	05.01.2008	22:46		67° 0.09' S	2° 59.54' E	0	MNat depth
044-3	05.01.2008	23:04		67° 0.05' S	2° 59.36' E	0	MNon deck
044-4	05.01.2008	23:14		67° 0.14' S	2° 59.40' E	0	SUITsurface
044-4	05.01.2008	23:21		67° 0.33' S	2° 59.72' E	0	SUITstart trawl
044-4	05.01.2008	23:44		67° 1.01' S	3° 0.71' E	0	SUITstop trawl
044-4	05.01.2008	23:57		67° 1.18' S	3° 0.45' E	0	SUITon deck
045-1	06.01.2008	03:32		67° 29.37' S	2° 59.75' E	0	CTD/ROsurface
045-1	06.01.2008	03:53		67° 29.41' S	2° 59.71' E	0	CTD/ROat depth
045-1	06.01.2008	04:18		67° 29.46' S	2° 59.58' E	0	CTD/ROon deck
045-2	06.01.2008	04:27		67° 29.53' S	2° 59.75' E	0	RMTsurface
045-2	06.01.2008	04:44		67° 29.98' S	3° 1.00' E	0	RMTheave
045-2	06.01.2008	04:45		67° 30.00' S	3° 1.07' E	0	RMTBegin Trawling
045-2	06.01.2008	05:10		67° 30.56' S	3° 2.56' E	0	RMTEnd of Trawl
045-2	06.01.2008	05:15		67° 30.64' S	3° 2.74' E	0	RMTon deck
046-1	06.01.2008	08:51		67° 58.13' S	3° 0.26' E	0	RMTsurface
046-1	06.01.2008	09:06		67° 58.61' S	3° 0.26' E	0	RMTBegin Trawling
046-1	06.01.2008	09:25		67° 59.24' S	3° 0.16' E	0	RMTEnd of Trawl

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
046-1	06.01.2008	09:30		67° 59.35' S	3° 0.13' E	0	RMTon deck
046-2	06.01.2008	09:42		67° 59.79' S	2° 59.67' E	0	MNsurface
046-2	06.01.2008	09:51		67° 59.77' S	2° 59.65' E	0	MNat depth
046-2	06.01.2008	10:06		67° 59.83' S	2° 59.72' E	0	MNon deck
046-3	06.01.2008	10:17		67° 59.77' S	2° 59.69' E	0	CTD/ROsurface
046-3	06.01.2008	11:42		67° 59.98' S	2° 59.80' E	4527	CTD/ROat depth
046-3	06.01.2008	13:06		67° 59.94' S	2° 59.30' E	0	CTD/ROon deck
047-1	07.01.2008	06:09		69° 40.40' S	1° 2.24' E	1843	LANDERsurface
047-2	07.01.2008	06:14		69° 40.39' S	1° 2.40' E	0	CALsurface
047-2	07.01.2008	08:15		69° 40.34' S	1° 2.30' E	0	CALstart
047-2	08.01.2008	02:48		69° 35.32' S	0° 57.47' E	0	CALEnd
047-1	08.01.2008	03:38		69° 39.52' S	1° 0.42' E	1555	LANDERreleased
047-1	08.01.2008	04:15		69° 40.28' S	1° 1.60' E	0	LANDERon Deck
048-1	12.01.2008	10:09		70° 24.11' S	8° 20.81' W	579	AGTsurface
048-1	12.01.2008	10:33		70° 24.00' S	8° 19.72' W	602	AGTAGT on ground
048-1	12.01.2008	10:44		70° 23.94' S	8° 19.14' W	602	AGTstart trawl
048-1	12.01.2008	10:54		70° 23.89' S	8° 18.67' W	595	AGTStop Trawl
048-1	12.01.2008	10:55		70° 23.88' S	8° 18.65' W	595	AGTStart hoisting
048-1	12.01.2008	11:04		70° 23.86' S	8° 18.68' W	597	AGTAGT off ground
048-1	12.01.2008	11:27		70° 23.81' S	8° 18.63' W	0	AGTon deck
048-2	12.01.2008	11:39		70° 23.94' S	8° 19.16' W	0	VIDEOin water
048-2	12.01.2008	12:00		70° 23.90' S	8° 19.23' W	611	VIDEOstart profile
048-2	12.01.2008	12:55		70° 23.65' S	8° 18.69' W	628	VIDEOend profile
048-3	12.01.2008	13:03		70° 23.59' S	8° 18.67' W	635	HNsurface
048-2	12.01.2008	13:09		70° 23.56' S	8° 18.69' W	640	VIDEOon deck
048-4	12.01.2008	13:13		70° 23.54' S	8° 18.71' W	643	MUCsurface
048-3	12.01.2008	13:32		70° 23.47' S	8° 18.65' W	652	HNon deck
048-4	12.01.2008	13:35		70° 23.45' S	8° 18.66' W	654	MUCat sea bottom
048-4	12.01.2008	13:48		70° 23.40' S	8° 18.58' W	659	MUCon deck
049-1	17.01.2008	07:36		69° 35.76' S	0° 0.89' W	0	MNsurface
049-1	17.01.2008	07:45		69° 35.73' S	0° 0.78' W	0	MNat depth
049-1	17.01.2008	08:01		69° 35.78' S	0° 0.83' W	0	MNon deck
044-1	05.01.2008	20:10		67° 0.52' S	3° 1.81' E	0	RMTEnd of Trawl
044-1	05.01.2008	20:16		67° 0.54' S	3° 2.03' E	0	RMTon deck
044-2	05.01.2008	20:25		67° 0.53' S	3° 2.04' E	0	CTD/ROsurface
044-2	05.01.2008	21:25		67° 0.31' S	3° 0.92' E	3232	CTD/ROat depth
044-2	05.01.2008	22:24		67° 0.16' S	2° 59.96' E	0	CTD/ROon deck
044-3	05.01.2008	22:30		67° 0.14' S	2° 59.80' E	0	MNsurface
044-3	05.01.2008	22:46		67° 0.09' S	2° 59.54' E	0	MNat depth
044-3	05.01.2008	23:04		67° 0.05' S	2° 59.36' E	0	MNon deck
044-4	05.01.2008	23:14		67° 0.14' S	2° 59.40' E	0	SUITsurface
044-4	05.01.2008	23:21		67° 0.33' S	2° 59.72' E	0	SUITstart trawl
044-4	05.01.2008	23:44		67° 1.01' S	3° 0.71' E	0	SUITstop trawl
044-4	05.01.2008	23:57		67° 1.18' S	3° 0.45' E	0	SUITon deck
045-1	06.01.2008	03:32		67° 29.37' S	2° 59.75' E	0	CTD/ROsurface
045-1	06.01.2008	03:53		67° 29.41' S	2° 59.71' E	0	CTD/ROat depth
045-1	06.01.2008	04:18		67° 29.46' S	2° 59.58' E	0	CTD/ROon deck
045-2	06.01.2008	04:27		67° 29.53' S	2° 59.75' E	0	RMTsurface
045-2	06.01.2008	04:44		67° 29.98' S	3° 1.00' E	0	RMTheave
045-2	06.01.2008	04:45		67° 30.00' S	3° 1.07' E	0	RMTBegin Trawling
045-2	06.01.2008	05:10		67° 30.56' S	3° 2.56' E	0	RMTEnd of Trawl

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
045-2	06.01.2008	05:15		67° 30.64' S	3° 2.74' E	0	RMTon deck
046-1	06.01.2008	08:51		67° 58.13' S	3° 0.26' E	0	RMTsurface
046-1	06.01.2008	09:06		67° 58.61' S	3° 0.26' E	0	RMTBegin Trawling
046-1	06.01.2008	09:25		67° 59.24' S	3° 0.16' E	0	RMTEnd of Trawl
046-1	06.01.2008	09:30		67° 59.35' S	3° 0.13' E	0	RMTon deck
046-2	06.01.2008	09:42		67° 59.79' S	2° 59.67' E	0	MNsurface
046-2	06.01.2008	09:51		67° 59.77' S	2° 59.65' E	0	MNat depth
046-2	06.01.2008	10:06		67° 59.83' S	2° 59.72' E	0	MNon deck
046-3	06.01.2008	10:17		67° 59.77' S	2° 59.69' E	0	CTD/ROsurface
046-3	06.01.2008	11:42		67° 59.98' S	2° 59.80' E	4527	CTD/ROat depth
046-3	06.01.2008	13:06		67° 59.94' S	2° 59.30' E	0	CTD/ROon deck
047-1	07.01.2008	06:09		69° 40.40' S	1° 2.24' E	1843	LANDERsurface
047-2	07.01.2008	06:14		69° 40.39' S	1° 2.40' E	0	CALsurface
047-2	07.01.2008	08:15		69° 40.34' S	1° 2.30' E	0	CALstart
047-2	08.01.2008	02:48		69° 35.32' S	0° 57.47' E	0	CALEnd
047-1	08.01.2008	03:38		69° 39.52' S	1° 0.42' E	1555	LANDERreleased
047-1	08.01.2008	04:15		69° 40.28' S	1° 1.60' E	0	LANDERon Deck
048-1	12.01.2008	10:09		70° 24.11' S	8° 20.81' W	579	AGTsurface
048-1	12.01.2008	10:33		70° 24.00' S	8° 19.72' W	602	AGTAGT on ground
048-1	12.01.2008	10:44		70° 23.94' S	8° 19.14' W	602	AGTstart trawl
048-1	12.01.2008	10:54		70° 23.89' S	8° 18.67' W	595	AGTStop Trawl
048-1	12.01.2008	10:55		70° 23.88' S	8° 18.65' W	595	AGTStart hoisting
048-1	12.01.2008	11:04		70° 23.86' S	8° 18.68' W	597	AGTAGT off ground
048-1	12.01.2008	11:27		70° 23.81' S	8° 18.63' W	0	AGTon deck
048-2	12.01.2008	11:39		70° 23.94' S	8° 19.16' W	0	VIDEOin water
048-2	12.01.2008	12:00		70° 23.90' S	8° 19.23' W	611	VIDEOstart profile
048-2	12.01.2008	12:55		70° 23.65' S	8° 18.69' W	628	VIDEOend profile
048-3	12.01.2008	13:03		70° 23.59' S	8° 18.67' W	635	HNsurface
048-2	12.01.2008	13:09		70° 23.56' S	8° 18.69' W	640	VIDEOon deck
048-4	12.01.2008	13:13		70° 23.54' S	8° 18.71' W	643	MUCsurface
048-3	12.01.2008	13:32		70° 23.47' S	8° 18.65' W	652	HNon deck
048-4	12.01.2008	13:35		70° 23.45' S	8° 18.66' W	654	MUCat sea bottom
048-4	12.01.2008	13:48		70° 23.40' S	8° 18.58' W	659	MUCon deck
049-1	17.01.2008	07:36		69° 35.76' S	0° 0.89' W	0	MNsurface
049-1	17.01.2008	07:45		69° 35.73' S	0° 0.78' W	0	MNat depth
049-1	17.01.2008	08:01		69° 35.78' S	0° 0.83' W	0	MNon deck
049-2	17.01.2008	08:10		69° 35.64' S	0° 0.86' W	0	SUITsurface
049-2	17.01.2008	08:18		69° 35.70' S	0° 0.22' W	0	SUITstart trawl
049-2	17.01.2008	08:31		69° 36.06' S	0° 0.61' E	0	SUITstop trawl
049-2	17.01.2008	08:46		69° 36.30' S	0° 0.64' E	0	SUITon deck
049-3	17.01.2008	08:54		69° 36.40' S	0° 0.48' E	1112	CTD/ROsurface
049-3	17.01.2008	09:31		69° 36.55' S	0° 0.10' E	1510	CTD/ROat depth
049-3	17.01.2008	10:04		69° 36.61' S	0° 0.53' W	0	CTD/ROon deck
049-4	17.01.2008	10:14		69° 36.59' S	0° 0.85' W	0	MNsurface
049-4	17.01.2008	10:31		69° 36.61' S	0° 1.28' W	0	MNat depth
049-4	17.01.2008	10:31		69° 36.61' S	0° 1.28' W	0	MNHoisting
049-4	17.01.2008	10:51		69° 36.61' S	0° 1.50' W	0	MNon deck
049-5	17.01.2008	11:11		69° 35.87' S	0° 1.15' W	0	RMTsurface
049-5	17.01.2008	11:21		69° 35.71' S	0° 1.89' W	0	RMTBegin Trawling
049-5	17.01.2008	11:37		69° 35.41' S	0° 3.02' W	0	RMTEnd of Trawl
049-5	17.01.2008	11:40		69° 35.37' S	0° 3.10' W	0	RMTon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
049-6	17.01.2008	11:54		69° 35.33' S	0° 2.87' W	0	CTD/ROsurface
049-6	17.01.2008	12:02		69° 35.33' S	0° 2.74' W	0	CTD/ROat depth
049-6	17.01.2008	12:17		69° 35.34' S	0° 2.49' W	0	CTD/ROon deck
050-1	17.01.2008	17:19		69° 0.39' S	0° 0.57' W	0	MNsurface
050-1	17.01.2008	17:28		69° 0.36' S	0° 0.60' W	0	MNsurface
050-1	17.01.2008	17:45		69° 0.38' S	0° 0.67' W	0	MNon deck
050-2	17.01.2008	17:50		69° 0.38' S	0° 0.67' W	0	CTD/ROsurface
050-3	17.01.2008	18:07		69° 0.35' S	0° 0.65' W	0	HNsurface
050-3	17.01.2008	18:29		69° 0.32' S	0° 0.68' W	0	HNon deck
050-2	17.01.2008	18:55		69° 0.27' S	0° 0.72' W	3378	CTD/ROat depth
050-2	17.01.2008	19:57		69° 0.19' S	0° 0.76' W	0	CTD/ROon deck
050-4	17.01.2008	20:01		69° 0.19' S	0° 0.77' W	0	MNsurface
050-4	17.01.2008	21:07		69° 0.26' S	0° 0.77' W	0	MNat depth
050-4	17.01.2008	22:12		69° 0.38' S	0° 0.69' W	0	MNon deck
050-5	17.01.2008	22:23		69° 0.28' S	0° 0.99' W	0	SUITsurface
050-5	17.01.2008	22:29		69° 0.34' S	0° 0.60' W	0	SUITstart trawl
050-5	17.01.2008	22:54		69° 0.73' S	0° 1.54' E	0	SUITstop trawl
050-5	17.01.2008	23:08		69° 0.79' S	0° 1.69' E	0	SUITon deck
050-6	17.01.2008	23:13		69° 0.78' S	0° 1.59' E	0	CTD/ROsurface
050-6	17.01.2008	23:21		69° 0.74' S	0° 1.55' E	0	CTD/ROat depth
050-6	17.01.2008	23:33		69° 0.70' S	0° 1.48' E	0	CTD/ROon deck
050-7	17.01.2008	23:37		69° 0.72' S	0° 1.46' E	0	MNsurface
050-7	17.01.2008	23:53		69° 0.77' S	0° 1.40' E	0	MNat depth
050-7	18.01.2008	00:15		69° 0.78' S	0° 1.44' E	0	MNon deck
050-8	18.01.2008	00:25		69° 0.75' S	0° 1.43' E	0	RMTsurface
050-8	18.01.2008	00:41		69° 0.74' S	0° 0.29' W	0	RMTheave
050-8	18.01.2008	01:11		69° 0.71' S	0° 3.38' W	0	RMTon deck
051-1	18.01.2008	04:42		68° 30.89' S	0° 0.16' E	0	RMTsurface
051-1	18.01.2008	05:00		68° 30.19' S	0° 0.42' E	0	RMTheave
051-1	18.01.2008	05:01		68° 30.15' S	0° 0.43' E	0	RMTBegin Trawling
051-1	18.01.2008	05:23		68° 29.38' S	0° 0.70' E	0	RMTEnd of Trawl
051-1	18.01.2008	05:28		68° 29.24' S	0° 0.75' E	0	RMTon deck
051-2	18.01.2008	05:39		68° 29.10' S	0° 0.71' E	0	CTD/ROsurface
051-2	18.01.2008	06:58		68° 29.21' S	0° 1.68' E	4259	CTD/ROat depth
051-2	18.01.2008	08:17		68° 29.09' S	0° 2.12' E	0	CTD/ROon deck
052-1	18.01.2008	11:43		68° 0.22' S	0° 0.03' W	0	RMTsurface
052-1	18.01.2008	11:59		67° 59.90' S	0° 1.53' W	0	RMTBegin Trawling
052-1	18.01.2008	12:26		67° 59.65' S	0° 4.29' W	0	RMTEnd of Trawl
052-1	18.01.2008	12:31		67° 59.62' S	0° 4.61' W	0	RMTon deck
052-2	18.01.2008	12:44		67° 59.60' S	0° 4.73' W	0	MNsurface
052-2	18.01.2008	12:53		67° 59.59' S	0° 4.83' W	0	MNat depth
052-2	18.01.2008	13:09		67° 59.57' S	0° 4.88' W	0	MNon deck
052-3	18.01.2008	13:15		67° 59.57' S	0° 4.88' W	0	CTD/ROsurface
052-3	18.01.2008	13:38		67° 59.55' S	0° 5.09' W	0	CTD/ROat depth
052-3	18.01.2008	14:05		67° 59.61' S	0° 5.37' W	0	CTD/ROon deck
052-4	18.01.2008	14:10		67° 59.61' S	0° 5.48' W	0	MNsurface
052-4	18.01.2008	15:19		67° 59.75' S	0° 6.06' W	0	MNat depth
052-4	18.01.2008	16:28		68° 0.04' S	0° 6.15' W	0	MNon deck
052-4	18.01.2008	16:29		68° 0.05' S	0° 6.16' W	0	MNHoisting
052-4	18.01.2008	16:29		68° 0.05' S	0° 6.16' W	0	MNon deck
052-5	18.01.2008	16:35		68° 0.09' S	0° 6.26' W	0	CTDsurface

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
052-5	18.01.2008	16:45		68° 0.15' S	0° 6.33' W	0	CTDat depth
052-5	18.01.2008	16:58		68° 0.18' S	0° 6.20' W	0	CTDon deck
052-6	18.01.2008	17:01		68° 0.20' S	0° 6.20' W	0	MNsurface
052-6	18.01.2008	17:20		68° 0.25' S	0° 6.19' W	0	MNat depth
052-6	18.01.2008	17:41		68° 0.36' S	0° 6.07' W	0	MNon deck
053-1	18.01.2008	20:49		67° 32.10' S	0° 0.14' E	0	RMTsurface
053-1	18.01.2008	21:04		67° 31.52' S	0° 0.07' E	0	RMTBegin Trawling
053-1	18.01.2008	21:26		67° 30.66' S	0° 0.07' W	0	RMTEnd of Trawl
053-1	18.01.2008	21:31		67° 30.52' S	0° 0.09' W	0	RMTon deck
053-2	18.01.2008	21:44		67° 30.53' S	0° 0.18' E	0	CTD/ROsurface
053-2	18.01.2008	22:05		67° 30.51' S	0° 0.29' E	0	CTD/ROat depth
053-2	18.01.2008	22:34		67° 30.47' S	0° 0.49' E	0	CTD/ROon deck
053-3	18.01.2008	22:40		67° 30.35' S	0° 0.48' E	0	SUITsurface
053-3	18.01.2008	22:48		67° 30.12' S	0° 0.45' E	0	SUITstart trawl
053-3	18.01.2008	23:12		67° 29.34' S	0° 0.39' E	0	SUITstop trawl
053-3	18.01.2008	23:24		67° 29.20' S	0° 0.34' E	0	SUITon deck
054-1	19.01.2008	02:32		67° 0.00' S	0° 0.27' W	0	CTD/ROsurface
054-1	19.01.2008	02:56		67° 0.04' S	0° 0.54' W	0	CTD/ROat depth
054-1	19.01.2008	03:21		67° 0.15' S	0° 0.65' W	0	CTD/ROon deck
054-2	19.01.2008	03:24		67° 0.16' S	0° 0.65' W	0	MNsurface
054-2	19.01.2008	03:42		67° 0.13' S	0° 0.86' W	0	MNat depth
054-2	19.01.2008	04:04		67° 0.20' S	0° 0.87' W	0	MNon deck
054-3	19.01.2008	04:11		67° 0.28' S	0° 0.99' W	0	RMTsurface
054-3	19.01.2008	04:29		67° 0.94' S	0° 1.67' W	0	RMTheave
054-3	19.01.2008	04:30		67° 0.97' S	0° 1.71' W	0	RMTBegin Trawling
054-3	19.01.2008	04:57		67° 1.76' S	0° 2.50' W	0	RMTEnd of Trawl
054-3	19.01.2008	05:00		67° 1.83' S	0° 2.57' W	0	RMTon deck
055-1	19.01.2008	08:51		66° 29.87' S	0° 0.10' E	0	CTD/ROsurface
055-1	19.01.2008	09:13		66° 29.96' S	0° 0.28' E	0	CTD/ROat depth
055-1	19.01.2008	09:43		66° 29.95' S	0° 0.37' E	0	CTD/ROon deck
055-2	19.01.2008	09:48		66° 29.97' S	0° 0.41' E	0	MNsurface
055-2	19.01.2008	10:06		66° 29.95' S	0° 0.48' E	0	MNat depth
055-2	19.01.2008	10:26		66° 29.96' S	0° 0.56' E	0	MNon deck
055-3	19.01.2008	10:36		66° 29.80' S	0° 0.74' E	0	RMTsurface
055-3	19.01.2008	10:51		66° 29.29' S	0° 0.74' E	0	RMTBegin Trawling
055-3	19.01.2008	11:13		66° 28.46' S	0° 0.65' E	0	RMTEnd of Trawl
055-3	19.01.2008	11:18		66° 28.33' S	0° 0.65' E	0	RMTon deck
056-1	19.01.2008	14:03		66° 0.10' S	0° 0.07' E	0	MNsurface
056-1	19.01.2008	14:12		66° 0.12' S	0° 0.01' E	0	MNat depth
056-1	19.01.2008	14:28		66° 0.10' S	0° 0.06' W	0	MNon deck
056-2	19.01.2008	14:35		66° 0.11' S	0° 0.06' W	0	CTD/ROsurface
056-2	19.01.2008	15:14		66° 0.16' S	0° 0.10' W	0	CTD/ROat depth
056-2	19.01.2008	16:05		66° 0.16' S	0° 0.07' W	0	CTD/ROon deck
056-3	19.01.2008	16:12		66° 0.16' S	0° 0.08' W	0	MNsurface
056-3	19.01.2008	17:19		66° 0.20' S	0° 0.11' E	0	MNat depth
056-3	19.01.2008	18:23		66° 0.29' S	0° 0.14' W	0	MNon deck
056-4	19.01.2008	18:29		66° 0.30' S	0° 0.14' W	0	CTD/ROsurface
056-4	19.01.2008	18:38		66° 0.30' S	0° 0.13' W	0	CTD/ROat depth
056-4	19.01.2008	18:49		66° 0.32' S	0° 0.12' W	0	CTD/ROon deck
056-5	19.01.2008	18:57		66° 0.32' S	0° 0.11' W	0	MNsurface
056-5	19.01.2008	19:15		66° 0.34' S	0° 0.13' W	0	MNat depth

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
056-5	19.01.2008	19:35		66° 0.38' S	0° 0.18' W	0	MNon deck
056-6	19.01.2008	19:41		66° 0.38' S	0° 0.15' W	0	RMTsurface
056-6	19.01.2008	19:56		66° 0.24' S	0° 1.20' E	0	RMTheave
056-6	19.01.2008	19:57		66° 0.23' S	0° 1.28' E	0	RMTBegin Trawling
056-6	19.01.2008	20:21		66° 0.02' S	0° 3.37' E	0	RMTEnd of Trawl
056-6	19.01.2008	20:26		65° 59.99' S	0° 3.69' E	0	RMTon deck
057-1	19.01.2008	23:08		65° 32.08' S	0° 0.05' E	0	SUITsurface
057-1	19.01.2008	23:15		65° 31.79' S	0° 0.12' E	0	SUITstart trawl
057-1	19.01.2008	23:39		65° 31.06' S	0° 0.06' W	0	SUITstop trawl
057-1	19.01.2008	23:50		65° 30.92' S	0° 0.11' W	0	SUITon deck
057-2	19.01.2008	23:56		65° 30.91' S	0° 0.14' W	0	CTD/ROsurface
057-2	20.01.2008	00:21		65° 30.83' S	0° 0.13' W	0	CTD/ROat depth
057-2	20.01.2008	00:52		65° 30.76' S	0° 0.07' W	0	CTD/ROon deck
057-3	20.01.2008	00:58		65° 30.72' S	0° 0.01' E	0	RMTsurface
057-3	20.01.2008	01:13		65° 30.40' S	0° 1.07' E	0	RMTheave
057-3	20.01.2008	01:38		65° 29.69' S	0° 2.76' E	0	RMTon deck
058-1	20.01.2008	04:27		65° 2.20' S	0° 0.18' W	0	RMTsurface
058-1	20.01.2008	04:44		65° 1.59' S	0° 0.69' W	0	RMTheave
058-1	20.01.2008	04:45		65° 1.56' S	0° 0.71' W	0	RMTBegin Trawling
058-1	20.01.2008	05:11		65° 0.77' S	0° 1.05' W	0	RMTEnd of Trawl
058-1	20.01.2008	05:15		65° 0.68' S	0° 1.03' W	0	RMTon deck
058-2	20.01.2008	05:24		65° 0.48' S	0° 0.96' W	0	MNsurface
058-2	20.01.2008	05:33		65° 0.47' S	0° 0.89' W	0	MNat depth
058-2	20.01.2008	05:51		65° 0.45' S	0° 0.81' W	0	MNon deck
058-3	20.01.2008	05:57		65° 0.46' S	0° 0.79' W	0	CTD/ROsurface
058-3	20.01.2008	07:09		65° 0.26' S	0° 0.44' W	3744	CTD/ROat depth
058-3	20.01.2008	08:17		65° 0.22' S	0° 0.06' E	0	CTD/ROon deck
058-4	20.01.2008	08:24		65° 0.23' S	0° 0.16' E	0	NNin the water
058-4	20.01.2008	08:42		65° 0.17' S	0° 0.38' E	0	NNat depth
058-4	20.01.2008	09:02		65° 0.13' S	0° 0.61' E	0	NNon Deck
058-5	20.01.2008	09:09		65° 0.10' S	0° 0.55' E	0	RMTsurface
058-5	20.01.2008	09:26		65° 0.08' S	0° 0.41' W	0	RMTaction
058-5	20.01.2008	09:45		65° 0.12' S	0° 1.03' W	0	RMTon deck
058-6	20.01.2008	09:56		65° 0.18' S	0° 0.88' W	0	CTD/ROsurface
058-6	20.01.2008	10:04		65° 0.21' S	0° 0.84' W	0	CTD/ROat depth
058-6	20.01.2008	10:17		65° 0.25' S	0° 1.13' W	0	CTD/ROon deck
059-1	20.01.2008	13:27		64° 30.03' S	0° 0.16' E	0	CTD/ROsurface
059-1	20.01.2008	13:48		64° 30.11' S	0° 0.09' W	0	CTD/ROat depth
059-1	20.01.2008	14:17		64° 30.22' S	0° 0.32' W	0	CTD/ROon deck
059-1	20.01.2008	14:21		64° 30.23' S	0° 0.41' W	0	MNsurface
059-1	20.01.2008	15:25		64° 30.35' S	0° 1.25' W	0	MNat depth
059-1	20.01.2008	16:32		64° 30.48' S	0° 1.76' W	0	MNon deck
059-3	20.01.2008	16:39		64° 30.49' S	0° 1.86' W	0	RMTsurface
059-3	20.01.2008	16:55		64° 30.39' S	0° 3.22' W	0	RMTheave
059-3	20.01.2008	16:56		64° 30.38' S	0° 3.30' W	0	RMTBegin Trawling
059-3	20.01.2008	17:17		64° 30.31' S	0° 4.76' W	0	RMTEnd of Trawl
059-3	20.01.2008	17:20		64° 30.31' S	0° 4.90' W	0	RMTon deck
060-1	20.01.2008	20:29		64° 0.10' S	0° 0.09' W	0	CTD/ROsurface
060-2	20.01.2008	20:40		64° 0.15' S	0° 0.19' W	0	HNsurface
060-1	20.01.2008	20:50		64° 0.23' S	0° 0.15' W	0	CTD/ROat depth
060-2	20.01.2008	20:53		64° 0.25' S	0° 0.19' W	0	HNon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
060-1	20.01.2008	21:16		64° 0.43' S	0° 0.28' W	0	CTD/ROon deck
060-3	20.01.2008	21:25		64° 0.49' S	0° 0.35' W	0	RMTsurface
060-3	20.01.2008	21:42		64° 0.49' S	0° 1.93' W	0	RMTBegin Trawling
060-3	20.01.2008	22:08		64° 0.51' S	0° 4.20' W	0	RMTEnd of Trawl
060-3	20.01.2008	22:15		64° 0.54' S	0° 4.54' W	0	RMTon deck
060-4	20.01.2008	22:19		64° 0.56' S	0° 4.60' W	0	MNsurface
060-4	20.01.2008	22:36		64° 0.70' S	0° 4.60' W	0	MNat depth
060-4	20.01.2008	22:38		64° 0.71' S	0° 4.59' W	0	MNHoisting
060-4	20.01.2008	22:58		64° 0.85' S	0° 4.54' W	0	MNon deck
060-5	20.01.2008	23:03		64° 0.87' S	0° 4.63' W	0	SUITsurface
060-5	20.01.2008	23:08		64° 0.84' S	0° 5.15' W	0	SUITstart trawl
060-5	20.01.2008	23:32		64° 0.65' S	0° 6.58' W	0	SUITstop trawl
060-5	20.01.2008	23:44		64° 0.50' S	0° 6.70' W	0	SUITon deck
061-1	21.01.2008	02:49		63° 30.05' S	0° 0.08' E	0	CTD/ROsurface
061-1	21.01.2008	03:11		63° 30.10' S	0° 0.06' W	0	CTD/ROat depth
061-1	21.01.2008	03:41		63° 30.24' S	0° 0.36' W	0	CTD/ROon deck
061-2	21.01.2008	03:45		63° 30.23' S	0° 0.42' W	0	RMTsurface
061-2	21.01.2008	04:02		63° 30.36' S	0° 1.69' W	0	RMTheave
061-2	21.01.2008	04:03		63° 30.37' S	0° 1.77' W	0	RMTBegin Trawling
061-2	21.01.2008	04:24		63° 30.53' S	0° 3.25' W	0	RMTEnd of Trawl
061-2	21.01.2008	04:28		63° 30.55' S	0° 3.44' W	0	RMTon deck
062-1	21.01.2008	07:36		62° 59.31' S	0° 3.63' E	0	RMTsurface
062-1	21.01.2008	07:52		62° 59.56' S	0° 2.45' E	0	RMTheave
062-1	21.01.2008	07:53		62° 59.57' S	0° 2.37' E	0	RMTBegin Trawling
062-1	21.01.2008	08:16		62° 59.81' S	0° 0.85' E	0	RMTEnd of Trawl
062-1	21.01.2008	08:19		62° 59.84' S	0° 0.70' E	0	RMTon deck
062-2	21.01.2008	08:30		62° 59.85' S	0° 0.68' E	0	MNsurface
062-2	21.01.2008	08:40		62° 59.87' S	0° 0.62' E	0	MNat depth
062-2	21.01.2008	09:02		62° 59.87' S	0° 0.78' E	0	MNon deck
062-3	21.01.2008	09:11		62° 59.88' S	0° 0.77' E	0	CTD/ROsurface
062-3	21.01.2008	09:52		62° 59.88' S	0° 0.83' E	0	CTD/ROat depth
062-3	21.01.2008	10:39		62° 59.87' S	0° 1.28' E	0	CTD/ROon deck
062-4	21.01.2008	10:45		62° 59.88' S	0° 1.18' E	0	RMTsurface
062-4	21.01.2008	13:01		62° 59.94' S	0° 8.38' W	0	RMTBegin Trawling
062-4	21.01.2008	15:10		62° 59.77' S	0° 14.55' W	0	RMTEnd of Trawl
062-4	21.01.2008	15:21		62° 59.76' S	0° 14.84' W	0	RMTon deck
062-5	21.01.2008	15:30		62° 59.74' S	0° 14.84' W	0	CTD/ROsurface
062-5	21.01.2008	15:38		62° 59.74' S	0° 14.80' W	0	CTD/ROat depth
062-5	21.01.2008	15:54		62° 59.75' S	0° 14.92' W	0	CTD/ROon deck
062-6	21.01.2008	16:02		62° 59.76' S	0° 14.87' W	0	MNsurface
062-6	21.01.2008	16:19		62° 59.79' S	0° 14.82' W	0	MNat depth
062-6	21.01.2008	16:40		62° 59.81' S	0° 14.76' W	0	MNon deck
063-1	21.01.2008	19:42		62° 29.56' S	0° 2.85' E	0	RMTsurface
063-1	21.01.2008	20:00		62° 29.74' S	0° 1.52' E	0	RMTBegin Trawling
063-1	21.01.2008	20:26		62° 30.05' S	0° 0.33' W	0	RMTEnd of Trawl
063-1	21.01.2008	20:33		62° 30.11' S	0° 0.51' W	0	RMTon deck
063-2	21.01.2008	20:45		62° 30.11' S	0° 0.41' W	0	CTD/ROsurface
063-2	21.01.2008	21:08		62° 30.16' S	0° 0.33' W	0	CTD/ROat depth
063-2	21.01.2008	21:39		62° 30.23' S	0° 0.19' W	0	CTD/ROon deck
064-1	22.01.2008	00:34		62° 0.04' S	0° 0.31' E	0	SUITsurface
064-1	22.01.2008	00:39		62° 0.13' S	0° 0.07' W	0	SUITstart trawl

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
064-1	22.01.2008	01:05		62° 0.45' S	0° 1.36' W	0	SUITstop trawl
064-1	22.01.2008	01:13		62° 0.57' S	0° 1.61' W	0	SUITon deck
064-2	22.01.2008	01:31		62° 0.47' S	0° 1.17' W	0	RMTsurface
064-2	22.01.2008	01:47		62° 0.66' S	0° 2.43' W	0	RMTheave
064-2	22.01.2008	02:14		62° 0.94' S	0° 4.33' W	0	RMTon deck
064-3	22.01.2008	02:23		62° 0.94' S	0° 4.31' W	0	MNsurface
064-3	22.01.2008	02:33		62° 0.99' S	0° 4.30' W	0	MNat depth
064-3	22.01.2008	02:48		62° 1.06' S	0° 4.25' W	0	MNon deck
064-4	22.01.2008	02:54		62° 1.08' S	0° 4.25' W	0	CTD/ROsurface
064-4	22.01.2008	03:32		62° 1.19' S	0° 4.43' W	0	CTD/ROat depth
064-4	22.01.2008	04:16		62° 1.30' S	0° 4.52' W	0	CTD/ROon deck
064-5	22.01.2008	04:22		62° 1.30' S	0° 4.50' W	0	MNsurface
064-5	22.01.2008	05:28		62° 1.37' S	0° 4.56' W	0	MNat depth
064-5	22.01.2008	06:33		62° 1.31' S	0° 4.66' W	0	MNon deck
064-6	22.01.2008	06:41		62° 1.28' S	0° 4.63' W	0	CTD/ROsurface
064-6	22.01.2008	06:49		62° 1.26' S	0° 4.65' W	0	CTD/ROat depth
064-6	22.01.2008	07:00		62° 1.26' S	0° 4.66' W	0	CTD/ROon deck
064-7	22.01.2008	07:06		62° 1.27' S	0° 4.69' W	0	MNsurface
064-7	22.01.2008	07:23		62° 1.31' S	0° 4.81' W	0	MNat depth
064-7	22.01.2008	07:43		62° 1.31' S	0° 4.81' W	0	MNon deck
064-8	22.01.2008	07:50		62° 1.40' S	0° 4.86' W	0	SUITsurface
064-8	22.01.2008	07:54		62° 1.54' S	0° 5.00' W	0	SUITstart trawl
064-8	22.01.2008	08:19		62° 2.16' S	0° 5.71' W	0	SUITstop trawl
064-8	22.01.2008	08:31		62° 2.27' S	0° 5.96' W	0	SUITon deck
065-1	22.01.2008	11:45		61° 30.00' S	0° 0.06' W	0	CTD/ROsurface
065-1	22.01.2008	12:06		61° 30.05' S	0° 0.13' W	0	CTD/ROat depth
065-1	22.01.2008	12:38		61° 30.05' S	0° 0.03' W	0	CTD/ROon deck
065-2	22.01.2008	12:44		61° 30.10' S	0° 0.11' W	0	RMTsurface
065-2	22.01.2008	13:00		61° 30.56' S	0° 1.00' W	0	RMTheave
065-2	22.01.2008	13:29		61° 31.45' S	0° 2.74' W	0	RMTon deck
066-1	22.01.2008	16:38		60° 59.85' S	0° 0.11' E	0	CTD/ROsurface
066-1	22.01.2008	16:58		60° 59.91' S	0° 0.02' E	0	CTD/ROat depth
066-1	22.01.2008	17:24		60° 59.94' S	0° 0.07' E	0	CTD/ROon deck
066-2	22.01.2008	17:28		60° 59.95' S	0° 0.04' E	0	MNsurface
066-2	22.01.2008	17:46		61° 0.02' S	0° 0.11' W	0	MNat depth
066-2	22.01.2008	18:04		61° 0.09' S	0° 0.28' W	0	MNon deck
066-3	22.01.2008	18:11		61° 0.13' S	0° 0.35' W	0	RMTsurface
066-3	22.01.2008	18:30		61° 0.61' S	0° 1.64' W	0	RMTheave
066-3	22.01.2008	18:31		61° 0.64' S	0° 1.71' W	0	RMTBegin Trawling
066-3	22.01.2008	18:56		61° 1.17' S	0° 3.05' W	0	RMTEnd of Trawl
066-3	22.01.2008	19:00		61° 1.24' S	0° 3.22' W	0	RMTon deck
067-1	22.01.2008	22:07		0° 0.00' N	0° 0.00' E	0	CTD/ROsurface
067-1	22.01.2008	22:32		60° 30.14' S	0° 0.00' E	0	CTD/ROat depth
067-1	22.01.2008	22:57		60° 30.17' S	0° 0.15' W	0	CTD/ROon deck
067-2	22.01.2008	23:02		60° 30.11' S	0° 0.13' W	0	RMTsurface
067-2	22.01.2008	23:21		60° 29.40' S	0° 0.09' E	0	RMTBegin Trawling
067-2	22.01.2008	23:47		60° 28.41' S	0° 0.46' E	0	RMTEnd of Trawl
067-2	22.01.2008	23:52		60° 28.24' S	0° 0.51' E	0	RMTon deck
068-1	23.01.2008	02:42		59° 59.82' S	0° 0.39' E	0	CTD/ROsurface
068-1	23.01.2008	04:26		59° 59.90' S	0° 0.24' E	5355	CTD/ROat depth
068-1	23.01.2008	06:18		59° 59.93' S	0° 0.13' E	0	CTD/ROon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
068-2	23.01.2008	06:26		59° 59.90' S	0° 0.00' E	0	RMTsurface
068-2	23.01.2008	06:42		59° 59.82' S	0° 1.24' W	0	RMTheave
068-2	23.01.2008	06:43		59° 59.82' S	0° 1.32' W	0	RMTBegin Trawling
068-2	23.01.2008	07:06		59° 59.77' S	0° 2.81' W	0	RMTEnd of Trawl
068-2	23.01.2008	07:09		59° 59.77' S	0° 2.99' W	0	RMTon deck
068-3	23.01.2008	07:20		59° 59.77' S	0° 3.22' W	0	MNsurface
068-3	23.01.2008	07:38		59° 59.78' S	0° 3.21' W	0	MNat depth
068-3	23.01.2008	07:58		59° 59.81' S	0° 3.25' W	0	MNon deck
068-4	23.01.2008	08:03		59° 59.82' S	0° 3.24' W	0	RMTsurface
068-4	23.01.2008	10:28		59° 59.80' S	0° 12.79' W	0	RMTBegin Trawling
068-4	23.01.2008	10:29		59° 59.80' S	0° 12.86' W	0	RMTheave
068-4	23.01.2008	13:58		59° 59.35' S	0° 26.24' W	0	RMTEnd of Trawl
068-4	23.01.2008	14:25		59° 59.40' S	0° 27.10' W	0	RMTon deck
069-1	23.01.2008	17:46		59° 29.94' S	0° 0.11' E	0	CTD/ROsurface
069-1	23.01.2008	18:08		59° 30.02' S	0° 0.25' E	0	CTD/ROat depth
069-1	23.01.2008	18:32		59° 30.16' S	0° 0.33' E	0	CTD/ROon deck
070-1	23.01.2008	21:43		59° 0.12' S	0° 0.02' E	0	CTD/ROsurface
070-1	23.01.2008	22:04		59° 0.24' S	0° 0.10' E	0	CTD/ROat depth
070-1	23.01.2008	22:28		59° 0.28' S	0° 0.22' E	0	CTD/ROon deck
070-2	23.01.2008	22:35		59° 0.20' S	0° 0.43' E	0	MNsurface
070-2	23.01.2008	22:52		59° 0.23' S	0° 0.62' E	0	MNat depth
070-2	23.01.2008	23:13		59° 0.14' S	0° 0.88' E	0	MNon deck
071-1	24.01.2008	02:20		58° 29.98' S	0° 0.19' W	0	CTD/ROsurface
071-1	24.01.2008	02:40		58° 29.96' S	0° 0.08' W	0	CTD/ROat depth
071-1	24.01.2008	03:08		58° 29.96' S	0° 0.26' E	0	CTD/ROon deck
072-1	24.01.2008	06:24		58° 0.19' S	0° 0.19' W	0	CTD/ROsurface
072-1	24.01.2008	06:47		58° 0.52' S	0° 0.36' W	0	CTD/ROat depth
072-1	24.01.2008	07:15		58° 0.92' S	0° 0.77' W	0	CTD/ROon deck
072-2	24.01.2008	07:21		58° 1.01' S	0° 0.85' W	0	MNsurface
072-2	24.01.2008	07:42		58° 1.31' S	0° 1.11' W	0	MNat depth
072-2	24.01.2008	08:04		58° 1.60' S	0° 1.25' W	0	MNon deck
073-1	24.01.2008	11:43		57° 30.10' S	0° 0.12' E	0	CTD/ROsurface
073-1	24.01.2008	12:08		57° 30.28' S	0° 0.12' E	0	CTD/ROat depth
073-1	24.01.2008	12:39		57° 30.45' S	0° 0.04' W	0	CTD/ROon deck
074-1	24.01.2008	16:37		57° 0.02' S	0° 0.06' E	0	CTD/ROsurface
074-1	24.01.2008	16:59		57° 0.01' S	0° 0.08' W	0	CTD/ROat depth
074-1	24.01.2008	17:23		57° 0.02' S	0° 0.14' W	0	CTD/ROon deck
074-2	24.01.2008	17:30		56° 59.99' S	0° 0.13' W	0	MNsurface
074-2	24.01.2008	17:48		57° 0.04' S	0° 0.11' W	0	MNat depth
074-2	24.01.2008	18:09		57° 0.07' S	0° 0.19' W	0	MNon deck
075-1	24.01.2008	21:36		56° 29.99' S	0° 0.22' E	0	CTD/ROsurface
075-1	24.01.2008	21:57		56° 30.05' S	0° 0.31' E	0	CTD/ROat depth
075-1	24.01.2008	22:27		56° 30.10' S	0° 0.38' E	0	CTD/ROon deck
076-1	25.01.2008	01:35		55° 59.99' S	0° 0.11' E	0	CTD/ROsurface
076-1	25.01.2008	01:58		55° 59.99' S	0° 0.19' E	0	CTD/ROat depth
076-1	25.01.2008	02:28		56° 0.08' S	0° 0.25' E	0	CTD/ROon deck
076-2	25.01.2008	02:37		56° 0.06' S	0° 0.04' E	0	MNsurface
076-2	25.01.2008	02:53		56° 0.07' S	0° 0.13' E	0	MNat depth
076-2	25.01.2008	03:14		56° 0.07' S	0° 0.29' E	0	MNon deck
077-1	25.01.2008	06:18		55° 29.99' S	0° 0.07' E	0	CTD/ROsurface
077-1	25.01.2008	06:39		55° 29.98' S	0° 0.10' E	0	CTD/ROat depth

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
077-1	25.01.2008	07:04		55° 30.03' S	0° 0.04' W	0	CTD/ROon deck
078-1	25.01.2008	10:11		55° 0.06' S	0° 0.00' W	0	CTD/ROsurface
078-1	25.01.2008	10:33		55° 0.10' S	0° 0.02' E	0	CTD/ROat depth
078-1	25.01.2008	10:57		55° 0.16' S	0° 0.06' W	0	CTD/ROon deck
078-2	25.01.2008	11:04		55° 0.18' S	0° 0.02' W	0	MNsurface
078-2	25.01.2008	11:21		55° 0.22' S	0° 0.05' E	0	MNat depth
078-2	25.01.2008	11:41		55° 0.22' S	0° 0.08' E	0	MNon deck
079-1	25.01.2008	14:50		54° 29.67' S	0° 0.15' W	0	CTD/ROsurface
079-1	25.01.2008	15:13		54° 29.61' S	0° 0.20' W	0	CTD/ROat depth
079-1	25.01.2008	15:45		54° 29.63' S	0° 0.36' W	0	CTD/ROon deck
080-1	25.01.2008	18:50		54° 0.01' S	0° 0.10' W	0	CTD/ROsurface
080-1	25.01.2008	19:11		53° 59.99' S	0° 0.08' W	0	CTD/ROat depth
080-1	25.01.2008	19:35		54° 0.00' S	0° 0.10' W	0	CTD/ROon deck
080-2	25.01.2008	19:42		54° 0.01' S	0° 0.10' W	0	MNsurface
080-2	25.01.2008	20:00		54° 0.05' S	0° 0.04' W	0	MNat depth
080-2	25.01.2008	20:20		54° 0.07' S	0° 0.21' W	0	MNon deck
081-1	25.01.2008	23:30		53° 30.08' S	0° 0.05' E	0	CTD/ROsurface
081-1	25.01.2008	23:53		53° 30.20' S	0° 0.43' E	0	CTD/ROat depth
081-1	26.01.2008	00:31		53° 30.47' S	0° 0.63' E	0	CTD/ROon deck
082-1	26.01.2008	03:48		52° 59.98' S	0° 0.11' E	0	CTD/ROsurface
082-1	26.01.2008	04:09		53° 0.05' S	0° 0.12' E	0	CTD/ROat depth
082-1	26.01.2008	04:38		53° 0.07' S	0° 0.05' E	0	CTD/ROon deck
082-2	26.01.2008	04:53		53° 0.04' S	0° 0.00' E	0	MNsurface
082-2	26.01.2008	05:10		53° 0.01' S	0° 0.06' W	0	MNat depth
082-2	26.01.2008	05:30		53° 0.08' S	0° 0.04' E	0	MNon deck
083-1	26.01.2008	08:48		52° 30.06' S	0° 0.17' E	0	CTD/ROsurface
083-1	26.01.2008	09:13		52° 30.05' S	0° 0.18' E	0	CTD/ROat depth
083-1	26.01.2008	09:43		52° 30.00' S	0° 0.08' E	0	CTD/ROon deck
084-1	26.01.2008	11:45		52° 12.02' S	0° 0.17' E	0	LANDERsurface
084-2	26.01.2008	11:51		52° 12.08' S	0° 0.23' E	0	RMTsurface
084-2	26.01.2008	13:15		52° 12.06' S	0° 3.44' W	0	RMTBegin Trawling
084-2	26.01.2008	15:22		52° 11.74' S	0° 6.42' W	0	RMTEnd of Trawl
084-2	26.01.2008	15:42		52° 11.78' S	0° 6.74' W	0	RMTon deck
084-3	26.01.2008	16:02		52° 11.78' S	0° 6.35' W	0	CTD/ROsurface
084-3	26.01.2008	16:59		52° 11.79' S	0° 6.48' W	3002	CTD/ROat depth
084-3	26.01.2008	18:30		52° 11.81' S	0° 6.62' W	0	CTD/ROon deck
084-1	26.01.2008	18:45		52° 11.70' S	0° 3.94' W	0	LANDERreleased
084-1	26.01.2008	19:37		52° 12.17' S	0° 0.25' E	0	LANDERon Deck
085-1	26.01.2008	20:56		52° 1.14' S	0° 0.07' E	0	LANDERsurface
085-2	26.01.2008	21:03		52° 1.15' S	0° 0.19' E	0	MNsurface
085-2	26.01.2008	21:12		52° 1.18' S	0° 0.24' E	0	MNat depth
085-2	26.01.2008	21:28		52° 1.19' S	0° 0.34' E	0	MNon deck
085-3	26.01.2008	21:35		52° 1.19' S	0° 0.33' E	0	MNsurface
085-3	26.01.2008	21:52		52° 1.20' S	0° 0.37' E	0	MNat depth
085-3	26.01.2008	22:10		52° 1.19' S	0° 0.42' E	0	MNon deck
085-4	26.01.2008	22:17		52° 1.19' S	0° 0.39' E	0	CTD/ROsurface
085-4	26.01.2008	22:29		52° 1.20' S	0° 0.41' E	0	CTD/ROat depth
085-4	26.01.2008	22:45		52° 1.20' S	0° 0.48' E	0	CTD/ROon deck
085-5	26.01.2008	22:58		52° 1.22' S	0° 0.47' E	0	MUCsurface
085-5	26.01.2008	23:41		52° 1.20' S	0° 0.20' E	2981	MUCat sea bottom
085-5	27.01.2008	00:29		52° 1.42' S	0° 0.20' E	0	MUCon deck

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
085-6	27.01.2008	00:33		52° 1.44' S	0° 0.18' E	0	GKGsurface
085-6	27.01.2008	01:10		52° 1.48' S	0° 0.18' E	2987	GKGat sea bottom
085-6	27.01.2008	01:57		52° 1.59' S	0° 0.08' E	2988	GKGon deck
085-7	27.01.2008	02:02		52° 1.58' S	0° 0.06' E	2988	MUCsurface
085-7	27.01.2008	02:40		52° 1.53' S	0° 0.16' E	2996	MUCat sea bottom
085-7	27.01.2008	03:27		52° 1.67' S	0° 0.36' E	2986	MUCon deck
085-8	27.01.2008	03:53		52° 1.61' S	0° 1.79' E	2998	EBSsurface
085-8	27.01.2008	05:38		52° 1.55' S	0° 1.72' E	3004	EBSon ground
085-8	27.01.2008	06:34		52° 1.54' S	0° 0.22' E	2987	EBSstart trawling winch stop
085-8	27.01.2008	06:44		52° 1.55' S	0° 0.04' W	2992	EBSend trawling start hoisting
085-8	27.01.2008	07:34		52° 1.61' S	0° 0.04' W	2994	EBSfrom the bottom
085-1	27.01.2008	08:04		52° 1.55' S	0° 0.01' W	0	LANDERreleased
085-8	27.01.2008	08:33		52° 1.10' S	0° 0.36' W	0	EBSon deck
085-1	27.01.2008	08:46		52° 0.35' S	0° 0.09' E	0	LANDERInformation
085-1	27.01.2008	09:19		52° 1.38' S	0° 0.80' E	0	LANDERInformation
085-1	27.01.2008	09:23		52° 1.31' S	0° 1.05' E	0	LANDERon Deck
085-9	27.01.2008	09:47		52° 0.29' S	0° 0.51' E	0	TRAPFreleased
085-9	27.01.2008	09:58		52° 0.19' S	0° 1.12' E	0	TRAPFHydrophon to the water
085-9	27.01.2008	10:01		52° 0.19' S	0° 1.33' E	0	TRAPFreleased
085-9	27.01.2008	10:19		52° 0.19' S	0° 2.46' E	0	TRAPFHydrophon out of the water
085-9	27.01.2008	10:38		52° 0.56' S	0° 1.30' E	0	TRAPFHydrophon to the water
085-9	27.01.2008	10:46		52° 0.69' S	0° 1.67' E	0	TRAPFInformation
085-9	27.01.2008	10:47		52° 0.70' S	0° 1.73' E	0	TRAPFHydrophon out of the water
085-9	27.01.2008	11:01		52° 0.48' S	0° 0.32' E	0	TRAPFHydrophon to the water
085-9	27.01.2008	11:06		52° 0.44' S	0° 0.55' E	0	TRAPFHydrophon out of the water
085-9	27.01.2008	11:07		52° 0.43' S	0° 0.62' E	0	TRAPFInformation
085-9	27.01.2008	11:40		52° 0.28' S	0° 1.05' E	0	TRAPFon deck
086-1	28.01.2008	14:16		51° 0.46' S	0° 3.70' W	0	CTD/ROsurface
086-1	28.01.2008	14:36		51° 0.62' S	0° 3.78' W	0	CTD/ROat depth
086-1	28.01.2008	15:05		51° 0.95' S	0° 4.16' W	0	CTD/ROon deck
087-1	28.01.2008	18:48		50° 30.02' S	0° 0.15' E	0	CTD/ROsurface
087-1	28.01.2008	19:18		50° 30.08' S	0° 0.05' E	0	CTD/ROat depth
087-1	28.01.2008	19:42		50° 30.08' S	0° 0.11' W	0	CTD/ROon deck
088-1	28.01.2008	23:14		50° 0.00' S	0° 0.58' E	0	CTD/ROsurface
088-1	28.01.2008	23:44		50° 0.38' S	0° 1.31' E	0	CTD/ROat depth
088-1	29.01.2008	00:10		50° 0.72' S	0° 1.72' E	0	CTD/ROon deck
089-1	29.01.2008	03:42		49° 29.91' S	0° 0.23' W	0	CTD/ROsurface
089-1	29.01.2008	04:03		49° 29.93' S	0° 0.14' W	0	CTD/ROat depth
089-1	29.01.2008	04:33		49° 29.91' S	0° 0.03' W	0	CTD/ROon deck
090-1	29.01.2008	07:39		48° 59.92' S	0° 0.11' E	0	CTD/ROsurface
090-1	29.01.2008	09:09		49° 0.30' S	0° 0.11' W	3946	CTD/ROat depth
090-1	29.01.2008	10:21		49° 0.59' S	0° 0.11' E	0	CTD/ROon deck
090-2	29.01.2008	10:34		49° 0.64' S	0° 0.03' W	0	MUCsurface
090-2	29.01.2008	11:31		49° 0.95' S	0° 0.03' E	0	MUCat sea bottom

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
090-2	29.01.2008	12:31		49° 1.35' S	0° 0.10' E	0	MUCon deck
090-3	29.01.2008	12:37		49° 1.36' S	0° 0.19' E	0	GKGsurface
090-3	29.01.2008	13:30		49° 1.71' S	0° 0.02' E	4008	GKGat sea bottom
090-3	29.01.2008	14:33		49° 2.26' S	0° 0.04' E	0	GKGon deck
090-4	29.01.2008	15:25		49° 0.85' S	0° 6.08' E	0	AGTsurface
090-4	29.01.2008	17:28		48° 59.44' S	0° 1.81' E	0	AGTAGT on ground
090-4	29.01.2008	17:51		48° 59.24' S	0° 1.40' E	0	AGTstart trawl
090-4	29.01.2008	18:01		48° 59.17' S	0° 1.21' E	0	AGTStop Trawl
090-4	29.01.2008	18:02		48° 59.16' S	0° 1.19' E	0	AGTStart hoisting
090-4	29.01.2008	19:10		48° 59.14' S	0° 1.26' E	0	AGTAGT off ground
090-4	29.01.2008	21:27		48° 59.09' S	0° 1.21' E	0	AGTon deck
091-1	30.01.2008	00:25		48° 29.99' S	0° 0.26' W	0	CTD/ROsurface
091-1	30.01.2008	00:53		48° 29.80' S	0° 0.29' W	0	CTD/ROat depth
091-1	30.01.2008	01:29		48° 29.89' S	0° 0.59' W	0	CTD/ROon deck
091-2	30.01.2008	01:35		48° 29.86' S	0° 0.62' W	0	MNsurface
091-2	30.01.2008	01:53		48° 29.86' S	0° 0.84' W	0	MNat depth
091-2	30.01.2008	02:12		48° 29.83' S	0° 1.05' W	0	MNon deck
092-1	30.01.2008	05:17		48° 0.01' S	0° 0.05' E	0	CTD/ROsurface
092-1	30.01.2008	05:42		48° 0.04' S	0° 0.08' E	0	CTD/ROat depth
092-1	30.01.2008	06:06		48° 0.00' S	0° 0.02' E	0	CTD/ROon deck
093-1	30.01.2008	09:16		47° 30.01' S	0° 0.12' W	0	CTD/ROsurface
093-1	30.01.2008	09:38		47° 30.02' S	0° 0.19' W	0	CTD/ROat depth
093-1	30.01.2008	10:07		47° 29.94' S	0° 0.18' W	0	CTD/ROon deck
093-2	30.01.2008	10:19		47° 29.90' S	0° 0.19' W	0	MNsurface
093-2	30.01.2008	10:36		47° 29.91' S	0° 0.34' W	0	MNat depth
093-2	30.01.2008	10:57		47° 29.89' S	0° 0.42' W	0	MNon deck
081-1	25.01.2008	23:30		53° 30.08' S	0° 0.05' E	0	CTD/ROsurface
081-1	25.01.2008	23:53		53° 30.20' S	0° 0.43' E	0	CTD/ROat depth
081-1	26.01.2008	00:31		53° 30.47' S	0° 0.63' E	0	CTD/ROon deck
082-1	26.01.2008	03:48		52° 59.98' S	0° 0.11' E	0	CTD/ROsurface
082-1	26.01.2008	04:09		53° 0.05' S	0° 0.12' E	0	CTD/ROat depth
082-1	26.01.2008	04:38		53° 0.07' S	0° 0.05' E	0	CTD/ROon deck
082-2	26.01.2008	04:53		53° 0.04' S	0° 0.00' E	0	MNsurface
082-2	26.01.2008	05:10		53° 0.01' S	0° 0.06' W	0	MNat depth
082-2	26.01.2008	05:30		53° 0.08' S	0° 0.04' E	0	MNon deck
083-1	26.01.2008	08:48		52° 30.06' S	0° 0.17' E	0	CTD/ROsurface
083-1	26.01.2008	09:13		52° 30.05' S	0° 0.18' E	0	CTD/ROat depth
083-1	26.01.2008	09:43		52° 30.00' S	0° 0.08' E	0	CTD/ROon deck
084-1	26.01.2008	11:45		52° 12.02' S	0° 0.17' E	0	LANDERsurface
084-2	26.01.2008	11:51		52° 12.08' S	0° 0.23' E	0	RMTsurface
084-2	26.01.2008	13:15		52° 12.06' S	0° 3.44' W	0	RMTBegin Trawling
084-2	26.01.2008	15:22		52° 11.74' S	0° 6.42' W	0	RMTEnd of Trawl
084-2	26.01.2008	15:42		52° 11.78' S	0° 6.74' W	0	RMTon deck
084-3	26.01.2008	16:02		52° 11.78' S	0° 6.35' W	0	CTD/ROsurface
084-3	26.01.2008	16:59		52° 11.79' S	0° 6.48' W	3002	CTD/ROat depth
084-3	26.01.2008	18:30		52° 11.81' S	0° 6.62' W	0	CTD/ROon deck
084-1	26.01.2008	18:45		52° 11.70' S	0° 3.94' W	0	LANDERreleased
084-1	26.01.2008	19:37		52° 12.17' S	0° 0.25' E	0	LANDERon Deck
085-1	26.01.2008	20:56		52° 1.14' S	0° 0.07' E	0	LANDERsurface
085-2	26.01.2008	21:03		52° 1.15' S	0° 0.19' E	0	MNsurface
085-2	26.01.2008	21:12		52° 1.18' S	0° 0.24' E	0	MNat depth

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
085-2	26.01.2008	21:28		52° 1.19' S	0° 0.34' E	0	MNon deck
085-3	26.01.2008	21:35		52° 1.19' S	0° 0.33' E	0	MNsurface
085-3	26.01.2008	21:52		52° 1.20' S	0° 0.37' E	0	MNat depth
085-3	26.01.2008	22:10		52° 1.19' S	0° 0.42' E	0	MNon deck
085-4	26.01.2008	22:17		52° 1.19' S	0° 0.39' E	0	CTD/ROsurface
085-4	26.01.2008	22:29		52° 1.20' S	0° 0.41' E	0	CTD/ROat depth
085-4	26.01.2008	22:45		52° 1.20' S	0° 0.48' E	0	CTD/ROon deck
085-5	26.01.2008	22:58		52° 1.22' S	0° 0.47' E	0	MUCsurface
085-5	26.01.2008	23:41		52° 1.20' S	0° 0.20' E	2981	MUCat sea bottom
085-5	27.01.2008	00:29		52° 1.42' S	0° 0.20' E	0	MUCon deck
085-6	27.01.2008	00:33		52° 1.44' S	0° 0.18' E	0	GKGsurface
085-6	27.01.2008	01:10		52° 1.48' S	0° 0.18' E	2987	GKGat sea bottom
085-6	27.01.2008	01:57		52° 1.59' S	0° 0.08' E	2988	GKGon deck
085-7	27.01.2008	02:02		52° 1.58' S	0° 0.06' E	2988	MUCsurface
085-7	27.01.2008	02:40		52° 1.53' S	0° 0.16' E	2996	MUCat sea bottom
085-7	27.01.2008	03:27		52° 1.67' S	0° 0.36' E	2986	MUCon deck
085-8	27.01.2008	03:53		52° 1.61' S	0° 1.79' E	2998	EBSsurface
085-8	27.01.2008	05:38		52° 1.55' S	0° 1.72' E	3004	EBSon ground
085-8	27.01.2008	06:34		52° 1.54' S	0° 0.22' E	2987	EBSstart trawling winch stop
085-8	27.01.2008	06:44		52° 1.55' S	0° 0.04' W	2992	EBSend trawling start hoisting
085-8	27.01.2008	07:34		52° 1.61' S	0° 0.04' W	2994	EBSfrom the bottom
085-1	27.01.2008	08:04		52° 1.55' S	0° 0.01' W	0	LANDERreleased
085-8	27.01.2008	08:33		52° 1.10' S	0° 0.36' W	0	EBSon deck
085-1	27.01.2008	08:46		52° 0.35' S	0° 0.09' E	0	LANDERInformation
085-1	27.01.2008	09:19		52° 1.38' S	0° 0.80' E	0	LANDERInformation
085-1	27.01.2008	09:23		52° 1.31' S	0° 1.05' E	0	LANDERon Deck
085-9	27.01.2008	09:47		52° 0.29' S	0° 0.51' E	0	TRAPFreleased
085-9	27.01.2008	09:58		52° 0.19' S	0° 1.12' E	0	TRAPFHydrophon to the water
085-9	27.01.2008	10:01		52° 0.19' S	0° 1.33' E	0	TRAPFreleased
085-9	27.01.2008	10:19		52° 0.19' S	0° 2.46' E	0	TRAPFHydrophon out of the water
085-9	27.01.2008	10:38		52° 0.56' S	0° 1.30' E	0	TRAPFHydrophon to the water
085-9	27.01.2008	10:46		52° 0.69' S	0° 1.67' E	0	TRAPFInformation
085-9	27.01.2008	10:47		52° 0.70' S	0° 1.73' E	0	TRAPFHydrophon out of the water
085-9	27.01.2008	11:01		52° 0.48' S	0° 0.32' E	0	TRAPFHydrophon to the water
085-9	27.01.2008	11:06		52° 0.44' S	0° 0.55' E	0	TRAPFHydrophon out of the water
085-9	27.01.2008	11:07		52° 0.43' S	0° 0.62' E	0	TRAPFInformation
085-9	27.01.2008	11:40		52° 0.28' S	0° 1.05' E	0	TRAPFon deck
086-1	28.01.2008	14:16		51° 0.46' S	0° 3.70' W	0	CTD/ROsurface
086-1	28.01.2008	14:36		51° 0.62' S	0° 3.78' W	0	CTD/ROat depth
086-1	28.01.2008	15:05		51° 0.95' S	0° 4.16' W	0	CTD/ROon deck
087-1	28.01.2008	18:48		50° 30.02' S	0° 0.15' E	0	CTD/ROsurface
087-1	28.01.2008	19:18		50° 30.08' S	0° 0.05' E	0	CTD/ROat depth
087-1	28.01.2008	19:42		50° 30.08' S	0° 0.11' W	0	CTD/ROon deck
088-1	28.01.2008	23:14		50° 0.00' S	0° 0.58' E	0	CTD/ROsurface

Station PS071	Date	Time (start)	Time (end)	Position (Lat.)	Position (Lon.)	Depth (m)	Gear
088-1	28.01.2008	23:44		50° 0.38' S	0° 1.31' E	0	CTD/ROat depth
088-1	29.01.2008	00:10		50° 0.72' S	0° 1.72' E	0	CTD/ROon deck
089-1	29.01.2008	03:42		49° 29.91' S	0° 0.23' W	0	CTD/ROsurface
089-1	29.01.2008	04:03		49° 29.93' S	0° 0.14' W	0	CTD/ROat depth
089-1	29.01.2008	04:33		49° 29.91' S	0° 0.03' W	0	CTD/ROon deck
090-1	29.01.2008	07:39		48° 59.92' S	0° 0.11' E	0	CTD/ROsurface
090-1	29.01.2008	09:09		49° 0.30' S	0° 0.11' W	3946	CTD/ROat depth
090-1	29.01.2008	10:21		49° 0.59' S	0° 0.11' E	0	CTD/ROon deck
090-2	29.01.2008	10:34		49° 0.64' S	0° 0.03' W	0	MUCsurface
090-2	29.01.2008	11:31		49° 0.95' S	0° 0.03' E	0	MUCat sea bottom
090-2	29.01.2008	12:31		49° 1.35' S	0° 0.10' E	0	MUCon deck
090-3	29.01.2008	12:37		49° 1.36' S	0° 0.19' E	0	GKGsurface
090-3	29.01.2008	13:30		49° 1.71' S	0° 0.02' E	4008	GKGat sea bottom
090-3	29.01.2008	14:33		49° 2.26' S	0° 0.04' E	0	GKGon deck
090-4	29.01.2008	15:25		49° 0.85' S	0° 6.08' E	0	AGTsurface
090-4	29.01.2008	17:28		48° 59.44' S	0° 1.81' E	0	AGTAGT on ground
090-4	29.01.2008	17:51		48° 59.24' S	0° 1.40' E	0	AGTstart trawl
090-4	29.01.2008	18:01		48° 59.17' S	0° 1.21' E	0	AGTStop Trawl
090-4	29.01.2008	18:02		48° 59.16' S	0° 1.19' E	0	AGTStart hoisting
090-4	29.01.2008	19:10		48° 59.14' S	0° 1.26' E	0	AGTAGT off ground
090-4	29.01.2008	21:27		48° 59.09' S	0° 1.21' E	0	AGTon deck
091-1	30.01.2008	00:25		48° 29.99' S	0° 0.26' W	0	CTD/ROsurface
091-1	30.01.2008	00:53		48° 29.80' S	0° 0.29' W	0	CTD/ROat depth
091-1	30.01.2008	01:29		48° 29.89' S	0° 0.59' W	0	CTD/ROon deck
091-2	30.01.2008	01:35		48° 29.86' S	0° 0.62' W	0	MNsurface
091-2	30.01.2008	01:53		48° 29.86' S	0° 0.84' W	0	MNat depth
091-2	30.01.2008	02:12		48° 29.83' S	0° 1.05' W	0	MNon deck
092-1	30.01.2008	05:17		48° 0.01' S	0° 0.05' E	0	CTD/ROsurface
092-1	30.01.2008	05:42		48° 0.04' S	0° 0.08' E	0	CTD/ROat depth
092-1	30.01.2008	06:06		48° 0.00' S	0° 0.02' E	0	CTD/ROon deck
093-1	30.01.2008	09:16		47° 30.01' S	0° 0.12' W	0	CTD/ROsurface
093-1	30.01.2008	09:38		47° 30.02' S	0° 0.19' W	0	CTD/ROat depth
093-1	30.01.2008	10:07		47° 29.94' S	0° 0.18' W	0	CTD/ROon deck
093-2	30.01.2008	10:19		47° 29.90' S	0° 0.19' W	0	MNsurface
093-2	30.01.2008	10:36		47° 29.91' S	0° 0.34' W	0	MNat depth
093-2	30.01.2008	10:57		47° 29.89' S	0° 0.42' W	0	MNon deck
094-1	30.01.2008	14:13		47° 0.12' S	0° 0.05' E	0	CTD/ROsurface
094-1	30.01.2008	14:35		47° 0.20' S	0° 0.04' W	0	CTD/ROat depth
094-1	30.01.2008	15:05		47° 0.30' S	0° 0.11' W	0	CTD/ROon deck
095-1	30.01.2008	18:25		46° 29.86' S	0° 0.02' E	0	CTD/ROsurface
095-1	30.01.2008	18:51		46° 29.96' S	0° 0.31' E	0	CTD/ROat depth
095-1	30.01.2008	19:18		46° 30.14' S	0° 0.51' E	0	CTD/ROon deck
095-2	30.01.2008	19:23		46° 30.18' S	0° 0.53' E	0	MNsurface
095-2	30.01.2008	19:42		46° 30.35' S	0° 0.64' E	0	MNat depth
095-2	30.01.2008	20:03		46° 30.61' S	0° 0.99' E	0	MNon deck
095-3	30.01.2008	20:21		46° 30.36' S	0° 1.53' E	0	CPRinto water
095-3	31.01.2008	09:05		44° 56.02' S	2° 29.51' E	0	CPRon deck

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