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The Expedition ANTARKTIS-XXIII/6 of the Research Vessel "Polarstern" in 2006

Edited by
Ulrich Bathmann
with contributions of the participants

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ANT-XXIII/6

17 June 2006 - 21 August 2006
Cape Town - Lazarev Sea - Cape Town

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1. ÜBERBLICK UND FAHRTVERLAUF

U. Bathmann
Alfred-Wegener-Institut für Polar- und Meeresforschung

Am 17. Juni 2006 begann das Forschungsschiff *Polarstern* von Kapstadt aus den sechsten Fahrtabschnitt ihrer 23. Antarktis-Expedition. Während des Fahrtabschnittes wurden Untersuchungen zu einem umfangreichen marinen Forschungsprogramms während des antarktischen Winters durchgeführt. Der Fahrtabschnitt endete am 21. August 2006 in Kapstadt.

Um das Arbeitsgebiet in der eisbedeckten Lasarewsee so früh wie möglich zu erreichen, nahm *Polarstern* nach Auslaufen von Kapstadt direkten Kurs zur ersten Position bei 52°S 3°E. Nur einige Forschungsarbeiten, die während der Fahrt durchgeführt werden konnten, wurden schon nach Ablaufen aus Kapstadt begonnen.

Bei den Arbeiten während der Fahrt handelte es sich um Beobachtungen mariner Wirbeltiere (Seevögel, Robben, Wale). Ein holländisches Team führte Beobachtungen von Seevögeln, einschließlich Pinguinen, vom Peildeck des Schiffes aus 2 Beobachtungskojen heraus bei Tageslicht durch. Zählungen von Walen und Robben wurden von einem von der Internationalen Walfang-Kommission (International Whaling Commission, IWC) gestellten Beobachter vorgenommen. Der IWC-Beobachter zeichnete zudem diverse Parameter zur Charakterisierung der Meereisbedeckung auf. Parallel zu den visuellen Beobachtungen mariner Säuger wurden auf der Anreise zwei verschiedenartige automatisierte Überwachungssysteme eingesetzt. Das eine System basiert auf speziellen passiven Hydrophon-Ketten, die vom Schiff geschleppt werden. Das andere nutzt Infrarot-Kameras, die im Krähennest montiert mit einer Bildverarbeitungs-Software betrieben werden und es erlauben, den warmen Wal-Blas auch bei Dunkelheit und schlechten Sichtverhältnissen zu erkennen.

Nördlich der Ausbreitungsgrenze von Meereis war der Einsatz eines sammelnden Schleppsystems, des Continous Plankton Recorders (CPR) möglich. Der CPR fing oberflächennahes Zooplankton mittels eines hinter dem Schiff geschleppten Systems.

Am 21. Juni kündigte sich in der Wettervorhersage ein schwerer Sturm an, so dass das Schiff ohne Verzögerung 120 Seemeilen weit in das Meereisfeld aus Pfannkucheneis hineinfuhr. Dennoch mußte *Polarstern* während des Orkans gegen Wind und Wellen anhalten, da diese nicht, wie erwartet, vom Meereis gedämpft wurden. Nach dem Durchzug des Sturmtiefs konnten die Forschungsarbeiten am 26. Juni im Lasarewmeer zwischen 60° Süd und dem antarktischen Kontinent fortgesetzt werden. In 30 Seemeilen Abstand wurden Proben für das Hauptprogramm der

Expedition genommen. Das marine Hauptmessprogramm begann im Norden des aus 3 Transekten bestehenden Messnetzes. Die vom BMBF geförderte LAsarewsee KRIll Studie (LAKRIS), einem deutschen Beitrag zu SO-GLOBEC, bildet den Kern dieses Programms.

SO-GLOBEC (Southern Ocean Global Ocean Ecosystems Dynamics) ist ein internationales und multi-disziplinäres Wissenschaftsprogramm, das ein besseres Verständnis der physikalischen und biologischen Faktoren, die Wachstum und Reproduktion und den Überwinterungserfolg von antarktischem Krill (*Euphausia superba*) beeinflussen, anstrebt. LAKRIS zielt darauf ab, Prozesse der saisonalen Populationsdynamik und die physiologische Kondition von Krill in einem interdisziplinären Ansatz zu quantifizieren, und zwar in einer Region, die bisher nur wenig beprobt und hinsichtlich ihrer Bedeutung für die Krillbestände fast unbekannt ist.

Das im Rahmen von LAKRIS vorgesehene Messprogramm verteilt sich auf drei Forschungsfahrten zu verschiedenen Jahreszeiten, von denen diese hier die zweite war - abgesehen von einer Pilotstudie, die bereits mit der *Polarstern*-Reise ANT-XXI/4 erfolgreich absolviert wurde. Die jetzige Reise ANT-XXIII/6 war die erste Winterreise des Projektes. Thematisch gliedert sich LAKRIS in fünf Teilprojekte:

SAISONALE UND ZWISCHENJÄHRLICHE VARIABILITÄT IN DER DEMOGRAPHISCHEN STRUKTUR DER KRILL-BESTÄNDE IN DER LASAREWSEE. Ein standardisiertes Beprobungsprogramm mit RMT (Rectangular Midwater Trawl)-Netzhols wird im Rahmen von LAKRIS durchgeführt, um biologische Daten über die Krill-Population in der Lasarewsee zu gewinnen. Das Hauptaugenmerk wird auf die Schätzung der mittleren Bestandsstärke und die Stärke der Jahresklassen in Relation zu Umweltvariablen gerichtet. Der Reproduktionserfolg des Laicherbestandes wird ebenso untersucht wie die Larvenverteilung und die Überlebensrate während des Winters.

HORIZONTALE UND VERTIKALE VERTEILUNG VON KRILL UND ZOOPLANKTON. Die täglichen vertikalen Wanderungsbewegungen und geographischen Verteilungen von Schlüsselorganismen wie Krill (*Euphausia superba, E. crystallorophias*), Copepoden (*Calanus propinquus, Rhincalanus gigas, Oithona* spp.) und anderem Zooplankton (Salpen, Pteropoden, Chaetognathen, Amphipoden) sowie Fischen (Myctophiden) wurden mittels eines Mehrfrequenz-Echolotes (38, 72, 120, 200 kHz) aufgezeichnet. Anhand der gefundenen Verteilungen sollen vor allem folgende Fragen bearbeitet werden: Wandern die Organismen täglich in Relation zum Lichtfeld, zu den Nahrungsbedingungen und/oder zu den Fressfeinden? Trennen sich Populationen unterschiedlicher Arten und/oder unterschiedlicher Entwicklungsstadien der gleichen Art unter bestimmten Umweltbedingungen oder zu bestimmten Jahreszeiten? Ist die geographische Verteilung bestimmter Arten Schwankungen unterworfen und was sind gegebenenfalls die Ursachen dafür?

AUSWIRKUNGEN DER WASSERMASSENZIRKULATION UND DER SAISONALEN MEEREISBEDECKUNG AUF DAS ZOOPLANKTON. Das Projekt ist ausgerichtet auf die Identifikation von Beziehungen zwischen dem physikalischen Umfeld und dem Vorkommen von Zooplankton in der Lasarewsee. Besonderes Gewicht wird auf die mögliche Rolle des Weddell-Wirbels für die Schließung des Lebenszyklus' von Krill gelegt. Die Datenbasis für diese Untersuchung wird geschaffen durch Aufzeichnung multi-disziplinärer Zeitreihen mit verankerten Instrumenten und durch schiffsgestützte räumliche Messaufnahmen.

SAISONALE DYNAMIK DER PHYSIOLOGISCHEN KONDITION VON KRILL MIT SCHWERPUNKT AUF DEN LARVENSTADIEN. Es sollen verschiedene Fitness-Indikatoren, die eine Vorhersage des Rekrutierungserfolges und der Überlebensrate der Nachfolge-Generation erlauben, quantifiziert werden. Die Arbeiten mit Krilllarven konzentrieren sich darauf, welche Fähigkeit sie entwickelt haben, um im nahrungsarmen Winter, trotz hoher metabolischer Aktivität, zu überleben.

SAISONALE LIPID-DYNAMIK UND ENERGETISCHE ANPASSUNGEN VON *EUPHAUSIA SUPERBA* UNTER BESONDERER BERÜCKSICHTIGUNG DER JUGEND- UND ERWACHSENEN-STADIEN. Die Untersuchungen konzentrieren sich auf die saisonale Dynamik der Lipid-Anreicherung und deren Nutzung. Der Energiebedarf bei verschiedenen Überwinterungsstrategien und für die Reproduktion wurden durch Laborexperimente und mittels Feldmessungen festgestellt.

Die Studie "Ernährungsbedingungen von Seevögeln durch Nahrungsnetze" hinterfragte in der saisonal eisbedeckten Lasarewsee die dominierende Rolle von Krill als Nahrungsorganismus der Meereiszone. Die umfassenden, dem Krill gewidmeten Forschungsarbeiten wurden ergänzt durch zusätzliche Projekte, die andere Zooplankton-Gruppen wie pelagische Tunicate (Salpen), Quallen (Medusen) und Flohkrebse (Amphipoden) untersuchen. Die Untersuchung von Fischlarven ergänzt das Programm. Zentrale Frage bei all diesen Untersuchungen ist, welchen Fraßdruck diese verschiedenen Zooplankton-Gruppen ausüben und welchen Fluss von Materie und Energie durch das Nahrungsnetz und durch die vertikale Wassersäule sie bewirken. Hiebei wurden auch Zooplankter der tieferen Wasserschichten untersucht.

Ein Tauchcamp wurde bei 66°S am Greenwich-Meridian aufgebaut (Näheres im Kapitel 17) und zwischen dem 14. und 18. Juli 2006 betrieben. Während der Taucharbeiten wurden zahlreiche Krill und Krilllarven gesammelt und fotografiert.

Die Reise wurde fotografisch begleitet, um in Bildmaterial die Forschungstätigkeit unter winterlichen Bedingungen für die Öffentlichkeitsarbeit zu dokumentieren.

ITINERARY AND SUMMARY

Polarstern left Cape Town on Saturday, 17 June 2006, at 21:00 local time. In order to access the working area in the Lazarev Sea as soon as possible, *Polarstern* headed almost straight towards its first scientific position at 52°S 3°E. On the way to the Antarctic only such scientific activities started that needed no extra ship time.

The projects planned on the way south focussed on observations of marine vertebrates and zooplankton. A Dutch team visually observed penguins and seabirds from the upper bridge from out two wooden cabins. One observer sent by the International Whaling Commission (IWC) to participate in the cruise contributed cetacean sightings and records of other wildlife such as seals. The IWC observer also recorded a comprehensive suite of sea ice data. In addition to the visual observations of marine mammals, two different automated monitoring systems were tested during transit. The one is a passive acoustic system consisting of towed hydrophone streamers that are custom-tailored to the detection of marine mammals. The other system is based on two infrared cameras, which were mounted at the crow's nest and were operated with image processing software that continuously monitored the regions next to the ship for infrared signatures of whale spouts even at night and poor visibility.

On the southward route from Cape Town continous sampling of the near-surface zooplankton by use of the so-called Continuous Plankton Recorder (CPR) was performed.

On 21 June a strong depression system was predicted for the coming weekend so that the ship instantly moved into the sea ice zone consisting of 1 m sized pancake ice flows. About 120 nautical miles within the sea ice area *Polarstern* had to face the strong winds and waves that were not dampened by the sea ice according to expectations. After a few days the depression had passed and the ship continued its journey south. On 26 June we performed our next station in the investigation area in the Lazarev Sea between 60°S and the Antarctic continent. In 30 nm distance, stations were sampled for the major marine research programme of this cruise, the BMBF-funded LAzarev Sea KRIll Study (LAKRIS). This is a German contribution to SO-GLOBEC and the present expedition was the first winter cruise within the framework of this project.

The Southern Ocean Global Ocean Ecosystems Dynamics (SO-GLOBEC) programme is an international, multidisciplinary effort to understand the physical and biological factors that influence the growth, reproduction, recruitment, and survival of Antarctic krill (*Euphausia superba*) with special emphasis on its overwintering mechanisms. As part of SO-GLOBEC, LAKRIS aims to quantify seasonal population dynamics and physiological condition of krill in an interdisciplinary approach and in a region of the Antarctic that is poorly sampled and understood, especially during winter. Field work for LAKRIS was distributed over three cruises in different seasons, of which the winter cruise was the second, apart of a pilot study already conducted during *Polarstern* cruise ANT-XXI/4. The LAKRIS-project is divided in 5 subprojects with the following topics, the details of which will be reported in separate chapters. Therefore, only a short summary is provided herewith.:

SEASONAL AND INTERANNUAL VARIABILITY IN KRILL DEMOGRAPHY OF HIGH LATITUDE KRILL STOCKS IN THE LAZAREV SEA. A standardized RMT (Rectangular Midwater Trawl) net sampling programme carried out during the LAKRIS study collected biological data on the krill population in the southern Lazarev Sea. The main focus was the estimation of average spatial krill density and the determination of year-class strength in relation to key environmental variables. Reproductive success of the spawning stock was studied as well as larval distribution and survival during the winter period.

HORIZONTAL AND VERTICAL DISTRIBUTION OF KRILL AND ZOOPLANKTON. Diel vertical migration and geographical distribution of target organisms like krill (*Euphausia superba, E. crystallorophias*), copepods (*Calanus propinquus, Rhincalanus gigas, Oithona* spp.), other zooplankter (salps, medusae, pteropods, chaetognaths, amphipods) and fish (Myctophiden) were detected by means of a four-split beam acoustic array (38, 72, 120, 200 kHz). Some major questions were: Do organisms migrate daily in relation to the light field, feeding conditions and/or to the predator field? Do populations of different species and/or different developmental stages of one species segregate in certain environmental conditions or different times of the year? Is the geographical distribution of species subject to change and if so, what are the possible causes?

EFFECTS OF WATER MASS CIRCULATION AND SEA ICE ON THE ABUNDANCE OF ZOOPLANKTON. The project aimed at identifying relationships between the physical environment and the abundance of zooplankton in the Lazarev Sea. Special emphasis was on the possible role of the Weddell Gyre circulation in closing the life cycle of krill. The data base for this study was collected by moored instruments to reveal temporal variations, by shipboard observations to map spatial distributions, and will also encompass the analysis of historical ADCP (Acoustical Doppler Current Profiler) data from the region.

SEASONAL DYNAMICS OF PHYSIOLOGICAL CONDITION OF KRILL WITH EMPHASIS ON THE LARVAE STAGES. The subproject quantified various fitness indicators, which will permit the prediction of recruitment success and mortality rates of the following generation and how these factors will be influenced. The work on larval krill did focus on their mechanisms that have evolved to survive the nutrient poor winter conditions despite high larval metabolism.

SEASONAL LIPID DYNAMICS AND ENERGETIC ADAPTATIONS OF *EUPHAUSIA SUPERBA*, WITH EMPHASIS ON JUVENILE AND ADULT STAGES. The subproject focussed on seasonal dynamics of lipid accumulation and utilization of juvenile and adult stages of krill. Energetic requirements with regard to overwintering strategies and reproductive effort were quantified using experiments and field data.

A study about “Seabird food chains in the Antarctic sea ice zone” investigated the dietary requirements of the ex top predators especially by closely examining the under ice fauna. The role of krill as a main food source for such surface feeding populations is challenged. Our extensive study of krill was complemented by further projects, which focus on other zooplankton genera such as pelagic tunicates (salps) and jellyfish (medusae), and on fish and fish larvae. The central question addressed by these projects was the grazing impact exerted and the flow of biogenic matter through the food chain and water column accomplished by those groups of zooplankton.

A diving camp was established on an ice floe at about 66°S on the Greenwich meridian (see chapter 17 for further details) between 14 and 18 July, 2006. During the diving operation numerous krill and krill larvae were collected and photographs were taken.

A photographer accompanied the cruise for education and outreach to the general public. Special emphasis was given on the hard working conditions and the results obtained during the Antarctic winter.

The cruise ended according to plan on 21 August in Cape Town.

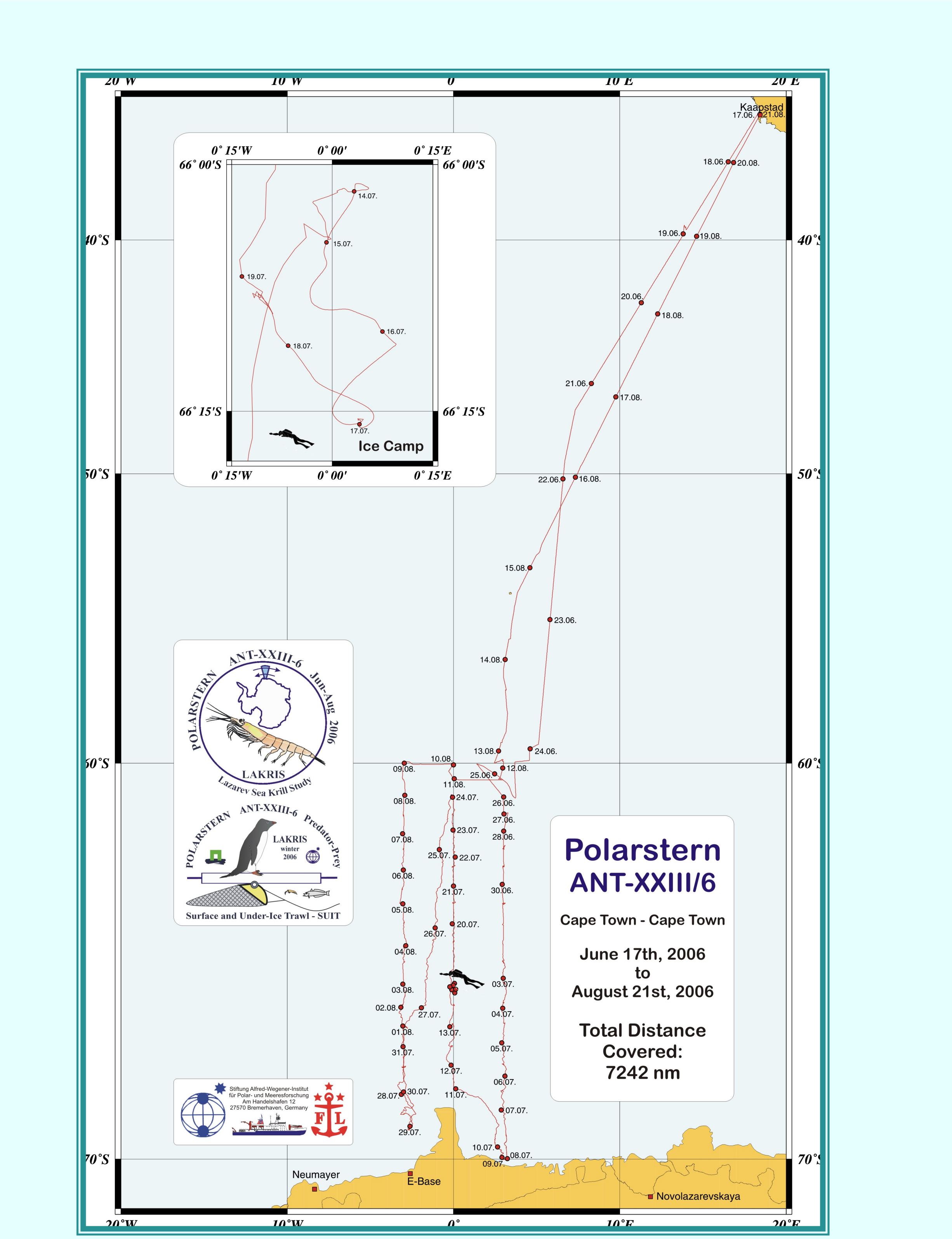

Fig. 1.1: Cruise track of Polarstern ANT-XXIII/6 in the Lazarev Sea. Details see text.

2. WEATHER

Max Miller, Klaus Buldt
Deutscher Wetterdienst

Polarstern left Cape Town on Saturday 17 of June 2006 at 21:00 local time. The cruise to Antarctica started under fair skies with southeasterly winds of 3 to 4, later 5 Bft.

On the first day we crossed the subtropical high with moderate winds from southeast to southwest. As we came closer to the frontal zone the wind shifted to northwest and increased gradually. Crossing the front on 20 June at 43.9°S 10.4°E the wind shifted to south and increased up to 8 Bft. At the same time the temperature dropped from 11 to 6 °C. A new, extensive low at 61°S 8°W quickly gained influence to the weather on our course. Already on 21 June northwesterly winds Bft 9 were recorded on board. Due to the fact that an intensive depression with wave hights up to 13 m was expected for the following weekend (24/25 June) decision was taken to head quickly into the ice. Doing so the temperature dropped below zero in the early morning of 23 June at 54°S 6°E.

In the following night *Polarstern* reached the ice edge at 58.5°S 5°E, while the northerly wind slowly increased to Bft 6 to 7. In the afternoon of 24 June the northerly wind increased to Bft 9 to 10. Along with this a very strong 3-hours-fall of air pressure (15.9 hPa) was observed! The intense depression moved in the following hours from 56°S 14°W (Saturday 12 UTC) to 65°S 8°E (Sunday 12 UTC) (Fig. 2.4). As *Polarstern* approached this track of the low north- to northwesterly wind increased to 10 Bft. This had significant influence to the ice, which was pushed southward. In the night to Sunday the wind increased even a little more so that Bft 11 with isolated gusts exceeding 80 knots and a wave hight up to 15 m were observed. Comparing air pressure and wind speed measured on board the ship a central pressure of the depression below 930 hPa was calculated.

Even in the following 3 days, this strong depression had influence on the weather condition along our course. Again wind forces around 8 Bft from the west were observed. Along with this the temperature dropped continiously to -10 to -15 °C, some times to -20 °C.

Sailing further south weather conditions remained calm. During this period we either got under high pressure influence or we were in the center of shallow lows. That's why winds hardly exceeded Bft 7. Similar conditions were prevalent at the second northbound part of the journey along the prime meridian. During this transect a diving camp was put up at 66°S 0°E from 14 July until 18 July. During these days the wind increased only for short periods up to Bft 7 along with this heavy snow fall and later on drifting snow was observed. In the beginning temperature ranged from -5 to –10 °C. After 16 July -20 °C were registered.

On 29 July the last northbound transect began at 69.5°S 3°W. First the winds remained light and variable and the temperature ranged between -13 and -20 °C. On 30 July a low at 45°S 35°W rapidly intensified and headed southeastward. *Polarstern* was affected by this low on 31 July and 1 August. Northwesterly to easterly winds were registered with a mean wind speed up to 47 knots. At the same time temperature went up from -15 to -1 °C. But already in the following night temperature dropped again to -10 °C.

Weather conditions during the last miles to the ice edge remained calm. During this period *Polarstern* was again frequently located in the centers of week lows. Thus winds from various directions seldom exceeded 6 Bft.

In the morning of 14 August, already heading for Cape Town, open waters were reached along 56.8°S. As two strong depressions were about to cross our course in the following days *Polarstern* headed first north towards Bouvet Island. The first one we managed by heading into the center of the low, which avoided strong winds from ahead. The second smaller but more intensive low first moved eastward along 40°S. But about to cross our course it changed direction to southeast. After it had passed our course at 45°S 11°E, southwesterly winds increased up to Bft 9 (only short intervalls of 10). On Friday, 18 August the wind gradually decreased. The final part of the journey led through a high pressure area with its center southwest of Cape of Good Hope.

The weather conditions along the meridional transects are displayed in figures 2.1 to 2.3.

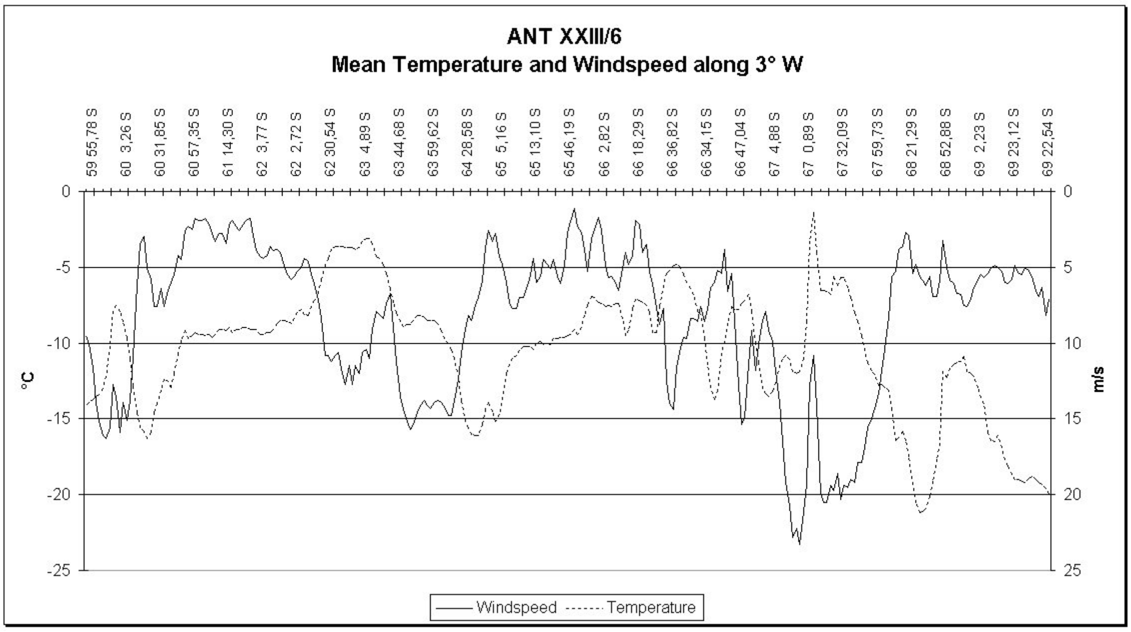

Fig. 2.1: Air temperature and wind speed along 3 °W

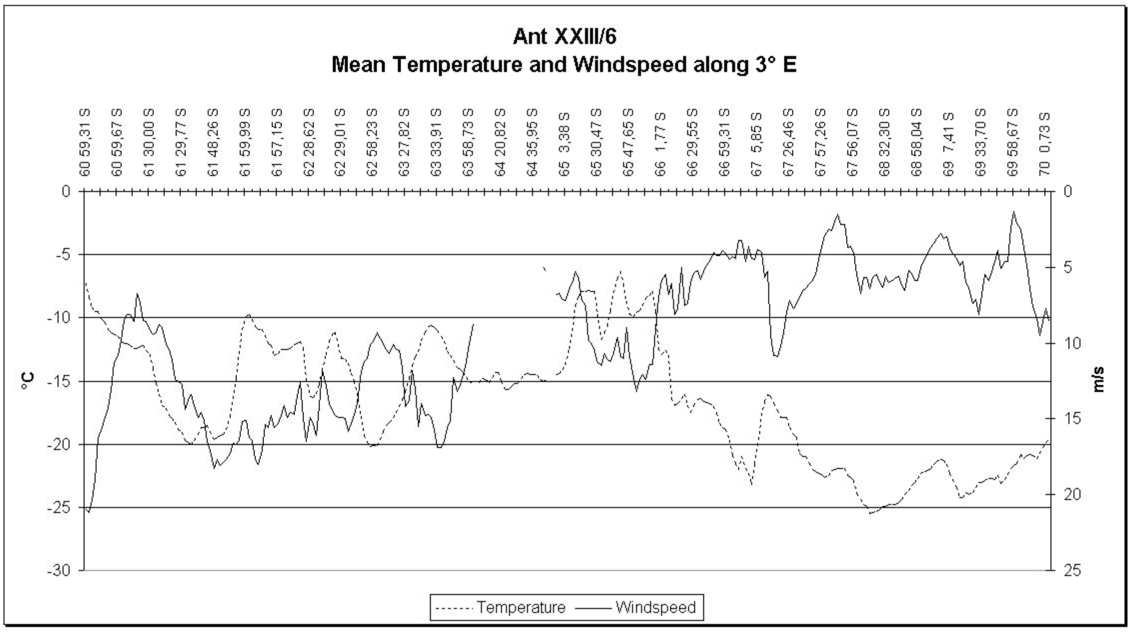

Fig. 2.2: Air temperature and wind speed along 3 °E

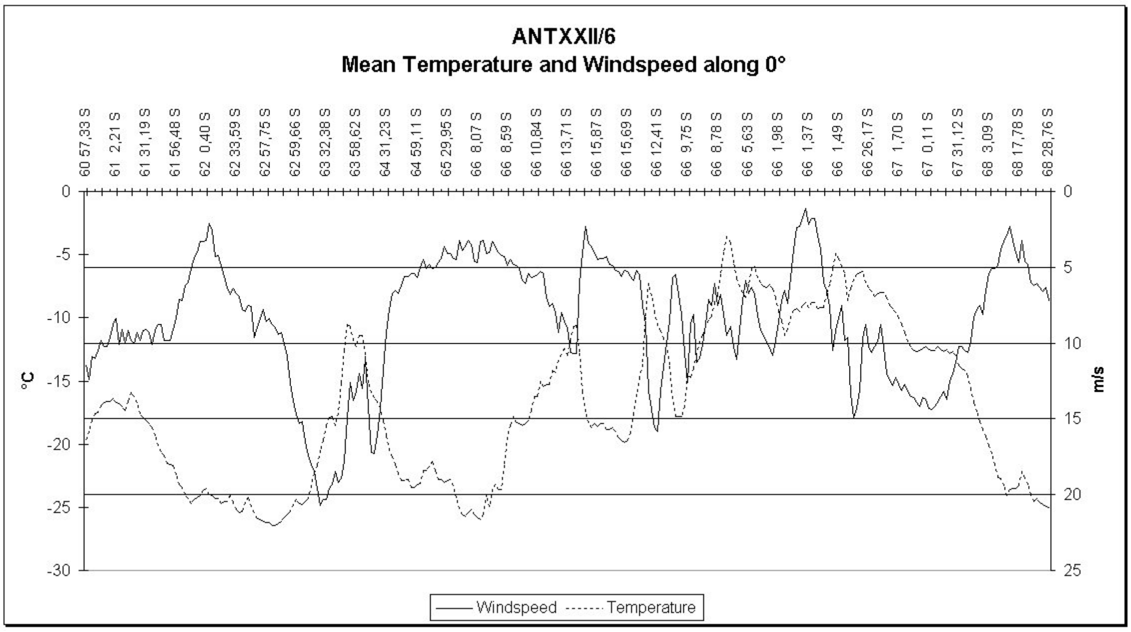

Fig. 2.3: Air temperature and wind speed along 0°

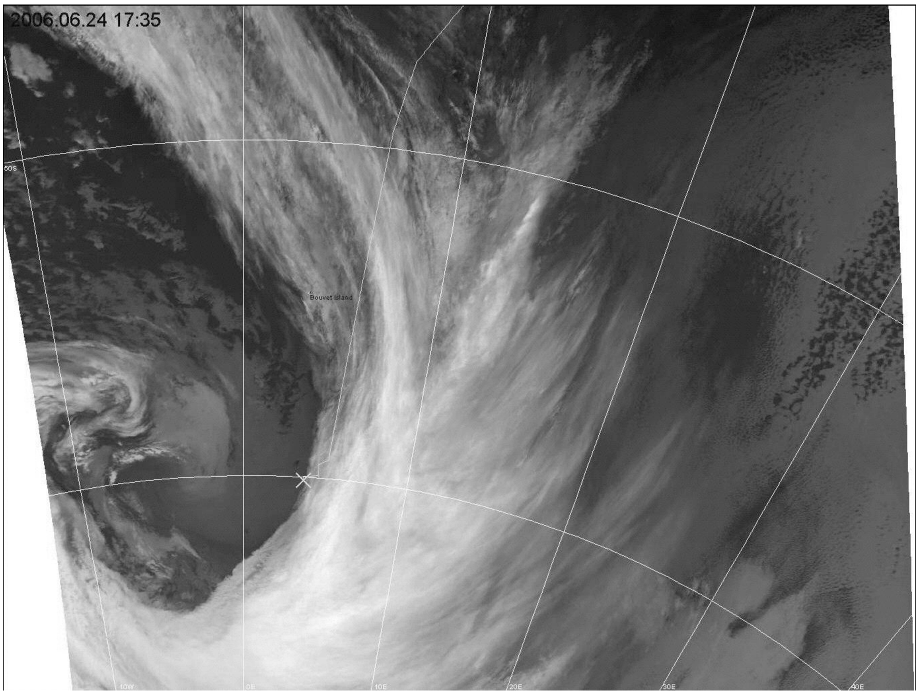

Fig. 2.4: Weather situation on 24 June in the afternoon

3. DEMOGRAPHY OF ANTARCTIC KRILL AND OTHER EUPHAUSIACEA IN THE LAZAREV SEA IN WINTER 2006

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Bundesforschungsanstalt für Fischerei (BFA Fisch)
not on board: V. Siegel

Introduction and objectives

The seas surrounding the Antarctic continent are characterized by enormous seasonal fluctuations in ice cover ranging from 4.1 * 10^6 km^2 in summer to 21.5 * 10^6 km^2 in winter (Mackintosh 1972). The Antarctic krill, *Euphausia superba*, is one of the major components of the zooplankton community in the seasonal pack-ice zone (Hempel 1985) and seasonal as well as interannual fluctuations in ice cover are likely to have an effect on the distribution, life cycle and population dynamics of this key species. Already Mackintosh strongly recommended a more intensive collection of data on krill within the pack-ice zone, since even the vast amount of data of the historic "Discovery" expeditions contributed little to the knowledge of krill biology in areas covered by sea ice. However, due to limited accessibility to these regions, research has only recently begun to investigate the marginal ice zone. Initial observations have been made possible by diving operations, ROVs, or through light traps sampling from the fast ice. All have reported krill living and feeding under the ice and stressed the importance of ice-algae for krill overwintering.

With the occurrence of stronger, ice-strengthened research vessels, studies have been extended further into the sea ice zone. Studies were mainly carried out during early to late summer in the marginal ice-zone of the southern Scotia Sea / northern Weddell Sea. Most of these studies have provided valuable qualitative observation on phytoplankton, zooplankton and krill. However, quantitative studies on krill population parameters in ice covered areas are still extremely scarce in the scientific literature.

The Lazarev Sea is located in the high-latitude part of *E. superba*'s range, directly adjacent to the Antarctic continent. The shelf is very narrow and across the survey area the bathymetry is usually deeper than 4,000 m. In summer, the Lazarev Sea is almost completely free of pack-ice, while during winter the maximum ice extend reaches from the continent (at 70°S) as far as 58°S, i.e. more than 2,400 km to the north. This extreme seasonal amplitude in ice extend and the long period of ice coverage from May to December create quite a different environmental scenario for the krill stock compared to the well-studied Antarctic peninsula or Scotia Sea region, where even during winter part of the krill distribution range is free of sea ice.

For this reason one of the main objectives for the LAKRIS winter cruise with *Polarstern* was to penetrate into the pack-ice zone during winter as far as possible and repeat the sampling of the standard station grid already covered during preceding autumn (2004) and early summer seasons (2005/06). In this way, it was anticipated to study the processes influencing the abundance of krill species and their distribution and demography. The region chosen for the LAKRIS study appears to mark the core of hydrographic inflow from the Indian Ocean to the Weddell Sea.

The primary objective of the net sampling programme was to clarify krill population distribution dynamics during winter, when krill are supposed to switch from their summer pelagic mode of life to their winter ice-related behaviour.

Work at sea

Material and Methods

During 26 June to 13 August 2006 a station grid was surveyed between 60°S and 70°S close to the continent. The planned grid consisted of 84 standard stations along 4 meridional transects at 3°E, 0°, 3°W and 6°W. 54 of these stations were sampled successfully (Fig. 3.1). During the survey the entire survey area was completely covered by winter sea ice which made conditions for towed net sampling extremely difficult. The entire transect 4 on 6°W and several stations on transects 1 to 3 had to be cancelled due to bad weather or heavy sea ice conditions and finally time constraints.

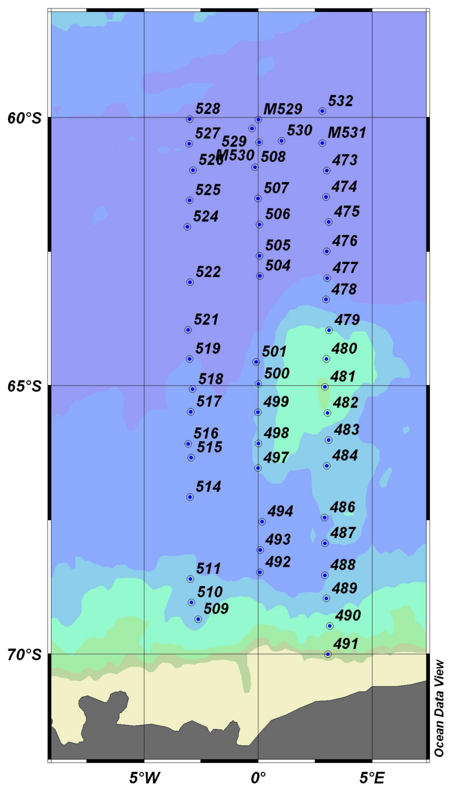

Fig. 3.1: RMT station grid in the Lazarev Sea during ANT-XXIII/6 winter cruise from 26 June to 13 August 2006

Standard oblique tows were planned to be conducted by the multiple RMT1+8 to sample vertically stratified depth layers down to 400 m depth. Due to extremely difficult ice conditions and a failure of the electronic net devices, this part of the net sampling programme could not be realized. Instead krill and zooplankton sampling was carried out with the standard gear RMT 1+8 (Rectangular Midwater Trawl, Baker et al. 1973). When sampling in ice, a sufficient sized area of free 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 ranged 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 was 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 species was counted from representative subsamples. Krill was preserved in 4 % formalin seawater solution before length measurements were undertaken and sex and maturity stages were determined. 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 Seafisheries Research Institute. A brief station summary is given in Table 3.2 at the end of this chapter 3.

Preliminary Results

Distribution and Abundance

The net sampling programme took part during a period of complete sea ice coverage of the survey area. Under these circumstances 48 samples out of a total of 54 contained krill in varying quantities. The largest catches yielded 7,400 krill in the south-eastern and 2,900 specimens in the central northern survey area (compared to 2,580 krill in early summer 2005 or 94,000 specimens in autumn 2004) in a standard haul (see Fig. 3.2a). The main krill concentrations occurred in the northern-western part between 60° and 66°S (Fig. 3.2a). Stations with very few or no krill were scattered randomly across the area. However, the poorest catches were obtained in the south-western sector south of 67°S.

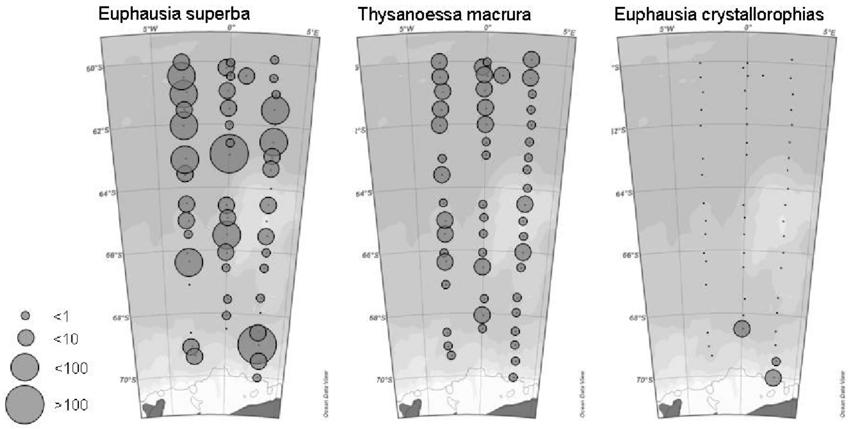

Fig. 3.2: Spatial distribution of euphausiid species given as numerical densities (N 1,000 m^{-3}) for the 200 m surface layer
a. Euphausia superba
b. Thysanoessa macrura
c. Euphausia crystallorophias

Krill abundance estimates for the current winter Lazarev survey results in 13.86 krill 1,000 m^{-3}, respectively. This is a significant increase compared to the mean numerical densities for the Lazarev Sea survey compared to early summer of the same year 2005/06 (see Tab. 3.1). 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 seasonal effects in stock size development caused by immigration and emigration or interannual changes caused by dramatic fluctuations in stock size. Certainly further data are needed from different years.

Tab. 3.1: Krill numerical densities from net sampling surveys in the Lazarev Sea in winter (July/August 2006 present study), autumn (April) 2004 and early summer (December) 2005. Densities are calculated using the TRAWLCI method described by de la Mare (1994a).

	2006 (winter)		2005 (early summer)		2004 (autumn)	
	N 1000 m^{-3}	N m^{-2}	N 1000 m^{-3}	N m^{-2}	N 1000 m^{-3}	N m^{-2}
Mean	13.86	2.72	3.15	0.63	31.12	6.22
SE	5.54	1.108	1.054	0.211	9.032	1.806
Lower conf. int.	6.604	1.321	1.698	0.338	18.406	3.681
Upper conf. int.	40.509	8.102	7.237	1.447	64.842	12.968

A quantitative evaluation of the other Euphausiacea species seems to be essential, because they not only overlap with Antarctic krill in the same area, but they 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

The ice-krill *Euphausia crystallorophias* is an endemic species of the neritic Antarctic coastal zone. Therefore, it was not surprising to find this species exclusively at the narrow shelf and the slope stations of the continent (Fig. 3.2c). Numbers were relatively low and abundance was highest in the eastern part of the station grid. 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.

During the 2004 the species *E. frigida* was found at most of the stations north of 62°S. During this cruise not a single specimen occurred in our samples. If this is an indication for a seasonal shift in distribution of the species or an interannual decrease in population size cannot be answered at this stage.

Another species frequently found in Antarctic waters is *Thysanoessa macrura*. This species was distributed across all stations of the survey grid with slightly higher densities in the north-western part of the station grid (see Fig. 3.2b). Densities were one order of magnitude lower in winter than in the preceding spring when *Thysanoessa macrura* outnumbered the density of *E. superba* five times. Samples from the multiple RMT indicated substantially higher densities of *Thysanoessa macrura* when the net was fished in deeper depth strata down to 400 m. This would point to a seasonal vertical migration of the species to deeper waters in winter, but needs more detailed analysis of the stratified net samples.

Size and Maturity composition

Figure 3.3 summarizes the composite length and maturity composition of the three relevant species across the entire survey area. From these figures it is obvious that the krill population in winter 2006 was dominated by a large fraction of one- and two-year-old krill (modal size classes around 25 and 35 mm). The majority of the population consisted of this size and age group, indicating a relatively strong 2005 and to a lesser extent 2006 year-class in the Lazarev Sea (if we set the birthday for 1 January). On the other hand, the length frequency distribution shows a gap in size classes larger 50 mm which would represent the old spawning stock of the last season. These animals have probably died away after the spawning season with the onset of the winter. The poor occurrence of krill between 40 to 50 mm size probably indicates relatively weak age-classes 3 and 4+, and the conclusion would be that recruitment success of krill in the Lazarev Sea shows large interannual variation.

Frequency of juvenile Antarctic krill was below 20 %, 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. The composite maturity stage composition showed a clear dominance of subadult (immature) stages. Some males and females were found in the adult resting stage 3A. Since maturation of krill should occur at size classes smaller 40 mm, this result supports the hypothesis, that part of the adult krill stock has undergone a regression of external sexual characteristics after the end of the spawning season before the start of the winter. This observation was already made during the autumn 2004 survey in the area.

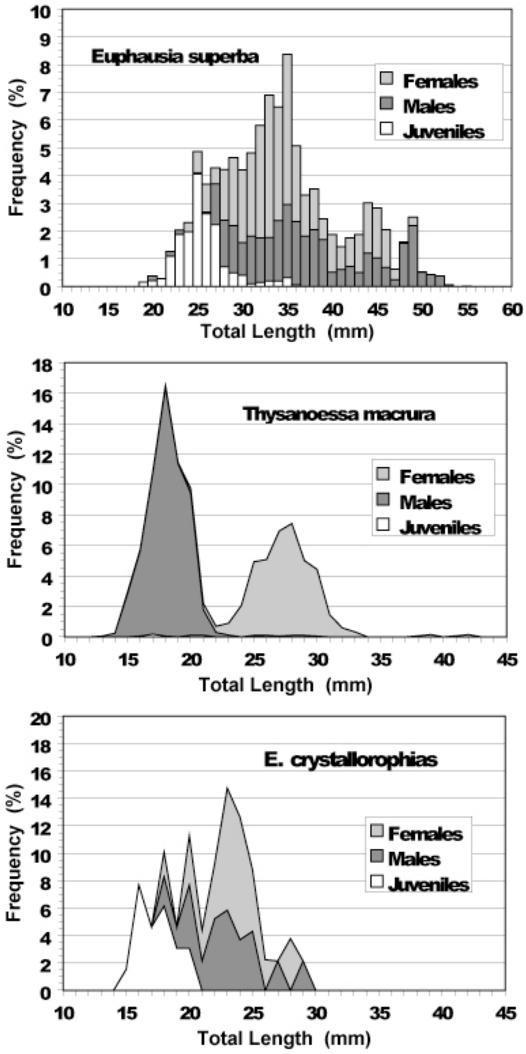

Fig. 3.3: Composite length frequency distribution of Antarctic krill Euphausia superba for the study area

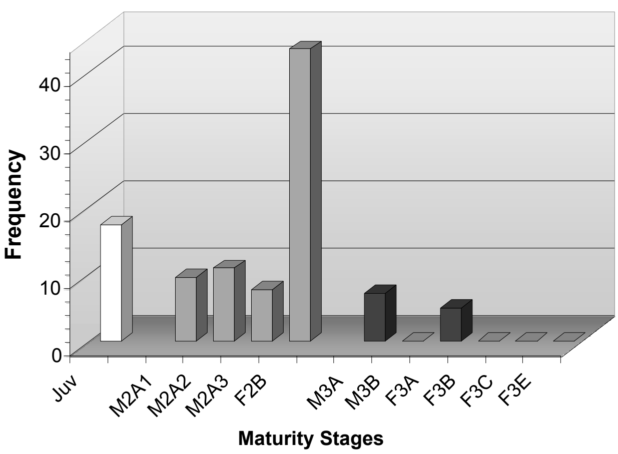

Fig. 3.4: Overall maturity stage composition of Euphausia superba during winter; M = male, F = female, stage 2 = immature, stage 3 = mature, 3A pre-spawning or resting stage

The length frequency distribution of *Thysanoessa macrura* (Fig. 3.3b) shows a clear bimodal distribution pattern. Hardly any juveniles were present in the samples. This developmental stage was probably still in the late furcilia larval stage (see section on Euphausiacea larvae). Surprisingly the first modal size group consisted almost exclusively of males while the second was represented by males. Most females were carrying spermatophores which is not surprising, since *Thysanoessa macrura* is thought to spawn mainly in August/September. However, no early larval stages were found in the samples (see below chapter on larvae), indicating that spawning activities had just begun during the survey period.

Number of *Euphausia crystallorophias* was low, so the length frequency does not clearly reflect the modes of the early age classes (Fig. 3.3c). However, by the occurrence of the juvenile developmental stage and size classes between 15 and 20 mm, it is clear that age group one is well represented. However, size groups larger 30 or 35 mm are missing from the samples. These size classes should represent the spawning stock in coming reproductive season the following December.

Size distribution of the Antarctic krill *Euphausia superba* was not uniform across the survey area. In figure 3.5 stations are grouped according to their similarity in length frequency distributions. The station cluster 1 was located in the more southern and western area and represents the smallest size classes of the krill population. These krill were of 26 to 27 mm modal size and represent mainly age class one. Cluster 3 had a modal size of approximately 35 mm, which would reflect the dominance of age-two krill Cluster 2 showed intermediate sized krill mainly in the central area. Cluster 2 therefore seems to represent a transition zone and a mixture of one and two-year-old krill. No clear separation of larger, adult krill was observed during winter.

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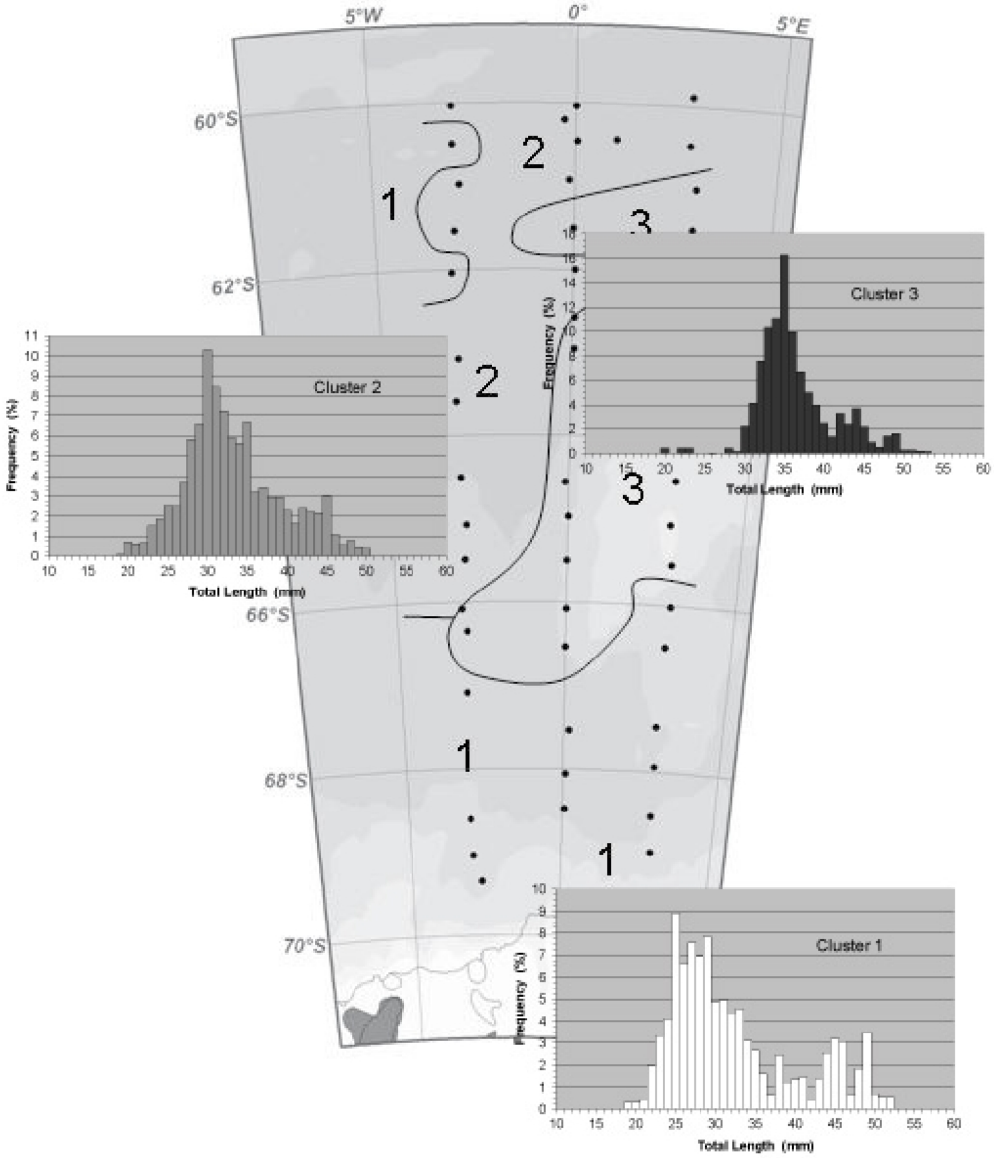

Fig. 3.5: Spatial distribution of station clusters (3.1-3.3) and related krill length frequency distributions in the Lazarev Sea during winter 2006

Tab. 3.2: Station list of RMT8 net hauls during ANT-XXIII/6 survey in the Lazarev Sea during winter 2006

Station	Time Start (UTC hhmmss)	Time End (UTC hhmmss)	Latitude	Longitude	Bottom Depth (m)	Fishing Depth min	Fishing Depth max	Filt Vol RMT8 (m^3)
473	203500	211200	605936S	0030106E	5403	0	200	23987
474	22000	30200	612918S	0025906E	5386	0	200	18396
475	215800	224300	615712S	0030536E	5390	0	200	21352
476	40000	44400	622954S	0030118E	5297	0	200	23105
477	215700	224000	625924S	0030142E	5369	0	200	18834
478	201800	210500	632354S	0025912E	4742	0	200	20586
479	125000	133300	635824S	0030648E	2829	0	200	26199
480	213000	220900	643006S	0025936E	2127	0	200	16233
481	103600	111800	650136S	0025624E	1407	0	200	16334
482	3500	11900	653030S	0030254E	2646	0	200	23868
483	210000	214500	660100S	0030618E	3544	0	200	21170
484	52500	60600	662948S	0030118E	3760	0	200	19900
486	74100	82900	672724S	0025512E	4564	0	200	21170
487	214600	223000	675618S	0025630E	4548	0	200	18411
488	160300	164800	683206S	0025542E	4121	0	200	20257
489	61700	70400	685806S	0025954E	3763	0	200	21785
490	202700	211500	692848S	0030906E	1924	0	200	16767
491	124400	132800	700024S	0030418E	493	0	200	19272
492	111100	115500	682842S	0000454E	4286	0	200	18971
493	234400	3000	680342S	0000530E	4499	0	200	17318
494	192700	201100	673206S	0001048E	4649	0	200	20360
497	181500	190000	663206S	0000006E	4647	0	200	20160
498	33800	42500	660454S	0000054E	3668	0	200	20006
499	184200	192000	652954S	0000030E	3576	0	200	16644
500	24000	32400	645812S	0000112E	3751	0	200	16719
501	124300	132500	643340S	000454W	4694	0	200	18971
504	71800	75800	625730S	0000436E	3882	0	200	15748
505	141600	145600	623448S	0000412E	5218	0	200	15286
506	92700	100900	620006S	0000348E	5370	0	200	19164
507	233500	1900	613100S	000200W	5268	0	200	15972
508	170900	175100	605554S	000730W	-9	0	200	23715
509	35700	44200	692342S	023742W	3314	0	200	23910
510	204100	212500	690230S	025430W	3568	0	200	20624
511	105500	114100	683624S	025754W	4036	0	200	21627
514	92900	101500	670448S	025830W	4478	0	200	22506
515	215300	223500	662042S	025542W	4512	0	200	19871
516	145600	154600	660506S	030412W	4755	0	200	26012
517	235800	4000	652918S	025706W	4917	0	200	16091
518	84000	92400	650412S	025218W	5092	0	200	15901
519	11200	15800	643012S	030006W	5092	0	200	23573
521	235500	3700	633536S	030354W	5192	0	200	17350
522	80900	85000	630442S	025842W	5226	0	200	18282

Station	Time Start (UTC hhmmss)	Time End	Latitude	Longitude	Bottom Depth (m)	Fishing Depth min	max	Filt Vol RMT8 (m^3)
524	30000	34400	620230S	030600W	5346	0	200	23945
525	185300	193500	613254S	030006W	5332	0	200	17437
526	31600	40000	605906S	025112W	5349	0	200	21577
527	202800	211000	602948S	030030W	5376	0	200	21133
528	51900	60300	600206S	030012W	4812	0	200	21534
529	65800	70300	600236S	0000036E	5390	300	400	5000
529	70300	71300	600242S	0000054E	5390	200	300	9000
529	71300	73700	600312S	0000112E	5390	0	200	20000
529	220100	224200	601242S	001536W	5390	0	200	19679
530	25300	33800	602612S	0000130E	5374	0	200	17749
530	115000	115800	602754S	0000324E	5374	300	400	5000
530	115800	120900	602754S	0000218E	5374	200	300	9000
530	120900	123200	602736S	0000142E	5374	0	200	18000
531	23300	23800	602854S	0025912E	5402	300	400	4000
531	23800	24900	602848S	0024854E	5402	200	300	10000
531	24900	31300	602824S	0024812E	5402	0	200	17000
532	2400	10600	595318S	0025430E	5381	0	200	18467

3.1 Distribution and abundance of krill larvae in winter 2006

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Objectives

Investigations on Antarctic krill larvae have a long history starting with the early 'Discovery' studies in the 1920/30ies. These historic studies concentrated on the description of the various krill larval stages and their Antarctic distribution. Although these studies covered most of the Antarctic Ocean, the circumpolar data were collected over a time period of many years and research effort was not spread evenly across the Southern Ocean. Especially regions with heavy sea ice conditions were less adequately sampled and sampling during winter was scarce and did not penetrate into the pack-ice zone. Recent studies concentrated on quantitative aspects of krill larvae distribution in the Southwest Atlantic (Antarctic Peninsula and Scotia Sea) and Prydz Bay area in the Indian Ocean. Areas like the Bellingshausen, Amundsen and Lazarev Seas remain remote and sea ice conditions are difficult to access during most times of the year. However, the Lazarev Sea is thought to be the doorway to the Weddell Sea and possibly the entrance of the krill population into the Weddell Gyre. A single year study by Russian scientists from March 1982 (Makarov and Sysoyeva, 1985) concentrated on the distribution of krill larvae in this area and paid less attention to quantitative aspects of larval abundance and composition. The pooled data from a multi-year collection of some krill larvae data in the Lazarev Sea by the 'Discovery', indicate that this region of the Southeast Atlantic is at least of seasonal importance to krill larvae occurrence. However, it is unclear, if those larvae which occur in the Lazarev Sea in autumn are locally produced or if these are transported into the area from other spawning sources. Even less information is available on other euphausiid larvae. A standardized survey has not yet been carried out in this area.

The South Atlantic sector of the Antarctic – especially the Antarctic Peninsula region - is thought to represent the most productive spawning area of the circum-Antarctic krill populations. This hypothesis regards the Scotia Sea as a seasonally important area for the occurrence of krill larvae. This idea was confirmed in principle during the international FIBEX expedition in 1982 (Rakusa-Suszczewski, 1984) and the CCAMLR Survey 2000 (Siegel et al. 2004). These surveys showed a large amount of krill larvae in the western part of the Atlantic sector. On the other hand, a limited number of data from the 'Discovery' expeditions indicate that these larval concentrations move further to the east with the progressing season. In autumn to early winter krill furcilia larvae had spread at latitudes from 50 to 60°S as far as 20°E (Marr, 1962).

Around the 0-degree meridian in the Southeast Atlantic krill distribution ranges from approximately 50°S to the Antarctic continent at 70°S, which is the widest latitudinal coverage in the species circum-Antarctic distribution. The northern part north of 60°S is under the influence of the eastward flowing "northern branch of the Weddell Gyre" and is therefore downstream of the Scotia Sea krill population and reflecting spawning success there. During summer the area is ice-free, whereas it is completely covered by sea ice between June and December. However, little information on krill spawning and larval occurrence is available from the southern part of this broad latitudinal krill habitat, i.e. the Lazarev Sea.

If, however, the Weddell Gyre is the source of high krill densities in the Scotia Sea, then the westward moving water masses of the Lazarev Sea should seed substantial amounts of krill larvae into the system to sustain the large population observed at the northern outflow of the Weddell Gyre. To test this hypothesis, we used the RMT station grid in the Lazarev Sea between 60 and 70°S to collect additional data during winter on the distribution and abundance of krill larvae after the end of the spawning season.

Work at sea

Sampling

Double oblique RMT1 samples (0-200-0 m) were taken as part of a suite of standard netting protocols carried out at each station. Mesh size of the RMT1 is 330 µm. Nets were towed for an average of 40 min and the resulting samples, or in some cases subsamples, were preserved in 4 % formalin in seawater. Samples were sorted for macroplankton and large species such as krill, salps and other gelatinous forms were removed. Samples were then split using a folsom plankton splitter into a series of aliquots. One to two fractions of between a 1/2 to 1/8 of the preserved amount were usually counted to ascertain the numbers of euphausiid larvae. Data were finally standardised to abundance N m^{-2} based on flow rates determined from flow meters attached next to the RMT 1 net. It is known that the RMT1 can fish independently of the RMT8 and presents a mouth area to the water which is very sensitive to ships speed (Pommeranz et al. 1983). We determined that the average speed of the net through the water for all deployments was 2.5 knots at which speeds the mouth area ranges from around 0.4-0.6 m^2 (mean ~ 0.5 m^2). Larval abundance data were standardised accordingly. Larval calyptopis and furcilia stages were identified using the description of Kirkwood (1982). Additional information on *E. crystallorophias* furcilia larvae are given by Fevolden (1980).

Preliminary Results

In winter 2006 larvae of *E. superba* consisted almost exclusively of furcilia stages with late F5 and F6 being the most common (Tab. 3.1.1). Calculating backwards from the day of their first or last occurrence, we can make some estimation about the onset and end of the spawning event of the current season. Assuming that F1 larvae are generally 63 and F6 are at least 120 days old (Mauchline 1980; Ikeda 1984), then the latest spawning probably occurred in late May and the start of the spawning season should be before the end of February. The latter conclusion is not in close conformity with observations made during the preceding summer season 2006. Here we already observed the very first gravid females and first calyptopis larvae in late December. This suggests that reference to the age of larvae in the relevant literature is either an underestimate or the very minimum age of the relevant stages. Maybe the older the larvae, the longer they remain in the various stages.

Tab. 3.1.1.: Frequency of occurrence (%) of *E. superba larval* stages in the Lazarev Sea in April 2004 (autumn) and July/August 2006 (winter*); C = calyptopis,* F *= furcilia stages*

Larval stage	Autumn 2004	Winter 2006
C1	21.1	
C2	46.9	
C3	20.2	0.8
F1	10.3	4.3
F2	0.9	12.9
F3	0.5	13.0
F4	0	9.1
F5	0	29.2
F6	0	30.2

If the situation between 2004 and 2006 reflects the general larval development, then furcilia 2 larvae as the average stage in April develop into furcilia 5 and 6 until July within three months. The relevant size classes for C2 are 2.7 to 2.9 mm and 9.5 to 11.3 mm for F5 and F6, respectively. The growth of krill larvae would correspond to 6.6 to 8.6 mm during this early winter period.

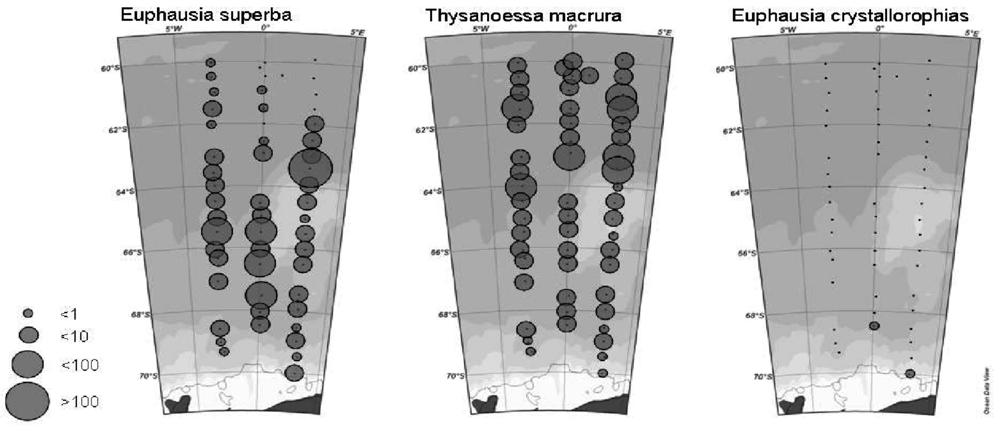

Fig. 3.1.1: Distribution of Euphausiacea furcilia larvae in winter 2006, numbers are representing density values per m^2.

Greatest abundance of krill larvae was located in the central part of the survey area between 62° and 68° S (Fig. 3.1.1). Highest densities were 118 larvae m^{-2}, while the average was 6.8 m^{-2}. Compared to historic data of the FIBEX 1982 or the CCAMLR 2000 surveys (Tab. 3.1.2), the densities of larvae in the Lazarev Sea are relatively low. We have some indication that the FIBEX spawning event was one of the most successful from the number of larvae as well as from the recruitment indices (Hempel 1982; Siegel and Loeb 1995). However, due to the lack of time series data, it is impossible to decide whether the 2004 and 2006 were unusually poor year for krill larvae or whether the situation is quite common in the Lazarev Sea.

Tab. 3.1.2: Krill Larvae densities (N m^{-2}) during FIBEX 1982 (Siegel 1986), CCAMLR 2000 (Siegel et al. 2004) and the present study in the Lazarev Sea

	Calyptopis	Furcilia	Total
Lazarev Sea April 2004			
Mean	310	48	358
Lower and upper quartile	0 - 52	0 - 22	0 - 127
Lazarew Sea July/August 2006			
Mean		7	7
Lower and upper quartile		0 – 5.1	0.5.1
Scotia Sea West January 2000			
Mean	1842	203	2133
Lower and upper quartile	0 - 191	0 - 0	0 - 221
Scotia Sea West January 1982			
Mean	19307	435	18601
Lower and upper quartile	0 - 3004	0 - 83	3 - 4607

Thysanoessa macrura larvae were mostly damaged and identification of different furcilia stages and separation from juveniles was often difficult. Therefore, we also measured total length of furcilia larvae routinely to facilitate separation into different stages. There was a distinct difference in body shape, even when all spines were broken off, between individuals with a length of 4 - 5 mm and larger ones. The 4 – 5 mm larvae are probably true F6, whereas larger specimens obviously belong to the juvenile developmental stage.

According to the above classification, the proportion of late furcilia (F4-F6) made up 39.5 % and juveniles 60.6 %, respectively. No furcilia F1-F3 were found in the winter samples. The conclusion is that *Thysanoessa macrura* were actually developing from the late larval stages into the juvenile phase. Therefore, the larval phase took about one year after hatching, since in July/August adult females were currently carrying spermatophores. The spawning stock was ready to spawn the next generation, although at the time of the survey (which ended on 13 August) no calyptopis larvae had been observed in the area.

Thysanoessa larvae were spread across the entire survey area. Although no central area of distribution could be observed, the larval densities were slightly higher in the northern part of the study area north of 64°S. Highest densities reached only 17 larvae m^{-2}, while the average was 4.3 m^{-2} (quartile range 1.3 – 5.5). These numbers are even lower than the ones calculated for *E. superba* (see Table 3.1.2), but the narrow range of values also indicates that *Thysanoessa* larvae are more uniformly dispersed across the area. It may also be remembered that the ice-edge at the beginning of the survey was located at 61° and at the end at approximately at 58°S thus most of the larval generation is covered by sea ice during the early winter phase, but still developing.

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4. ACOUSTIC MEASUREMENTS

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not on board: Sören Krägefsky[1]

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Objectives

The scientific echosounder EK 60 is one of the fixed sounding systems onboard *Polarstern*. It provides an acoustic image of the water column and is usually used to detect fish shoals and other species in the water column. Our main aim on this cruise was to achieve a continuous mapping of the zooplankton in the water column along the entire krill survey area and along the stations. The data will be used to calculate the biomass estimate for CCAMLR and will be put in conjunction with the abundance of krill that is seen in the RMT stations. Furthermore, the data will be related to the acoustic measurements performed along previous LAKRIS cruises in the working area to achieve more insight into seasonal variations.

Work at sea

The EK 60 provides four operating frequencies, ranging from 38 kHz to 200 kHz, with different penetration depths, ranging from ca. 400 m to ca. 1,000 m. The data is displayed online and recorded in digital format. All frequencies were operated regularly with a recorded depth of 1,000 m each and at a pingrate of 2.5 s. On some occasions, lasting around 6 to 12 hours each, the recorded depth was expanded to 3,000 m with a reduced pingrate of 5 s to provide additional information on the deeper layers that were sampled in parallel with the deep-towed RMT.

To achieve high quality data, the intention was to run the EK 60 as the single sounding device along the entire cruise. However, the ADCP and DOLOG had to be operated constantly in parallel, but without degrading the data quality. From the DWS Deep Water Sounder it is known that it interferes with the EK 60, however, during short time intervals during station work the DWS was running to provide accurate depth information for the CTD downcasts. After entering the sea ice, the acoustic measurements were strongly affected by frazil ice in the uppermost water column. High amounts of platelets ice passing under the ships hull while moving the ship reduced the data quality.

In total, the EK 60 was in operation for 63 days with a total data volume of approx. 540 GByte. Some minor data loss occurred due to power and network failure. Data conversion, processing and visualisation were done onboard using MATLAB®-Routines written by the working group. Final post processing and evaluation of the data will be performed later on.

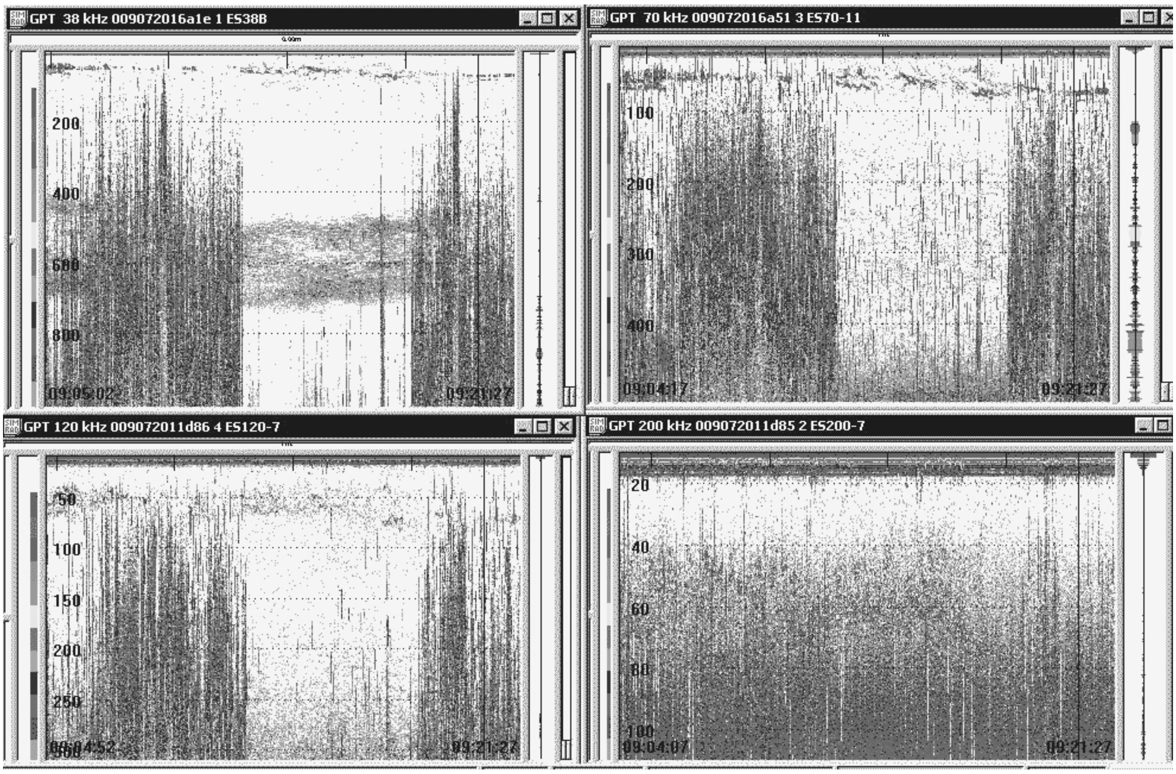

Fig. 4.1: Screenshot of the echosounder recording of all four frequencies with a time displayed of 15 minutes. During the recording the ship was steaming through sea ice (left), open leads (middle) and again sea ice (right). Please note the difference in data quality.

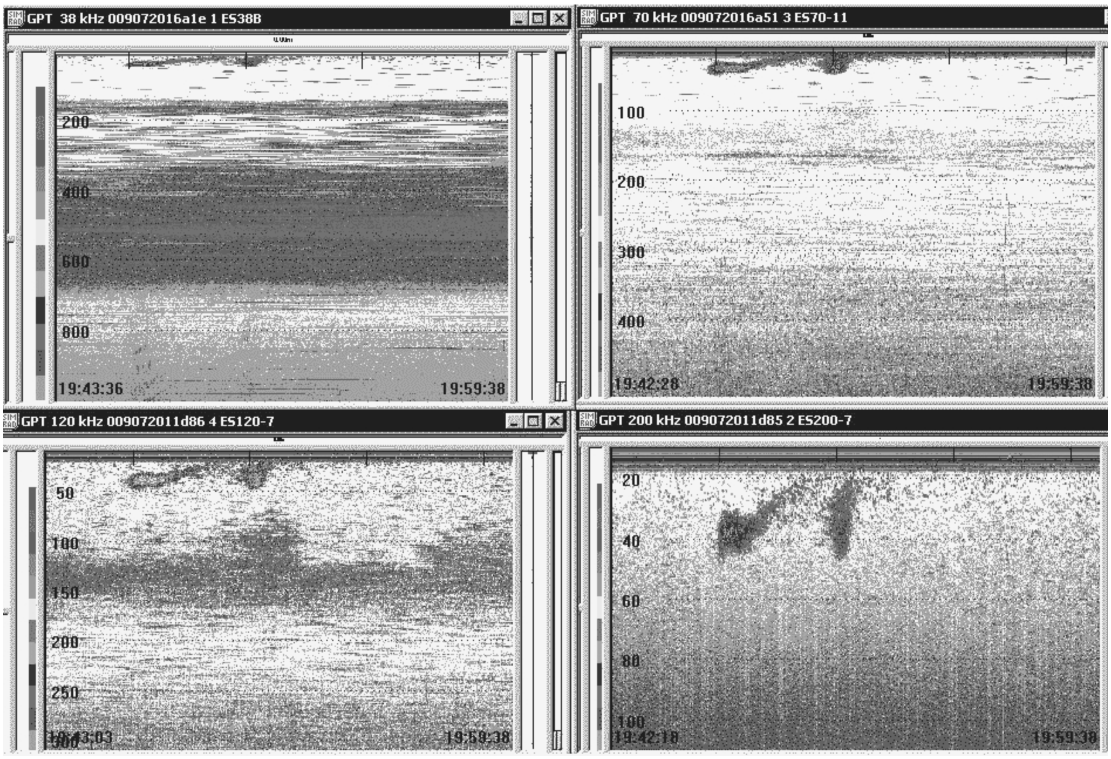

Fig. 4.2: Screenshot of the echosounder recording during the evening of 16.07. located at the diving camp. Diving performed in parallel showed strong occurrence of krill larvae under the ice. In all four recorded frequencies a cloudy structure is visible reaching from a depth to 42 m to the surface.

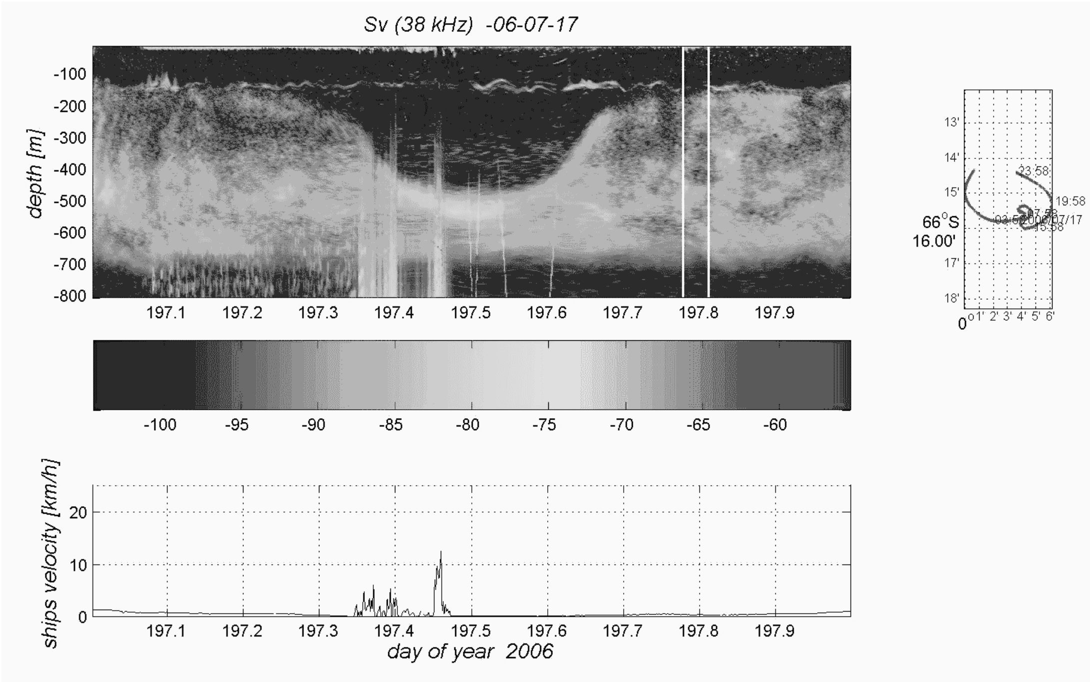

Fig. 4.3: 38 kHz data of 17.07. (Julian day 197) during the ice camp. The figure shows the integrated sounder data (120 seconds, 2 m) of the whole day with the colour scale (in dB), the ship's velocity and the track plot. Strong diurnal variations in the zooplankton layers can be observed that correlate well with daylight. During sunrise the zooplankton moves ca. 300 m deeper from 150 m depth to 450 m depth. Another layer at around 150 m depth remains constantly at its depth.

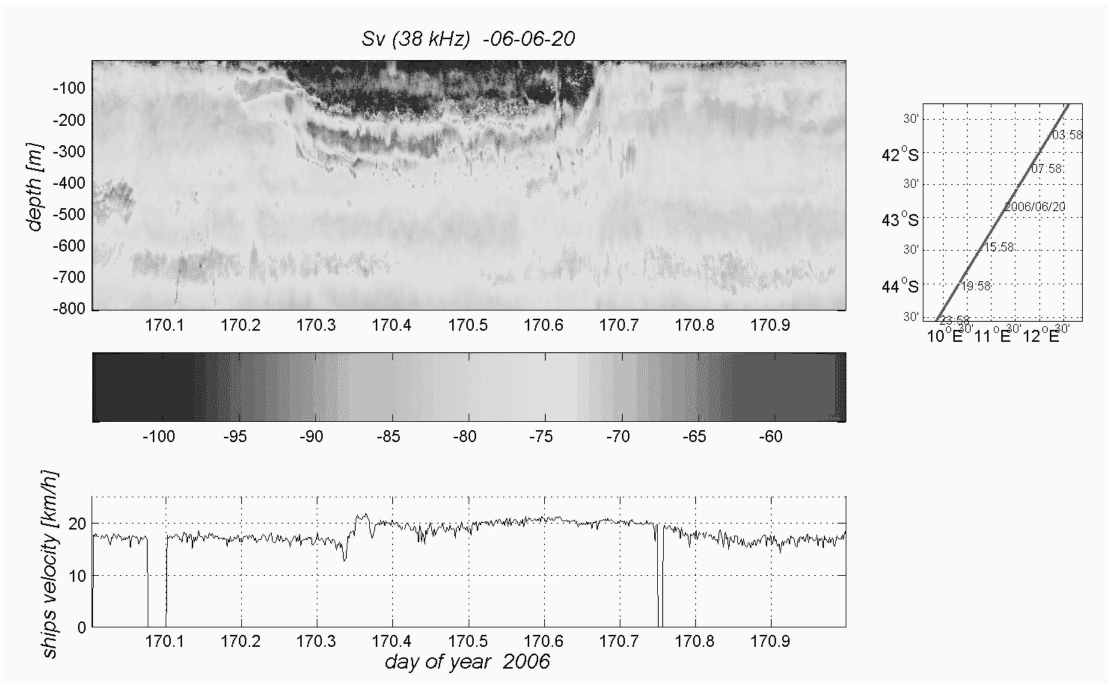

Fig. 4.4: 38 kHz data during steaming southward. Again, strong diurnal variations are observed. Please note that at this latitude the sounding signals from the water column are much stronger than further south.

5. EFFECTS OF WATER MASS CIRCULATION AND SEA ICE ON THE ABUNDANCE OF ZOOPLANKTON

Boris Cisewski[2], Daniela Ewe[2], Julia Hager[2], Andrea Lenderink[2], Ismael Nunez-Riboni[1], Christian Sahlmann[1], Timo Witte[3]

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[2]University Bremen
[3]Optimare

Objectives

The project is aimed at identifying relationships between the physical environment and the abundance of zooplankton in the Lazarev Sea. The overarching goal is to reveal whether or not the Weddell Gyre Circulation acts as a mechanism that supports krill by closing its life cycle.

In particular we seek answers to the following questions:

- Does the distribution pattern of zooplankton, and especially of krill, correlate with the distribution of water masses?
- Are horizontal differences in the demographic structure of the krill population explicable by advection?
- What is the role of sea ice in shaping the horizontal and vertical zooplankton distribution patterns?

Work at sea

Methods

During this cruise, between 26 June and 12 August 2006, 90 casts were taken from *Polarstern* with a Sea-Bird 911*plus* probe – most at a pressure of 500 - 1,000 dbar; however, 37 casts extended to full ocean depth. Study area and station locations are shown in figure 5.1. Water samples were collected with a General Oceanics' rosette sampler with 24 12-l bottles. For the station work we deployed the CTD with duplicate T and C sensors. The duplication allows for intermediate checks of sensor drifts on board. The instruments were calibrated before the cruise. For *in-situ* calibration, temperatures were measured with a digital reversing thermometer Sea-Bird SBE35, and salinity samples were analyzed with a Guildline-Autosal-8400A salinometer onboard. Furthermore, the hydrographic data base was extended by vertical profiles of light transmissivity and oxygen. All CTD casts are listed in Table 5.1.

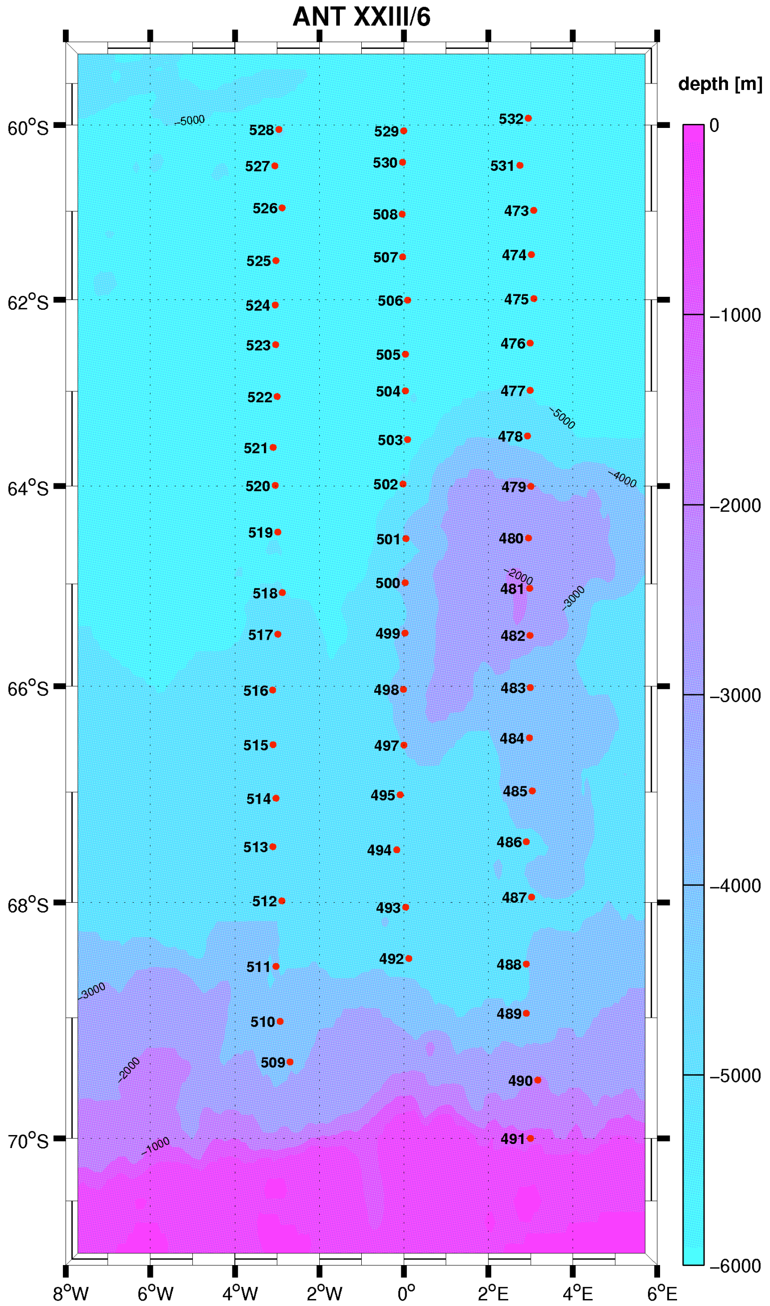


Fig. 5.1: Overview of all CTD station positions performed during the cruise

Current velocities were observed continuously using a hull-mounted 153.6-kHz RDI acoustic Doppler current profiler (ADCP type "Ocean Surveyor"). East (u) and north (v) velocity components were averaged in 2 min ensembles in 4 m thick depth bins between 19 and 335 m depth. The transducers were located 11 m below the water line and were protected against ice floes by an acoustically transparent plastic window. The reference layer was set to bins 6 to 15 avoiding near surface effects and biases near bin 1. Heading, roll and pitch data from the ship's gyro platforms were used to convert the ADCP velocities into earth coordinates. The ship's velocity was calculated from position fixes obtained by the Global Positioning System (GPS) or DGPS if available. 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 centerline. To give an estimate of these errors standard water track calibrations methods provided a velocity scale factor and constant angular offset between the transducer and the GPS antenna array. The further ADCP 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 signal, 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.

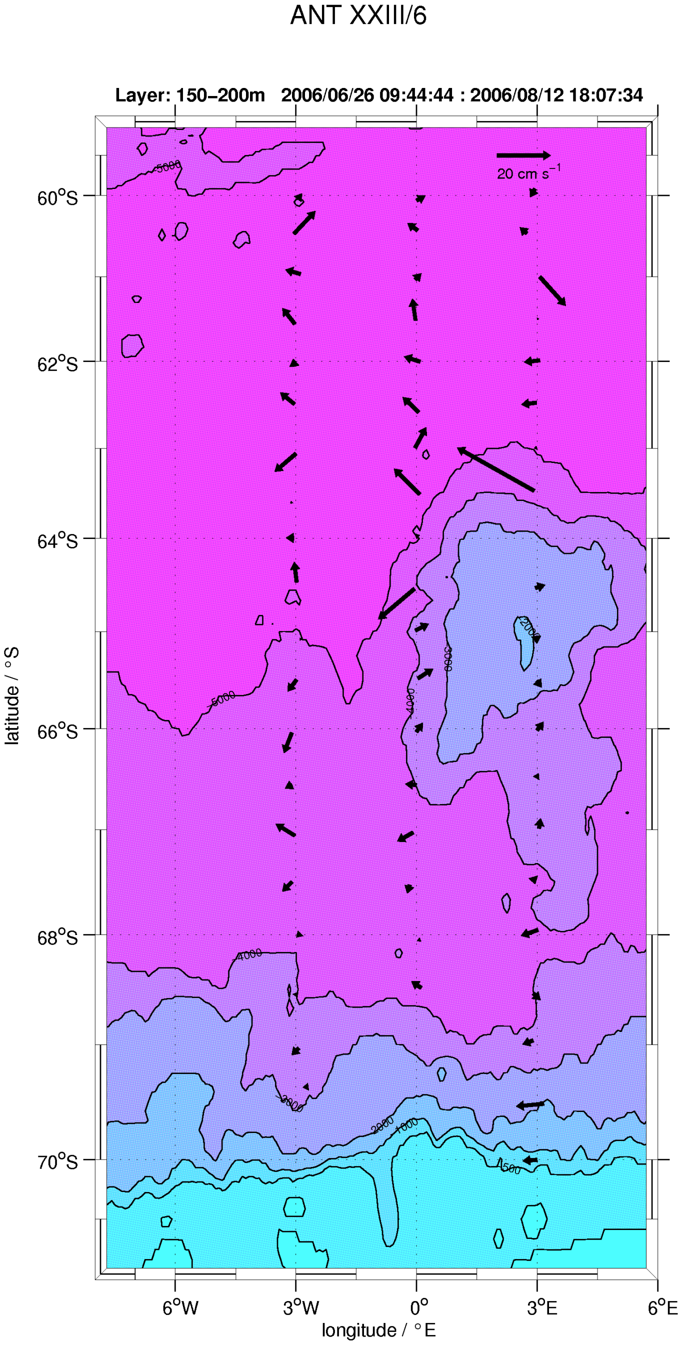
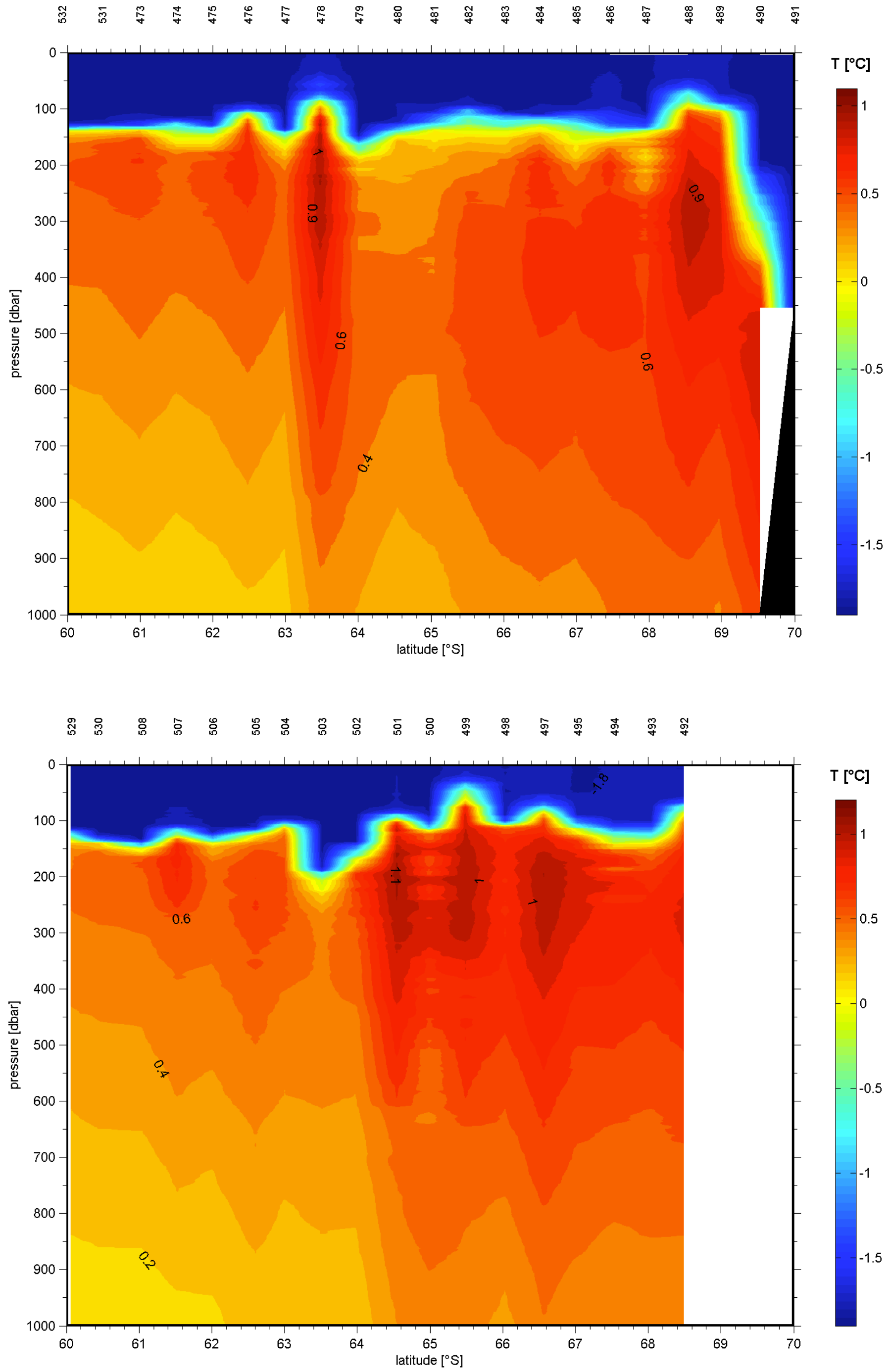
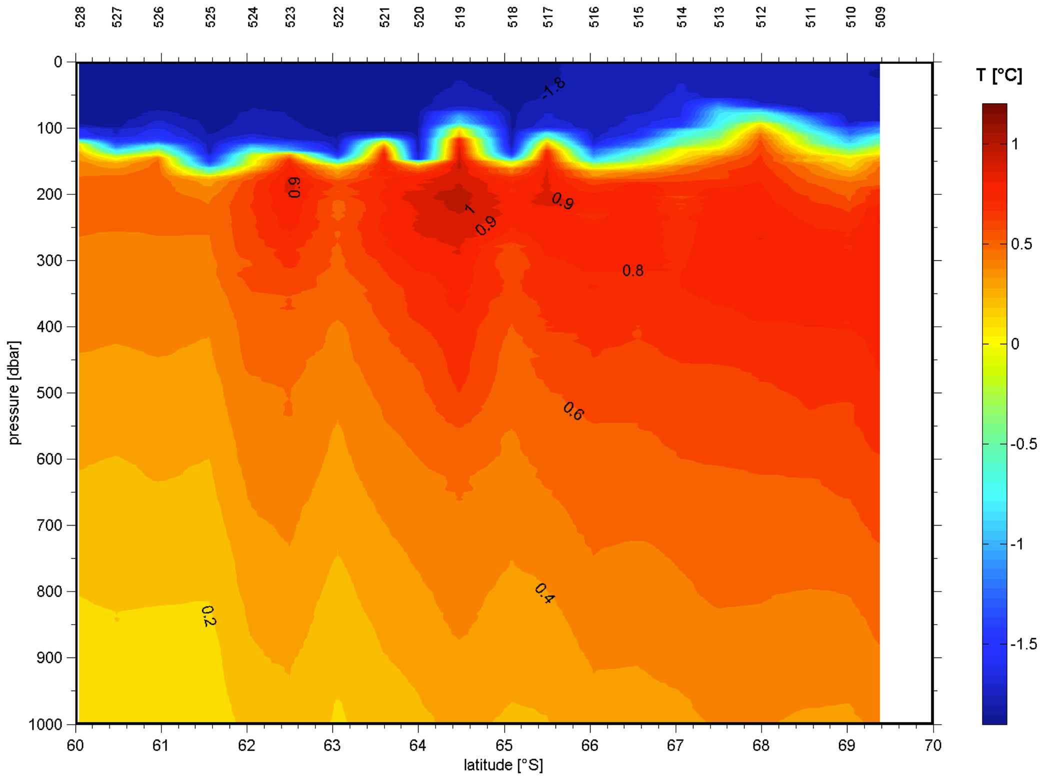


Fig. 5.2: Horizontal currents in the depth range 150 – 200 m measured between 26 June and 12 August with the VM-ADCP at regularly spaced CTD station grid points. The pattern of current vector reveals strong currents flowing around the North Western edge of Maud Rise in westerly / south-westerly direction. The weakest currents occur over Maud Rise. The westward flowing Antarctic Coastal Current can only be observed on the 3°E transect between 68.5 – 70°S.



Figs. 5.3a-b: Temperature distribution of the upper 1,000 m along the meridional transects at 3°E (a), 0° (b). While the upper 100 - 150 meters along all three transects reveal a homogenous layer of surface waters with temperatures near the freezing point, the layer of the temperature maximum lies between 150 - 300 m. In combination with the circulation pattern derived from the ADCP this suggests that Maud Rise has a strong topographical impact on the flow field and the associated water mass circulation.



Figs. 5.3c: Temperature distribution of the upper 1,000 m along the meridional transects at 3°W (c). While the upper 100 - 150 meters along all three transects reveal a homogenous layer of surface waters with temperatures near the freezing point, the layer of the temperature maximum lies between 150 - 300 m. In combination with the circulation pattern derived from the ADCP this suggests that Maud Rise has a strong topographical impact on the flow field and the associated water mass circulation.

Tab. 5.1: CTD-station list ANT-XXIII/6

Station	Cast	Latitude	Longitude	Latitude	Longitude	NBSdepth	EchoS	Pmax	Start	at depth	Stop
473	1	-60.992167	3.072717	60 59.530 S	3 4.363 E	5375.000000	DWS	5492.000000	26.06.06 08:10	26.06.06 09:44	26.06.06 11:18
474	3	-61.494533	3.020483	61 29.672 S	3 1.229 E	5340.000000	DWS	5457.000000	27.06.06 04:37	27.06.06 06:20	27.06.06 07:53
474	6	-61.483217	3.063900	61 28.993 S	3 3.834 E	5346.000000	Sandwell	257.000000	27.06.06 09:46	27.06.06 09:53	27.06.06 10:11
475	2	-61.988150	3.076300	61 59.289 S	3 4.578 E	5384.000000	DWS	5390.000000	28.06.06 05:13	28.06.06 07:10	28.06.06 08:48
475	6	-61.986000	3.026467	61 59.160 S	3 1.588 E	5375.000000	Sandwell	251.000000	28.06.06 12:28	28.06.06 12:46	28.06.06 12:58
476	2	-62.479417	2.988950	62 28.765 S	2 59.337 E	5375.000000	DWS	5446.000000	29.06.06 05:01	29.06.06 06:44	29.06.06 08:17
476	5	-62.409767	3.086383	62 24.586 S	3 5.183 E	5532.000000	Sandwell	250.000000	29.06.06 12:57	29.06.06 13:05	29.06.06 13:19
477	2	-62.991283	2.990533	62 59.477 S	2 59.432 E	5369.000000	DWS	5447.000000	29.06.06 23:11	30.06.06 00:40	30.06.06 02:16
478	1	-63.476250	2.928250	63 28.575 S	2 55.695 E	4758.000000	DWS	4798.000000	30.06.06 10:11	30.06.06 11:29	30.06.06 12:51
479	2	-64.003817	3.009000	64 0.229 S	3 0.540 E	2828.000000	DWS	2796.000000	01.07.06 05:40	01.07.06 06:35	01.07.06 07:31
480	2	-64.535117	2.951017	64 32.107 S	2 57.061 E	2091.000000	DWS	2092.000000	01.07.06 22:48	01.07.06 23:26	02.07.06 00:08
480	5	-64.537283	2.945467	64 32.237 S	2 56.728 E	2081.000000	Sandwell	252.000000	02.07.06 01:43	02.07.06 01:51	02.07.06 02:06
481	2	-65.041667	2.978333	65 2.500 S	2 58.700 E	1490.000000	DWS	1578.000000	02.07.06 11:52	02.07.06 12:26	02.07.06 12:59
482	3	-65.508250	2.987967	65 30.495 S	2 59.278 E	2646.000000	DWS	2627.000000	03.07.06 01:43	03.07.06 02:34	03.07.06 03:22
483	3	-66.014417	2.995433	66 0.865 S	2 59.726 E	3406.000000	DWS	3249.000000	03.07.06 15:04	03.07.06 15:54	03.07.06 17:01
483	6	-66.024417	3.079283	66 1.465 S	3 4.757 E	3641.000000	DWS	251.000000	03.07.06 19:54	03.07.06 20:02	03.07.06 20:19
484	2	-66.493050	2.974100	66 29.583 S	2 58.446 E	3760.000000	DWS	3755.000000	04.07.06 06:25	04.07.06 07:35	04.07.06 08:36
485	1	-66.988633	3.041800	66 59.318 S	3 2.508 E	3279.000000	DWS	3272.000000	04.07.06 16:50	04.07.06 17:53	04.07.06 18:56
485	7	-66.978617	3.084933	66 58.717 S	3 5.096 E	3350.000000	Sandwell	252.000000	05.07.06 00:54	05.07.06 01:02	05.07.06 01:14
486	3	-67.455167	2.899100	67 27.310 S	2 53.946 E	4563.000000	DWS	4598.000000	05.07.06 09:58	05.07.06 11:10	05.07.06 12:22
487	2	-67.952917	3.023700	67 57.175 S	3 1.422 E	4547.000000	DWS	4579.000000	05.07.06 22:45	05.07.06 23:57	05.07.06 01:14
487	8	-67.940900	2.995733	67 56.454 S	2 59.744 E	4548.000000	DWS	251.000000	06.07.06 06:29	06.07.06 06:35	06.07.06 06:52
488	2	-68.538750	2.898833	68 32.325 S	2 53.930 E	4135.000000	DWS	4152.000000	06.07.06 17:46	06.07.06 19:06	06.07.06 20:26
489	2	-68.961850	2.899933	68 57.711 S	2 53.996 E	3770.000000	DWS	3772.000000	07.07.06 07:33	07.07.06 08:46	07.07.06 09:53
490	3	-69.520467	3.169133	69 31.228 S	3 10.148 E	1924.000000	DWS	1901.000000	07.07.06 21:44	07.07.06 22:20	07.07.06 22:56
491	5	-69.998250	2.995600	69 59.895 S	2 59.736 E	476.000000	DWS	453.000000	08.07.06 15:20	08.07.06 15:31	08.07.06 15:44
491	7	-70.012333	3.055500	70 0.740 S	3 3.330 E	478.000000	DWS	251.000000	08.07.06 19:09	08.07.06 19:17	08.07.06 19:31
492	2	-68.489717	0.120117	68 29.383 S	0 7.207 E	4258.000000	Sandwell	1003.000000	11.07.06 12:24	11.07.06 12:44	11.07.06 13:05
492	6	-68.468167	0.093150	68 28.090 S	0 5.589 E	4210.000000	Sandwell	251.000000	11.07.06 18:03	11.07.06 18:11	11.07.06 18:28
493	2	-68.041033	0.044817	68 2.462 S	0 2.689 E	4507.000000	DWS	4542.000000	12.07.06 00:54	12.07.06 02:20	12.07.06 03:36
493	8	-68.057000	-0.019533	68 3.420 S	0 1.172 W	4499.000000	DWS	251.000000	12.07.06 10:22	12.07.06 10:30	12.07.06 10:44
494	2	-67.528067	-0.166683	67 31.684 S	0 10.001 W	4649.000000	DWS	1001.000000	12.07.06 18:28	12.07.06 18:49	12.07.06 19:13
495	2	-67.025000	-0.084667	67 1.500 S	0 5.080 W	4716.000000	DWS	4754.000000	13.07.06 04:31	13.07.06 06:01	13.07.06 07:29
497	3	-66.561467	0.001683	66 33.688 S	0 0.101 E	4638.000000	DWS	1001.000000	13.07.06 20:03	13.07.06 20:24	13.07.06 20:48
498	2	-66.031850	-0.007350	66 1.911 S	0 0.441 W	3668.000000	DWS	3696.000000	14.07.06 04:52	14.07.06 06:00	14.07.06 07:05
498	7	-66.025767	0.078183	66 1.546 S	0 4.691 E	3579.000000	Sandwell	251.000000	14.07.06 14:03	14.07.06 14:11	14.07.06 14:26
498	13	-66.019583	0.069767	66 1.175 S	0 4.186 E	3630.000000	DWS	3631.000000	14.07.06 21:01	14.07.06 22:08	14.07.06 22:51
498	27	-66.179950	0.151900	66 10.797 S	0 9.114 E	3484.000000	Sandwell	251.000000	16.07.06 14:23	16.07.06 14:30	16.07.06 14:44
498	31	-66.262983	0.067050	66 15.779 S	0 4.023 E	3840.000000	DWS	1001.000000	17.07.06 11:42	17.07.06 12:03	17.07.06 12:26
498	38	-66.233183	0.024400	66 13.991 S	0 1.464 E	3701.000000	Sandwell	251.000000	18.07.06 01:24	18.07.06 01:31	18.07.06 01:42
498	42	-66.194633	0.084883	66 11.678 S	0 5.093 E	3536.000000	Sandwell	1002.000000	18.07.06 09:17	18.07.06 09:46	18.07.06 10:08
499	2	-65.485300	0.028967	65 29.118 S	0 1.738 E	3578.000000	Sandwell	1000.000000	19.07.06 20:04	19.07.06 20:29	19.07.06 20:51
500	2	-64.985800	0.032750	64 59.148 S	0 1.965 E	3751.000000	DWS	1001.000000	20.07.06 03:45	20.07.06 04:05	20.07.06 04:27
501	2	-64.541900	0.049567	64 32.514 S	0 2.974 E	4590.000000	Sandwell	1000.000000	20.07.06 13:48	20.07.06 14:12	20.07.06 14:34
502	1	-63.980150	-0.021300	63 58.809 S	0 1.278 W	5230.000000	Sandwell	5273.000000	20.07.06 21:24	20.07.06 23:04	21.07.06 00:36
502	5	-63.950867	0.113733	63 57.052 S	0 6.824 E	5302.000000	Sandwell	251.000000	21.07.06 05:51	21.07.06 06:05	21.07.06 06:20
503	2	-63.513800	0.089033	63 30.828 S	0 5.342 E	5292.000000	Sandwell	1001.000000	21.07.06 12:43	21.07.06 13:14	21.07.06 13:39
504	2	-62.995367	0.037817	62 59.722 S	0 2.269 E	5226.000000	Sandwell	1001.000000	21.07.06 23:13	21.07.06 23:39	22.07.06 00:01
504	7	-62.970500	0.045417	62 58.230 S	0 2.725 E	5184.000000	Sandwell	251.000000	22.07.06 05:40	22.07.06 05:53	22.07.06 06:08
505	2	-62.599867	0.038267	62 35.992 S	0 2.296 E	5224.000000	Sandwell	1001.000000	22.07.06 15:18	22.07.06 15:45	22.07.06 16:10
506	1	-62.005300	0.088800	62 0.318 S	0 5.328 E	5370.000000	DWS	5442.000000	22.07.06 23:56	23.07.06 01:36	23.07.06 03:04
506	6	-61.999117	0.070733	61 59.947 S	0 4.244 E	5356.000000	Sandwell	251.000000	23.07.06 08:42	23.07.06 08:57	23.07.06 09:09
507	1	-61.521450	-0.025867	61 31.287 S	0 1.552 W	5278.000000	Sandwell	1001.000000	23.07.06 22:20	23.07.06 22:51	23.07.06 23:15
508	1	-61.034733	-0.037000	61 2.084 S	0 2.220 W	5455.000000	DWS	5457.000000	24.07.06 07:46	24.07.06 09:25	24.07.06 10:57
508	8	-60.982950	-0.139850	60 58.977 S	0 8.391 W	5408.000000	Sandwell	251.000000	24.07.06 16:04	24.07.06 16:16	24.07.06 16:33
509	2	-69.370867	-2.690483	69 22.252 S	2 41.429 W	3311.000000	DWS	3303.000000	29.07.06 01:17	29.07.06 02:26	29.07.06 03:23
509	7	-69.387717	-2.677433	69 23.263 S	2 40.646 W	3294.000000	Sandwell	250.000000	29.07.06 08:13	29.07.06 08:25	29.07.06 08:39
510	2	-69.029517	-2.927550	69 1.771 S	2 55.653 W	3572.000000	DWS	1001.000000	29.07.06 17:08	29.07.06 17:34	29.07.06 17:56
511	2	-68.558233	-3.026333	68 33.494 S	3 1.580 W	4088.000000	Sandwell	1001.000000	30.07.06 12:24	30.07.06 12:49	30.07.06 13:12
512	2	-67.985283	-2.886933	67 59.117 S	2 53.216 W	4090.000000	DWS	4107.000000	30.07.06 21:39	30.07.06 22:58	31.07.06 00:12
513	1	-67.499950	-2.098417	67 29.997 S	2 5.905 W	4310.000000	Sandwell	1001.000000	31.07.06 13:14	31.07.06 13:39	31.07.06 14:04
514	3	-67.056817	-3.025583	67 3.409 S	3 1.535 W	4456.000000	Sandwell	1001.000000	01.08.06 10:35	01.08.06 11:01	01.08.06 11:29
515	1	-66.557383	-3.094967	66 33.443 S	3 5.698 W	4541.000000	DWS	4542.000000	01.08.06 23:20	02.08.06 00:57	02.08.06 02:16
515	6	-66.596433	-3.120517	66 35.786 S	3 7.231 W	4530.000000	Sandwell	251.000000	02.08.06 07:59	02.08.06 08:12	02.08.06 08:23
516	1	-66.037750	-3.101983	66 2.265 S	3 6.119 W	4755.000000	DWS	4804.000000	03.08.06 04:59	03.08.06 06:43	03.08.06 08:11
516	7	-66.042167	-3.056950	66 2.530 S	3 3.417 W	4834.000000	Sandwell	250.000000	03.08.06 13:35	03.08.06 13:46	03.08.06 13:58
517	2	-65.495500	-2.983800	65 29.730 S	2 59.028 W	4917.000000	Sandwell	1001.000000	04.08.06 01:05	04.08.06 01:29	04.08.06 01:55
518	3	-65.084917	-2.875917	65 5.095 S	2 52.555 W	5068.000000	Sandwell	1000.000000	04.08.06 10:43	04.08.06 11:07	04.08.06 11:32
518	9	-65.087550	-2.858400	65 5.253 S	2 51.504 W	5046.000000	Sandwell	251.000000	04.08.06 17:00	04.08.06 17:12	04.08.06 17:25
519	2	-64.474267	-2.982050	64 28.456 S	2 58.923 W	5028.000000	Sandwell	1001.000000	05.08.06 02:24	05.08.06 02:49	05.08.06 03:14
520	2	-63.994383	-3.043967	63 59.663 S	3 2.638 W	5205.000000	DWS	5271.000000	05.08.06 10:09	05.08.06 11:46	05.08.06 13:20
520	7	-63.973400	-3.250817	63 58.404 S	3 15.049 W	5158.000000	Sandwell	252.000000	05.08.06 18:08	05.08.06 18:19	05.08.06 18:32
521	2	-63.598083	-3.091467	63 35.885 S	3 5.488 W	5192.000000	Sandwell	1001.000000	06.08.06 01:01	06.08.06 01:25	06.08.06 01:47
522	2	-63.057383	-2.997983	63 3.443 S	2 59.879 W	5218.000000	Sandwell	1000.000000	06.08.06 09:14	06.08.06 09:38	06.08.06 10:02
523	2	-62.496933	-3.033950	62 29.816 S	3 2.037 W	5314.000000	Sandwell	1001.000000	06.08.06 20:40	06.08.06 21:03	06.08.06 21:33
524	4	-62.059150	-3.043450	62 3.549 S	3 2.607 W	5346.000000	DWS	5424.000000	07.08.06 07:41	07.08.06 09:21	07.08.06 10:54
524	7	-62.065783	-3.069250	62 3.947 S	3 4.155 W	5313.000000	Sandwell	250.000000	07.08.06 12:17	07.08.06 12:27	07.08.06 12:39
525	2	-61.562467	-3.025250	61 33.748 S	3 1.515 W	5332.000000	Sandwell	1001.000000	07.08.06 20:17	07.08.06 20:39	07.08.06 21:05
526	4	-60.962900	-2.879217	60 57.774 S	2 52.753 W	5346.000000	DWS	5419.000000	08.08.06 07:08	08.08.06 08:51	08.08.06 10:37
526	9	-60.976867	-2.945467	60 58.612 S	2 56.728 W	5264.000000	Sandwell	250.000000	08.08.06 14:41	08.08.06 14:50	08.08.06 15:05
527	2	-60.476367	-3.052750	60 28.582 S	3 3.165 W	5404.000000	Sandwell	1001.000000	08.08.06 21:52	08.08.06 22:14	08.08.06 22:43
528	2	-60.049433	-2.955950	60 2.966 S	2 57.357 W	4813.000000	DWS	4881.000000	09.08.06 06:26	09.08.06 08:00	09.08.06 09:31
528	7	-59.949083	-2.963867	59 56.945 S	2 57.832 W	5234.000000	Sandwell	252.000000	09.08.06 14:11	09.08.06 14:25	09.08.06 14:41
529	2	-60.066083	-0.000750	60 3.965 S	0 0.045 W	5392.000000	DWS	5471.000000	10.08.06 08:28	10.08.06 10:10	10.08.06 11:47
529	6	-60.026167	-0.013433	60 1.570 S	0 0.806 W	5320.000000	Sandwell	250.000000	10.08.06 14:37	10.08.06 14:47	10.08.06 15:00
530	3	-60.435017	-0.030583	60 26.101 S	0 1.835 W	5372.000000	DWS	1001.000000	11.08.06 05:11	11.08.06 05:35	11.08.06 06:00
530	8	-60.451733	0.020500	60 27.104 S	0 1.230 E	5180.000000	Sandwell	250.000000	11.08.06 10:13	11.08.06 10:23	11.08.06 10:38
531	2	-60.470900	2.747317	60 28.254 S	2 44.839 E	5402.000000	DWS	5484.000000	12.08.06 04:00	12.08.06 05:46	12.08.06 07:25
532	2	-59.916800	2.946867	59 55.008 S	2 56.812 E	5378.000000	DWS	5454.000000	12.08.06 16:27	12.08.06 18:09	12.08.06 19:47
532	6	-59.885733	2.970267	59 53.144 S	2 58.216 E	5369.000000	Sandwell	251.000000	12.08.06 22:28	12.08.06 22:38	12.08.06 22:51

6. SEASONAL PHYSIOLOGICAL CONDITION OF ANTARCTIC KRILL, *EUPHAUSIA SUPERBA,* IN THE LAZAREV SEA WITH SPECIAL EMPHASIS ON THEIR LARVAL STAGES

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Introduction and objectives

Euphausia superba, hereafter krill, plays a central role in the marine Antarctic ecosystem and is a species of increasing commercial interest. Up to now the overwintering mechanisms of adult krill and its larval stages have not been well understood but they are essential for comprehension of the population dynamics of this species.

The extent of sea ice and the success of overwintering are major factors, which influence condition, recruitment and population size of Antarctic krill. Suggested survival mechanisms of adult krill fall into two categories: firstly, non-feeding strategies (utilisation of stored lipids, reduction in metabolic rate and shrinkage in size), and secondly, switching to alternative food sources (ice algae, zooplankton, sea bed detritus). All of these overwintering mechanisms have been observed at different times and places, but their importance remains unclear.

Additionally, the mechanisms differ with ontogeny, with larval krill having a greater feeding requirement than adults. Up to now, it is not clear if adult and larval krill have similar mechanisms of coping with the winter situation. The larval phase of krill is a critical stage of its life cycle and their survival and growth influence population success.

However, we have only cursory information of the ecology of krill larvae. Most studies on larval krill address their regional distribution pattern but ecophysiological field studies are scarce. Given the influential role of krill in the Antarctic community, an understanding of the physiological condition of their larval stages during winter might give insights into their recruitment success. One reason for the low number of ecophysiological field studies on larval krill is the availability of animals in good condition and the amount required for the experiments. Net sampling of larvae especially at air temperatures far below 0 °C delivers animals in weak condition because they are often frozen in the cod end of the nets, or damaged during trawling. The ideal way to get larvae in good conditions for ecophysiological studies is sampling with the help of divers. Sampling by diving also gives some important additional information about the origin of the animals (e.g. ice hollows, ice cracks, open water under the ice), and their habitat (e.g. brown ice, currents). This information is essential for data interpretation and for an understanding of the survival strategy of larval krill during winter and how this influences their population dynamics.

The diving group on this cruise collected larval krill in excellent condition using a sampling gear called MASMA (MAnguera Sub MArina), which works like a vacuum cleaner, sucking the larvae gently out of ice hollows and cracks. A detailed description of this sampling tool is given in the diving report of this cruise (Chapter 17).

The aim of the study was to investigate the physiological condition of adult krill and its larval stages by examining the functional relationships of feeding and metabolic rates to food availability, their growth rates and biochemical composition during winter.

During the expeditions ANT-XXI/4 and ANT-XXIII/2 we were able to analyse the condition of krill during austral autumn and early summer. The aim of this cruise was to estimate the physiological condition of larval and adult krill in austral winter by measuring their length, dry mass, elemental (carbon, nitrogen) and biochemical (protein, lipids, carbohydrates) composition, metabolic rates (oxygen consumption and ammonium production) and activity of metabolic enzymes, growth rates, feeding rates, melatonin and serotonin concentration.

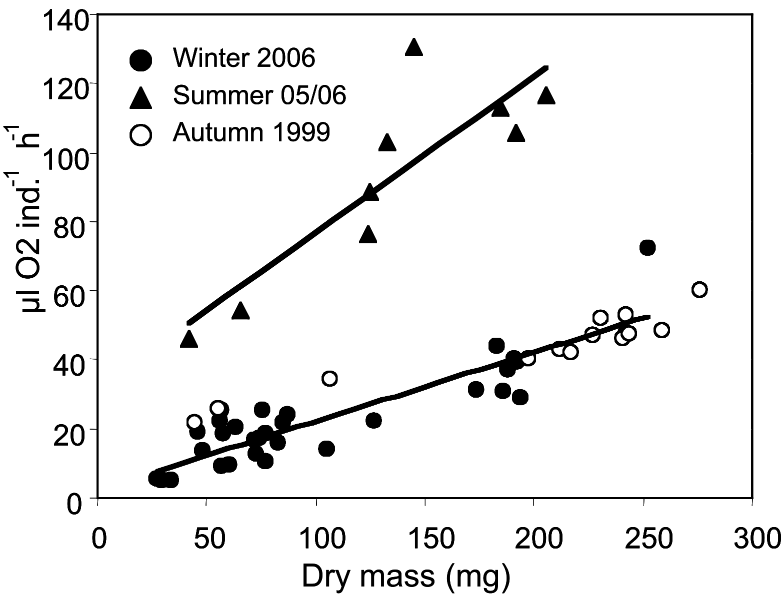

Fig. 6.1: Oxygen uptake rates of freshly caught adult krill in different seasons in the Lazarev Sea

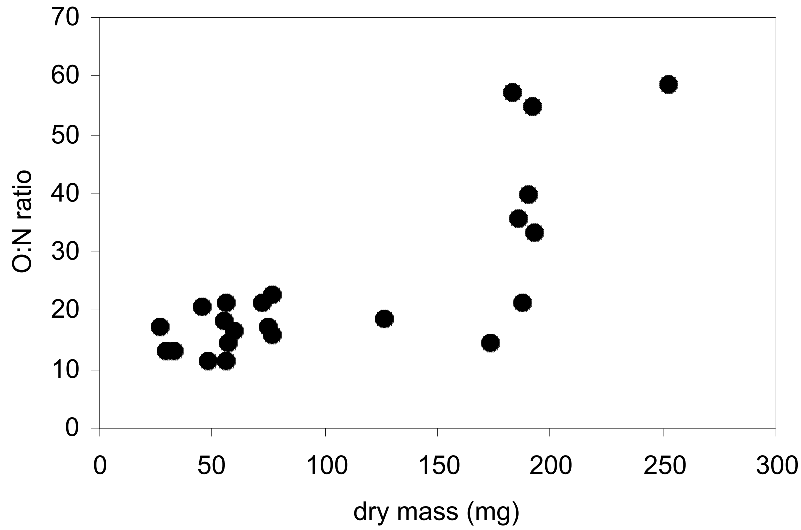

Fig. 6.2: O:N ratio of freshly caught adult krill from this winter cruise

Work at sea

a) and b) Elemental, biochemical composition and metabolic rates

Freshly caught animals were frozen in liquid nitrogen and stored at -80 °C for measuring length, dry mass, elemental (carbon, nitrogen) and biochemical (protein, lipids, carbohydrates) composition and activity of metabolic enzymes (malat dehydrogenase, citrat sythase) at the AWI.

For metabolic rate measurements freshly caught larval and adult krill were incubated for 24 h in sealed 2.5 l bottles (1 adult, 10 - 15 larval krill per bottle) equipped with micro optodes. Oxygen uptake rates were measured after 24 h using the Winkler technique by taking 50 ml sub-samples in Winkler bottles (3 replicates per bottle) and by online data collection via micro optodes. The ammonium excretion rates were measured photometrically, using the method of Solarzano.

The respiration rates of adult krill (per dry mass) were calculated onboard by using a length/mass regression and C conversion from former cruises in the Lazarev Sea (0.0005*(length mm $^{3.3312}$), C = 52 % of DM). Adult krill showed values 50 % lower than those of early summer and similar values to austral autumn (Fig. 6.1). The O:N ratios, calculated from the measured oxygen uptake and ammonium excretion rates, increased with dry mass (Fig. 6.2), suggesting that mainly lipids were catabolised in large adult krill.

Furcilia showed oxygen uptake rates between 0.2 and 0.6 μl O_2 ind.$^{-1}$ h^{-1}, similar to values measured in late summer and early autumn. In contrast the ammonium production rates in winter were more than double the rates measured during the other seasons (winter: 0.02 - 0.08, late summer, autumn: 0.002-0.04 μg NH_4 ind.$^{-1}$ h^{-1}), resulting in low O:N ratios, assuming a preference for heterotrophic diet.

In addition to oxygen determinations based on the classical Winkler technique we established the use of micro optodes, a method for online oxygen determination based on optical sensors. The comparison between oxygen uptake rates measured either by the Winkler method or by micro optodes shows a significant correlation (Fig. 6.3). The function for the linear regression equals f(x) = 0.99 + 3.73 (R^2 = 0.99) for measurements during ANT-XXIII/2 and f(x) = 0.98x + 0.52 (R^2 = 0.86) for measurements during this cruise. This indicates that both methods give highly similar values with mirco optodes showing the potential to substitute the time consuming Winkler method during future experiments.

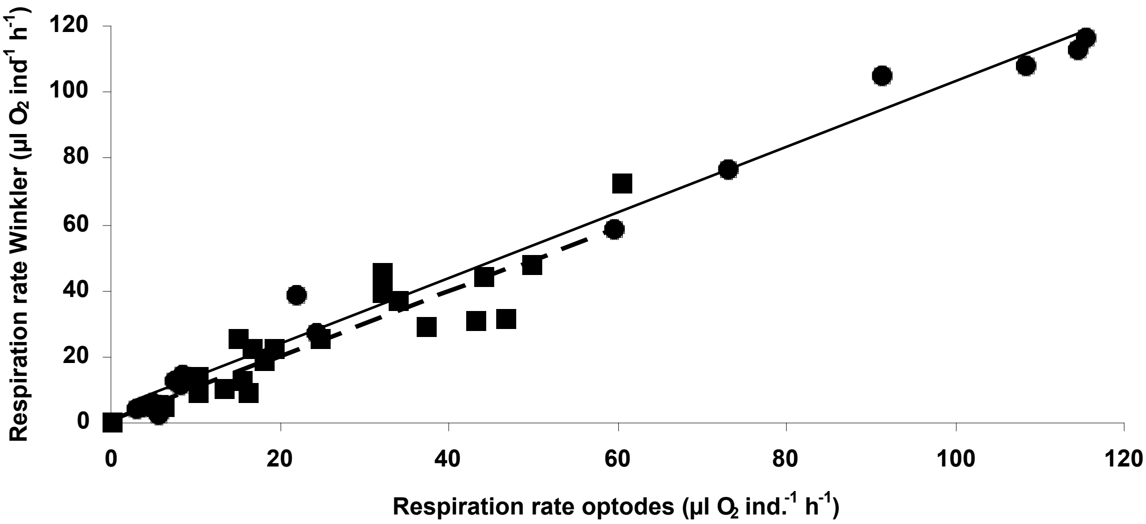

Fig. 6.3: Correlation between respiration rates determined by the Winkler method or by micro optodes; circles, solid line = data from ANT-XXIII/2; squares, dashed line = data from ANT-XXIII/6

c) Growth rates of larval, juvenile and adult krill

We conducted 7 moulting experiments, three with larval krill, one with juvenile krill and three with adult krill (Tab. 6.1). Experiments were run for 5 days, with adults and juveniles and 3 days for larval krill. Freshly caught adult krill and larvae were placed individually in 2 and 0.2 litre beakers, respectively, filled with seawater. The animals were controlled twice a day (morning and evening) for exuvia. The animal and its exuvia were measured. The mean difference in length of the uropod of moulted exoskeletons and the postmoult animals was measured to determine growth per intermoult period as a percentage of the initial length. The duration of the intermoult period (IMP) was calculated from the total number of individuals moulted in the experiments (N_{moult}), the total number of animals incubated ($N_{incubated}$,) and the duration of the experiments (t): IMP = (t $N_{incubated}$)/ N_{moult}. Dead krill and those that moulted during the course of the incubations were removed but were still included in the total number incubated ($N_{incubated}$). Combining growth data with moulting frequency provides an estimate of growth rates of larvae and adults in our working area during winter. Growth is highly influenced by food concentration and quality. Early larval stages (mainly Furcilia III, Fig. 6.4) showed an IMP of 24 days, similar to autumn larvae, whereas older stages (Furcilia IV to VI) had an IMP of 37 and 38 days that is

10 days longer than the IMP in late summer and autumn. Figure 6.5 gives an overview of the length frequency of the different laval stages in the growth experiments that were randomly selected from the catch and should mirror the stage distribution in the field. Juvenile krill showed an intermoult period of 35 days that is 10 days longer than known from summer. The IMP of adult krill ranged between 54 and 105 days which is more than double the summer IMP values.

Tab. 6.1: Summary of the growth experiments: F = Furcilia, IMP (d) = intermoult period in days, Growth (%) = Growth during IMP, Growth (mm/d) = Growth per day in mm.

Station	stage	Number of animals	IMP (d)	Number of moults	Mean Growth (%)	Mean Growth (mm/d))
PS69/478	FII-FV	68	24	5	9.62	0.0035
Divecamp	FIV-FVI	157	37	10	1.33	0.0004
PS69/515	FIV-FVI	412	38	32	1.57	0.0003
PS69/489	juveniles	70	35	9	2.39	0.0000
PS69/474	adults	63	105	3	0.13	0.0000
PS69/508	adults	53	71	3	0.16	0.0000
PS69/516	adults	54	54	5	0.89	0.0009

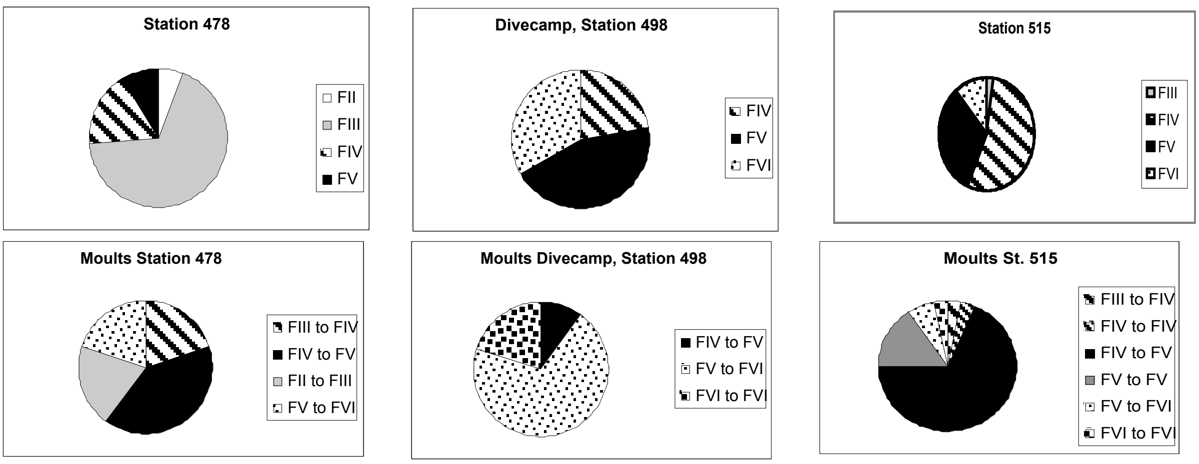

Fig. 6.4: Relative distribution of larval stages in the growth experiments (above) and stages moulted (below)

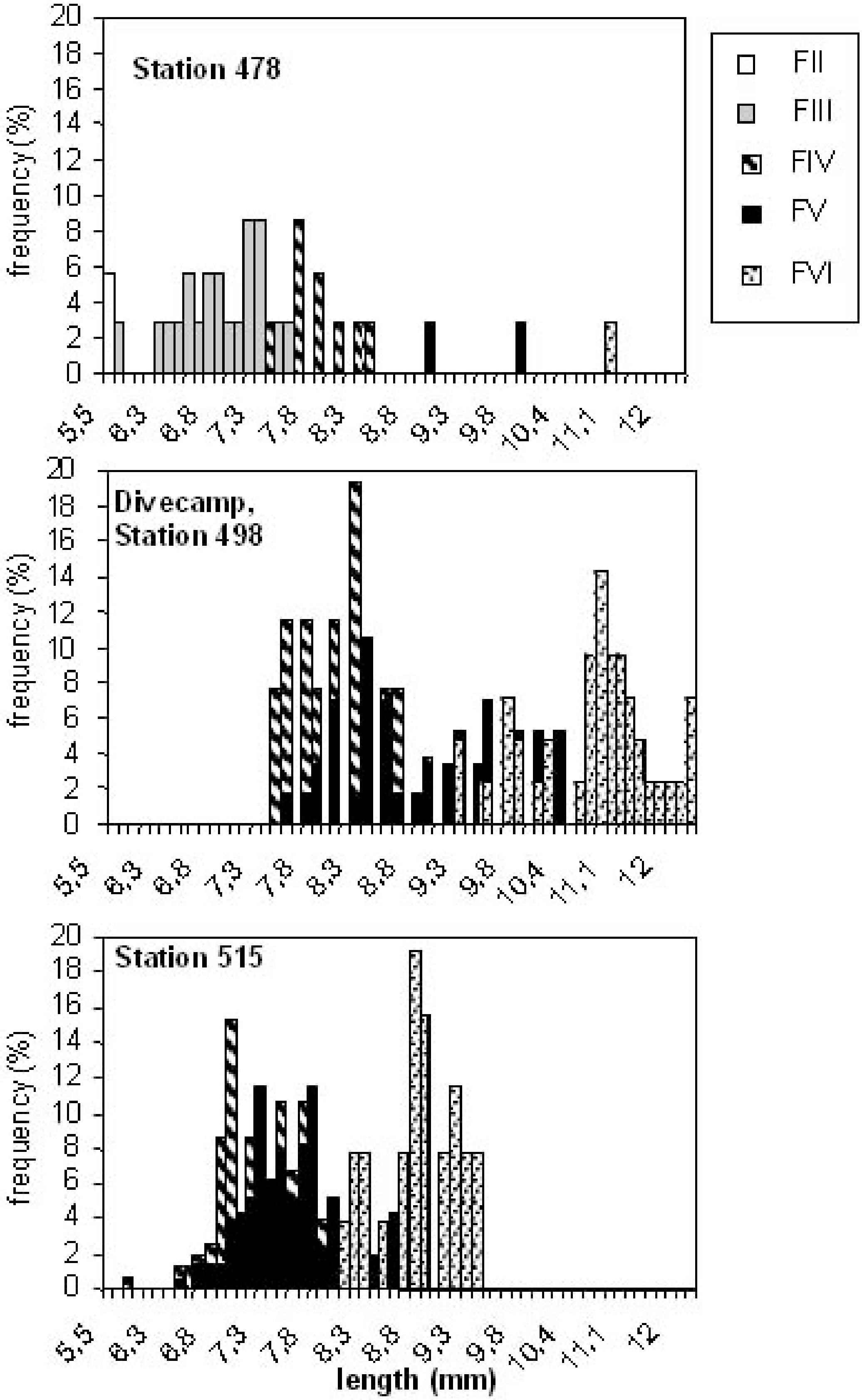

Fig. 6.5: Length frequency of furcilia larvae in the growth experiments

d) Feeding rates and behaviour

The incubation technique was used for larval and adult krill to calculate feeding rates at different food concentrations. The food medium (natural seawater enriched with melted ice algae and microzooplankton) was transferred through silicon tubing to 2.4 litre bottles for larval krill and 65 l containers for adult krill. In larval krill, the experiments comprised of 4 replicate bottles (10 to 17 larval krill each) and 2 controls without animals and in adult krill one container with 15 to 20 animals and one control without animals. The Chl*a* concentration in the experiments ranged from 0.1 to 19 µg Chl*a* per litre. A main objective of the feeding experiments was to determine the importance of zooplankton as a food source, especially for larval krill, since in winter these could be a significant alternative source of energy. The animals were incubated in filtered seawater enriched with natural phytoplankton concentrate and a specific amount of copepods (50 to 60 per 2.4 litre bottle) of the following species: (*Calaus propinquus* CII-CIV, *Metridia gerlachii* CIII-CIV, *Microcalanus* sp., *Oithona* sp., *Ctenocalanus citer*). The copepods were collected using a 200 µm mesh hand-net with a 1 litre closed cod end, towed vertically from 50 m to the surface. The uneaten food items were preserved at the end of each 24 h experiment for comparison with ungrazed controls or initials. The preserved samples will be analysed at the AWI.

In total, the amount of experiments was as follows:

- Larval krill: 11 grazing experiments with different concentrations of ice algae and five grazing experiments with natural seawater enriched with ice biota and copepods.

- Adult krill: Seven grazing experiments with different concentrations of ice algae and five experiments with natural seawater enriched with ice biota and copepods.

In addition, gut pigment content and grazing rates of larval krill were measured, in cooperation with Evgeny Pakhomov, on freshly caught animals using the gut fluorescence technique. The gut pigment content is assumed to be a relative index of herbivory to assess potential feeding on phytoplankton and/or sea ice algae. Furcilia showed gut content values in the range of 0.2 to 5 ng pigment ind.$^{-1}$, similar values to those reported from winter studies on furcilia at the Antarctic Peninsula.

For calculating ingestion rates from the individual pigment contents the gut evacuation constant *k* has to be estimated. Gut evacuation rate experiments consist of in vitro incubation of 60 individuals in 20 litre aquarium filled with 0.2 µm filtered seawater. The incubation lasted 3 h with gut fluorescence measured at 30 min. intervals. For each measurement 2 furcilia were extracted in 7 ml 90 % Aceton over night in the refrigerator. Gut evacuation rate constants (k h^{-1}) were derived from the slope of the regression versus time data (Fig. 6.6).

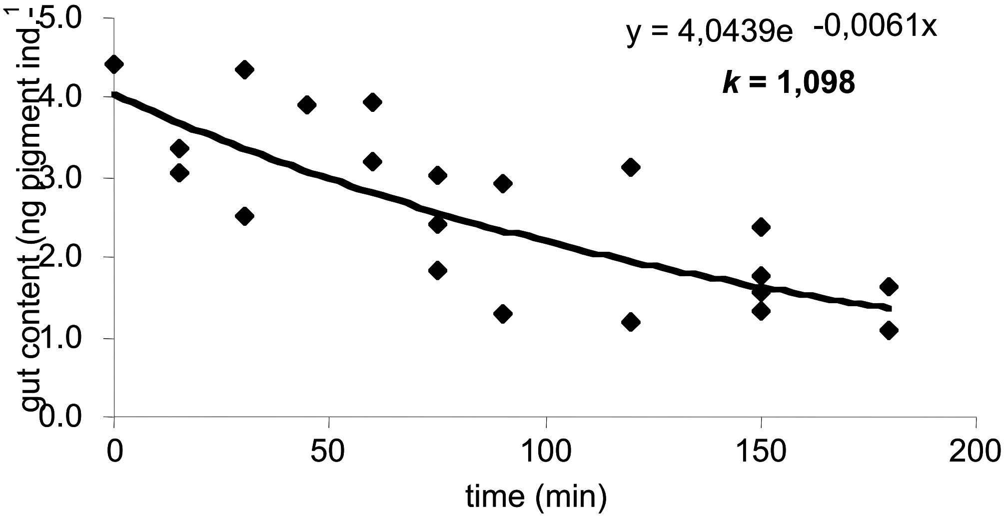

Fig. 6.6: Gut evacuation rate constant (k h^{-1})

The provisional grazing rates were calculated on a carbon base using a C:Chl*a* ratio of 50 and a length/mass regression and C derived from previous cruises in the study area (ANT-XIII/3, ANT-XXI/4).

Adult krill: 0.0005*(length mm $^{3.3312}$)
Larval krill: 0.0048*(length mm$^{2.30425}$).

Furcilia larvae stages IV to VI from the Lazarev Sea showed a much lower response to increasing food concentration in winter than in austral autumn (Fig. 6.7), whereas adult individuals showed a low response already in autumn and winter compared to early summer (Fig. 6.8).

The ingestion rates of furcilia larvae derived from the incubation method ranged between 0.02 and 0.3 μg C ind.$^{-1}$ h^{-1} and were in a similar range to the ingestion rates calculated from gut pigment measurements (0.08 to 0.4 μg C ind.$^{-1}$ h^{-1}).

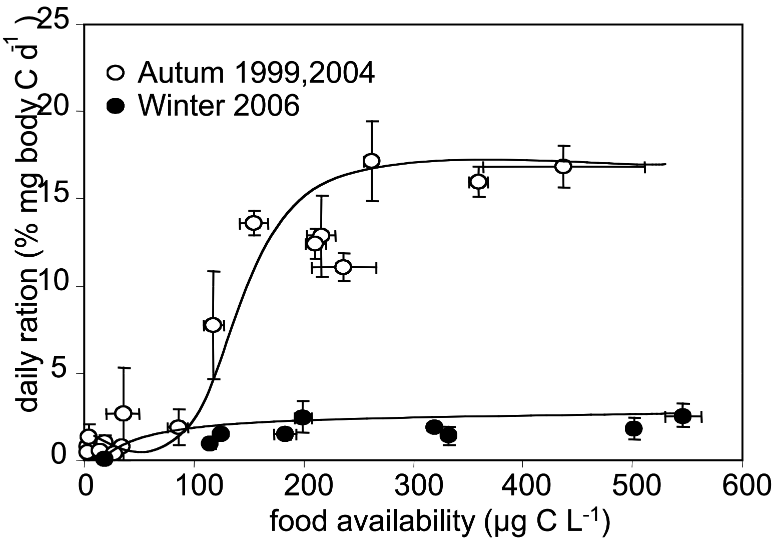

Fig. 6.7: Dependence of daily ration (DR) of larval krill on food availability in autumn compared to the winter season in the Lazarev Sea

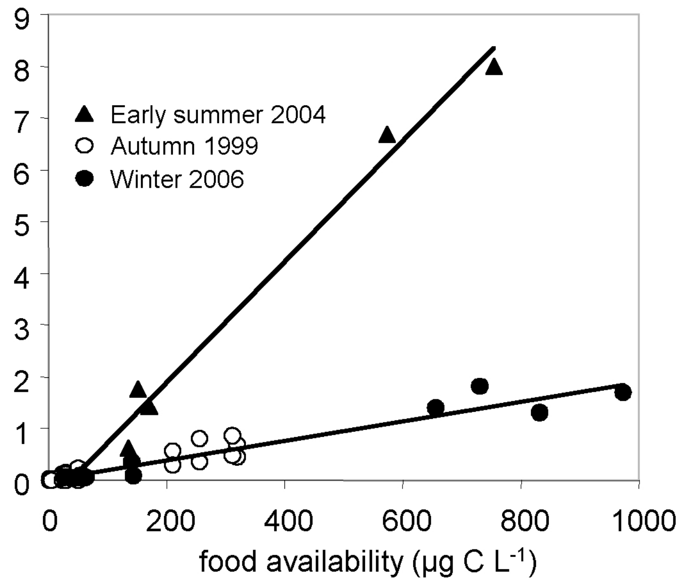

Fig. 6.8: Dependence of daily ration (DR) of adult krill on food availability in early summer and autumn compared to the winter season in the Lazarev Sea

e) Melatonin and serotonin concentration

It has been documented that the feeding activity and metabolic rates of adult krill are reduced during winter and autumn in comparison to summer values. Our working hypothesis is that melatonin (N-acetyl-5-methoxytryptamine) production in the animal may change seasonally in correspondence with metabolic activity and therefore function as a transducer for seasonal responses. Melatonin has been detected in the eyestalks of numerous crustacean species but its role and mechanism of action in physiology are still unclear. In contrast, it is well known from such diverse groups as dinoflagellates and vertebrates that melatonin is involved in the regulation of various daily and seasonal shifts in physiology and behaviour. In addition, the biochemically related indoleamine serotonin (5-hydroxytryptamine) is suspected to be involved in the transductions of rhythmic behaviour in crustaceans. Serotonin levels in crustaceans show a diurnal pattern and the substance is discussed as a component of the inner clock.

Our general aim is to detect if serotonin and melatonin are present in *E. superba*. If so, we would like to evaluate whether the concentration of these substances cycles in parallel with seasonal metabolic activity pattern in krill. Therefore, freshly caught adult krill was frozen immediately in liquid nitrogen and stored at -80 °C for analysis of melatonin and serotonin concentration at AWI. Haemolymph samples were taken before freezing from some of the animals in order to correlate the indoleamine concentration within the eyestalks and their body fluid.

During preliminary experiments on board of *Polarstern*, melatonin and serotonin concentration was measured in fresh eyestalks and haemolymph samples by use of commercially available ELISA-kits (enzyme linked immuno sobent assay). The results of the ELISA determinations are shown in Table 6.2.

Tab. 6.2: Melatonin and serotonin content of different body parts determined by enzyme immuno sorbent assay (ELISA); SOG = supraesophageal ganglion; n.d. = not detected.

sample	sampling season	fresh /frozen	melatonin	serotonin
eyestalks	winter	fresh	n.d.	225 pg / eyestalk
eyestalks	winter	frozen	n.d.	260 pg / eyestalk
eyestalks	summer	frozen	0,5 pg / eyestalk	260 pg / eyestalk
haemolymph	winter	fresh	n.d.	n.d.
haemolymph	summer	frozen	0,3 pg / µl	10 pg / µl
SOG	winter	fresh	not tested	350 pg / SOG

Melatonin immunoreactivity was observed in the eyestalks and haemolymph of animals sampled during summer, whereas no melatonin was found in animals sampled in winter. A similar pattern was found for the occurrence of serotonin in the haemolymph of *E. superba*. In contrast, the serotonin content in the eyestalks of krill showed no differences between animals sampled during different seasons.

We cannot rule out that the observed levels of melatonin and serotonin represent overestimations due to cross reactivity as samples were used without further purification. Therefore, further validation of the applied methods is required.

In most of the animals high levels of melatonin are associated with darkness. In contrast, the melatonin levels in crustaceans are known to peak in parallel with diurnal activity. Our results represent a first indication for the involvement of melatonin in the regulation of the metabolic state of krill. However, during application experiments when melatonin and serotonin were injected into the haemolymph of *E. superba* no effect on the respiration rate was observed.

Preliminary results

The most interesting results concerning our ecophysiological studies during the winter cruise ANT-XXIII/6 revealed two major points:

Against expectations from previous findings during late summer and autumn, the present winter cruise has revealed that furcilia larvae show similar overwintering mechanisms like the adults. These are low feeding rates on melted ice algae, high preference for carnivore diet and low growth rates. The results implicate that the main larval development occurs until late autumn before ice formation starts and that larval development might continue at the end of winter, at the beginning of spring, when more food is available in the water column.

In regions and seasons with large ice cover, net sampling for studying abundance of larval krill and for catching individuals for ecophysiological studies turned out to be an inadequate method. The dives during the dive camp as well as additional dives from the Zodiac (e.g. Station 515) have shown that hundreds to thousands of furcilia larvae were present under the ice. In contrast to the diving activities, parallel net tows with Multi- and Bongo nets caught only a few larvae (none to 20 individuals) during several tows. Even the RMT hauls indicated that only low numbers of larvae seem to be in the area. Video observations under the ice have shown that thousands of larvae are located in ice cracks and hollows under the ice, impossible to be reached by any net. Therefore abundance studies of larval krill by means of net tows in regions and seasons with large ice cover have to be reconsidered. The same hold true for interpretations on the population dynamic of krill. Investigations on physical and biological parameters under the ice, the under ice biota and the larvae located in this habitat in cooperation with scientific divers will give us a new and broader understanding of the ecology and hence the population dynamics of such a key species in the Antarctic marine ecosystem. This cruise has clearly shown that even under severe Antarctic winter conditions diving is a suitable and essential tool for future physiological and other biological studies on larval krill under the ice.

7. LIPID BIOCHEMISTRY OF ANTARCTIC ZOOPLANKTON

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7.1 Energetics and feeding ecology of Antarctic euphausiids: comparative lipid analyses of *Euphausia superba*, *E. crystallorophias*, *E. frigida*, *E. triacantha*, and *Thysanoessa macrura*

Objectives

Our study aimed at characterising the physiological condition and feeding behaviour of krill during the critical overwintering period by means of lipid analyses. Lipid content and lipid class composition indicate the amount and type of energy reserves present, and in comparison with summer and autumn these data allow estimates of the relative importance of lipids for the overwintering of krill. Particular emphasis was laid on the collection of all developmental and maturity stages present at this time of year in order to elucidate potential ontogenetic differences in the role lipids play during winter when feeding activity is low.

The fatty acid composition reflects the animals' feeding histories integrated over several weeks and is thus an important supplement to the classical gut content analyses providing short-term trophic information. Several feeding experiments were carried out to verify the potential of specific fatty acids as trophic markers in Antarctic euphausiids. Additionally, krill were kept in filtered seawater in order to monitor the catabolism of lipids during starvation, to elucidate whether the neutral and polar lipid classes are equally mobilised and whether essential fatty acids are conserved.

The five euphausiid species sampled are characterised by marked differences in their life cycles. While there is a wealth of information on the biology and ecology of *E. superba*, knowledge about the two more northerly distributed species *E. frigida*, *E. triacantha* is scarce, particularly with respect to their seasonal lipid dynamics. Unlike the other Antarctic euphausiids, *E. superba* does not rely on internal reserves for fuelling reproduction but is dependent on external sources making use of the summer phytoplankton bloom. These differences are mirrored in the species' lipid compositions with *E. superba* not relying on wax esters for lipid storage. Hence, comparative analyses shall help to better understand the ecophysiological advantages of different lipid compositions.

Another central topic to be addressed during the cruise was the accumulation of lecithin, which may attain exceptionally high levels in polar euphausiids. The physiological significance of this unusual phenomenon is still unknown. The identification of the position of these lecithin stores in the krill body (i.e. proximity to certain organs) and their ultrastructure, as well as a potential selective utilisation or conservation of this reserve under controlled feeding and starvation conditions may provide information on the ecophysiological role of this membrane lipid. Accordingly, the lipid-rich organs (i.e. gonads, hepatopancreas) of postlarval specimens of the five euphausiid species were dissected and either frozen in super-cooled hexane for cryosectioning and histochemical analyses or preserved in glutaraldehyde/paraformaldehyde for transmission electron microscopy (TEM).

Work at sea

Methods and accomplishments

Zooplankton was sampled by RMT 1+8 hauls (mesh size 330 and 4,500 *µ*m, respectively, 25 l closed cod-end) in the upper 20 - 70 m. Thus, the animals were obtained in good condition. Additionally, intact animals were taken from big catches with the standard RMT (double oblique tows to 200 m depth) as well as deep RMT (approx. 2,000 m) and SUIT hauls (under-ice surface). Krill larvae were obtained from RMT 1 or Bongo Net hauls (100 and 300 *µ*m mesh size, 200 m depth) as well as from a vacuum pump employed under the ice (MASMA). *T. macrura* was also present in the Multi Nets (100 *µ*m mesh size, 2,000 m depth), particularly in the deeper layers between 1,000 - 1,500 m water depth. Sampling was performed between 27 June and 14 August 2006.

In total, 421 samples of *E. superba*, 235 of *T. macrura*, 55 of *E. crystallorophias*, 22 of *E. frigida*, and eight of *E. triacantha* were collected for field measurements. Postlarval *E. superba* ranged between 20 and 53 mm in length; furciliae occurred in all stages with very similar lengths (5 - 11 mm). For the other four species, mainly adult specimens were collected, which were in early (*E. crystallorophias*, *E. triacantha*) or full reproductive stage (*E. frigida*, *T. macrura*). Females of the two latter species spawned during captivity and one egg sample of each species could be obtained. Live krill were immediately sorted and kept in filtered seawater for defaecation for 24 to max. 55 h, measured for total length, staged, rinsed with deionised water and frozen in glass vials at -80 °C or dissected for histochemistry and TEM.

Controlled feeding experiments were carried out with three species of instant algae (the diatom *Thalassiosira weissflogii* and the flagellates *Pavlova* sp. and *Isochrysis* sp., Reed Mariculture) or with late copepodites of *Metridia gerlachei* (Tab. 7.1). Krill were transferred to 15 or 20 l aquaria with filtered seawater and acclimated 24 hours for defaecation. Every day, krill were transferred to new aquaria with filtered seawater and algae (approx. 300 - 400 mg C/L) or copepods (14-17, ind./L, average carbon content will be determined in the home lab) were added. Sub-samples were taken every seven to twelve days (for lipid analyses) or one to six days (for enzyme analyses). Krill in poor condition were removed, measured, staged, rinsed with deionised water and frozen in glass vials at -80 °C. Food samples were regularly taken for later analysis of fatty acid composition. Additionally, faecal strings were isolated and frozen in dichloromethane/methanol (2:1 by volume) under nitrogen atmosphere at -80 °C for subsequent lipid analyses. Food uptake was not quantified in the algal experiments, and monitored by counting of copepods. No significant predation on copepods was detectable in any of the three experiments. Feeding on the different algal species was also low, as indicated by the fullness of the guts and the poor production of faecal strings.

Tab. 7.1: *Euphausia superba*: List of experiments

Station	Number of krill	Stage	Food	Duration (d)
474	19	Subadult	*Thalassiosira weissflogii*	32
474	12	Subadult	starvation	14
474	19	Subadult, juvenile	*Pavlova* sp.	21
489	32	Subadult, juvenile	*Thalassiosira weissflogii*	15
489	17	Subadult	*Isochrysis* sp.	14
489	12	Subadult, adult	*Metridia gerlachei*	12
489	10	Subadult, juvenile	starvation	7
489	30	Subadult, juvenile	*Pavlova+Isochrysis*	11
495	7	Subadult, juvenile	starvation	4
506	14	Subadult	*Thalassiosira weissflogii*	22
506	6	Subadult	*Metridia gerlachei*	6
508	14	Subadult	*Isochrysis* sp.	8
508	8	Subadult	starvation (enzymes)	5
518	26	Subadult	starvation (enzymes)	12
526	26	Subadult	*Metridia gerlachei*	7

In the home laboratory, dry mass of field and experimental samples will be measured after lyophilisation and total lipid content, lipid classes and fatty acid compositions will be determined for all samples.

For enzyme analysis, 108 field samples of *E. superba* and 25 of *T. macrura* were collected. Mid-gut glands were dissected from the freshly caught animal, rinsed with deionised water and frozen at -80 °C. The remainders of the specimens were separately frozen for lipid analysis. The activity of various lipolytic enzymes will be determined in the home laboratory. The presence and activity of wax ester hydrolases in *E. superba* will be measured to find out, if *E. superba* has the capability to utilise these energy-rich lipids when feeding on the calanoid copepod species. From the feeding experiment with *M. gerlachei* as food source, digestive glands of *E.*

superba specimens with filled guts were prepared in order to elucidate a potential induction of wax ester hydrolase activity. The results will be compared to the wax ester storing *T. macrura*. Additionally, changes in metabolic enzyme activities during starvation will be determined.

7.2 Seasonal lipid metabolism of *Clione antarctica*

Objectives

Clione antarctica, like its Arctic congener *C. limacina*, is characterised by a very unusual lipid composition. It is the only planktonic animal utilising diacylglycerolethers (DAGE) as storage lipid. Furthermore, its lipids comprise high percentages of odd-chain fatty acids that are characteristic for prokaryotes. *C. antarctica* is monophagous and feeds solely upon the thecosome pteropod *Limacina helicina*. The latter, however, does not contain these unusual lipids and fatty acids and hence, these compounds have to be synthesised by *C. antarctica de novo*. The ecophysiological significance of DAGE storage combined with odd-chain fatty acids remains speculative. Biosynthesis of DAGE is believed to be an evolutionarily rather ancient feature and - the lipid droplets being situated directly underneath the integument – they possibly act as a biocide.

Work at sea

A total of 51 live pteropod samples were collected by RMT (see above), total length was measured (11 - 30 mm), the animals were rinsed with deionised water and frozen at -80 °C. In collaboration with Marco Böer from the AWI, dry mass, lipid content, lipid class and fatty acid compositions will be determined in the home laboratory. Comparison with data from early summer will give first information on the seasonal lipid dynamics of this pteropod species.

8. POTENTIAL KRILL ALLERGENS

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University of Cape Town
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Objectives and work at sea

Currently, the main commercial use of krill is as feed for aquaculture. Only a small proportion is used for human consumption. In future, however, krill will most likely be caught for high quality chemical, pharmaceutical and health products but also as a protein source for human consumption. Due to its close proximity to the catching grounds of krill and its fishing interests, South Africa has an excellent position to benefit most from this rich natural source. Krill carries the risk, however, of containing proteins allergenic to humans as it is well known from other crustacean species. Allergy to crustaceans is one of the most common food allergies. So far, no research has been conducted in this regard on krill, although exposure to crustaceans can cause life-threatening reactions in allergic individuals. No crustacean species investigated so far has been found free of allergens.

The present study was designed, therefore, to investigate the allergic potential of krill in comparison with other crustacean species. To achieve these aims, it is planned

1) to extract, purify and elucidate the molecular structure of potential allergens from Antarctic krill during different seasons and physiological conditions and
2) to propose the right policies for public and occupational health to avoid problems currently experienced, for example in the lobster industry.

During the current winter cruise with *Polarstern*, samples of krill material were collected to study the role of tropomyosin, the muscle protein responsible for allergenicity in other crustacean species. This sampling complements the previous collection during Antarctic spring/summer 2005/2006 (ANT-XXIII/2). Sufficient material was sampled during both cruises and will be comparatively analysed at the University of Cape Town

9. PHYTOPLANKTON DURING WINTER IN THE LAZAREV SEA

Sarah Herrmann
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Objectives and work at sea

My aim was to examine the distribution of phytoplankton during winter in the Lazarev-Sea as well as its species composition.

During the cruise we took samples out of the 24 bottles of the CTD. The samples were taken at 9 depths, at 10, 20, 40, 60, 80, 100, 150, 200 and 250 m.

With a special device, the concentration-rack, we could concentrate the 24 - 36 l out of the Niskin bottles down to a 50 ml sample which still contained the same amount of plankton larger then 20 μm as we used 20 μm gauze in the 6 filtration-tops. consider obtain

Fig. 9.1: Concentration-rack in use

At each station samples were taken from the CTD without having to look for phytoplankton smaller than 20 μm.

These samples will be evaluated at the AWI to get information on the density and species composition in the course of increasing depth as well as changes in communities concerning latitudes.

The special interest lies on the outlasting stages of phytoplankton and during the cruise I took pictures of phytoplankton and “unknown swimming objects”. My first impression is that there is a higher density of giant diatoms like *Thalassiothrix antarctica* and chains of *Chaetoceros sp.* at a depth of around 80 m than at the surface.

The species composition also changed from northern latitudes to southern ones to more ice-correlated species like *Fragilariopsis cylindrus*.

I also conducted growth-experiments with water of 80 m depth also taken out of the CTD. This water was exposed to light with an intensity of 60 μmol Einstein m^{-2} s^{-1} to simulate spring. Every day the fluorescence was measured in vivo and every four days *in-situ*. I took also a sample at the beginning and one at the end of this experiment for further investigation at the AWI to see if there was a shift in the algal community and to determine the growth-rate.

During a first examination I could see, that *Thalassiosira antarctica* had grown very well which I had not observed before. For further investigation at the AWI I took living phytoplankton samples which I stored in a cool and dark container. My intention is to reanimate these samples at different time intervals to see how long the phytoplankton is able to survive at no-light winter conditions.

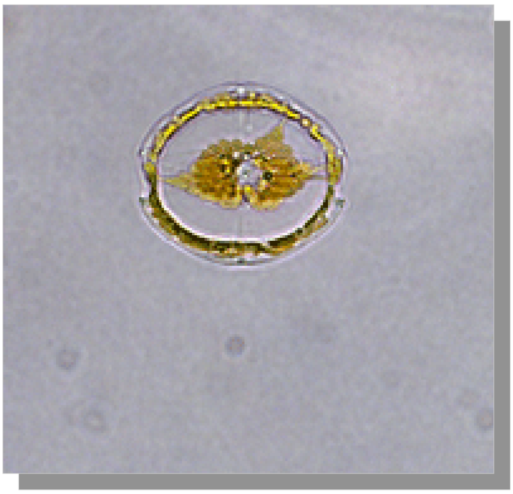


Fig.9.2: Unknown survival stage

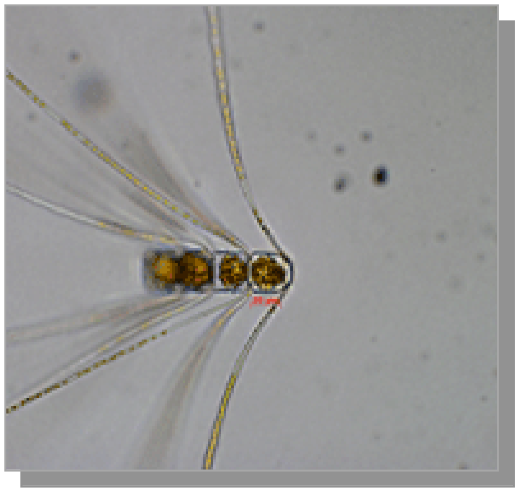


Fig.9.3: Chain of Chaetoceros atlanticus

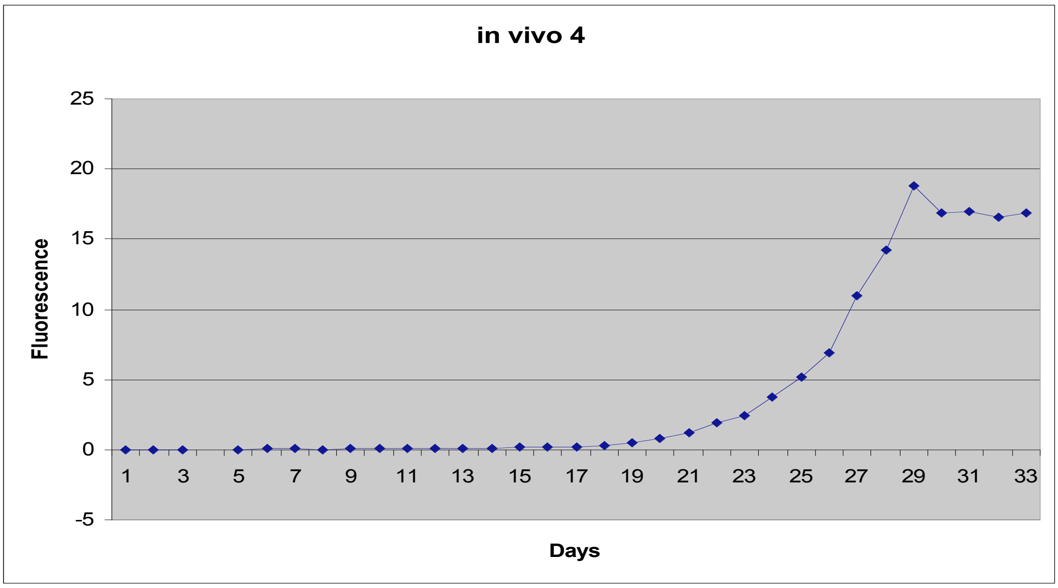
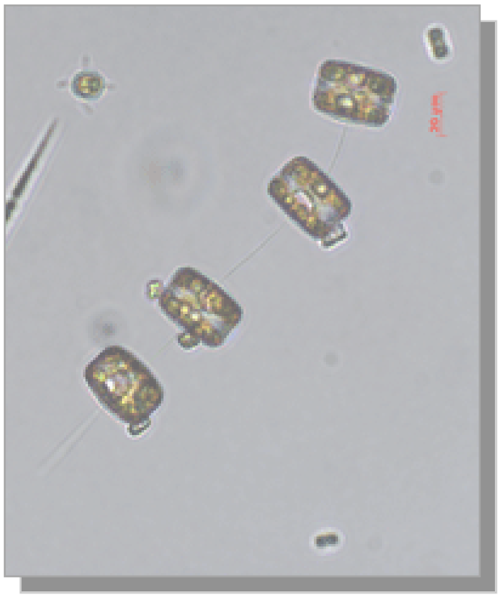


Fig. 9.4: Graph shows the development of the fluorescence over time of deposit 4

Fig.9.5: Thalassiosira antarctica chain



10. ZOOPLANKTON INVESTIGATIONS / COPEPODS (CALANOIDAE AND CYCLOPOIDAE)

Daria Martynova[2], Jan Michels[1], Britta Wend[1], Ruth Alheit[1]

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Introduction and objectives

A lot of observations on copepod abundance, species diversity, population structure, vertical and horizontal distribution, life cycle strategies and feeding have been conducted in the Southern Ocean. Most of them have been performed in spring (Wiley, 1985; Head & Harris, 1987; Atkinson & Shreeve, 1995; Burghart, 1999) and summertime (Drits & Pasternak, 1993; Atkinson, 1994; Pakhomov et al., 1997). Overwintering strategies of zooplankton species are partly studied but mostly from a biochemical point of view (Bathmann et al., 1993; Drits et al., 1993). Some investigations describe life cycle strategies related to food conditions (Pasternak & Schnack-Shiel, 2001). Winter studies on zooplankton, especially on grazing, are not numerous and have been conducted in the Weddel Sea (Nöthig et al., 1991; Pasternak, 2001) and the Scotia Sea (Hopkins et al., 1993).

It is widely accepted that organic carbon produced by phytoplankton near the sea surface (or released as ice algae) is the main source of the bulk of particulate organic carbon (POC) that passes through the water column and eventually provides inputs of organic compounds to the benthic animals. Copepods are often the most abundant metazoans in the pelagic environment (Mauchline, 1998). Thus, this zooplankton group may have a central role in organic and inorganic matter flux in marine ecosystems (Summerhayes, Thorpe, 1996; Svensen, Nejsgaard, 2003).

Calanoid copepods have evolved life cycles that are adapted to the annual pattern of ice-coverage and primary production in the Southern Ocean. Many species are able to utilize short-term food pulses and to cope with periods in which the food concentration is extremely low. Since data on the winter situation are extremely rare the different adaptation strategies are not yet fully understood. The investigations carried out during this expedition should provide detailed information on (1) abundance, species diversity, population structure and vertical and horizontal distribution of the zooplankton community with special emphasis on the dominant pelagic copepod species, (2) feeding, faecal pellet production and oxygen consumption rates of dominant copepod species, (3) lipid content and composition providing information on the amount and type of energy reserves indicating the different overwintering strategies in polar copepods, (4) other biochemical parameters such as protein and enzyme content and composition, stable isotope concentrations and C/N and O/N ratios.

Oithona similis (Copepoda: Cyclopoida) occurs in high numbers in almost all oceanic regions and is assumed to be a cosmopolitan. Thus this species must have a great impact on structuring the food web. Its feeding behaviour is discussed controversially in the literature showing a wide range in the food spectrum. Furthermore *Oithona similis* shows a more or less continuous reproduction with a lack of definite cohorts. This reflects a very long reproduction time during the year. This cruise is part of a comparative study between three oceanic regions (the Antarctic, the Arctic and the North Sea). One main aim of this study is to examine whether *Oithona similis* is a flexible cosmopolitan species or if genetically distinct species exist. The existence of such cryptic species could explain conflicting information in the literature. The genetical study additionally included individuals from different parts of the world ocean beyond the three above mentioned regions. Furthermore feeding and reproduction behaviour were investigated. To examine reproduction behaviour in the field, the stage composition, abundances, and the egg production rate were calculated.

Work at sea

Methods

Mesozooplankton samples were taken using a multiple opening-closing net system (multinet) equipped with five nets with a meshsize of 100 μm. Standard depth layers (1,000 - 500 m, 500 - 200 m, 200 - 100 m, 100 - 50 m, 50 - 0 m) were sampled at 55 stations covering the whole LAKRIS station grid. On the 3° E transect samples were collected at each station. The samples were fixed in 4 % formaline/seawater solution and will be analysed in the home laboratory. In addition many zooplankton samples taken in different depth layers between 2,000 m and the surface were fixed in ethanol for later molecular genetical investigations.

For experiments and biochemical analyses copepods were sampled by means of different plankton nets including multinet, Bongo net, RMT and handnet. The animals were picked out and sorted using a stereomicroscope. For biochemical samples copepods were rinsed with distilled water and frozen at -80 °C. These samples will be analysed in the home institute. Lipid studies will be performed in cooperation with D. Stübing and A. Schukat.

For the measurements of oxygen consumption rates copepods were kept for a given time period in closed glass bottles (100 ml volume) which were filled with oxygen saturated filtered seawater. At the end of the experiments the oxygen concentrations were determined using the Winkler titration method. Based on the differences in the oxygen concentrations of control bottles and the bottles with animals the preliminary oxygen consumption rates per mg dry weight were calculated using existing dry weight data from former expeditions. In the home laboratory the exact dry weight data of the animals used in the experiments will be determined and the rates will be recalculated.

Different types of experiments were conducted to estimate the feeding rates of major calanoid species. During the investigation period the most abundant species were

Calanus propinquus (copepodite stages IV and V, 200 - 0 m layer), *Metridia* spp. (mainly copepodite stage V, 200 - 0 m and below 500 m), *Calanoides acutus* (copepodite stage V, 1,500 - 1,000 m). These species have different life cycle strategies, which depend on their food preferences, food supply through the year and some other factors (e.g. Schiel et al, 1993, 1994). Twenty-four hour experiments were performed with *Calanus propinquus* and *Metridia* spp. Live animals were sorted from Bongo net and multinet samples and acclimated to the experimental conditions, which were quite close to the *in-situ* state (-1 °C, total darkness). Experiments were made using (a) natural seston concentrations, (b) added sea ice algae (initial concentration ca. 5 µg Chl *a* l^{-1}) and (c) surplus concentrations of natural seston, concentrated on 10 µm mesh gauze. Measurements of the Chl *a* content of seston were performed on board, samples were frozen at -20 °C for further CN analyses in the AWI. At the end of the experiments all faecal pellets were counted and retrieved for CN and Chl *a* analyses. Long-term experiments with copepodites V (CV) of *Calanus propinquus* and *Calanoides acutus* were performed under surplus food concentrations (sea ice algae). In case of *C. acutus* all the vials were kept in total darkness (3 weeks). Feeding behaviour of *C. propinquus* was studied during 18 days under three given light regimes: (1) total darkness, (2) 24 hours light with 16 mÅ intensity (1/4 of spring intensity in 0 - 50 m water layer), (3) 12/12 hours changing of light/darkness. The sea ice algae were used as food supply in both cases. Gut fluorescence samples of total zooplankton (0 - 200 m) were additionally taken during a 24 hour station (Sta. 498, 66°1' S 0°5' E) under different natural light conditions (dawn: ca. 70 % of daylight intensity; maximum sunlight intensity; dusk: ca. 40 % of daylight intensity; total darkness).

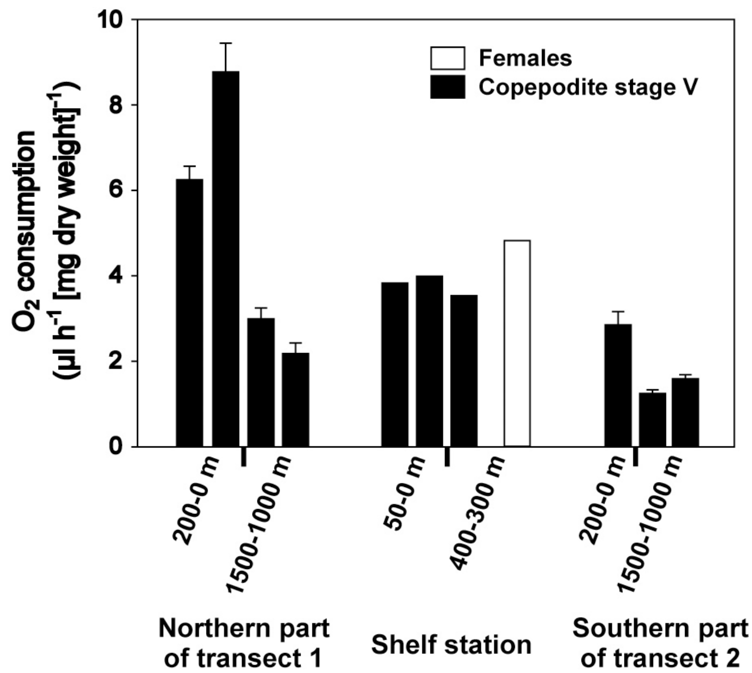
Sampling of *Oithona* species was conducted by means of a CTD rosette as well as a multinet (mesh size 55 µm) in the upper 250 m of the water column. For further information concerning the CTD sampling and handling of the probes see Herrmann (this issue, “Phytoplankton during winter in the Lazarev Sea.”). Sampling with the multinet was done in the following depth intervals: 250 - 200 m; 200 - 150 m; 150 - 100 m; 100 - 50 m; 50 - 0 m. Individuals for genetic analysis were removed from these samples and preserved in ethanol. The rest of each sample was fixed with formaldehyde (final concentration 4 %). The CTD and multinet samples will be examined in the laboratory for abundances, stage distributions, gut content, morphology and egg production rate. Feeding experiments were also conducted. Individuals for these experiments were taken out of the 50 - 0 m multinet samples. Adult females were placed in 100 ml bottles separately or in groups of up to 15 individuals for a time period of between 24 - 28 hours. The bottles were rotated on a plankton wheel. For adaptation to the experimental conditions as well as to starvation the individuals were placed in filtered seawater in the experimental bottles and rotated for at least 24 hours before beginning of the experiment. To examine what *Oithona similis* feeds under natural conditions the individuals were placed in water taken out of a Niskin bottle (10 m depth). Predators and feeding rivals were excluded from the experiment usinga pipette. At the beginning of the experiment 100 ml of the CTD water were fixed in acidic Lugol to conserve the original prey concentration. Furthermore two controls were used per experiment. At the end of each experiment the animal were checked for vitality and the water and the animals were preserved in acidic Lugol and formaldehyde, respectively.

Preliminary results

1. Oxygen consumption rates of dominant copepods

In the northern part of transect 1 the surface dwelling *Metridia* spp. CV had much higher oxygen consumption rates than the *Metridia* spp. CV found in the deep layer between 1,500 m and 1,000 m (Fig. 10.1a). At the shelf station at the southern end of transect 1 no differences in oxygen consumption rates could be found between surface and near bottom dwelling *Metridia* spp. CV. The oxygen consumption rates were relatively low and comparable to the rate of *Metridia* spp. females at this station (Fig. 10.1a). In the southern part of transect 2 *Metridia* spp. CV had the lowest oxygen consumption rates compared to those in the other areas. Again there was a significant difference between surface and deep dwelling *Metridia* spp. with much lower rates in the copepods from a depth of 1,500 - 1,000 m (Fig. 10.1a).

Fig. 10.1a. Oxygen consumption rates of Metridia spp.



Females and CIV and CV of *Calanoides acutus* were mainly found in the depth layer of 1,500 - 1,000 m and had very low oxygen consumption rates in all areas (Fig. 10.1b). The populations of this species seemed to have been overwintering in the deep water layers.

Calanus propinquus CV had relatively low oxygen consumption rates in all areas and different depth layers except for the northern part of transect 1 where a higher oxygen consumption rate could be observed. Some females found in a depth of 1,500 - 1,000 m had very low oxygen consumption rates and seemed to be inactive

(Fig. 10.1c). *Rhincalanus gigas* females had relatively low oxygen consumption rates (Fig. 10.1c).

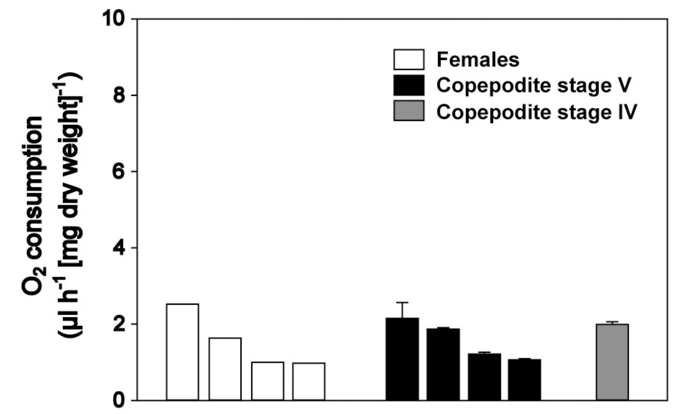


Fig. 10.1b. Oxygen consumption rates of Calanoides acutus

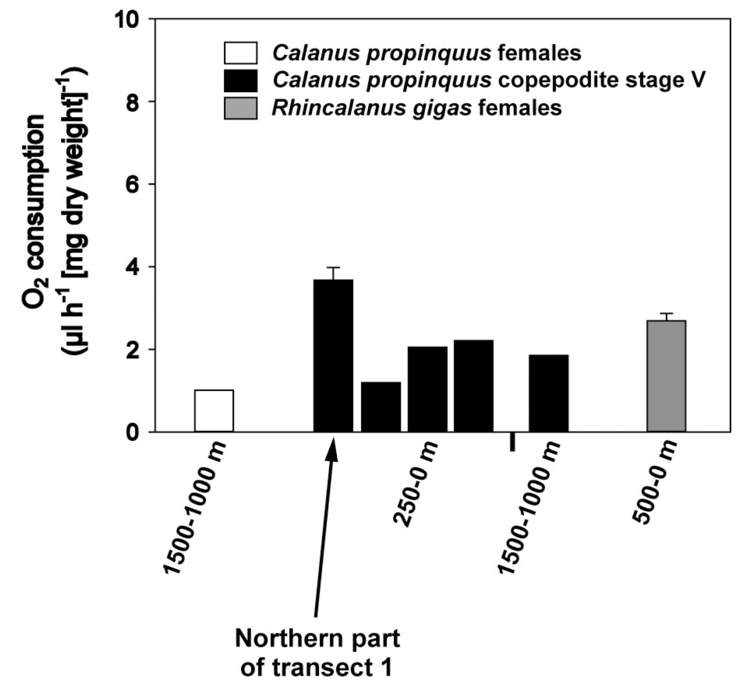


Fig. 10.1c. Oxygen consumption rates of Calanus propinquus and Rhincalanus gigas

Feeding of *Metridia* spp.

CV of *Metridia* spp. from distinct water layers had significant differences in their feeding and pellet production rates. Copepods from the upper layer seemed to be inactive under winter food conditions (low phytoplankton abundance), similar to the animals from deeper layers, having ice algae as food supply (Fig. 10.2a). *Metridia* spp. from the upper layer showed a rather quick response to increasing food concentration in terms of Chl *a* content (Fig. 10.2 a,b).

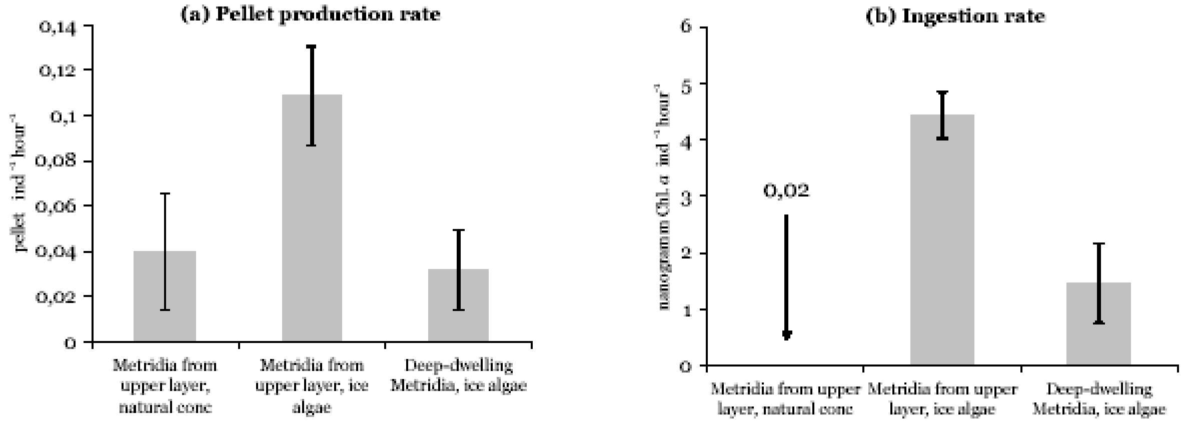


Fig. 10.2. Feeding rates of Metridia species

Feeding of *Calanus propinquus*

Feeding rates of copepodites of the two most abundant stages (CIV and CV) differed significantly in 24 hour experiments both in natural seston concentration and added ice algae food supplement (Fig. 10.3). CIV seemed to be quite inactive compared to the CV animals, even in high food concentrations.

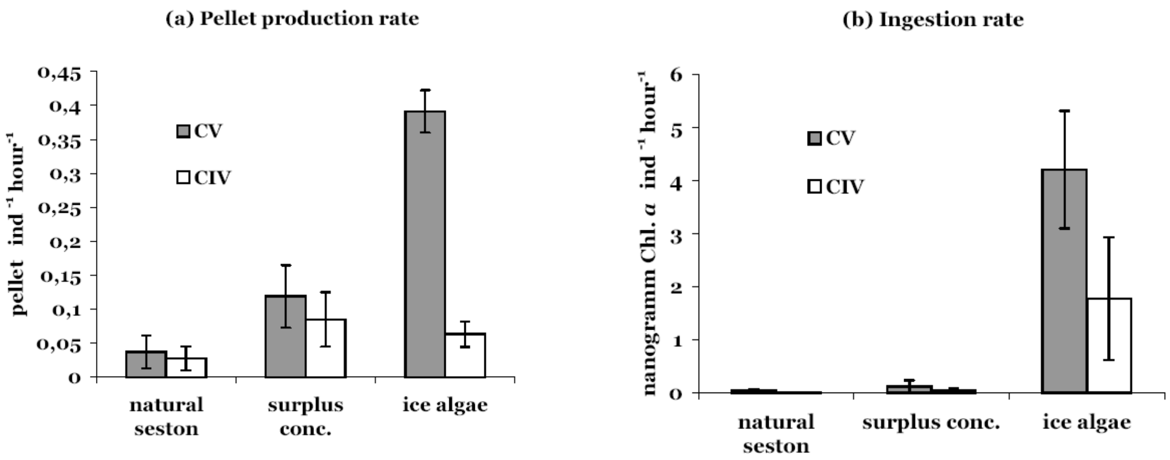


Fig. 10.3. Comparison of feeding rates of Calanus propinquus (CIV and CV copepodites)

Closer examination of the feeding behaviour of these stages revealed no significant differences in feeding rates on natural seston both in essential and artificially enriched water (Fig. 10.4). CIII also had low feeding rates.

An additional twenty-four hour experiment was performed to observe the reaction time of CV to an increasing food concentration (additional ice algae). After 6 hours the pellet production rate reached a plateau with average values of about 0.5 pellets ind^{-1} hour^{-1} (Fig. 10.5).

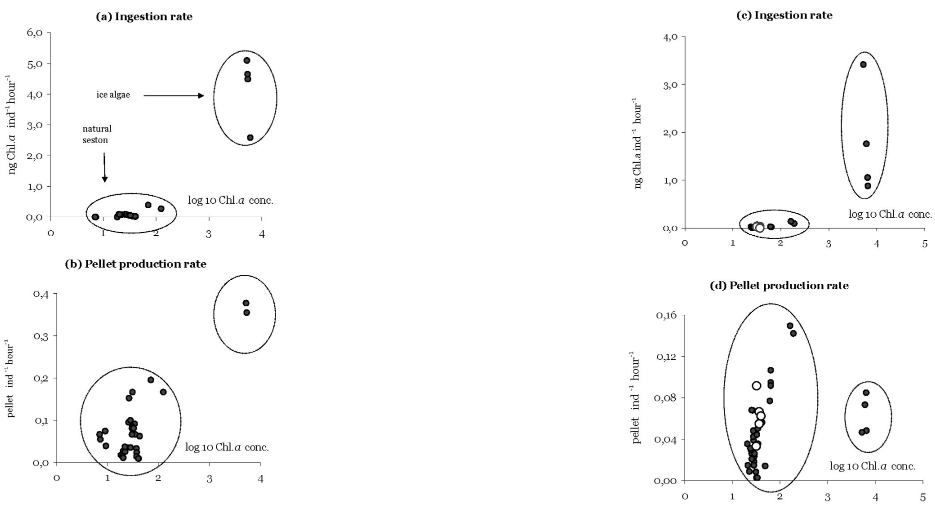


Fig. 10.4. Feeding rates of Calanus propinquus.
(a), (b) – CV; (c), (d) – CIV (black dots) and CIII (white dots)

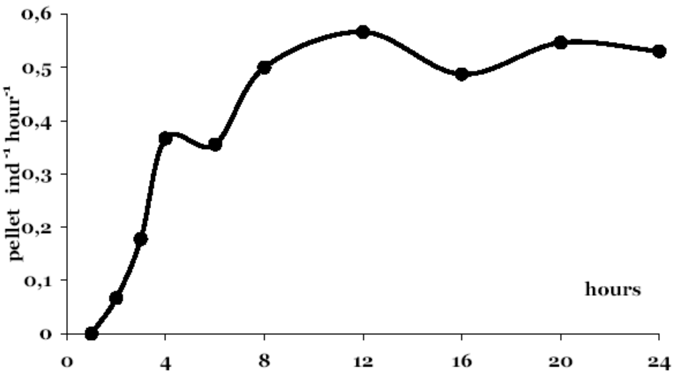


Fig. 10.5. Reaction of Calanus propinquus CV copepodites to additional food supply (ice algae)

Long-term experiment with *Calanus propinquus* (different light conditions)
Neither in CIV nor in CV an increase of the pellet production rates under the different light regimes (24 hours light, 12/12 hours changing light) was observed. The pellet production rates of the CIV were significantly lower (t-test, p<0,001) than those of the CV (Fig. 10.6).

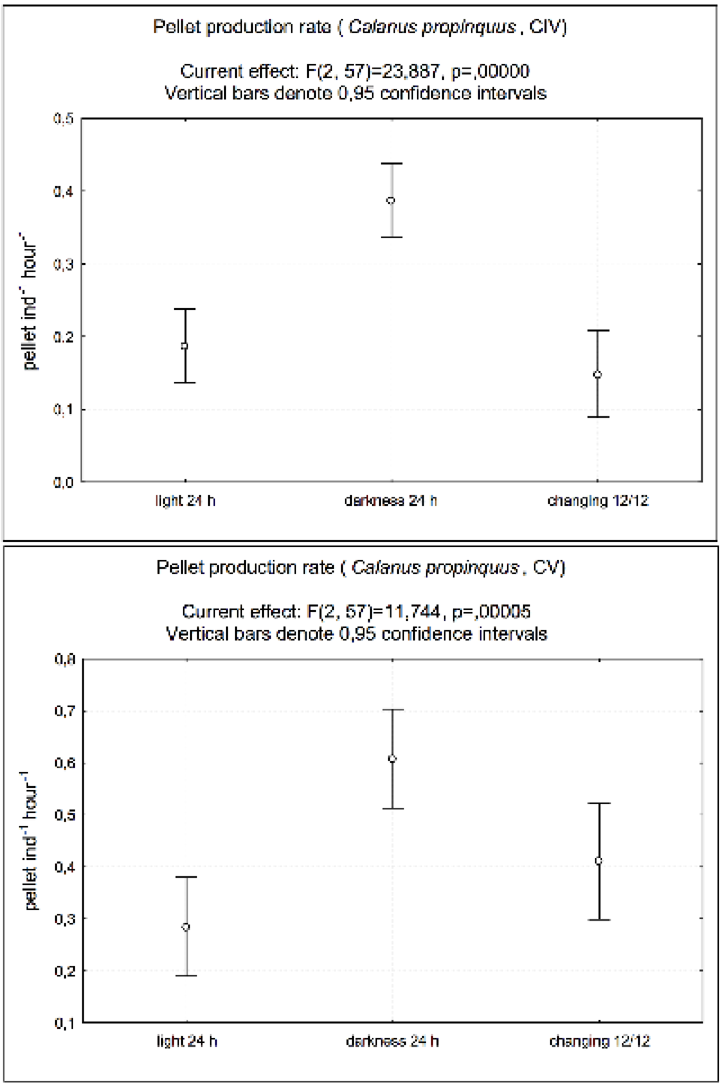


Fig. 10.6. Pellet production rate in different light conditions

Long-term experiment with *Calanoides acutus*, CV
Keeping animals in surplus food supply and total darkness for three weeks did not activate any visual changes in the copepod's behaviour and the size of their oil sacks. Further lipid analyses will be performed in the shore lab.

Oithona investigations

All the samples will be analysed in the shore laboratory with respect to the genetics, morphology, gut content, stage abundance and composition and reproduction. The preserved samples of the feeding experiments will be analysed for prey concentrations, and the gut content of the animals will be investigated.

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11. ECOLOGY OF PELAGIC TUNICATES IN THE LAZAREV SEA DURING JUNE-AUGUST 2006

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Objectives

Antarctic salps, *Salpa thompsoni* and *Ihlea racovitzai*, are widely distributed throughout the Southern Ocean south of the Antarctic Polar Front. While *S. thompsoni* is documented mainly from low Antarctica (40 - 60ºS), it was recently recorded in coastal waters around the Antarctic continent. Unlike *S. thompsoni*, *I. racovitzai* is a high Antarctic species and generally has not been found north of the APF. Overall, salps are considered to be the third most important metazoans after Antarctic krill and copepods in the Southern Ocean. Their populations may undergo explosive growth under certain environmental conditions due to their capacity of rapid asexual reproduction (budding). Ecologically, salps have been shown to be able to remove organic matter at rates exceeding daily primary productivity. Furthermore, salps produce large fast sinking fecal pellets and thus locally contribute significantly into the process of channeling surface biogenic carbon into long-living pools on the sea bottom.

Previous South African and LAKRIS expeditions showed high interannual variability in salp density in the Lazarev Sea. Despite general distribution and some information of salp life cycles are available from Discovery Reports, our understanding of salp distribution and ecology is still incomplete, particularly beyond austral summer. For example, the question on how the low-Antarctic *S. thompsoni* appears in the coastal regions is still unresolved. Furthermore, there is an indication that life cycle of *S. thompsoni* could be disrupted in the south most locations. Therefore, it was imperative to obtain winter data set on *S. thompsoni* distribution and biology. Finally, the importance of the second salp species *I. racovitzai*, which is usually presented in background quantities in the coastal seas, is largely unknown.

Work at sea

The major aims of this cruise where to investigate salp ecology, including their spatial distribution, developmental stage composition and feeding intensity in the Lazarev Sea during austral winter (June - August) 2006. Salps were collected at every grid station by conducting the standard oblique 0 - 200 m RMT 8+1 tows. Large salps (oral-atrial (OA) length > 20 mm) were counted, sexed and measured from RMT-8, while small salps (OA length < 20 mm) were analyzed from RMT-1 nets. It should be noted that *S. thompsoni*, due to its scarcity throughout the grid were collected from all available sampling gears, including multinets and deep sea (down to 2,500 m) RMTs. Immediately after capturing, stomachs of 3 to 15 salps of a variety size classes were dissected out and placed individually into plastic tubes filled with 10 ml of 90 % acetone for gut pigment extraction in darkness at -18 °C for at least 48 hours. Pigments where measured using the Turner Design fluorometer before and after acidification. Finally, developmental stages of aggregate and solitary forms of *S. thompsoni* only have been identified with the special attention to any abnormalities in the salp embryo development. Fecal pellets (for *I. racovitzai* only) were collected individually either during the experiments, when individual alive salps were placed in the 20 l bucket, or collected from the salp guts when there where visibly on their way out but not yet released. Unfortunately, fecal pellet production experiments were only successful for the first 1 or 2 hours, after which salps stopped moving. As a consequence, the fecal pellet composition should be considered as preliminary results. Fecal pellets where individually placed into plastic tubes filled with 10 ml of 90 % acetone and processed as above.

Preliminary results

Composition and distribution.

The entire sampling area has been covered with the ice during June - August 2006. Two species of salps, *Salpa thompsoni* and *Ihlea racovitzai*, have been found in RMT-8+1 tows in the top 200-m water layer of the Lazarev Sea. Frequency of occurrence of *S. thompsoni* and *I. racovitzai* in samples was 27 and 100 %, respectively. Winter 2006 appeared to be very poor in *S. thompsoni* with total densities not exceeding 0.9 ind.1,000m^{-3}. Mean *S. thompsoni* density was 0.34 ± 2.22 ind.1,000m^{-3}.

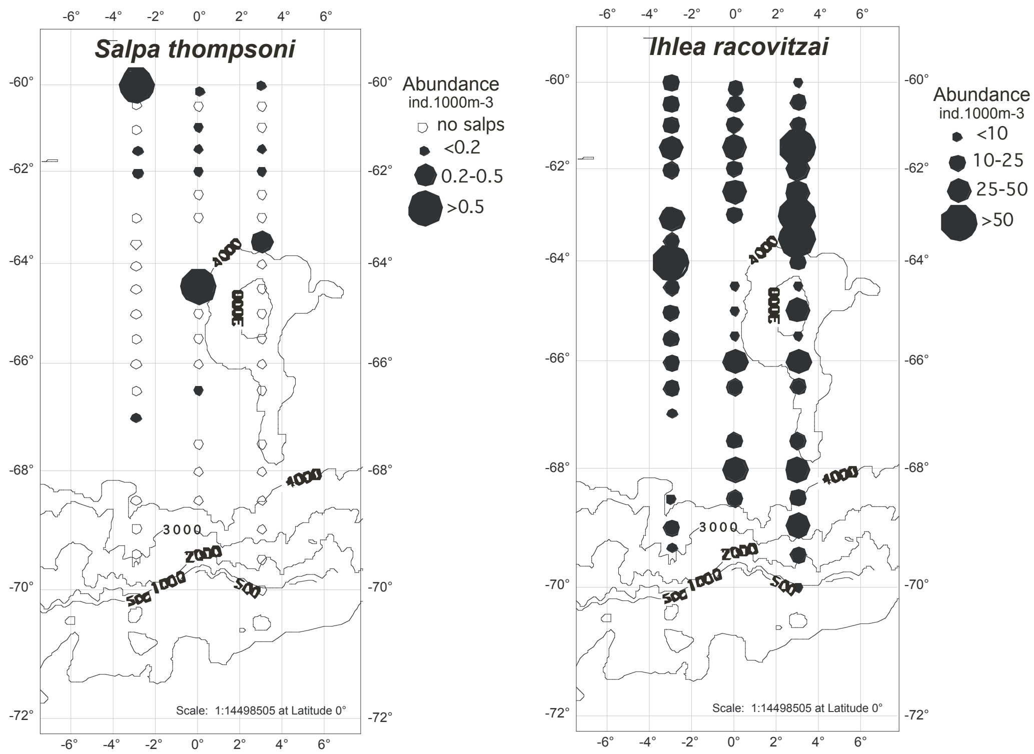
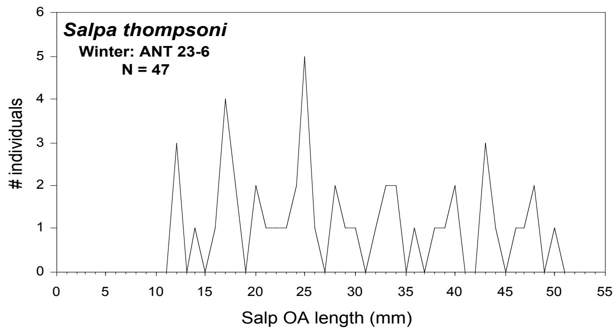


Fig. 11.1: Spatial distribution of Salpa thompsoni *and* Ihlea racovitzai *in the Lazarev Sea during June-August 2006*

Only once, *S. thompsoni* was caught at density of 16 ind.1,000m^{-3} at the northernmost station of 3°W transect. This high density appeared at multinet sampling depth of 1,500 - 2,000 m (Fig. 11.1). Most findings of *S. thompsoni* concentrated in the northern part of the survey and around the Maud Rise (Fig. 11.1). Abundance of *I. racovitzai* ranged from 4.7 to 78.1 ind.1000m^{-3}, with a mean of 22.6 ± 16.3 ind.1000m^{-3}. Spatial distribution was relatively uniform with slightly elevated densities between 61 and 64° South along all three transects (Fig. 11.1).

Size structure and development

Population of *S. thompsoni* has been represented by only solitary forms with length ranging from 12 to 50 mm (Fig. 11.2). Several cohorts were visible in the size range between 10 and 50 mm with slightly pronounced peaks at 12, 17, 25 and 43 mm (Fig. 11.2). Approximately half of all specimens resembled embryos with a large eleoblast still present. Only 6 % of solitaries did not show any remains of eleoblast, while remaining specimens were in transitional stages between eleoblast/no eleoblast stages (Fig. 11.2). As a consequence developmental stage 1 was the dominant stage during June - August 2006.



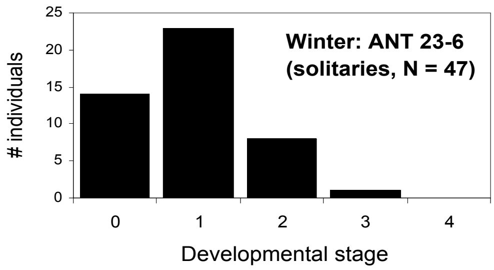


Fig. 11.2: Length frequency distribution and development stage composition of Salpa thompsoni in the Lazarev Sea during June - August 2006

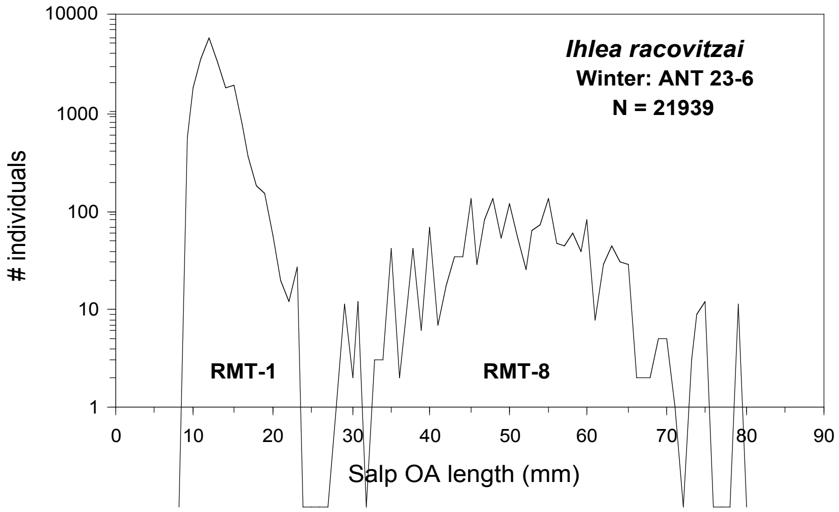


Fig. 11.3: Length frequency distribution of Ihlea racovitzai in the Lazarev Sea during June - August 2006

Length frequency distribution of *I. racovitzai* was not different across the grid with two distinct size cohorts at 12 - 16 mm and 45 - 55 mm (Fig. 11.3). All specimens were solitary forms. A strong small cohort, that was always present in RMT-1 catches, indicates that *I. racovitzai* recently completed sexual reproduction and produced numerous overwintering cohort.

Feeding dynamics

The feeding intensity of *S. thompsoni* has been low and majority specimens had orange stomachs, indicating that not filtering but rather eleoblast supplies are still in use to meet their energetic demands (Fig. 11.4). Majority of *S. thompsoni* specimens were frozen individually for subsequent stomach content and elemental composition analyses. Unlike *S. thompsoni*, *I. racovitzai* solitaries were actively feeding and specimens > 30 mm showed pronounced diel vertical migration, being most numerous in 0 - 200 m layer during the darkness. The relationship between *I. racovitzai* length and concentration of pigments in the salp stomach has been best fitted by the power function (Fig. 11.4). Gut pigments ranged from ~ 50 to almost 5500 ng(pig).ind^{-1} in 15 and 65 mm long *I. racovitzai* (Fig. 11.4) and where not related to the ambient chlorophyll-*a* concentrations across the grid.

Despite pronounced diel vertical migration of larger *I. racovitzai*, there was no visible diel pattern in feeding activity of different size-classes of *I. racovitzai*.

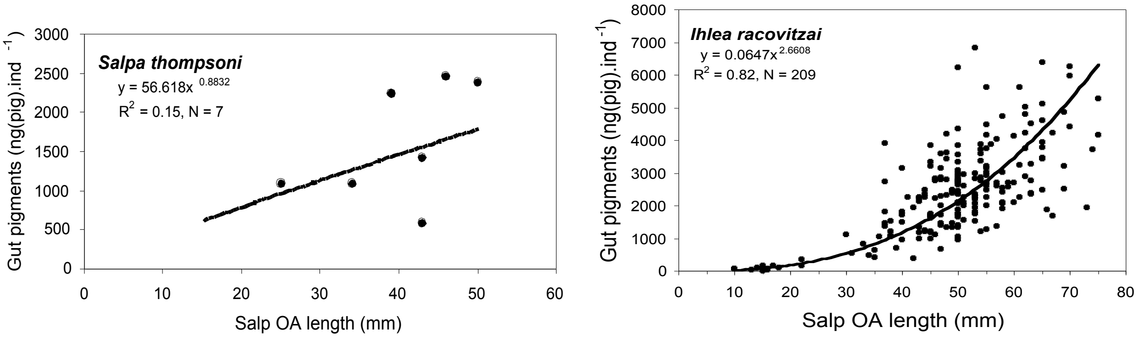


Fig. 11.4: Gut pigment contents of Salpa thompsoni (left) and Ihlea racovitzai (right) in the Lazarev Sea during June - August 2006

Absence of the diel feeding pattern allowed very rough calculations of salp daily grazing rates, using the equation $I = G \times 24 \times k$, where *I* is ingestion rate (ng(pig).ind-1day-1), *G* is mean daily gut pigment content (ng(pig).ind^{-1}), and *k* is gut evacuation rate constant. Since no gut evacuation rates were estimated during this study, doubled gut passage time obtained previously for *S. thompsoni* during summer 1997/98 was used. In this regard, gut passage time for *I. racovitzai* <20 mm and >20 mm was assumed to be equal to 8 and 12 hours, respectively. The conservative ingestion rates were 215, 4159 and 6499 ng(pig).ind^{-1}day^{-1} for salps <20 mm, 20 - 50 mm and >50 mm, respectively. Using salp size structure at each station, the grazing impact would range from 0.3 (lowest salp density of 0.005 ind.m^{-3}) to 56 ng(pig).m^{-3}day (highest salp density of 0.078 ind.m^{-3}). Considering that mean chlorophyll-*a* in the top 200 m was ~50 ng.m^{-3} throughout the entire grid, despite even very preliminary calculations, the population of *I. racovitzai* alone on average (mean salp 0.023 ind.m^{-3}) appears to remove entire chlorophyll standing stock within 3 - 4 days.

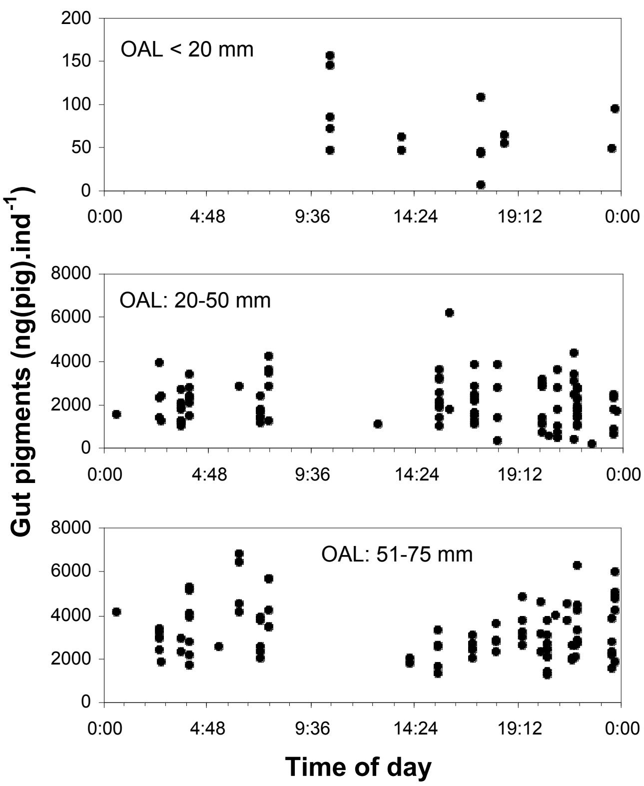


Fig. 11.5: Diel variability in gut pigment content of different size groups of Ihlea racovitzai in the Lazarev Sea during June - August 2006

We know little about the primary productivity in the area but the above findings indicate that either pelagic primary productivity is higher than we assume or salps are very efficient to use micro-layers of higher chlorophyll concentrations. Alternatively, under the ice freezing/defreezing friction may provide continuous rain of ice algae, which is consumed by *I. racovitzai*. Samples of salp gut contents and stable isotopes collected during the cruise will further provide evidence on the diet composition of *I. racovitzai*.

Preliminary results on fecal pellet (FP) pigment composition of >50 mm *I. racovitzai* show that FP pigment content increased with the salp length, averaging to 126, 255 and 320 ng(pig).pellet^{-1} in 53 mm, 59 mm and 69 mm long salps, respectively (Fig. 11.6). It appears that FP pigments where also positively correlated with the mean salp gut pigment contents (Fig. 11.6). These values are the first reported estimates of FP pigment concentrations of *I. racovitzai* and appeared to be similar to these of *S. thompsoni*.

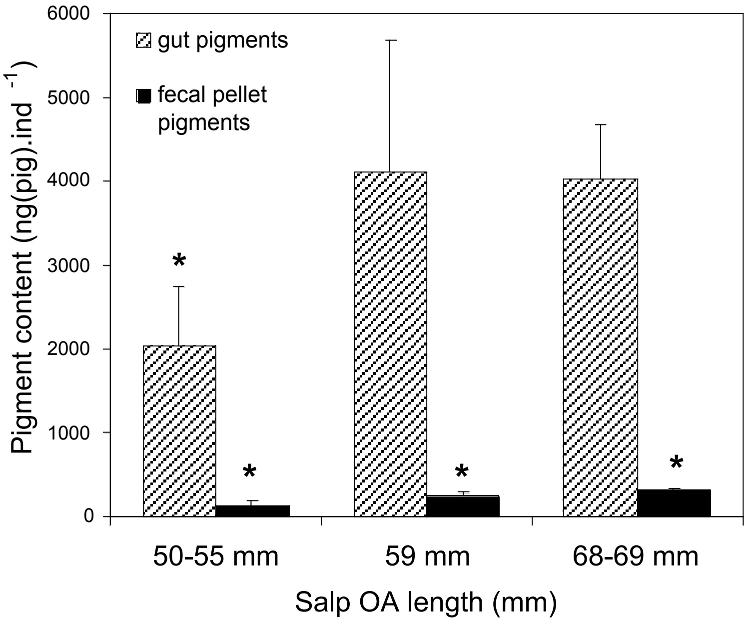


Fig. 11.6: Gut pigment and fecal pellet contents of Ihlea racovitzai in the Lazarev Sea during June - August 2006. Bars represent one SD. Asterisks highlight significantly different mean values.

Concluding remarks

In summary, winter 2006 appeared to be a scarcity year for *Salpa thompsoni*, while population of *Ihlea racovitzai* was moderately numerous. Although, summer *S. thompsoni* densities could be as high as 100 - 1,000 ind.1,000 m^{-3} (Dec 1994 - Jan 1995), previous summer (LAKRIS: ANT-XXIII/2) also revealed very low abundances of this species. At this point, it is difficult to conclude whether *S. thompsoni* is able to complete its life cycle in the southern parts of the Lazarev Sea. Majority of solitary forms of this species where most likely concentrated below 500 m, mainly between 1,000 - 2,000 m. The question, whether these specimens are a result of the sexual reproduction of *S. thompsoni* in the area of investigation or being advected into the area from the north still remains open. Regarding the population of *I. racovitzai*, this species increased in numbers compared to the summer (LAKRIS: ANT-XXIII/2) cruise. Moreover, this species produced a numerous cohort of small solitaries just prior to the winter survey. Whether this is a normal behavior of *I. racovitzai* population is difficult to conclude and requires further investigation. *I. racovitzai* is clearly dominated the salp community of the Lazarev Sea during austral winter. There is a strong interannual variability in the salp density in the Lazarev Sea. However irrespective of variable densities, the annual cycles in *I. racovitzai* development appeared to be similar between different years. In total, 34 *S.* thompsoni and 230 *I. racovitzai* have been frozen for the subsequent elemental and biochemical analyses, which will help in the interpretation of the salp behavior in the Lazarev Sea.

Additional activities

Overall, 70 surface and melted sea ice POM samples have been collected along the transect between Cape Town and 70ºS as well as in the Lazarev Sea for the stable isotope analysis. In addition, 507 samples of various zooplankton and micronekton species were also collected for the subsequent stable isotope analysis. These samples will be analyzed along with the similar data sets collected during autumn (LAKRIS: ANT-XXI/4) and summer (LAKRIS: ANT-XXIII-2) campaigns to reconstruct epi- and mesopelagic food webs in the Lazarev Sea.

Lastly, ~ 200 specimens of lantern fish, mostly *Electrona antarctica*, and bathylagid, mainly *Bathylagus antarcticus*, were preserved across the survey for future stomach content analyses to understand their importance as zooplankton and Antarctic krill predators in the Southern Ocean. This is a collaborative project with A. Van de Putte (Belgium) and H. Flores (Holland).

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

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Alfred-Wegener-Institut

Objectives

This project focuses on the distribution and abundance of carnivorous zooplankton taxa like chaetognaths and amphipods, their feeding habits and predation impact as well as their role in the carbon cycle of the Lazarev Sea. The results of these investigations are extremely important, e.g. with regard to the degree mesopelagic carnivores feed on over-wintering zooplankton originating from epipelagic layers.

Work at sea

Investigations on board *Polarstern* were made by a combination of sampling and experimental approaches.

29 Multinets (100 μm mesh size) were deployed along three transects (3°W, 0°, 3°E) with the following depth intervals: 0 - 500 m, 500 - 750 m, 750 - 1,000 m, 1,000 - 1,500 m, 1,500 - 2,000 m. All chaetognaths and amphipods were taken out of these samples. All chaetognaths were counted and species of the genus *Eukrohnia* were additionally measured. Most of the chaetognaths were then immediately stored at -80 °C for later analysis (gut content, CN-ratio, lipids). *Eukrohnia* specimens with brood or marsupial sacs were separated for further observation. Additional animals of this genus, which were in a good condition, were picked for feeding and respiration experiments (according to the Winkler-method). The results of the respiration measurements will not be shown, as dry-weight and carbon content were not measurable on board. In case of the feeding experiments, actively swimming species were placed in 1 l-jars with seawater and were allowed to defecate. After a starvation period of one day feeding experiments were conducted by offering the two copepod species *Oithona simillis* and *Metridia gerlachei*.

The same methods apply to the amphipod species *Cyllopus lucasii* and *Primno macropa*. As the two amphipod species occur from the surface down to 2,000 m and could not be caught with the Multinet, they were taken from the RMT 8 (rectangular midwater trawl; 4.5 mm mesh size) at 35 stations, which has been deployed down to 200 m. A longer starvation period of 48 h was chosen for the amphipods in the feeding experiments, because of their guts being often completely filled. Copepods, chaetognaths and other amphipods were offered to these species. In case of the amphipods the produced faecal pellets were taken for measurements of the sinking velocities. The size has been measured as well as the content and the CN-ratio will be investigated.

Furthermore three deep RMTs down to approx. 3,000 m (5,000 m rope length) were deployed to catch deep living species. This was basically done to broaden the knowledge on species composition in the meso- and bathypelagic part of the water column. Some living chaetognaths of the genus *Sagitta* were frozen for further analysis in the home laboratories.

Preliminary results

Geographical distribution and abundance of chaetognaths

Among the chaetognaths the genus *Eukrohnia* was frequently found during this expedition. A determination down to species level of all specimens found could not be conducted on board.

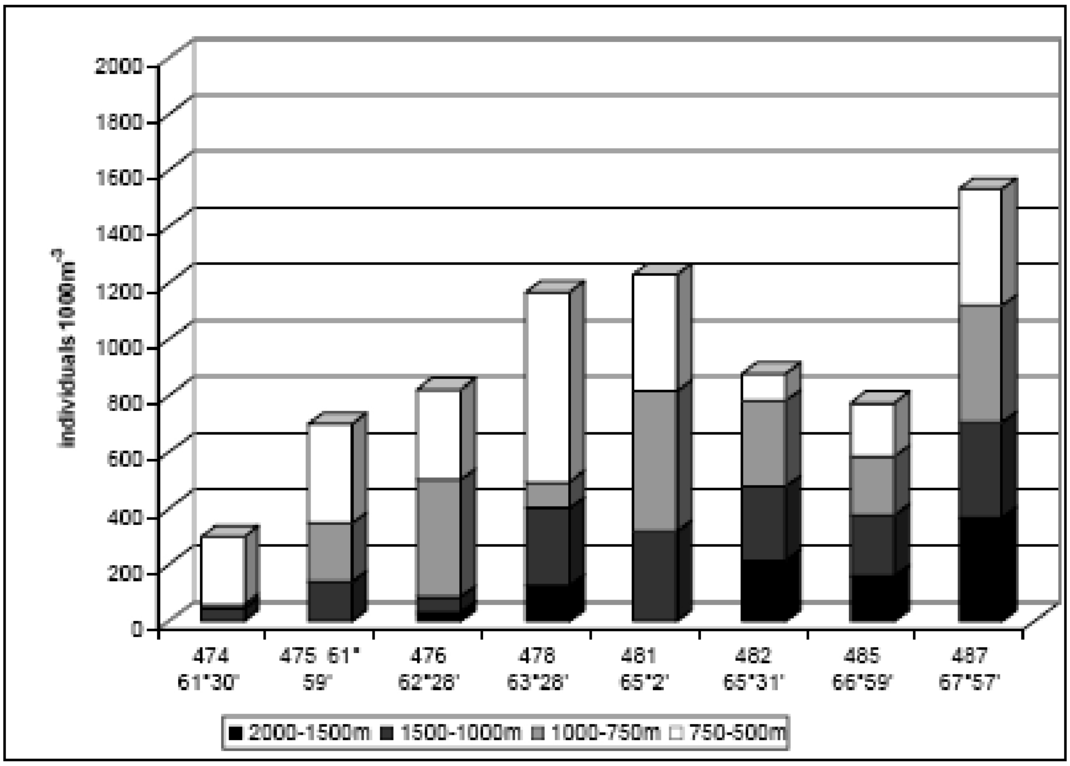

Fig. 12.1: Abundance of chaetognaths (ind. 1,000m^{-3}) on the first transect (0°)

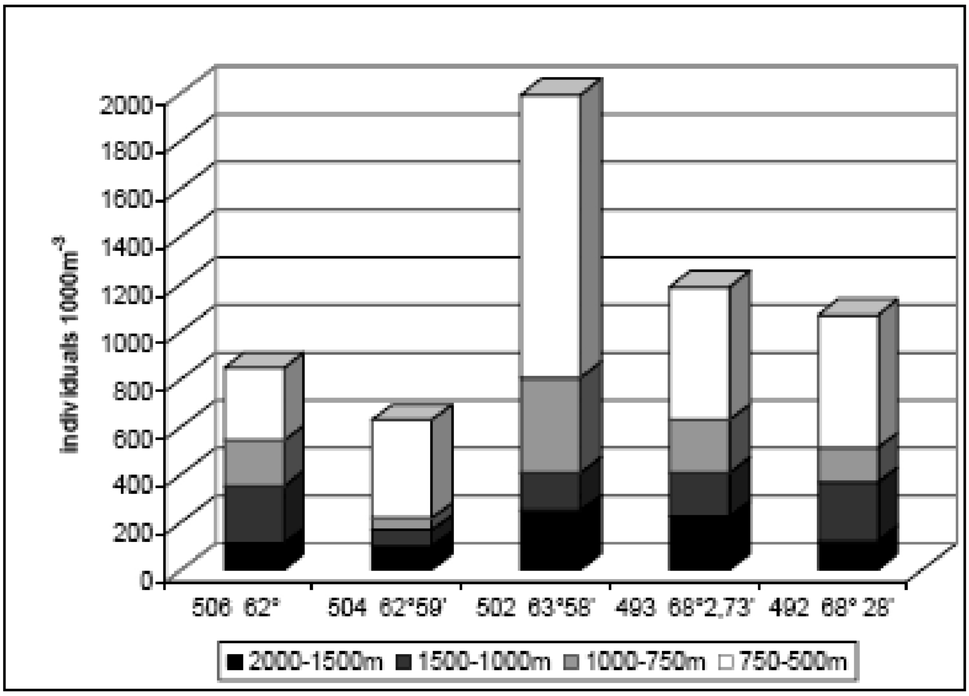

Fig. 12.2: Abundance of chaetognaths (ind. 1,000m^{-3}) on the second transect (0°)

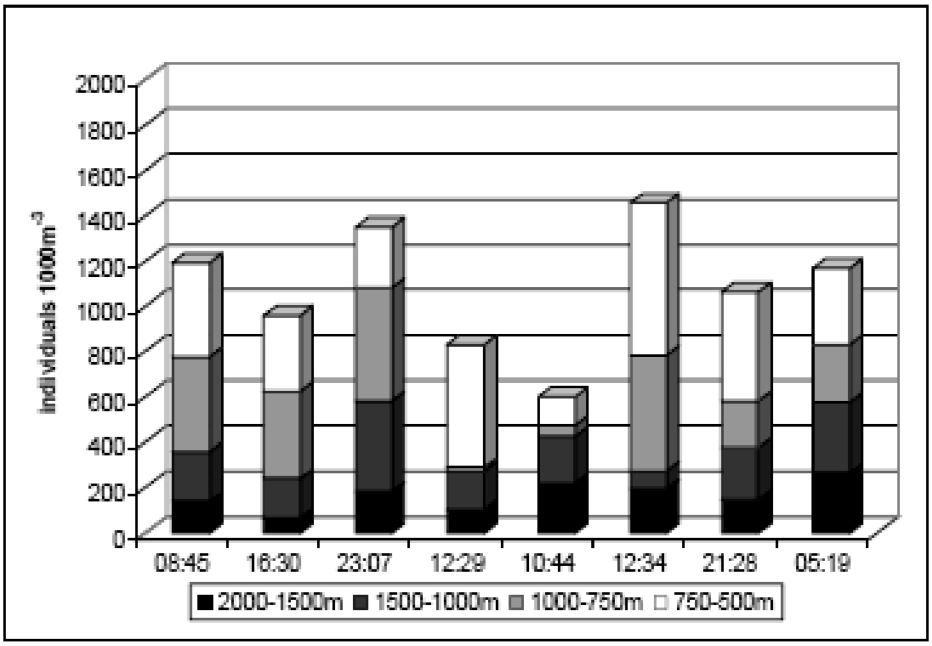

Fig. 12.3: Abunance chaetognaths (ind. 1,000m^{-3}) of at the 24h station 498 (dive camp) on the second transect (0°)

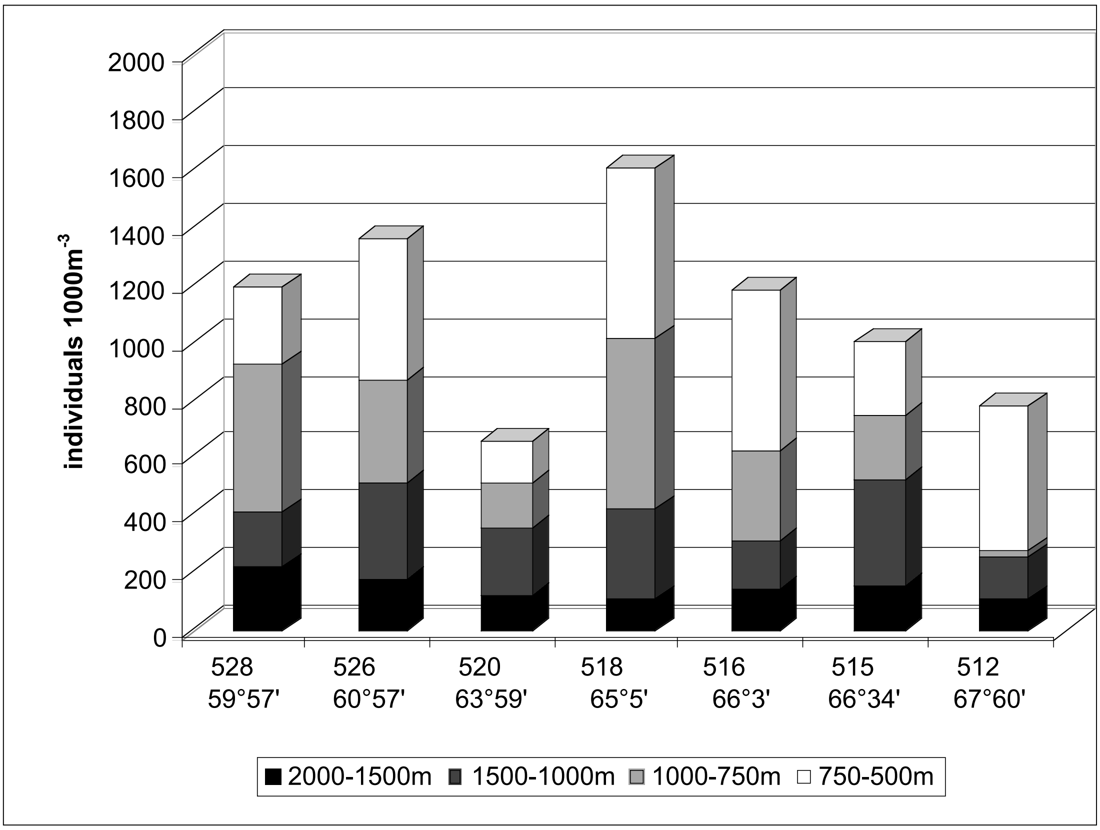

Fig. 12.4: Abundance of chaetognaths (ind. 1,000m^{-3}) on the third transect (3°W)

Overall highest numbers of chaetognaths were counted between 500 and 1,000 m water depth. In this depth interval *Eukrohnia hamata* seemed to be the most abundant chaetognath species. On the first transect increased numbers of chaetognaths were found at station 481, which was situated near Maud Rise (65°S), and at the southernmost station (St. 487, Fig. 12.1). The highest abundance of chaetognaths has been observed at station 502 on the second transect (Fig. 12.2). The reason for these results as for most of the peaks on the three transects and at the 24h-station (Fig. 12.3) is not clear. It is suggested that these high abundances are closely linked to the hydrography. The stations 516 and 518 on the third transect seem therefore to be affected by a flow of water mass coming southwestwardly from Maud Rise (Fig.12.4). A final interpretation requires a comparison with the hydrography data.

Vertical population composition in *Eukrohnia sp.*

The investigation of the chaetognath composition on board was focused on specimens larger than 18 mm in length. The figures 12.5 to 12.8 show an increasing number of *Eukrohnia* specimens with well developed reproductive organs (filled testes or female reproductive organs), brood sacs and orange gut to more than 40 % with depth. Therefore winter seems to be a season for sex and reproduction among this species.

Only few animals had food in their gut (up to 2 %).

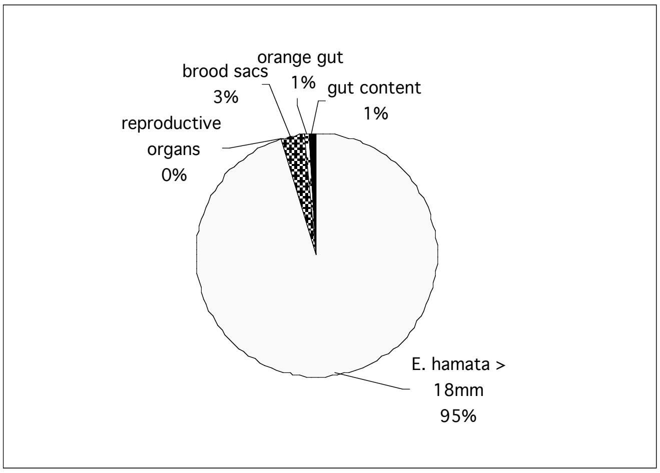

Fig. 12.5: Population composition of Eukrohnia sp. between 500 - 750m water depth

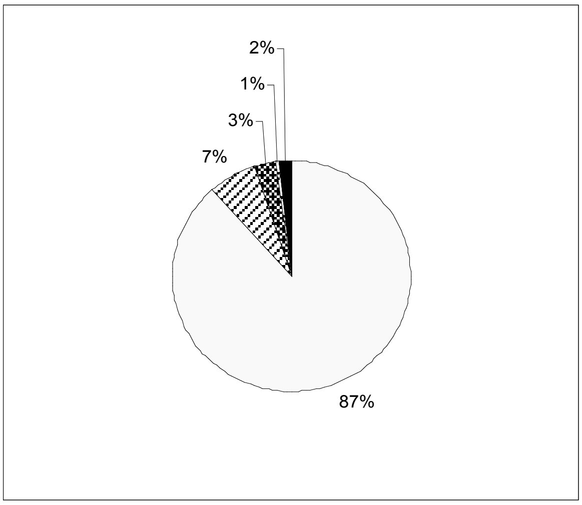

Fig. 12.6: Population composition of Eukrohnia sp. between 750 - 1,000 m water depth

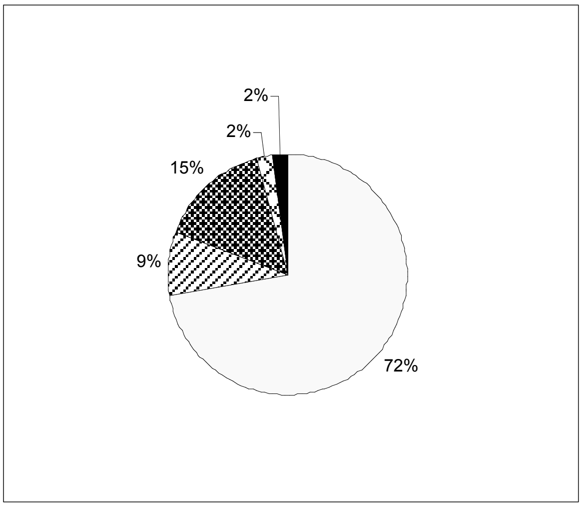

Fig. 12.7: Population composition of Eukrohnia sp. between 1,000 - 1,500 m water depth

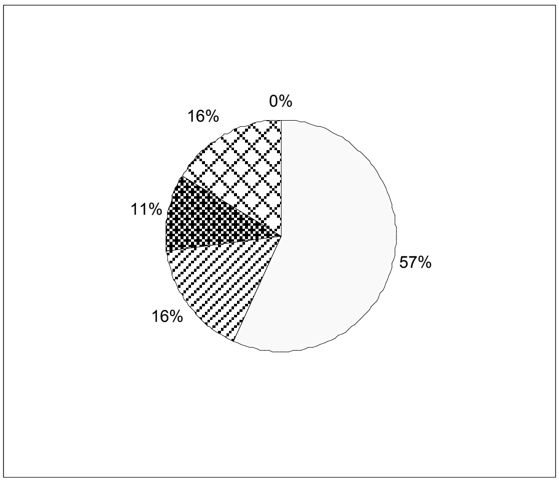

Fig. 12.8: Population composition of Eukrohnia sp. between 1,500 - 2,000 m water depth

Feeding

Among the chaetognaths *Eukrohnia* species as well as *Sagitta gazellae* did not feed in any of the experiments conducted on board. As mentioned before, most of the chaetognaths' guts were empty and some *Eukrohnia* individuals of the deeper layers had orange guts, which could result from ingested copepods. *Sagitta* seemed to be a more actively feeding species, especially on other chaetognaths and *Thysanoessa macrura.*

The amphipod *Cyllopus lucasii* did not feed on phytoplankton and copepods like *Metridia gerlachei* or *Calanus propinquus*. However, up to 50 % of *C. lucasii* were feeding on the chaetognath *Eukrohnia hamata* in the experiments.

In contrary the amphipod *Primno macropa* did not feed on copepods or chaetognaths. Feeding could only be observed on their own species or on other amphipods. They seem to be aggressive feeders, as even some mother's carapace were found cleaned by the hungry brood.

Reproduction

Some *Eukrohnia* species (*E. bathypelagica*, *E. bathyantarctica*) as well as the amphipods *Cyllopus lucasii* and *Primno macropa* were reproducing. They brood their young by keeping the eggs in a marsupium until they hatch.

13. MARINE BIRDS AND MAMMALS WINTERING IN THE LAZAREV SEA: FURTHER EVIDENCE OF A MAJOR ROLE OF SEA ICE IN STRUCTURING THE ANTARCTIC

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Marine and Coastal Zone Research (ALTERRA)

Introduction and objectives

The IMARES (formerly Alterra) project on Antarctic top predators and their prey aims to enhance knowledge on Southern Ocean foodwebs, in particular those related to the seasonal sea ice zone. Top predator communities mirror underlying ecosystems. In the Southern Ocean, top predator abundances strongly suggest that biological production in sea ice is a major driving force behind the animal population sizes and biodiversity of the Antarctic. Understanding the sea ice related foodweb is thus critical for a proper evaluation of the potential impacts of climate change. 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 that focuses on the upper levels in the foodweb. Following the autumn study in the Lazarev Sea in 2004 (ANT-XXI/4), quantitative studies of distributions of top predators were combined with an innovative technique to sample prey abundance in the upper surface layer of the ocean, including that directly under ice. For this purpose a new type of net was developed, the Surface and Under-Ice Trawl (SUIT) which was successfully deployed in sampling the upper 2.5 meter of surface water (Flores *et al.,* this volume). This report gives an initial view on the results of the study of the distribution of top predators. As a first step towards comparison to other food-web levels, data are presented in spatial patterns of food requirements of the top predator community. Data analysis in relation to catches of the SUIT net on board will be conducted in a later phase. Major other datasets for integrated distributional analysis are the whale studies by IWC and acoustic survey, catches from the RMT (Rectangular Midwater Trawl) and echosounding studies (SIMRAD).

Work at 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 with temperatures down to -25 °C. 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 was frequently necessary in dense and heavy ice, where the ship often followed a somewhat 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 were corrected for diurnal patterns in haul-out behaviour, but because most observations were around the short midday light period this has very minor influence.
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. During ANT-XXIII/6, a dedicated whale observer collected line-transect data from the inside bridge, and once processed, such data may assist in calibrating the 'effective whale detection ranges' to be used in association with the bird and seal censuses.

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 standard altitude of 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 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.)

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.

For ship based counts, analyses in this paper are based on averages of all 10 minute counts per degree of latitude and transect leg. Helicopter data were grouped by flight, usually conducted over a north to south distance between 30 and 60 nm (half a degree to full degree of latitude). In a later phase both types of data will be integrated in the same spatial units.

In this preliminary analysis, data from ship-survey and heli-survey could not yet be fully integrated. Helicopter surveys are expected to give an underestimate of actual densities, as a large proportion of animals in the ice areas are diving (whales, seals, penguins), and can be easily missed in fast overflight. However, as the amount of ship surveys was limited by the very short daylength, the helicopter surveys will be better for establishing spatial distribution patterns. Figures for carbon consumption rates in this paper were derived from the ship-based censuses.

Preliminary results and discussion

Thanks to the availability of helicopters, surveys could be made over most of the grid area, taking maximum usage of the short daylight hours in Antarctic winter. Gaps in heli coverage could be mostly filled with ship-based observations and vice versa. Overall we achieved a much better coverage than we could have hoped for in a winter expedition. Data analyses in this paper cover the long southward voyage, the full transect-grid and the initial part of the home voyage (up to 15 August). The grid area is here defined as south of 56°S and between 3°E and 3°W, which includes the ice-edge that was positioned at about 56°45'S in the later stage of our cruise. Ship based surveys were continued on the homeward voyage, which will be included in later analyses.

For our analyses we used a total of 754 ship based 10-min-counts (126 hrs), during which an area of 1,179 km^2 was surveyed. Of these, 508 counts were made within the grid, covering a surface area of 932 km^2 (Fig.13.1A). Helicopter flights were made only within the grid study area. Data include 31 flights with nearly 52 hrs of flying and over 6,800 km's of flying and a total band-transect surface surveyed of 1,408 km^2.

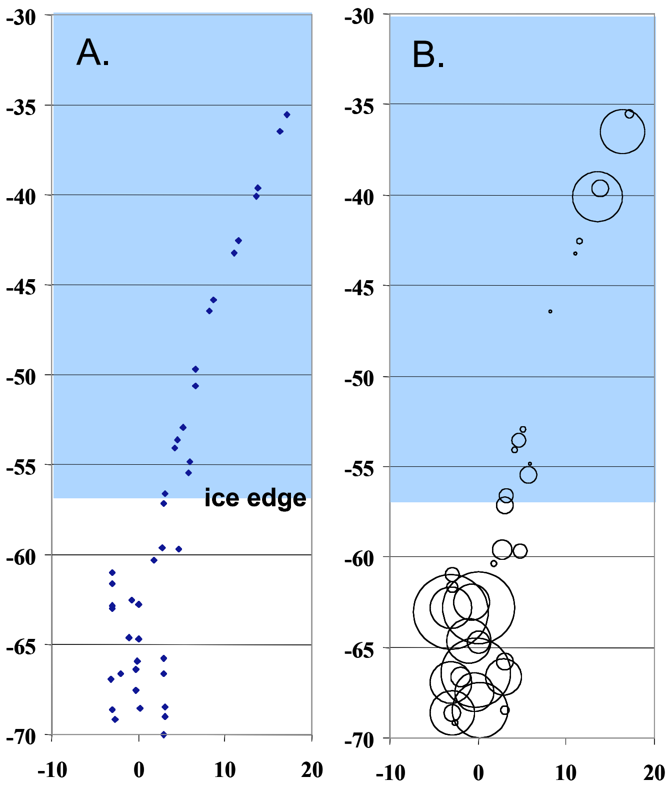

Fig.13.1: Ship-based surveys. Data availability (A) and proportional abundance of toppredators in terms of combined food requirement (B). Data grouped by degree of latitude and grid leg.

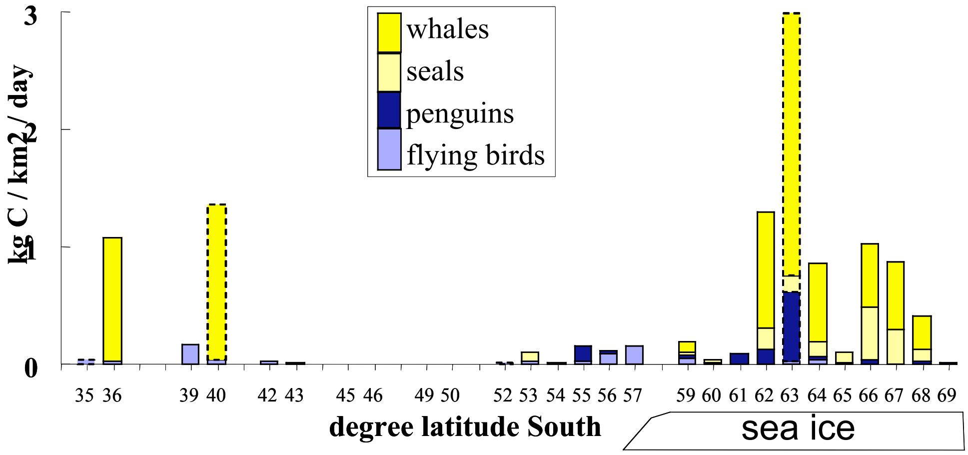

Fig.13.2: Food requirements of the top predator community calculated from ship-based observations. Data grouped per degree of latitude. Label for latitude on x-axis omitted where no data available. Bar-contours broken where the number of 10-min counts was l0 or less, with lower reliability of the average figure for that latitude.

On the wider geographical scale of figures 13.1 and 13.2, the earlier described pattern of strongly elevated food requirements of the top predator community in ice covered areas is now also clearly visible in the midwinter situation. Observations of similar patterns in other seasons triggered our project on predators and prey in the ice environment. In open waters food requirements are comparatively low, except for irregular situations with larger whales in the observations. Throughout the annual cycle the sea ice apparently provides an area of rich food supply and high biological production, which is still largely unexplained. Both graphs also show a remarkable lowered abundance of top predators in the marginal ice zone (MIZ) over 4 to 5 degrees of latitude, where very young and poorly developed ice dominated. In spring and summer, this outer zone, then of melting and retreating ice, is often enriched in predators. In our winter situation, higher levels of top predator abundance in the MIZ were only present in a narrow band along the outer rim, with negligable effect on the average figure per degree of latitude. The low predator densities in the young sea ice between the ice edge at 56°45'S southward until about 62°S is more clearly visible in figure 13.3B.

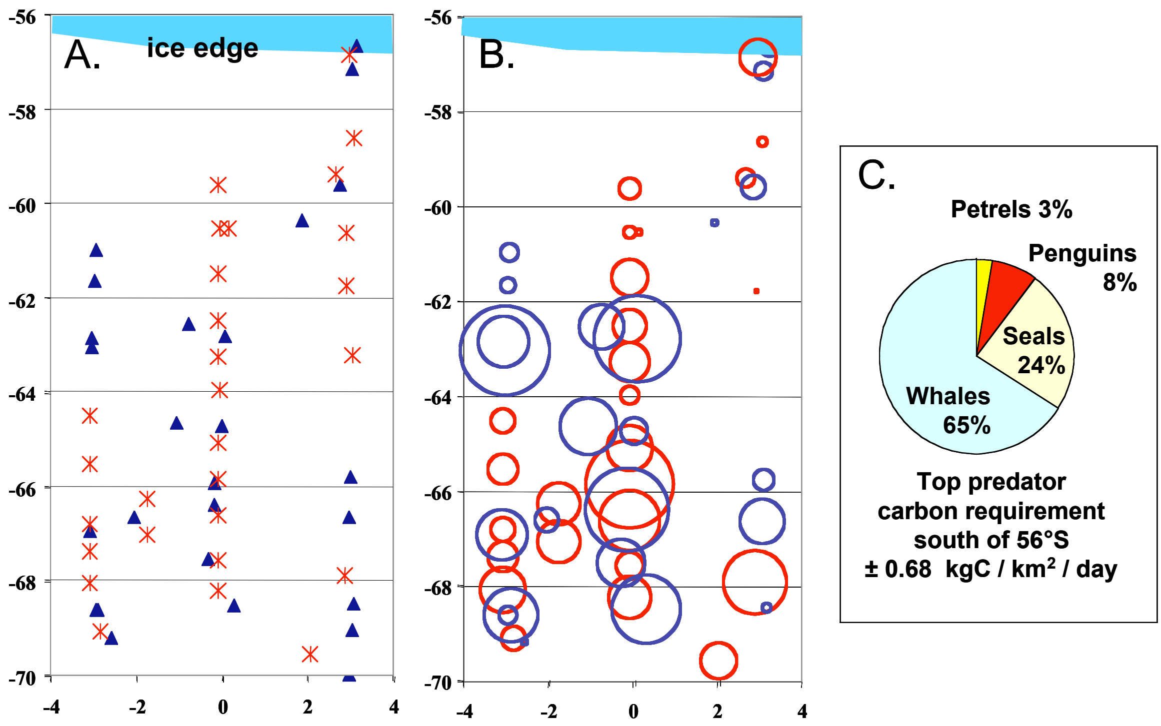

Fig.13.3: Top predator surveys by ship and helicopter in the grid area south of 56°S.
A: data availability by average positions of helicopter flights (crosses) and average positions of shipbased observations (triangles) grouped by degree of latitude and grid leg.
B: proportional abundance of toppredators in terms of combined daily food requirement.
C: Role of main predator groups in overal daily carbon consumption.

A second remarkable feature in figure 13.3B is the low abundance of predators over the seamount Maud Rise along 3° East from about 60°S to 66°S. High abundance of predators is seen to the west and south and southwest of Maud Rise. In between a slightly poorer zone may be running southwestward between 64° and 66°S, a phenomenon also suggested by our observations in autumn 2004 when this area was open water (van Franeker et al. 2005). Predators were less abundant in our most southerly stations, giving no indications of rich animal populations in or near the coastal polynia areas over the shelf. However, extreme ice and weather conditions prevented that we really entered the coastal shelf zone, we only came close to such area in the eastern grid leg.

The more southern winter sea ice zone of the Lazarev Sea appeared accessible only for the heavier predators (Fig. 13.3C). Antarctic Minke Whale (*Baleanoptera bonaerensis*) was remarkably common, capable of making breathing holes in ice of at least up to 20 cm thick. The only other species of whales identified in the grid were a group of Killer Whales *(Orcinus orca)* in the more northern part and a small group of Southern Bottlenose Whale *(Hyperoodon planifrons)* just out of the ice edge. Second most important predator group were seals, almost exclusively Crabeater Seal *(Lobodon carcinophagus)*. In the ice, two Ross Seals *(Ommatophoca rossii)* and two Leopards Seals *(Hydrurga leptonyx)* were seen, and some Antarctic Fur Seals *(Arctocephalus gazella)* on pancake floes at the outer rim of the ice and in open water. The role of penguins as consumers in the ice was relatively low. Emperor Penguins *(Aptenodytes* *forsteri)* were observed as scattered individuals or small groups throughout the area. Adélie Penguins *(Pygoscelis adeliae)* were concentrated in the central zone to the west of Maud Rise, and showed a high proportion of first year birds.

Chinstrap Penguins *(Pygoscelis antarctica)* were only seen north of the ice edge. South of the ice edge area, flying birds, i.e. petrels like Antarctic *(Thalassoica antarctica)* and Snow Petrel *(Pagodroma nivea)* played only a very minor role as consumers in the ice system. Some numbers were seen to the west of Maud Rise in the same area as Adélie Penguins, but concentrations were only seen in the northern MIZ. Densest numbers were observed along the ice edge, but in part these seemed flocks resting during the day that may disperse further into the MIZ and open waters during night. The final location for operation of the SUIT net (see Flores et al., this vol) was chosen on the basis of considerable numbers of petrels feeding in the MIZ at around 57°45' during night time, approximately 100 km south of the ice edge. The only other petrel species seen within the ice was the Southern Giant Petrel *(Macronectes giganteus).* Southern Fulmar *(Fulmarus glacialoides)* and Blue Petrel *(Halobaena caerulea)* first appeared just north of the ice edge.

Overall, the catches of surface prey with the SUIT net (Flores et al., this vol) did not correlate very well with predator abundance, even not for strictly surface feeding petrels.

Where catches were high, predators were present, but not vice versa. Apparently prey stocks are available to predators but out of reach of sampling devices like the SUIT net or RMT nets. However, data need to be analysed further in the light of diurnal variations and also in close relation with data from SIMRAD echosounder and other studies done on board. Patterns need also to be evaluated in the light of oceanographical data in relation to Maud Rise and Weddell Sea Gyre. The above mentioned final SUIT-trawl, positioned at a spot with high density of nightly feeding petrels, did show high surface abundance of krill and also caught intermediate prey (squid). Stomach contents of two Antarctic Petrels that collided with ship structures during snowfall that night were sampled and revealed krill in one stomach and a mix of squid and fish in the second one.

The preliminary conclusion from this winter expedition in the Lazarev Sea is that the sea ice zone in winter, like in other seasons, provides food to considerable populations of predators, indicating rich biological production. A major role of the upper surface layer, the hypothesis underlying our project, was made likely by part of the observations, but not consistently so and requires further integrated analysis and dedicated planning of future work.

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13.1 Fresh from the fridge: Top predators' food sources under the pack-ice

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Objectives

Introduction

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) at the ice edge persist and sometimes even increase towards the inner pack-ice, indicating considerable primary and seconsdary production in these areas (Van Franeker et al. 1997). But water column primary production 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. In this top-down approach, the distribution of the prey of birds and mammals is the next logical step after quantifying the occurrence of top predators (van Franeker et al., this volume).

Flying birds, and on many occasions also penguins, seals and whales, often rely on prey they find in the upper few meters of the water column. In order to explain feeding and prey distribution of these abundant 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 during winter.

At IMARES Texel, the need to investigate the ice-associated community in more detail led to the development of a special under-ice trawl (SUIT = Surface and Under Ice Trawl). After a first LAKRIS campaign with SUIT in austral autumn 2004, the winter expedition 2006 provided the rare opportunity to sample under Antarctic pack-ice during the dark period of the year.

Work at sea

Materials & Methods

Trawling of SUIT was attempted 29 times on the regular CCAMLR grid and at one station at the northern ice edge between June 30 and August 14, 2006.

The net system consisted of a steel frame with a 2.25 x 2.25 m net opening and a 15 m long 7 mm half-mesh 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 at the surface. To enable sampling under undisturbed ice, an asymmetric sprout let the net shear at an angle of ca. 30° starboard from the ship's track at a cable length of 120 m. Wheels on top of the frame allowed the net to 'roll' along the underside of ice floes. A flashlight was attached to the frame in order to reduce escaping of animals by shock-blinding them.

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 80, 110 and 130 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 [m^3] was calculated as the product of effective towing time [s], average towing speed [$m\ s^{-1}$] and net opening area (2.25^2 = 5,06 m^2). A mechanical impeller flow meter (Hydrobios) was mounted additionally for comparison with conventional flow meter data.

Fishing was done during complete darkness in 22 of the 30 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 25 and 30 minutes towing time, with the exception of the ice edge station, where towing time was 49 minutes. During each trawl, irregularities, changes in ship speed, ice coverage [%] and ice thickness [cm] were constantly recorded.

Animals ≥ 0.5 cm were separated to species level where possible. Displacement volume 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. 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 -30 °C.

The total length (TL, front edge of eye - tip of telson) of krill 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. Krill were grouped into males, females / juveniles and gravid females. The standard length (SL, tip of snout - beginning of tail fin) was used in size measurements of fish and fish larvae. Cephalopod size was expressed as TL and mantle length (ML). The density of animals [ind. m^{-2}] was calculated as the number of individuals per m^2 trawled surface. Biomass density per station [g m^{-2}] was calculated in a similar way, assuming 1 ml = 1 g.

Results

Net performance

Of the 30 hauls, 22 could be completed successfully. Due to storm and ice damage, only three southerly stations on the 3°E transect could be completed. The other two transects (0° and 3°W) could be covered over the entire latitudinal range.

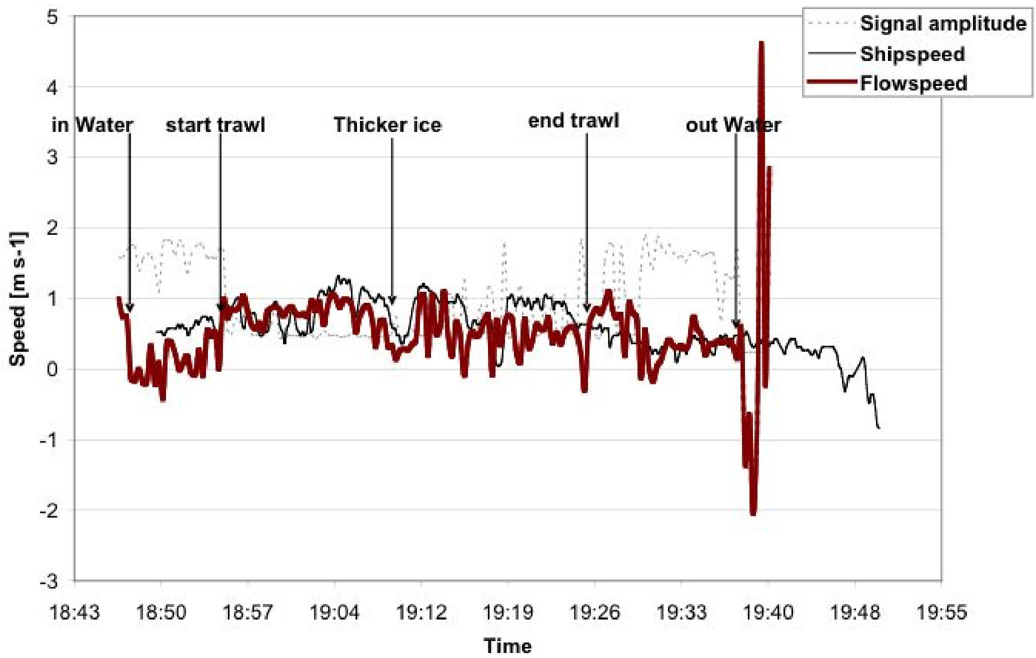


Fig. 13.1.1: Example of real-time current speed measurements in SUIT frame opening. Specific events during trawling indicated in graph

Current speed of water entering the net opening showed a consistant pattern in each successful haul. During deployment and heaving, current speed was low. In these periods, high signal amplitudes indicated disturbance. As soon as the net reached its dedicated position, current speed and amplitudes stabilized. Typically, current speed in the net was slightly lower than the ship's speed. The real-time data collection also allowed identifying periods of poor towing performance and other irregularities which helped to draw conclusions on the overall quality of each tow (Fig. 13.1.1).

Species composition

Zooplankton and nekton species represented a wide range of taxa. They covered a size spectrum from < 5 to > 400 mm in total length. The species encountered most often were *E. superba*, the siphonophore *Diphyes antarctica* and the pteropod *Clione* sp. The amphipod *Eusirus microps* was found on 9 stations. Individuals from this species covered a wide size range. Larval *Trematomus loennbergi* and larvae of at least one other nototheniid species (cf. *Pagothenia borchgrevinki*) were also caught under the pack-ice. Among the nekton caught under ice were two species of theutoid squid, *Electrona antarctica* and a nototheniid fish (Tab. 13.1.1).

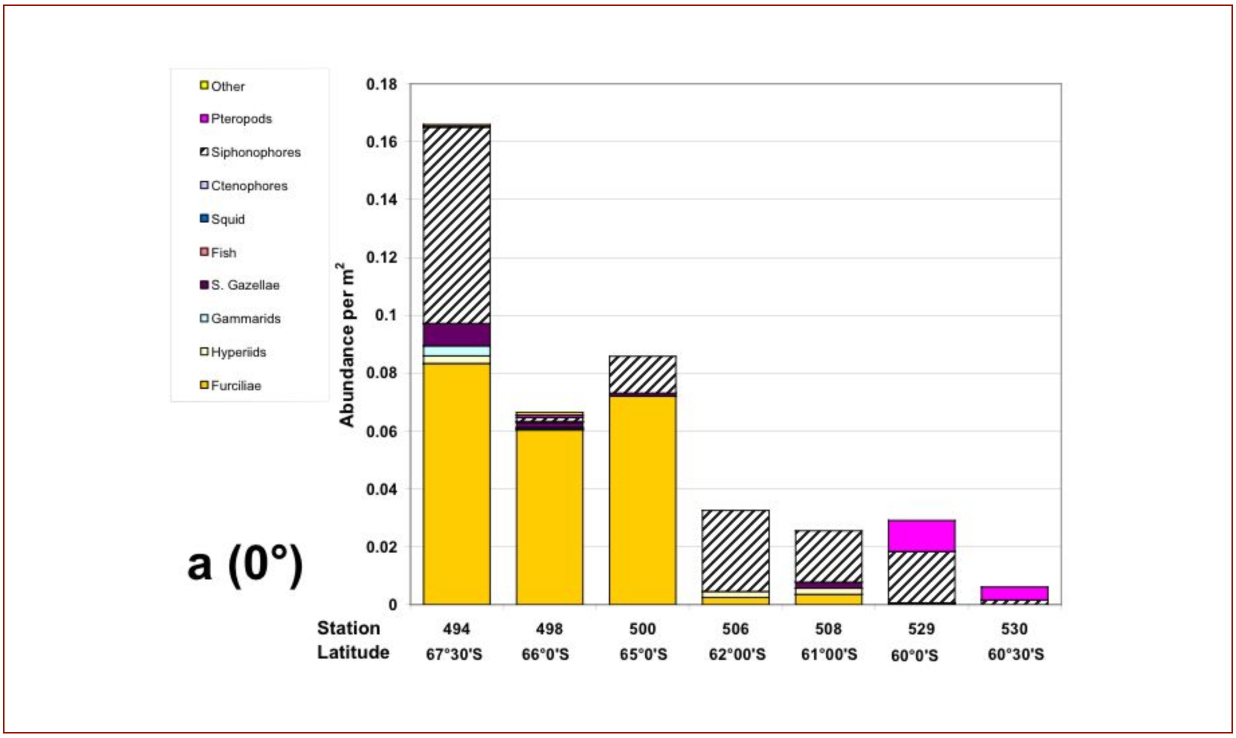
Tab. 13.1.1: List of makrozooplankton and nekton species and euphausiid larvae collected during ANT-XXIII/6 and number of hauls where they occurred.

Taxon	No of hauls	Size range [mm]*
Calycopsis borchgrevinki	6	
Siphonophora (cf. *Diphyes antarctica*)	24	
Ctenophora indet.	9	
Clio pyramidata	6	
Clione sp.	23	
Spongiobranchaea australis	4	
Theutoidea indet.	1	ca. 200
Theutoidea indet. (cf. *Kondacovia longimana*)	1	420
Tomopteridae indet.	4	
Vanadis antarctica	3	
Eusirus microps	9	6-40
Eusirus sp.	4	
Hyperiidae indet.	6	
Hyperia macrocephala	2	
Hyperiella dilatata	2	
Hyperoche sp.	*2*	
Cyllopus lucasi	7	
Primno macropa	5	
Euphausia superba	23	18-51
E. superba furcilia larvae	13**	
Thysanoessa macrura furcilia larvae	1**	

Taxon	No of hauls	Size range [mm]*
Sagitta gazellae	16	
Salpidae indet.	4	
Electrona antarctica	1	
Nototheniidae indet.	1	136
Pisces indet. larvae	1	37
Nototheniidae indet. larvae	2	50
Trematomus loennbergi larvae	4	27-41

*TL; SL for fish. **Furciliae only partly identified

While krill was caught at most stations, it was abundant only in the northern part of the 3°W-transect. At those stations, it dominated all other zooplankton species by several orders of magnitude, reaching densities of up to 31 ind. m^{-2}. A difference between the two fully covered transects (0° and 3°W) was evident also in the other species. When krill was excluded, *Clione* sp. dominated the species community throughout the latter transect, whereas their density was low on the other, except for the two northernmost stations (Fig. 13.1.2a, b). A latitudinal pattern was apparent for several species like krill larvae (furciliae), *E. microps* and larval *T. loennbergi*, which were caught mainly in the southern part of the survey area.



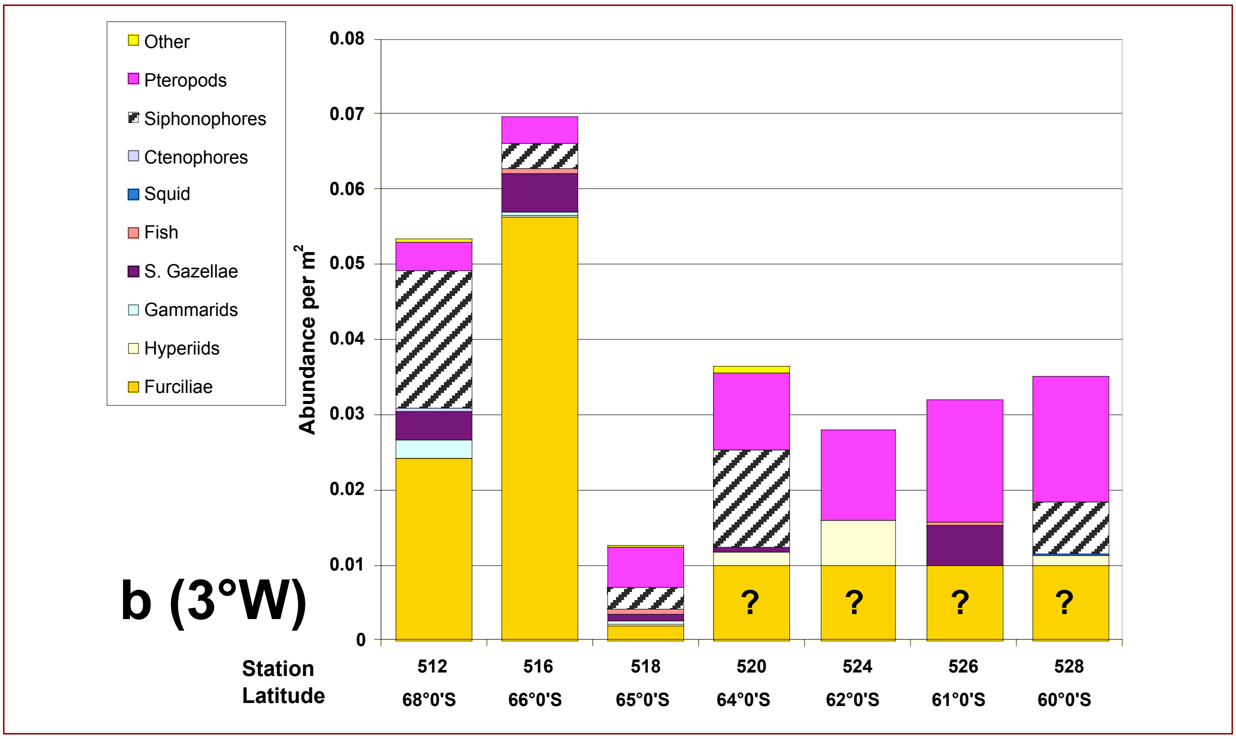


Fig. 13.1.2: Abundance distribution of species on the 0° (a) and 3°W transects (b). Note that furciliae were not quantified from station 520 onwards.

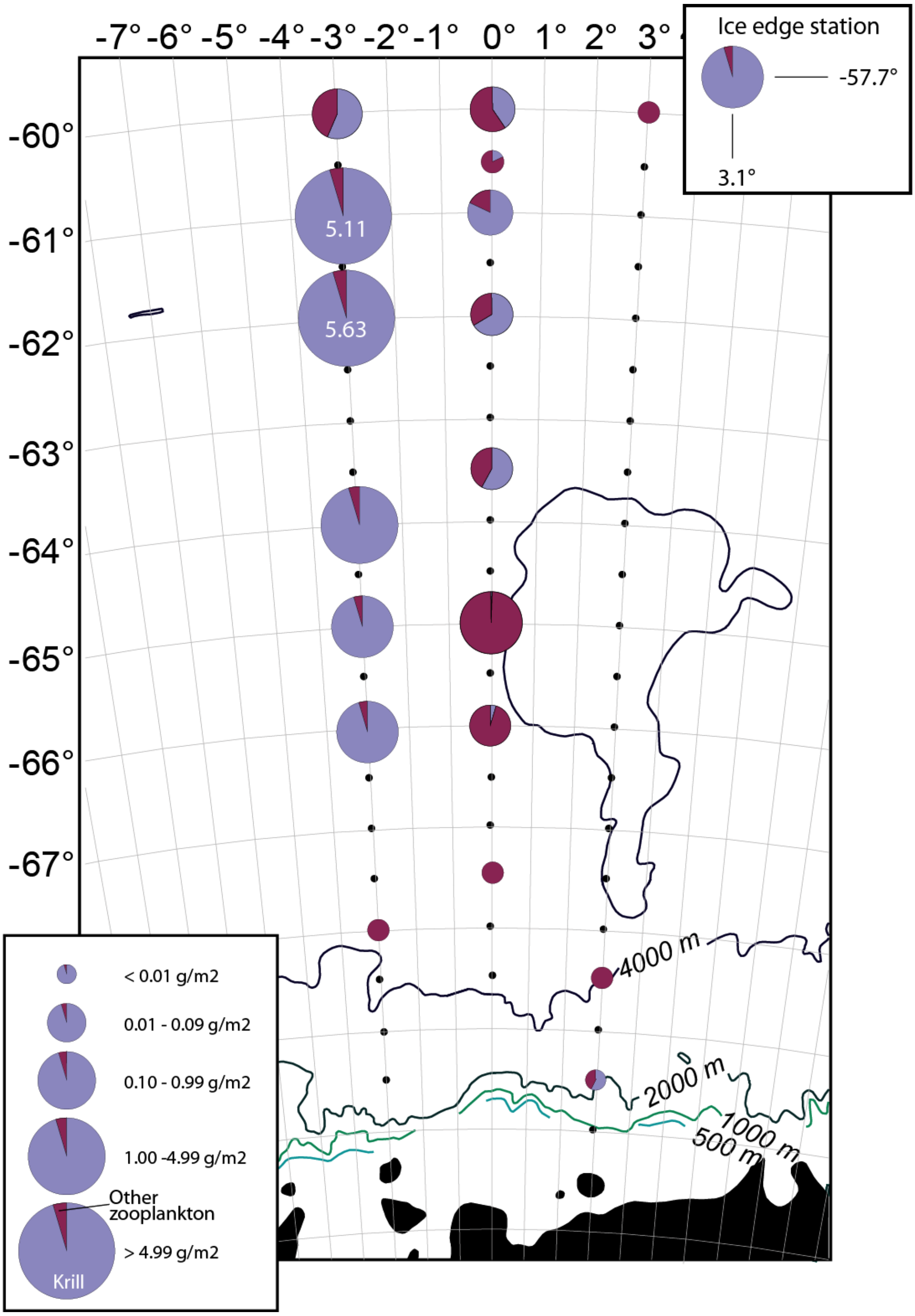


Fig. 13.1.3: Biomass distribution of surface zooplankton and nekton in the area of investigation

Biomass distribution

On the westernmost transect, catches were dominated by large amounts of krill on 5 of the 7 stations, peaking at more than 5 g m^{-2} on the 6°S and 62°S stations. In contrast, biomass density of krill was moderate compared to other zooplankton and nekton on the prime meridian and eastern transect, where biomass density under the ice was below 0.1 g m^{-2} at most stations. It was below 0.01 g m^{-2} at the four stations south of 67°S. *E. superba* also dominated the biomass composition at the ice edge station, where total biomass density (0.8 g m^{-2}) was comparable to the 3°W transect (Fig. 13.1.3).

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. Among them, station 498 (66°S 0°) differed from the other two in yielding a low amount of krill, both at day (0.006 m^{-2}) and night (0.001 m^{-2}; Fig. 13.1.4).

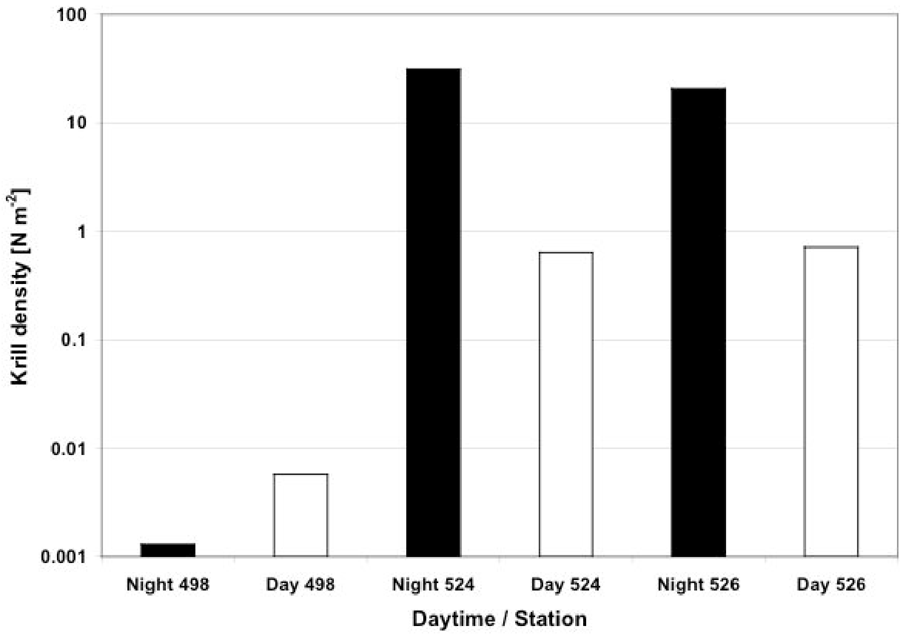


Fig. 13.1.4. Day-night comparison of krill density. Note logarithmic scale of y axis.

The catch was dominated by furcilia larvae which occurred in similar amounts at both times. The density of siphonophores (mainly *D. antarctica*), which were the second most abundant group at day, was significantly lower during the night. The opposite pattern was apparent for *Clione* sp., which was absent from the daytime catch (Fig. 13.1.5a). The other two stations, 524 (62°S 3°W) and 526 (61°S 3°W), were clearly dominated by juvenile and adult krill. In both of them, krill catches at night were two orders of magnitude higher than at day (Fig. 13.1.4). Among other zooplankton, a pattern similar to Station 498 was apparent for siphonophores (mainly *D. antarctica*) and pteropods (mainly *Clione* sp.; Fig. 13.1.5b). Ctenophores, which were caught at Station 498 at nighttime but could not be quantified due to disruption, only occurred at day at station 524 and 526.

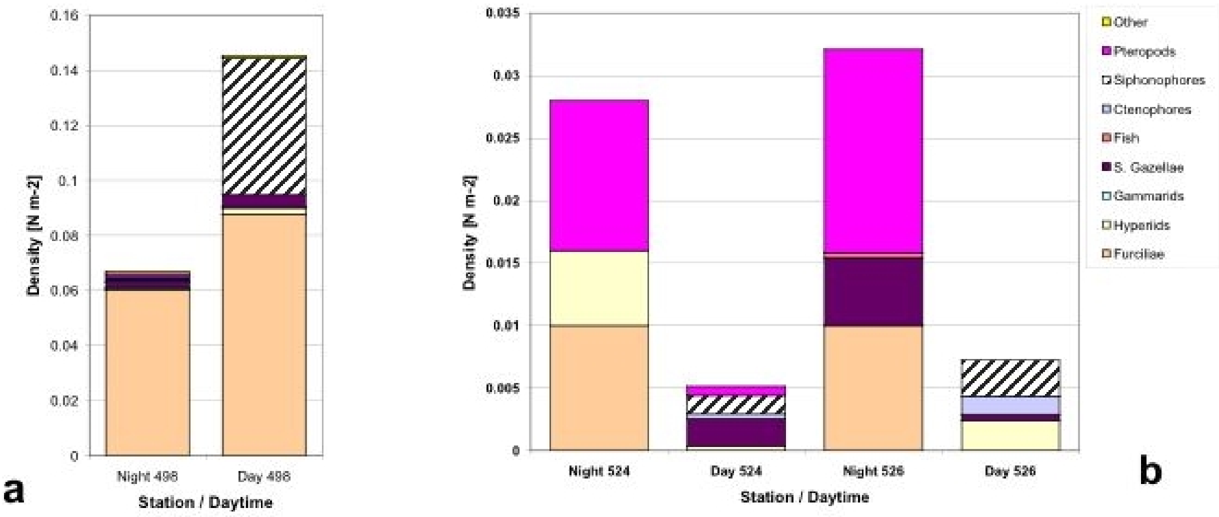


Fig. 13.1.5. Day-night comparison of species composition when krill is excluded. Note the different scale of figure 13.1.5a (station 498) and 6b (stations 524 and 526).

Krill length distribution

The size of adult and juvenile krill ranged from 18 to 51 mm in females / juveniles and 23 to 48 mm in males. Major peaks were at 33 and 28 mm in both sexes, indicating that most animals were probably 1-2 years old (Fig. 13.1.6).

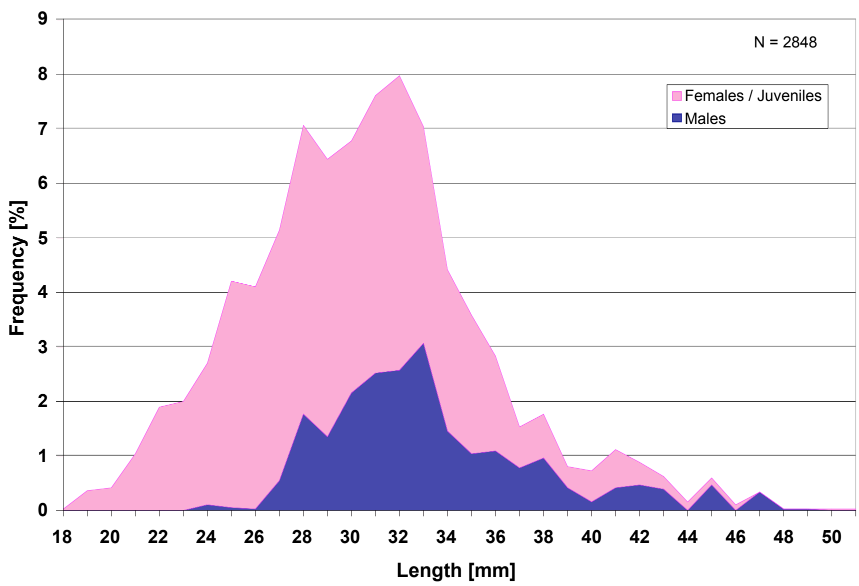


Fig. 13.1.6: Length-frequency distribution of post-larval krill

Discussion

Net performance

In spite of severe storm rampage and several damages caused by heavy ice in the beginning of the sampling period, more than 73 % of the SUIT deployments could be successfully completed. Across all successful stations, a stable pattern in water flow indicated that the orientation of the opening as well as the net's speed were steady and predictable during the effective towing time. During deployment and heaving, turbulences were indicated by reduced inward current speeds and high signal amplitudes which were probably caused by air bubbles mixed into the water. These turbulences most likely occurred because the net opening was not oriented in flow with the movement of the net. Therefore, we regard catchability to be low outside the effective towing period.

While density estimates based on SUIT trawling are most likely realistic for most species of macrozooplankton including krill (Flores et al., 2005), smaller species (e.g. furciliae) were probably underestimated because of the relatively large mesh size in the frontal part of the net. Conversely, fast swimming species like adult fish and squid were perhaps not sampled quantitatively due to their ability to escape the net.

Species composition and distribution patterns

The results of the under-ice trawls illustrate that a considerable variety of macrofauna can be found in close proximity to sea ice in winter. For most of the planktonic species, it cannot be determined if they represented parts of pelagic populations randomly dispersed to the surface layer, or if they actively seeked the ice environment. Some species were more evidently associated with the sea ice undersurface, like furcilia larvae of krill which were observed to aggregate in crevices and caves during this expedition (Freier et al., this volume). Furciliae are probably a valuable prey for predators like *S. gazellae*, ctenophores, larger crustaceans, fish and squid. The repeated occurrence of *E. microps* in SUIT catches and its consistent size range add evidence to the hypothesis of a sympagic or pelago-sympagic mode of life of this species (Krapp et al., in press). The encounter of a juvenile nototheniid and two species of squid indicates that large nekton species also make use of the ice habitat to an extent which is possibly underestimated by SUIT sampling, as discussed above.

Except for the northernmost stations, the 3°W transect differed significantly from the 0° transect in species composition and biomass. Hydrographical features, like advection from other water masses, seem the most likely explanation of the observed pattern. The role of hydrography in the distribution pattern of under-ice zooplankton and nekton will be investigated in detail as soon as detailed hydrographical data become available.

Krill and sea ice

The importance of sea ice for krill larvae is widely acknowledged (e.g. Daly 2004). High densities of krill furciliae caught directly under ice in the southern part of the area investigated and observations of divers during this expedition confirm this view.

Our results provide quantitative evidence that juvenile and adult krill can be found in dense aggregations under ice during winter, supporting the hypothesis that *E. superba* uses the sea ice as a foraging ground during the dark season (e.g. Sprong & Schalk 1992). Day-night comparisons indicate that the use of the ice habitat followed a diel pattern. This perception was supported by aggregations of acoustic targets moving from mesopelagic depths to the surface at dusk and back down at dawn during this expedition (U. Bathmann, pers. comm.). At stations where high amounts of krill were caught under the ice, standard RMT catches were low, indicating that the vast majority of the migrating krill did not stay in the water column, but resided directly under the ice. However, due to the limited sampling depth of the standard RMT (200 m), it cannot be excluded that a part of the krill population remained at greater depth.

Top predator – prey correlation

For a preliminary comparison of SUIT-based distribution of surface zooplankton / nekton and top predator densities see van Franeker et al., this volume. Sampling the under-ice environment with SUIT proved to be valuable to illustrate that many prey species of common Antarctic top predators can be found in close association with sea ice. However, it turned out to be difficult to relate the distribution of predators and their potential prey quantitatively. These difficulties were probably caused by a combination of low prey density under ice at most stations and the top predator community being dominated by animals (seals, whales) which can also rely on deeper-dwelling prey, e.g. mesopelagic fish (Van de Putte et al., this volume). The ice edge station could exemplify that concentrations of surface-feeding petrels can be correlated with appropriate amounts of prey in the surface layer of ice-covered waters.

Acknowledgements

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14. DISTRIBUTION, COMPOSITION AND FOOD WEB STRUCTURE OF MESOPELAGIC MICRONEKTON IN THE LAZAREV SEA DURING WINTER 2006

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Introduction and objectives

Within the framework of the Belgian Antarctic PELAGANT-project (sponsored by the Department of Belgian Science Policy, BELSPO), adult and larval fish were collected during ANT-XXIII/6. The samples will be used to determine the distribution of pelagic key-species in relation to the biotic and abiotic factors of the environment and to analyse the pelagic ichthyological diversity at the species, population and ecosystem level. Here we present results for the Greenwich transect and at 3°E which are representative for the whole area.

Work at sea

Material and methods

Samples were routinely collected from all Rectangular Midwater Trawls. The Rectangular Midwater Trawl nets (RMT 8+1) consist of an RMT 1 mounted above an RMT 8 with a mouth area of 1 and 8 m^2 and a cod end mesh size of 0.33 and 0.85 mm, respectively. Three types of trawls were used: Standard RMT (S-RMT), deep RMT (D-RMT) and multi-RMT (M-RMT). Each S-RMT haul consisted of a standard double oblique tow from the surface down to 200 m (450 m cable length) and back to the surface. Towing speed was approximately 2.5 knots. During a D-RMT, a similar double oblique haul was done from the surface to a deeper depth such as 400 or 2,000 meter. For a M-RMT, a system consisting of 3 RMT 8+1-nets that can be alternatively opened and closed, is used. During an M-RMT, the nets are lowered to a depth of 400 m and pulled up back to the surface, with the nets opening from 400 to 300 meters, 300 to 200 meters and 200 meters to the surface, respectively. However, M-RMT trawls were not successful in the first two transects.

After each trawl, fish and fish larvae were collected from the RMT 8. Subsequently they were measured and photographed. After this, 3 equal subsamples were taken and preserved frozen, on formalin (4 % buffered) or on ethanol (100 %) for further analysis (see below).

Results

In all the trawl types *Electrona antarctica* and *Notolepis coatsi* were the most abundant species. In the S-RMT the two species compromised more 98.5 % of the total catch (Tab. 14.1). Larvae and post-metamorphic *E. antarctica* occurred regularly throughout the sampling area (Fig. 14.1). The frequent occurrence of post metamorphic stages is probably due to the extended nighttime regime. Larvae and post-metamorphic fish of other species seem to be occurring sporadic throughout the sampling area. However the occurrence of *Pleuragramma antarcticum* in the S-RMT samples apparently is confined to the southernmost stations and possibly the shelf area or the coastal current.

Fewer species in total were represented in the D-RMT's. However, species composition was quite different from the S-RMT's (Tab. 14.1). In the 0 - 200 m trawls pelagic larvae of different species were clearly present. In the deep trawls we found several meso-pelagic and deep sea fish species.

Tab. 14.1: Species composition of total catch for S-RMT and D-RMT

	0 - 200 m	0 - 400 m	0 - 2000 m
Bathylagus antarcticus		19.61%	24.82%
Benthalbella elongata	-	1.96%	-
Electrona antarctica	53.37%	50.98%	35.77%
Gymnoscopelus braueri	0.12%	-	0.73%
Gymnoscopelus nicolsi	0.12%	-	-
Notolepis coatsi	45.26%	25.49%	33.58%
Macrurid sp.	0.25%	-	-
Murenolepis sp.	0.25%	-	-
Pleuragramma antarcticum	0.50%	-	-
Cyclothone sp.	-	1.96%	5.11%
Notothenia kempi	0.12%	-	-

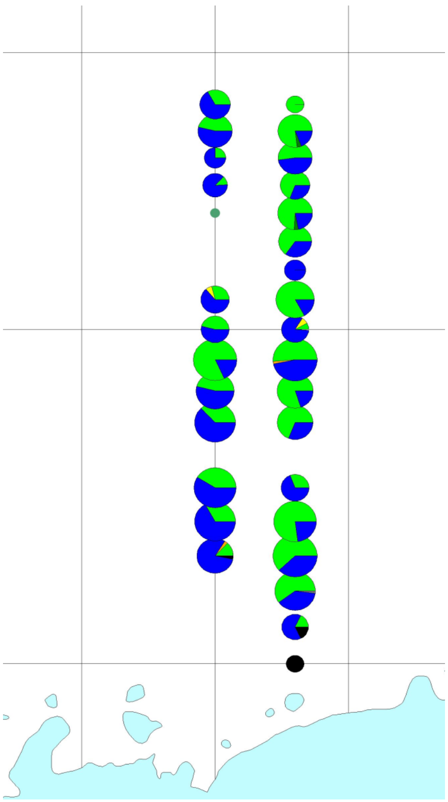


Fig. 14.1: Species distribution for S-RMT in the sampling area. E. Antarctica ; N. coatsi ; P. antarcticum ; Macrurids; Murenolepids; other myctophids; size of pie chart indicates relative catch size

Deep RMT

Two deep RMT were deployed in the first two transects, one to 400 meter and one to 2,000 meter. Species composition of these two trawls overlapped with that of the S-RMT's. However the number of meso-pelagic and deep sea fish was higher in the D-RMT's. Larval stages of *Notothenia kempi*, *P. antarcticum*, Macrurids and Murenolepids were restricted to the upper 200 m. A single specimen of *Gymnoscopelus braueri* was caught in this layer as well. A specimen of *Benthalbella elongata* was caught in the 400 m trawl, which was a first record for this area. Furthermore a *Cyclothone sp.* specimen was caught in the same trawl but due to damage to the specimen the genus could not be determined. The only species present in all trawls were *E. antarctica* and *N. coatsi*. A low number of *Gymnoscophelus braueri* was caught in the S-RMT and the 2,000 m trawl.

Bathylagus antarcticus was only found in the D-RMT's. *Cyclothone microdon* was only found in the 2,000 m D-RMT.

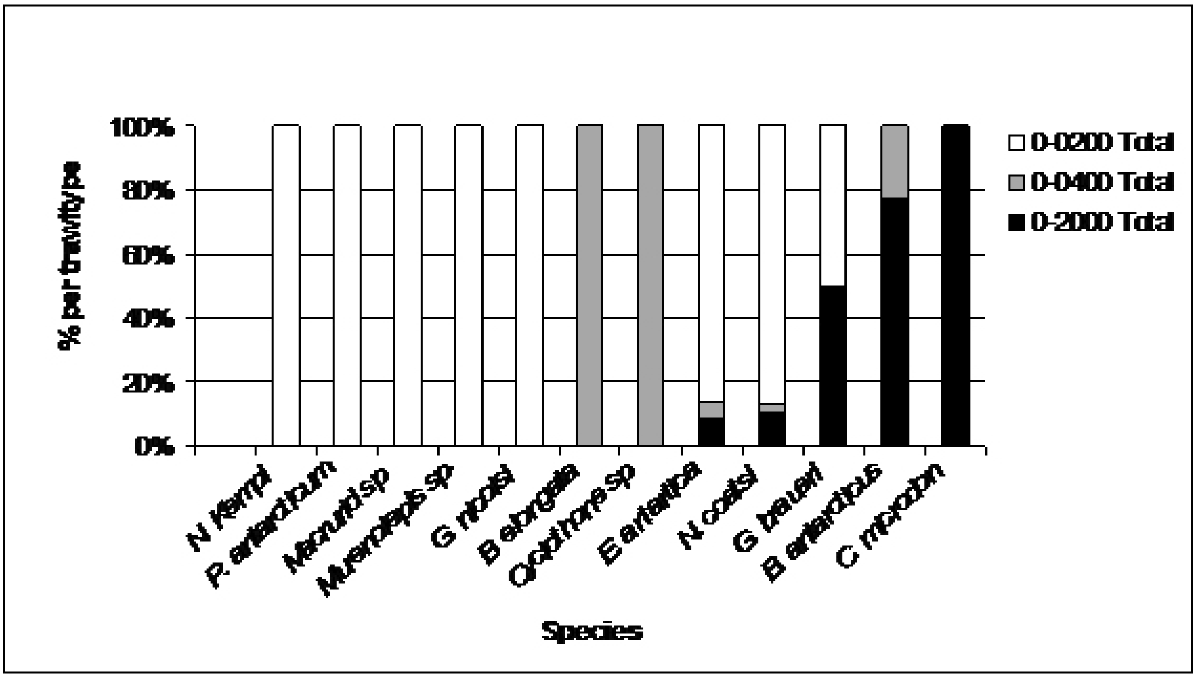


Fig. 14.2: Proportion of total catch per species according to the 3 trawling depths

The length-frequency distribution of *E. antarctica* was similar for the S-RMT and the 400 m D-RMT with a mayor peak in the 30 - 34 mm size class. Individuals of the 20-29 mm size range were virtually absent from the S-RMT. However they constituted the most abundant size class in the 2,000 m D-RMT. In both D-RMTs the peaks of higher size classes seemed to be relatively more pronounced than in the S-RMT. The observed peaks in length frequencies are consistent with a 3 - 4 year lifespan, as quoted in literature.

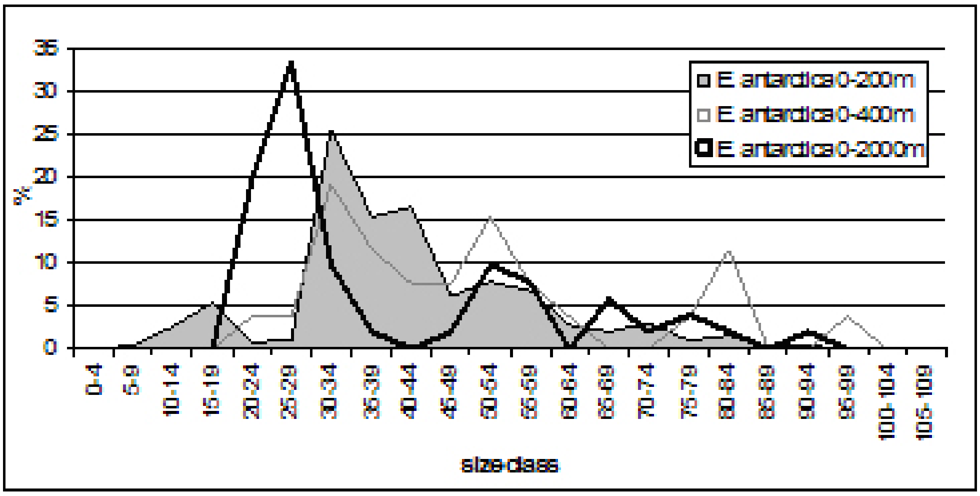


Fig. 14.3: Length frequency distribution of E. antarctica for the different maximum trawl depths

The size range of *N. coatsi* in the S-RMT was 15 to 74 mm, with a maximum in the 50 - 54 mm size class. For the D-RMT there seems to be a shift in size range to larger specimen correlated to increasing depth. The only adult specimen of *N. coatsi* (SL=349 mm) was caught in the 2,000 m D-RMT.

Fig. 14.4: Length frequency distribution of N. coatsi for the different maximum trawl depths

B. antarcticus was only found in in the D-RMT's. Fish from the whole known size range were sampled. However no clear pattern could be observed.

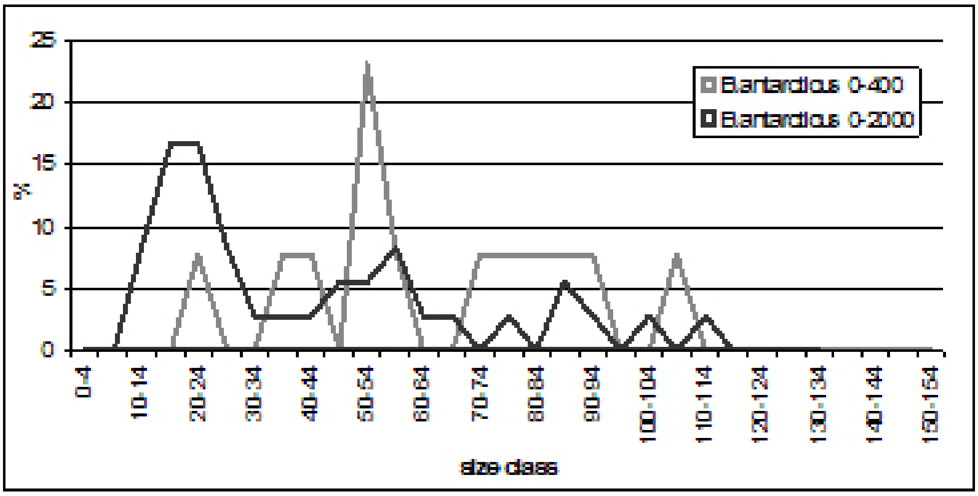


Fig. 14.5: Length frequency distribution of B. Antarcticus for the different maximum trawl depths

Preliminary conclusions

Both the geographic and bathymetric distribution of most of the species caught correspond to their known distribution and ecology.

E. antarctica was, as expected from a strong diurnal migrating species, present in high numbers in all layers. Furthermore there is an indication that there is an ontogenetic shift in depth distribution. Larvae up to 20 mm SL seem to be most abundant in the epi-pelagic layers, while the distribution of metamorphosing specimen seems to be restricted to deep layers. Post-metamorphic individuals have the typical vertical migrating behaviour of the adults and are found in all layers, depending on the light regime.

N. coatsi is characterized in this survey by pelagic larval stages and deep sea adult stages. The length frequency distribution suggests a positive correlation between average size and maximum trawl depth. There is no indication that adults display vertical migrating behaviour as sometimes noted in literature.

B. antarcticus, as a less pronounced vertical migrating species, was only found in deeper layers. The low abundance of *G. braueri* and *G. nicolsi* was somewhat surprising and cannot be explained immediately.

Further prospects

The various sampling methods will allow us to perform different investigations. The main focus lies on the most abundant species: *E. antarctica*.

Formalin-preserved samples will be used for stomach content analysis. Stomach analysis allows to asses the role of *Electrona antarctica* as a predator of phyto- and zooplankton. These analyses will be performed in close collaboration with E. Pakhomov and H. Flores.

Frozen samples will be used for energy measurements using bomb calorimetry. Energy measurements by other researchers and our own autumn-data show that *E. antarctica* is a high energetic species and thus a valuable addition or alternative to krill in the diet of top-predators such as birds and seals. For this area we will collect the first seasonal data on energy content for *E. antarctica*. Additionally, we have collected enough samples of *B. antarcticus* to perform a first study of length dependence in energy content for this species. These analysis will be performed at the KULeuven in collaboration with H. Flores.

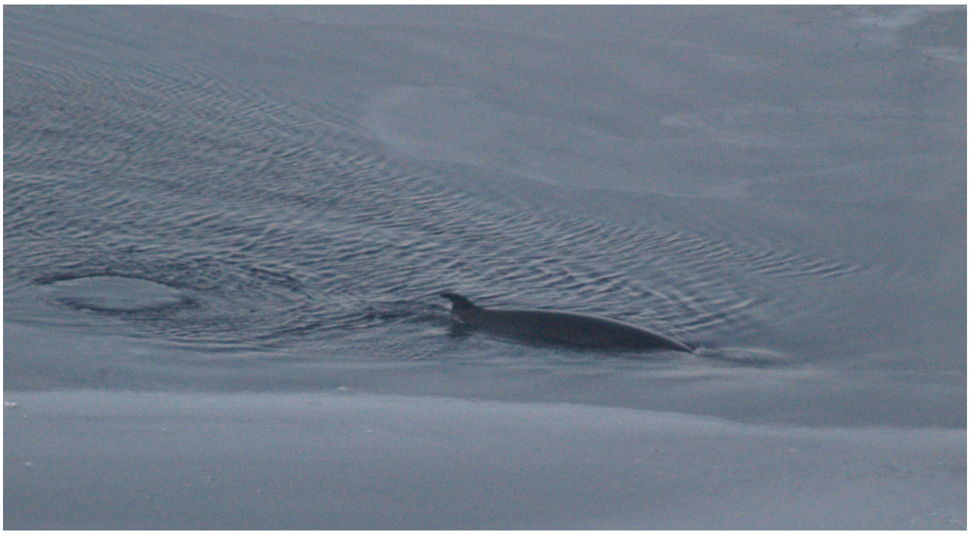
Ethanol preserved samples of *E. antarctica* will be genotyped with mitochondrial DNA and microsatellite markers developed by the KULeuven. Genotypes of this area and other areas around the continent will be analysed with a combination of statistical methods such as network analysis, genetic diversity and structure, estimation of population dynamical parameters and assignment. For each different species up to five individuals were preserved for “Barcoding of life”. After taking a reference tissue sample, the animal was fixed on formalin. The aim of “barcoding of life” is to create a reference database that allows species identification based on genetic markers. These analysises will be performed at the KUleuven.

By analysing and comparing data from the Lazarev Sea over different seasons, we should obtain a better understanding of the role of fish and in particular *E. antarctica* within the ecosystem of the Lazarev Sea.

Acknowledgements
We would like to express our gratitude to the AWI and U. Bathmann for our participation to this campaign. V. Siegel for the use of the samples collected with the RMT-nets and last but not least Captain S. Schwarze and the crew of *Polarstern* for their effort and dedication.

15. CETACEAN AND WILDLIFE DIVERSITY CRUISE SUMMARY WINTER 2006

Maria Garcia
Whale Ecology Group (IWC)



15.1: Minke whale travelling in a lead

Introduction and objectives

The cetacean survey data collected in this cruise is the third data set for the Lazarev Sea, in which both cetacean sightings and sea ice habitat will provide a base reference for studying patterns in cetacean distribution across a range of seasonal conditions. Even though, cetacean research programmes in Antarctica have been conducted since 1999 with the collaboration and support of the International Whaling Commission (IWC) Scientific Committee, on board of multidisciplinary research cruises of many nations; this is the first time in which standardized sea ice habitat data has been collected simultaneously with cetacean observations over three seasons for a specific region. These type of data sets in which wildlife visual surveys and sea ice photographic records are incorporated, are useful when investigating the connections between cetacean distribution and the ecology and dynamics of the Southern Ocean ecosystem

The IWC participates in these studies as part of the Southern Ocean Global Ocean Ecosystem Dynamics (SO GLOBEC) research. The Lazarev Sea, is one of the many regions in which cetacean data has been collected and incorporated to local, regional and circumpolar scale models to investigate how spatial and temporal variability in both biological and physical processes influences cetaceans. Other areas include: the Western Antarctic Peninsula, the Ross Sea and East Antarctica.

Biological aspects and populations' distribution data over Antarctic winter are scarce, due to the difficult conditions for scientific survey in the Southern Ocean under heavy ice and rough weather conditions. This German multidisciplinary survey in the Lazarev Sea was a unique opportunity that provided new data sets to fill the lack of knowledge regarding the distribution of top predators in the Antarctic winter. Thus this survey will play an important role in expanding our understanding of the seasonal processes that structure the ecosystem and will improve our understanding of the importance of sea ice as habitat when the sea ice cover is at its maximum extent.

The seasonal and spatial variability of sea ice as it forms and melts provides diverse habitat for cetaceans, but a standardized method to classify sea ice conditions throughout the pack ice was finally developed in the last decade. In 1999, sea ice physicists developed a standardized and comprehensive system to classify sea ice from vessels (ASPEcT). This system was used in ANT-XXIII/6 throughout the Lazarev Sea to survey the sea ice habitat through the areas in the shelf, shelf slope and off slope and seamounts such as Maud Rise. This type of data will provide an appropriate scale to explore the dynamics and complexity of the physical and biological ecosystem in the Antarctic for an understanding of how sea ice processes affect prey distribution and thus influence abundance of top predators' species such as minke whales.

Many species have been found in association with specific sea ice and physical conditions throughout summer, autumn and spring. Minke whales, *Balaenoptera bonaerensis*, for example, are one of the species known to inhabit these latitudes year-round and little is known about their distribution and habitat utilization. Recent studies by Deborah Thiele have shown the importance of sea ice as habitat for minke whales and some of the implications for current estimates of abundance, since sea ice, as habitat for these whales is likely to play a role in their distribution in space and time. Yet, so far, little attention has been given to the classification and analysis of sea ice as a form of habitat for minke and other whale species in an ecological context, as has commonly been done in terrestrial ecosystems. And no attempted had been made to determine the extent to which sea ice can be categorized in an ecologically meaningful way for whale species, particularly how the patchiness of whale distribution throughout the sea ice relates to the heterogeneity of the conditions and characteristics of the pack ice.

Work at sea

Methods

Ship based observations

One observer conducted a visual survey from the bridge of the *Polarstern* for cetaceans and other wildlife during daylight, subject to weather, visibility and sea state conditions, throughout the research cruise departing from Capetown to the

Lazarev Sea and returning to Cape Town, South Africa. The cruise was carried out in winter Antarctic pack ice, from 17 June to 21 August 2006. Bird and mammal sightings were recorded using a laptop-based version of the logging programme (LOGGER[1]) especially adapted for use in the Antarctic (SEA ICE LOGGER). This version of the programme allows for entry of individual records for any Antarctic cetacean, seal, penguin or flying bird species, and the full suite of Aspect Sea Ice Data Fields. The programme downloads directly into an ACCESS database where data is archived. Photographic records of cetaceans, other wildlife and sea ice were also collected using Olympus 500 Digital/SLR and Nikon Coolpix cameras.

Cetacean survey
The search area in the visual wildlife survey covered 135 degrees ahead along the track, from 270 degrees to 045 degrees of bearing off port side both in Open Ocean and the Antarctic pack ice. The survey included marine mammal sightings at any distance from the vessel. Throughout the pack ice regular checks behind the vessel were also carried out to search for cetaceans that would use this open water space to breathe. Cetacean sightability decreased off starboard side as the observer was position on port side, but with the aid of the officers on watch and bridge crew some sightings from that side of the vessel were recorded. All sighting records were entered in Sea Ice Logger and a digital image of whale habitat taken, as well as photos of the whales wherever possible.

Mammal and seabird diversity survey
Seals were recorded as they passed abeam of the ship and out to a distance of 1.5 nm either side of the vessel track in good visibility. Sightability of seals as well of whales was decreased off starboard side, as the observer was positioned over port side. The species, number of individuals as well as the distance to the ship in each sighting were recorded.

In the northern areas of the pack ice (above 64 degrees south), birds within 300 m off the ship and 360 degrees around the vessel, were identified, recorded and counted every half an hour; and entering each species in the 'other sightings' sheet individually, with the exception of large flocks which were recorded when sighted. In this type of 'bird counts' there was no effort taken to avoid recount of birds that were constantly accompanying the ship. As numbers and frequency of sightings and birds flying around the ship decreased as we travelled south, birds within 300 m were recorded when seen.

Sea ice habitat data
Sea ice within 1 km^2 area off port side was photographed, classified according ASPEcT protocols and recorded in Sea Ice Logger every 10 minutes when the ship was travelling at speeds greater than 5.5 knots. Outside the pack ice berg counts in

[1] These data were collected using software (Logger 2000 and Sea Ice Logger) developed by the International Fund for Animals Welfare (IFAW) to promote benign and non-invasive research (http://www.ifaw.org)

open water within the horizon in a 180° arc ahead of the vessel were recorded every half an hour within the comment area in Logger.

Helicopter based observations

The IWC observer took part in some of the Netherlands Antarctic Program (NAAP) marine top predators' aerial surveys, while *Polarstern* was stationary at various sampling stations. The track line consisted of two 60 nm transects, 30 nm apart from each other, running north and south parallel to the ship's track. The surveys were carried at a constant speed of around 60 knots/hour at about 250 feet of altitude. Wildlife observations from all three observers (two NAAP observer and the IWC observer) were recorded into data spreadsheets in which the position time and description of the sighting were noted. The NAAP GPS was used to extract the track line and waypoints throughout the transects. The waypoints were taken every 4 minutes by the NAAP team to do 'wildlife counts'.

Cetacean survey

The search area in the visual wildlife survey NAAP protocols included a transect band of 200 m ahead of transect, thus the front NAAP observer was focused in such an area ahead of the helicopter. The second NAAP observer and the IWC observer (sitting in the back of the helicopter) searched in greater areas towards the horizon for those animals out of transect. The search range of the second and third observers covered those areas from 030 to 115 degrees and 250 to 330 degrees respectively. Whale observations were opportunistic and unless the sighting seemed of interest, we did not use approaching mode when cetaceans were sighted. The position of the sighting, time, species and number of individuals were recorded. Photographs were also taken when possible.

Fig. 15.2: Ross Seal sighted from the helicopter

Mammal and seabird diversity survey

The time and position of the helicopter were recorded when there were seals and birds sighted.

Sea ice habitat data

Sea ice habitat was photographed every 3 minutes off port side by the IWC observer. The position, altitude and distance to the horizon for every photograph were later calculated and extracted from the GPS. The record of the photographs and additional notes of the habitat conditions were recorded in the Aerial Survey Log. ASPEcT classifications were used after the surveys to classify the sea ice habitat in 1 km^2 boxes and logged into and Access database.

Results

Cetacean and other wildlife observations

Only minke whales (*Balaenoptera bonaerensis* sp.) were sighted off the ship throughout the winter Antarctic pack ice in the Lazarev Sea. Other whale species such as humpback whales (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*) were sighted in the open ocean on our way south from Cape Town. The results of cetacean species sighted throughout the survey are in Table 15.1.

Humpback whales were mainly sighted near South African waters between 36 and 38 degrees south. The only fin whale sighted was recorded over the complex of seamounts between 50 and 55 degrees south. Minke whales sighted from the vessel were seen in many different ice conditions and throughout both the abyssal plain and seamount bathymetric complexes such as Maude Rise, which were the two main areas in which observations were conducted. The distribution of minke whales in general was very patchy throughout the survey area but it seemed to be higher in those areas of the slope and edge of Maud Rise. Groups of minke were rare and most of the sightings were individual whales travelling alone.

Tab. 15.1: Cetacean species sighted from *Polarstern* throughout the study area (south of 36°S of South Africa and the Lazarev Sea)

Cetacean Species	Number of sightings	Number of individuals
Humpback whales	3	5
Mike whales	26	33
Fin whales	1	3
Unidentified whales	11	17
TOTAL	41	58

Throughout the aerial surveys, minkes were also seen in similar regions and ice conditions to those seen from *Polarstern*. However, two new species were sighted by the NAAP team from in the aerial surveys. A pod of six killer whales (*Orcinus orca*) was sighted in the northern pack ice and three bottlenose whales (*Hyperoondon planifrons)* were seen throughout the ice edge. The map in figure 15.1 shows all the cetacean sightings and their distribution along the pack ice for both aerial and ship based results.

The main wildlife species encountered, other than cetaceans, were crabeater seals, adelie and emperor penguins (Tab. 15.2). Most of the wildlife was found throughout the abyssal plain. Crabeater seal distribution was fairly scattered throughout the three transects (Fig. 15.2.) with the greatest abundances at the abyssal plain followed by Maud Rise. Both Adelie and emperor penguins were mainly found in the presence of thick floes but their distribution throughout the winter pack ice was very different. Adelies were mainly found throughout the northern part of the survey area while Emperors were seen mainly below 65 degrees south (Fig. 15.3.).

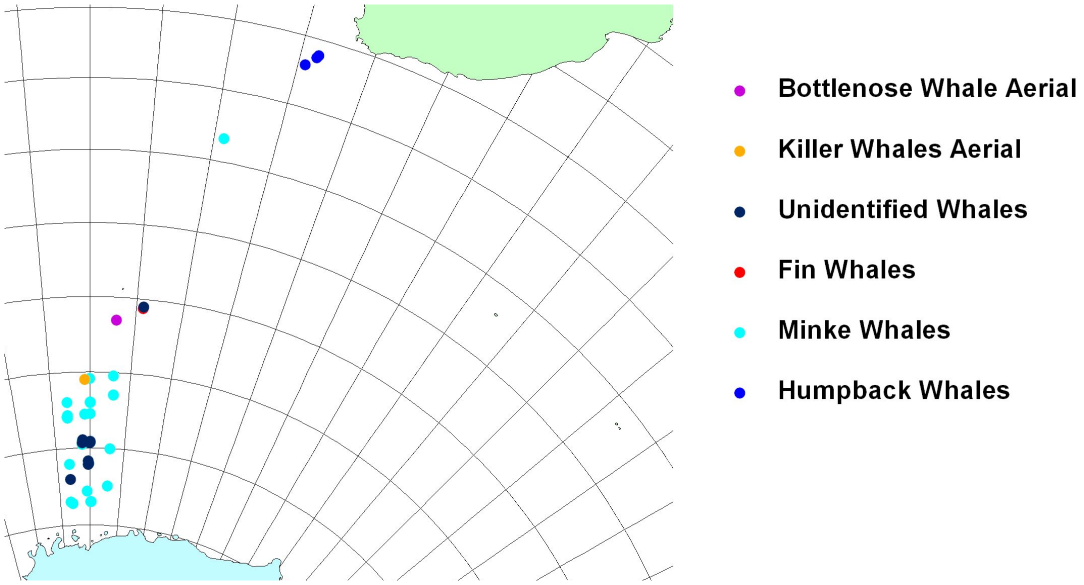


Fig. 15.1: Cetacean distribution throughout the survey area in winter 2006 at the Lazarev Sea (aerial and ship based observations).

Bird species recorded throughout the survey track differ greatly as we approached south. Petrels dominated higher latitudes (below 50°S), in particular Antarctic petrels. Snow petrels were restricted to the ice covered areas and Cape petrels to the ice free regions in the southern latitudes. Other species such as albatross, shearwaters and prions were mainly observed above 45°S (Fig. 15.4.).

Table 15.2: Seal and penguin ship based results

Species	Number of sightings	Number of individuals
Adelie penguin	50	474
Crabeater seal	43	72
Leopard seal	1	1
Emperor penguin	46	120
Unidentified penguin	8	23
Unidentified seal	25	37

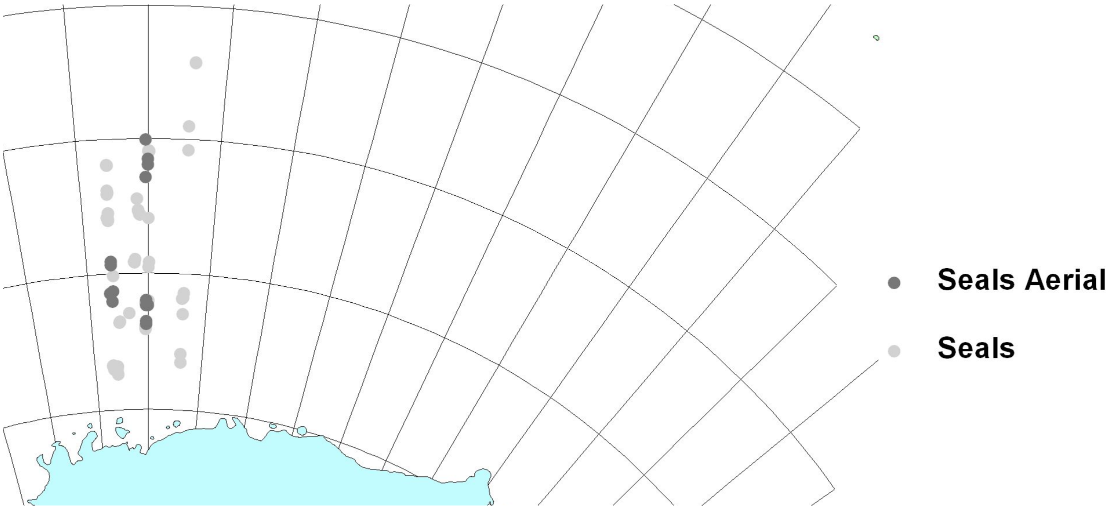


Fig. 15.2: Seal distribution throughout the survey area in the winter sea ice 2006 at the Lazarev Sea (aerial and ship based observations).

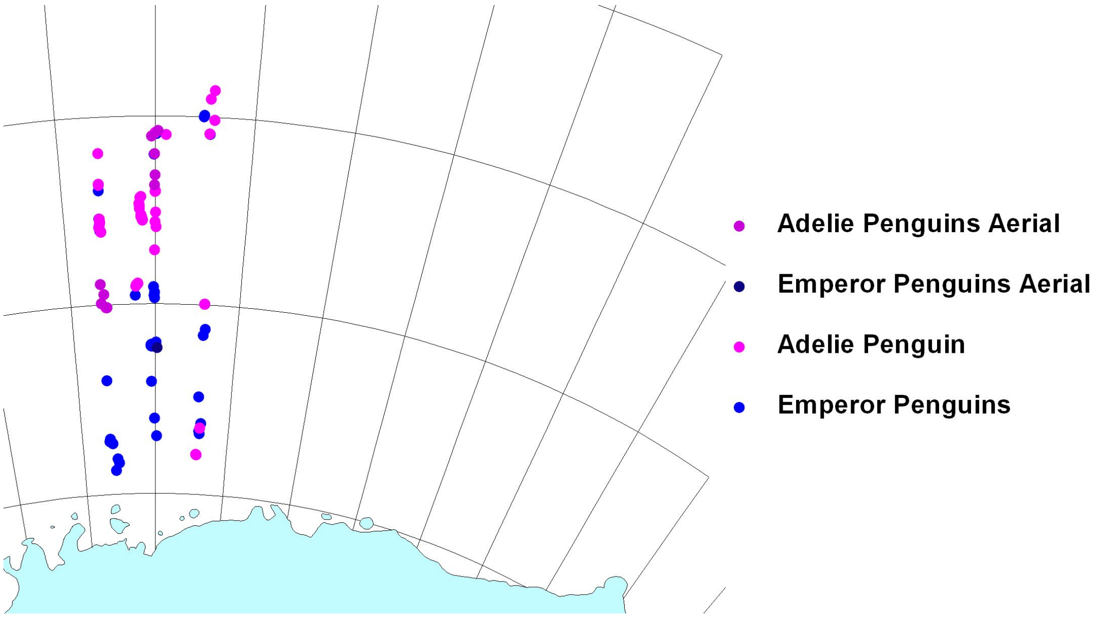


Fig. 15.3: Penguin distribution throughout the survey area in the winter sea ice 2006 at the Lazarev Sea (aerial and ship based observations)

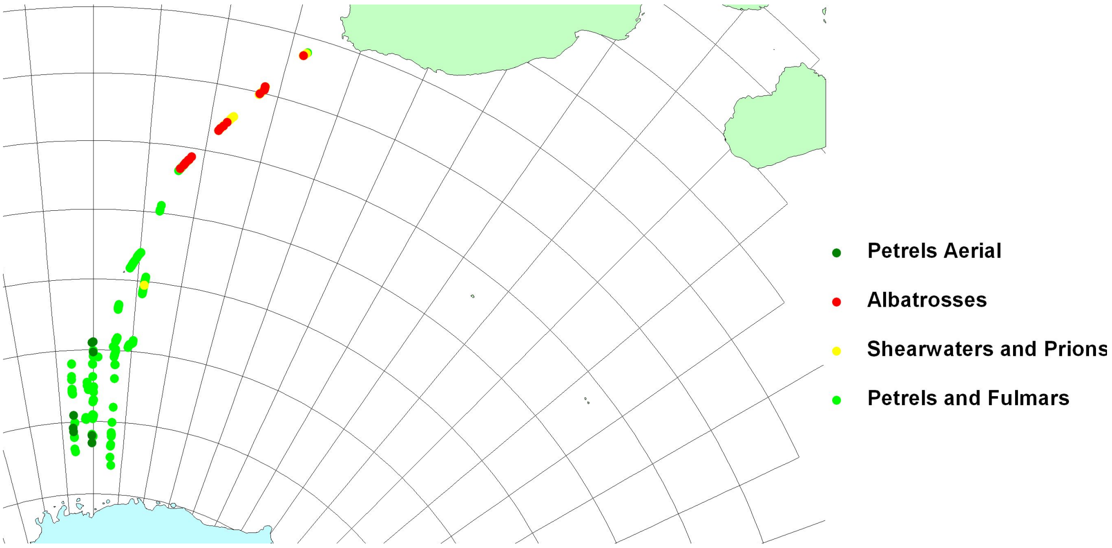


Fig. 15.4: Bird distribution throughout the survey area in the winter sea ice 2006 at the Lazarev Sea, excluding penguin sightings (aerial and ship based observations)

Ship based Sea Ice Habitat observations

Various sea ice types and conditions were seen throughout all transects. Most of the area survey through the Lazarev pack ice was covered by nilas and thin first year ice large and vast floes, with low ridging and surrounded by leads. The main sea ice characteristics and their frequency throughout the survey area are shown in figures 15.5 to 15.8.

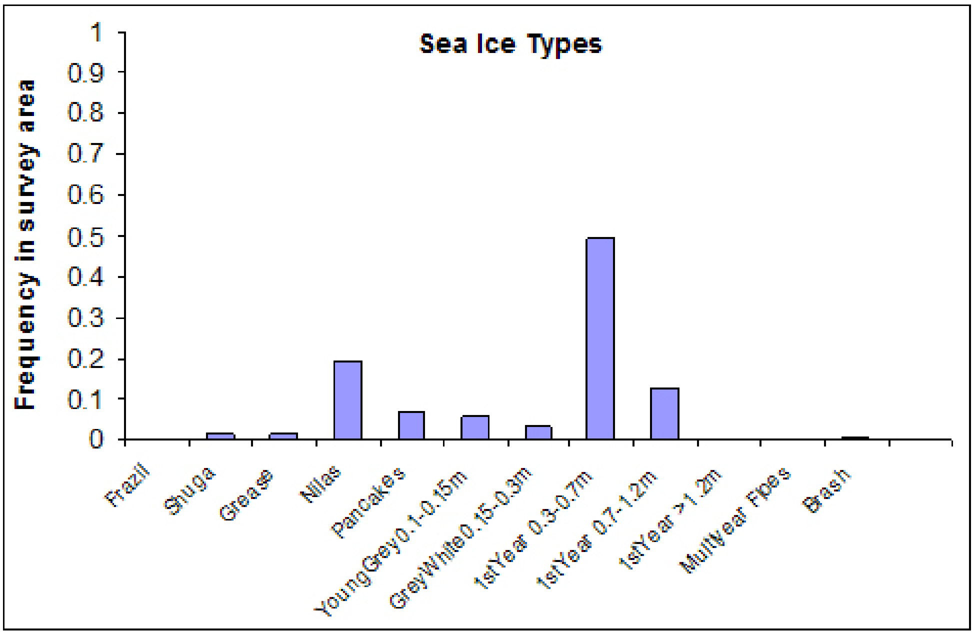


Fig. 15.5: Sea Ice types frequency throughout the survey area in the winter sea ice 2006 at the Lazarev Sea (ship based observations only)

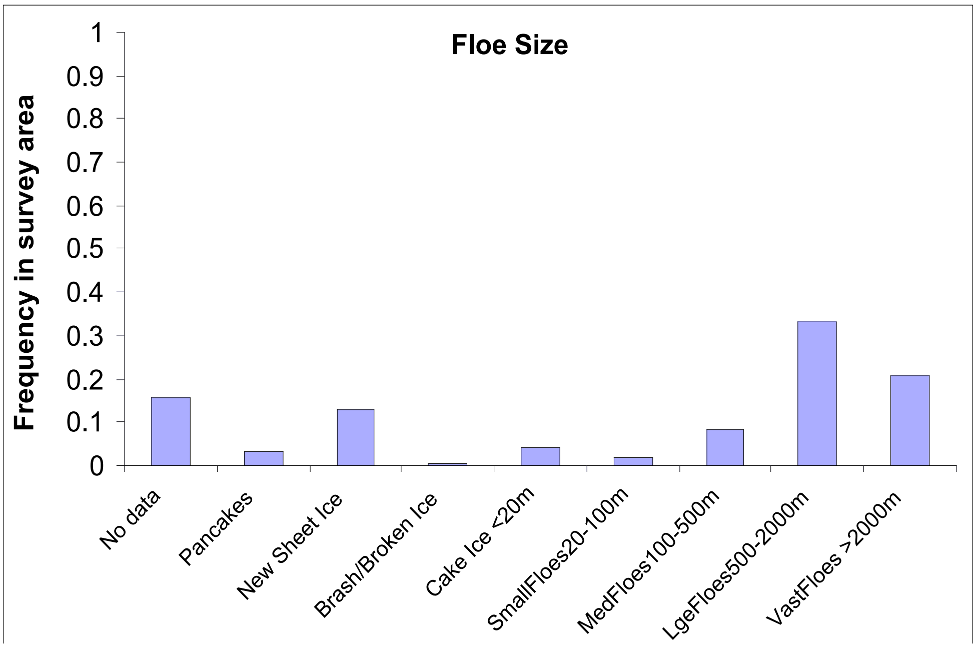


Fig. 15.6: Floe size frequency throughout the survey area in the winter sea ice 2006 at the Lazarev Sea (ship based observations only)

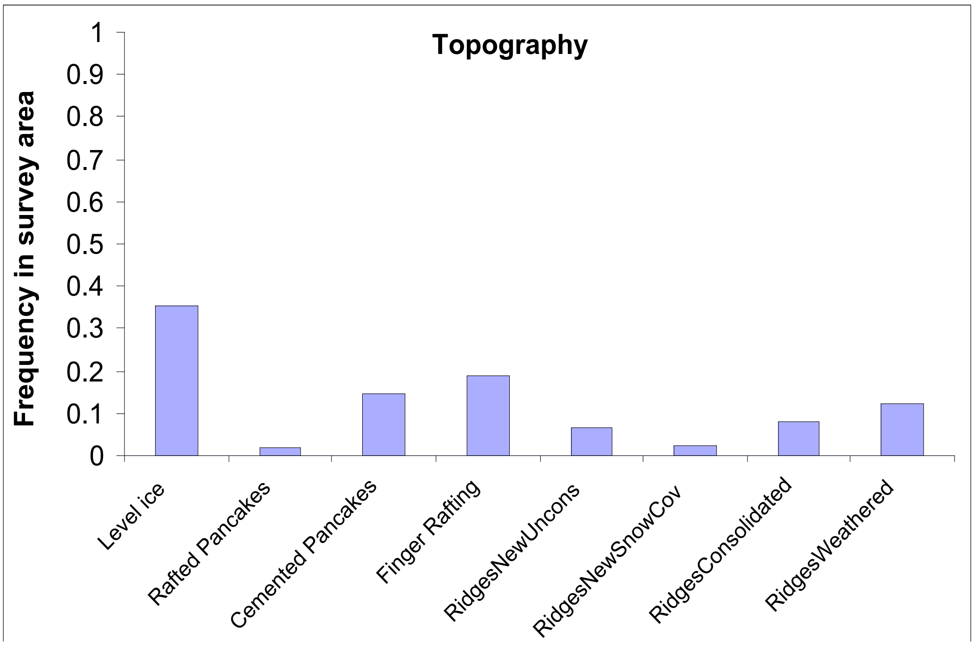


Fig. 15.7: Frequency of the topography and weathering processes throughout the survey area in the winter sea ice 2006 at the Lazarev Sea (ship based observations only)

Data

Cetacean data will be archived and held by the IWC SC Chair of the Environment Group Steering Group for Southern Ocean collaboration (Dr. D Thiele, Deakin University, Australia) and by the IWC. Requests for use of these data must be made to D Thiele and the IWC Secretariat Data Manager (dthiele@deakin.edu.au). Seal, seabird and diversity data will be archived by D. Thiele and released to interested researchers and databases as requested. All photographs collected during this cruise are copyright and requests must be made through D. Thiele for their use.

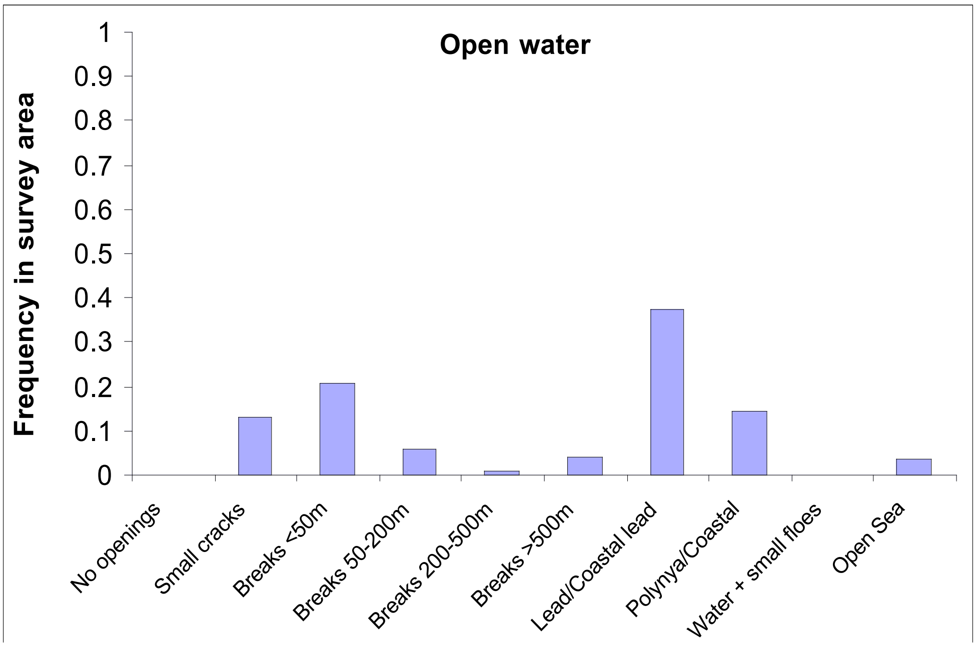


Fig. 15.8: Frequency of different areas of open water throughout the survey area in the winter sea ice 2006 at the Lazarev Sea (ship based observations only)

Acknowledgements

I would like to acknowledge the great support from the bridge crew, the Captain, Stefan Schwarze, and officers: Tilo Birnbaum, Steffen Spielke, Igor Hering and Herbert Bratz. I would like to thank the Alfred Wegener Institute for kindly providing berths on their science cruise for the IWC observer. I would also like to thank Uli Bathmann for his support throughout the voyage; and the NAAP team, especially to Jan van Franeker and Ruben Fijn, for allowing the IWC observer to participate in their aerial surveys and for their support in the observations from the bridge of *Polarstern*. And last but not least the IWC Scientific Committee for funding this project.

16. MARINE MAMMAL AUTOMATED PERIMETER SURVEILLANCE - MAPS

Holger Klinck, Elke Burkhardt
Alfred-Wegener-Institut

Objectives

The ship-based detection of marine mammals has a broad range of applications. Population ecologists focusing on whale distribution and migratory patterns are interested in effective methods for conducting marine mammal censuses. Users of hydroacoustic instruments are interested in the most effective use of reliable mitigation methods, assuming adverse reactions of marine mammals to the ship's presence. Because whales spend considerable periods of time both at the surface as well as submerged, numerous concurrent methods need to be employed to ensure detection, regardless of the whales' location. Underwater, vocalizing mammals can be detected by passive sonar. Its usefulness, however, is compromised by intrinsic vessel noise, which masks particularly low- to mid-frequency vocalizations of marine mammals. Near the surface, whales might be recognized by means of their warm blow, which stands out against the cold Antarctic environment.

During ANT-XXIII/6, a passive acoustic streamer and two infrared cameras were used to detect, identify and localize marine mammals in the vicinity of *Polarstern*. To compare the ship-based passive acoustic data with recordings from an acoustically less disturbed environment, a small hydrophone station was deployed on an ice floe about 60 nm away from *Polarstern*. During the diving operation the hydrophone station was used to listen for leopard seals and other marine mammals in the vicinity of the diving hole for security reasons.

Work at sea

Passive Acoustic Streamer: three 10 meter long, oil (ISOPAR M) filled streamer sections, each containing 5 hydrophones, were towed at a distance of 200, 500 and 600 meters behind the ship (Fig. 16.1). They were connected by a steel-armed tow cable containing 48 wires. The hydrophone separation within each group was 1.2 meters. Hydrophone sensitivity, including a 20 dB preamplifier, was –184 dB re 1 V / 1 µPa, the frequency response 20 Hz to 200 kHz (3 dB points). The streamer was deployed using a 10 kN, IP 67 protected Nyblad winch, certified to -50 °C and equipped with a slip ring for continuous connection to the electronics in the lab. The winch maintained a hauling speed of 1 m/s, independently of the ship's speed. Deployment and recovery of the streamer lasted about 10 minutes each and required one scientist and one member of the crew. The analogue signals were conditioned by a 16 channel KEMO VBF40 filter/amplifier with programmable high/low-pass settings from 1 Hz to 256 kHz and gains from -20 dB to 90 dB. A studio sound device, RME Fireface, continuously recorded 6 selected channels at full bandwidth (192 kHz sampling rate and 24 bit resolution) to a disc using the ASIORecorder – a recording software developed in cooperation with the University of Kaiserslautern. Data rate was about 12 GB per hour. Data was stored in one minute blocks as 'wav' files on exchangeable 500 GB external hard discs, which could each host about 41 hours of uncompressed audio data. After the deployment of the acoustic streamer the data was transferred in the mass storage of *Polarstern*. For monitoring purposes several channels could be mixed and processed for optimal human perceptibility with Bose NoiseCancelling™ headphones. The free available software Ishmael running on a second computer was used to visualize the acoustic data online.

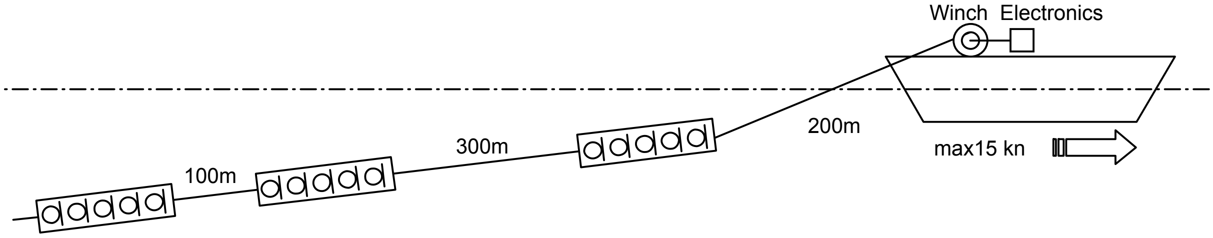


Fig. 16.1: Schematic drawing of the acoustic streamer

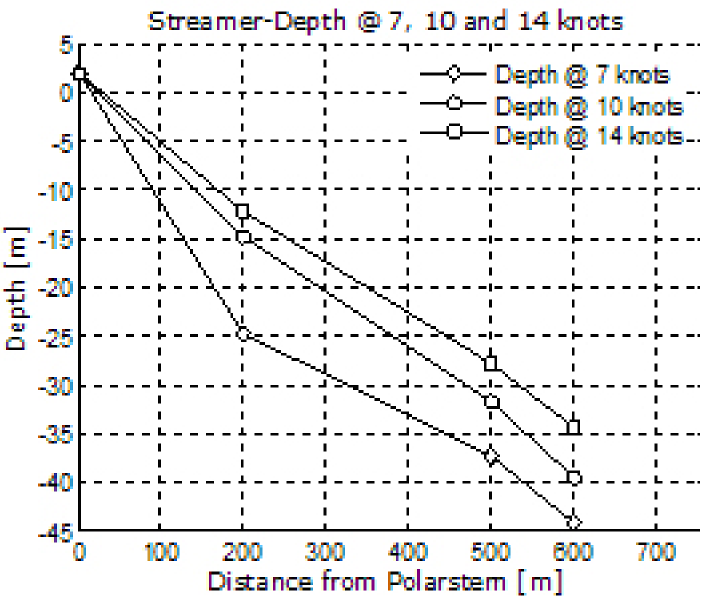


Fig. 16.2: Streamer depth as a function of tow speed. The markers at zero distance indicate the height of Polarstern's working deck.

The streamer's maximum operating depth is 60 meters, while its survival depth reads 120 meters. As the actual depth, measured by depth gauges in each streamer segment, was speed dependent (Fig. 16.2) the system had to be recovered when *Polarstern* slowed down below a speed of 5 knots. The streamer was deployed regularly between stations during cruising for a total of 734 nm and 66 hours, respectively (Tab. 16.1). It was also used under ice-covered conditions as long as

Polarstern could foreseeably cruise with at least 5 knots. During these occasions it was towed several times across ice floes without any damage.

Tab. 16.1: Streamer Deployments

Deployment			Recovery			Hours	Miles
1: 18.06. 17:28	37,1783° S	15,8273° E	19.06. 05:07	39,1513° S	14,2933° E	11:49	138,9
2: 22.06. 15:25	50,9360° S	06,4758° E	24.06. 10:13	59,4331° S	05,0655° E	42:48	513,2
3: 11.08. 13:30	60,4873° S	00,1400° E	12.08. 00:58	60,5035° S	02,9038° E	11:28	81,9
					Total:	66:05	734,0

During a heavy storm with wind speeds up to 12 Beaufort, the SUIT, a heavy under-ice trawl crashed into the streamer winch. The winch could not be repaired onboard but was still operational by using the manual cable guide.

Infrared Cameras

Two FLIR ThermoVision A40 infrared (IR) cameras, contained in protective housings and a visual camera, are mounted on the crow's nest of *Polarstern*. The cameras are connected to two PCs in the "wissenschaftlicher Arbeitsraum" via an optical FireWire link, where the image stream is displayed and the pictures and movies are stored. The spatial coverage of the IR camera is nominally 7° and 12° at a resolution of 320 x 240 pixels at 25 frames per second. The computer based system is running 24/7 (continuously). Some interruptions occurred, mainly resulting from system crashes due to software or hardware problems, which however, could be fixed during the cruise. The IR image data stream was fed to a Matlab based software, designed to automatically detect whale blows (developed in cooperation with the University of Chemnitz). However, the current version is considered an experimental setup only, with one of our goals being the enhancement of the data base for further developments. Once the ice edge was reached, the automated detection mode was changed to saturation recording mode. All data will be analyzed in Bremerhaven for the presence of animals. The data will help to improve the detection algorithm and reduce false alarm rates in the automated modus.

During the cruise the windows of the camera housings were covered with ice from time to time. The ice was removed easily and without any residuals using ethanol (98 %). The cameras and the housings endured heavy storms with wind speeds up to 12 Beaufort without any problems.

Ice Floe Station

A small hydrophone station was deployed on an ice floe at 61°49,5‘ S / 0°11,3' E about 60 nm away from *Polarstern* using a helicopter. The hydrophone (Reson TC4032) was lowered through a drilled hole to a water depth of 50 m. The hydrophone signal was filtered (10 Hz high pass filter) and amplified (30 dB) using a Reson EC6070. The acoustic data was recorded with a Microtrack recorder with 192 kHz/16bit. The data was stored on a CF Card with a capacity of 8 GB. The available record time was about 12 h.

In combination with the acoustic system a positioning system was also deployed on the ice floe. The positioning system consisted of an ARGOS transmitter for determining the stations position and a flashing light for easier detection of the station from the helicopter. A GPS was also installed to measure the drift of the ice floe and to validate the accuracy of the ARGOS system.

The deployment took about 45 min working time on the ice floe. The station worked without any problems although temperature was well below -25 °C. The delay of the received ARGOS positions was about 3 h. This delay was acceptable and the retrieving of the station was no problem. For the recovery 15 min working time was necessary on the ice floe.

Acoustic observation of the diving operation

The main diving operation took place between 14 and 18 July. During this period, *Polarstern* was on station about 670 m away from the diving camp which was established on an ice floe (Tab. 16.2). The hydrophone was deployed at a distance of 20 m to the main diving hole at a depth of 50 m.

Tab. 16.2: Start conditions

Position *Polarstern* 14.07.2006, 16:58:54	66,0214° S	00,0873° E
Position hydrophone 14.07.2006, 16:58:54	66,0274° S	00,0875° E
Distance		670 m

Because the ship had to move from time to time the distance between the ship and the hydrophone varied.

Preliminary results

During the diving camp the acoustic system was running continuously. All data were analyzed automatically with a Matlab routine for the presence of leopard seal calls. During the actual diving activities the acoustic system was operated by a scientist listening in real-time to the underwater sound.

The acoustic streamer was deployed 3 times. At the first transect close to the African continent a sperm whale and probably a beaked whale could be detected. No animals were detected on transects 2 and 3 (Fig. 16.3).

It has to be taken into account that this cruise took part in austral winter when most whale species are assumed to be in warmer regions. During the cruise ship- and helicopter-based visual sightings were recorded by the IWC and the ALTERRA groups. The numbers of sighted animals was relatively low which could be expected for the Lazarev Sea in this time of the year. Most sighted species were Minke whales and Crabeater seals. However, the acoustic streamer focuses on the detection of toothed whales which were only sighted twice during the entire cruise.

The IR cameras (7° and 12°) and the visual camera were operating 24/7. The system failed only a few times due to hard- or software failures. The software was modified and is now running smoothly.

During the cruise the automatic detection algorithm was disabled and the area in front of the ship recorded continuously. These data will be analyzed in Bremerhaven for the presence of animals. One minke whale blow was detected while checking the recorded data onboard (Fig. 16.4). The minke whale blow – the smallest baleen whale species – is the most faint blow and very difficult to detect.

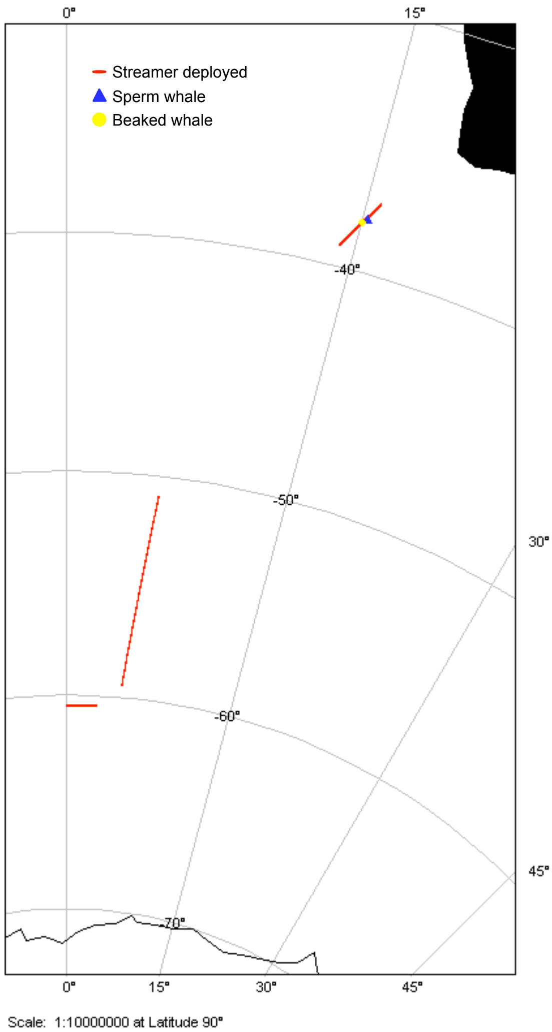


Fig. 16.3: Overview - acoustic streamer

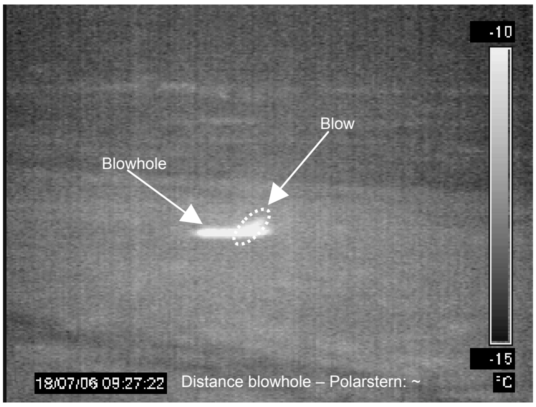


Fig. 16.4: IR camera snapshot

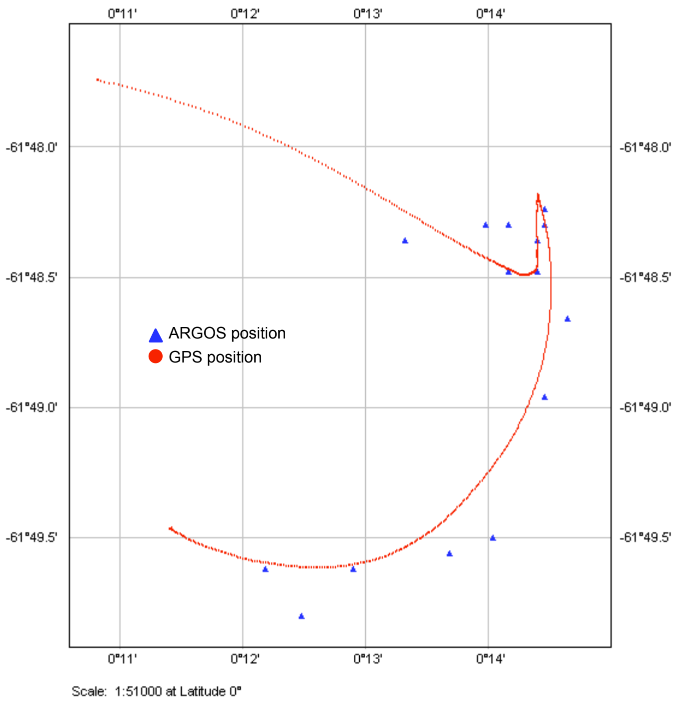


Fig. 16.5: Overview – ice floe station

The deployment of the small hydrophone station was rather successful. The differences between the ARGOS positions and the GPS positions were very small (Fig. 16.5).

During the 12 h recording period *Polarstern* was continiously steaming towards the station and therefore the ship's noise in the recordings increased with time. At the end of the recording period *Polarstern* was about 30 nm away from the station. The drift of the floe was derived from the GPS positions with 4,7 nm in 23 h (Fig. 16.5).

The data was analysed onboard *Polarstern*. In most of the recording an acoustic signal was present which was never recorded by the AWI 'Ocean Acoustics' group before. The signal is very regular with a duration of around 1,67 sec and an intersound interval of around 1,45 sec (Fig. 16.6). The main energy of the signal occurs in the frequency band of 150 - 300 Hz. It was suggested that the signal has a natural origin but there was no description found in literature. After contacting some experts in the field the riddle was solved by Tracey Rogers, the director of the Australian Marine Mammal Research Centre:

> *The recorded call is described as the "Bioduck" which is also heard off the Australian and New Zealand coasts, particularly off the West Australian coastline. Guesses as to its origin are varied, minke whales seems everyone's favourite guess, but until someone does some localisation work and goes to have a look what is making the sound, it will remain the "Bioduck".*

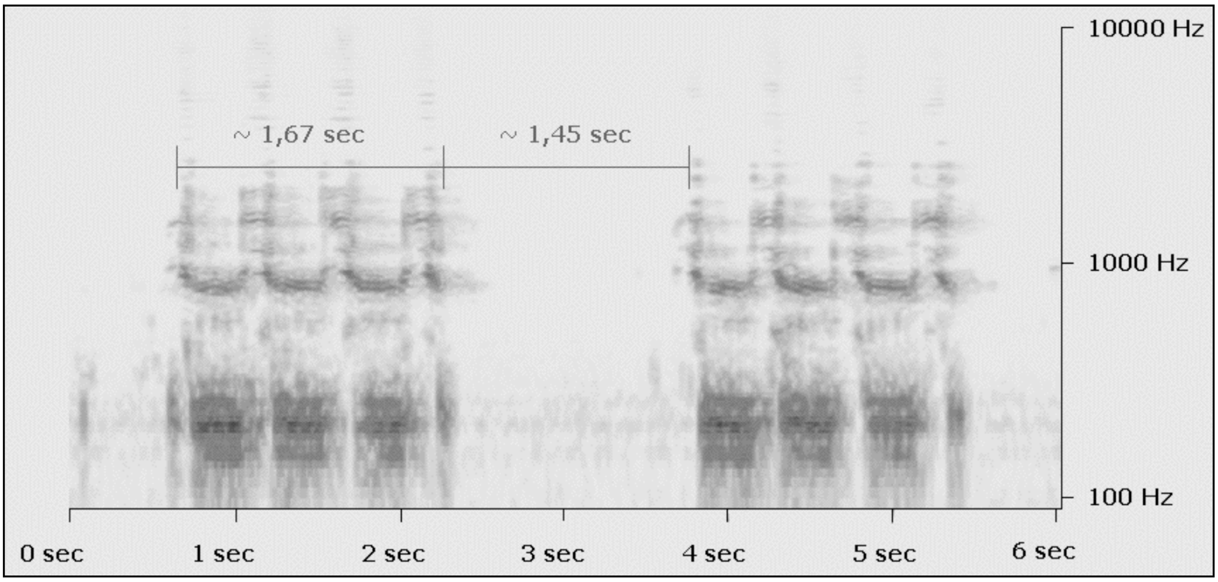


Fig. 16.6: Spectrogram of the "Bioduck"

The acoustic work during the diving operation was conducted under less favourable acoustic conditions. The distance between the ship and the hydrophone station was approx. 700 m (Tab. 16.2). First analysis of the recorded data showed that *Polarstern* on station (with running thrusters) is much louder compared to steaming. The frequency band between 330 and 370 Hz was used to detect leopard seal calls.

The following calculation according to the "passive sonar equation" indicates the efficiency of the system (for further information see: Urick, Principles of Underwater Sound, 1967, 423pp, McGraw-Hill, New York):

SL - TL = NL - DI + DT

SL = source level of a leopard seal call= 160 dB RMS re 1μPa (assumed value)
TL = maximum transmission loss = 20*log(r)
NL = noise level = band level *Polarstern* (330 - 370 Hz) = 130 dB RMS re 1μPa
DI = directionality index = omnidirectional = 0 dB
DT = detection threshold = -3 dB

TL = SL - NL + DI - DT = 160 - 130 + 0 + 3 = 33 dB
r = $10^{\wedge(33/20)}$ = 44,7 m

In summary the acoustic observation was not a useful tool under the given conditions. A detection range of 45 m is not enough to supply helpful information about the presence of marine mammals and the safety aspect of the divers.

For future diving operations the best practical way to acoustically detect marine mammals will be the set-up of a small hydrophone station and deploy it at greater distance to the ship in the area intended for the diving operation (Fig. 16.5). The technique worked without problems and the deployment and recovering of the station was routine.

In this case the detection radius can easily be extended to some kilometers (depending on the distance to the ship). With such a station the underwater soundscape can be recorded for hours/days. The actual automatic detection algorithm needs around 1/10 of the recording time to check the data for leopard seal calls which means 10 hours of data can be analysed in 1 hour - with prospect for further improvement.

17. SCIENTIFIC DIVING UNDER ANTARCTIC WINTER CONDITIONS DURING ANT-XXIII/6

Ulrich Freier[1)], Michael S. Yasseri[1)], Susanne Spahic[1)], Carsten Pape[1)], Hauke Flores[2)], Alejandro Olariaga[1)], Lutz Auerswald[3)]

[1)]Alfred-Wegener-Institut
[2)]Marine and Coastal Zone Research, Den Burg (Texel)
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Objectives

Diving on this cruise was carried out to collect larval krill (*Euphausia superba*) and other planktonic organisms in good condition for ecophysiologial experiments. In addition, sea ice biota were sampled from the location where the animals were collected. Video observation gave an overview of the sampling area for a better understanding of the ecology of larval krill during winter. Diving was conducted from an ice station for 5 days and during station work on the study transect from the zodiac.

Ice station

Before establishing a long term ice station a combination of different requirements were necessary:

- the occurrence of krill, especially larval krill
- ice thickness and stability
- a forecast of stable and moderate weather conditions for the following days
- control of leopard seal presence

From earlier cruises it was known that the area of the deep sea mount Maud Rise is a region with high krill abundance, so that the first transect (3°E) and second transect (0°) were the areas where it was most likely to construct the dive camp.

Work at sea

For receiving data about the occurrence of krill as well as ice thickness and stability helicopter flights were made along the transect to search for stable ice floats. A 50 x 50cm hole was cut in the ice using a chainsaw and the ice block removed with an improved pulley-system (Fig. 17.1). A hand net (200 μm mesh size) was towed vertically from 40 m to the surface in the ice hole for collecting larval krill. In addition a small hole was drilled to install the special DigiCam/Videorecorder which was used to observe the under ice surface for larval krill. When *Polarstern* reached the position the same procedure as described above was carried out. Transport of personnel and sledges with the necessary equipment (1 KW) generator, lights, DigiCam with tripod, chainsaw, handnets and sampling gear) onto the ice float was carried out via a Mummy-chair.

Fig. 17.1: The pulley system to prepare the sampling hole

On the early morning (7:00) of 14 July 2006, Pos. 66°06.00 S – 00°00.00 *Polarstern* reached a stable ice float (75 cm ice thickness) under which we found a large amount of krill larvae which could be seen directly under the ice using the DigiCam.

The weather forecast showed a stable depression in the west slowly moving east. The centre of the depression with moderate wind velocity was expected to arrive in the Maud Rise region in the next days. From helicopter flight observations conducted by Jan van Franeker and observations from the bridge we expected that no leopard seals were in the area.

After checking all the prerequisites for establishing the dive camp, at 13:00 we started to built up the ice camp in 500 m distance from the ship (Fig. 17.2). Two igloos were brought to the diving camp by helicopter. The power supply was provided by two 5 kw Knurtz generators. Electricity for light and heaters was installed as a second step. One igloo was used for storage and working, the other igloo contained the "first aid hospital" and was used for "warming up". Parallel to the installation of the dive camp a traverse from *Polarstern* to the ice camp was prepared for the skidoo. The skidoo was used to carry the diving equipment and other necessary equipment in both directions using Nannsen-sledges. The diving hole was cut in the ice (2 x 1m) close to the igloos with a chain saw. The single ice blocks were removed with a specially constructed tripod and an anchor-pulley system (Fig.17.3).

A second security hole was cut in a distance of about 25 m from the main diving hole. This should function as an escape and rescue hole when the dive hole would be occupied by larger animals. A modified Scott-tent (Fig. 17.4) for the divers and a second Scott-tent for the hydrophone-group were used as protection against wind. The Scott-tents were heated with gasheaters (butan;15 KW).

Fig. 17.2: The construction of the ice camp in 500 m distance from the ship – overview ice camp

Fig. 17.3: Tripod-pulley-anchor system with aluminium planks to remove the ice blocks from the hole

Fig. 17.4: A modified Scott tent

First and Second Aid

One igloo served as a field-hospital for the "doc in the igloo" in case of an emergency. Oxygen for possible diving accidents and "First Aid" was provided in the igloo. The planned safety procedure was tested in an emergency exercise. A person was transported to *Polarstern* with a Skidoo on a modified Nannsen-sledge. The entire sledge with the 'injured' person was taken via *Polarstern* crane direct from the ice to the helicopter-deck close to the hospital. The total transport time from the dive hole to the hospital was 6 min, much faster than helicopter transport. Because of the absence of a decompression chamber the dive depth was limited to 10 m.

Leopard seal occurrence

Due to safety regulations special attention was given to the appearance of leopard seals. From the *Polarstern* bridge the area around the ship and the ice camp was continuously observed by using binoculars. Depending on the weather conditions helicopter flights were carried out in a radius of 5 km from the ship. In total, 4 minke whales, 44 crabeater seals, 63 emperor penguins, 9 adelie penguins and 0 leopard seals were observed during ice station period (data: Jan van Franeker). For the underwater observation of the dive hole a laptop-based 24 hour survey was carried out with a special infrared DigiCam. Only drifting ctenophores and krill were observed. Additionally, an ultra-sensitive hydrophone was installed by the Ocean Acoustic Group about 80 m away from the dive hole for specific detection of leopard seal vocalization.

Diving

At the ice station

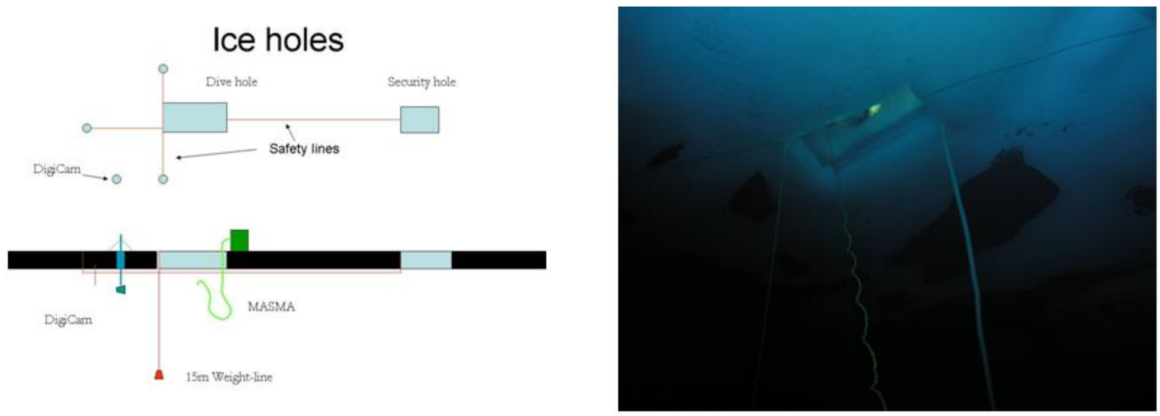

Fig. 17.5: Overview of the under water side of the dive hole with safety lines, DigiCam and MASMA

Due to incalculable water currents the diving area was secured under the ice by safety-lines which were fixed through small drill holes (Fig. 17.5). They served as guide and orientation lines for the diver. A 15 m vertical line with a weight of 8 kg was helpful to regulate the buoyancy of the diver.

From the Zodiac

Larger leads and polynias were used for diving from zodiac during station time on the study transect. The DSB-rubber boat with 35 hp Diesel outboard motor was used as diving platform, which was driven by a *Polarstern* crew member. The diving group consisted of three persons. Technical assistance was given from two additional persons placed in a second non-motorised rubber boat, which was used to transport the ROV or the MASMA (a detailed description is given below) and photo/video equipment. At the ice edge, the boats were connected to the ice with ice screws.

Sampling

A) Larval krill and other organisms

Krill larvae and other specimens were caught with bottle-connected hand nets and the MASMA -(MAnguera SubMArina) motor pump (Fig 17.6).The MASMA is a zooplankton pump newly designed by Alejandro Olariaga. The system consists of a motor driven centrifuge pump (0.40 m^3 min^{-1}) connected to a plankton filtration system. The filtration is carried out through a zooplankton net (200 μm mesh size) with a 2 litre cod end located inside the airtight container and placed upstream of the centrifuge pump. High volumes of water were transported to the container through a 2'' diameter tube (up to 50 m length). In this way the animals are concentrated in the cod end before the water reaches the pump. The animals sampled were in very good condition, and thus ideal for experimental studies. The handling was comfortable for the diver because of the almost weightless plastic tube. This tube could be used by the diver as a modified vacuum cleaner to catch distinct and selected animals. The MASMA turned out to be much more efficient than the hand nets and was used as standard sampling gear on this cruise during the ice camp and from the zodiac (see above, diving from the zodiac). At the ice station and from the zodiac up to 2,000 larval krill and innumerable amounts of copepods and other zooplankter were caught for ecophysiological experiments.

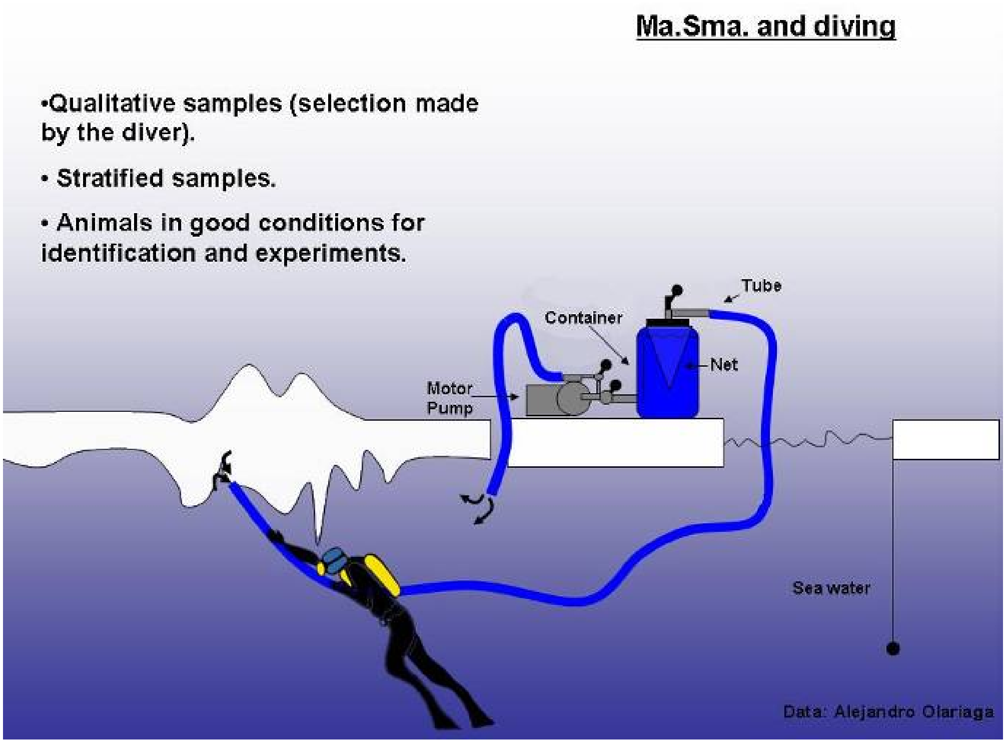

Fig. 17.6: The MASMA system for sampling organisms under the ice

B) Visual observations

Fotos from the under-water sampling area were taken with an Olympus C 8080 WZ with an Ikelite underwater housing and an Ikelite flash; videos were recorded with a Sony Digital Handycam and with the ROV (Remote Operated Vehicle). Diving observations have shown that krill larvae were drifting passively in the current. Larger swarms of larvae are also attached to the ice in deeper hollows and around ice dents in areas sheltered from the current. They change their location actively depending on the direction of the current. Ridges and layered ice floats are used as refuge niches. During darkness the light from the head torch attracted the larvae. They left their protected refuges and swam actively towards the light. At the ice station, the highest amount of larvae occurred during the first diving day, whereas significantly fewer larvae could be observed during the second day. Only few larvae were around on the third day whereas the amount of larval krill increased significantly on the last day.

C) Ice algae

Ice pieces from the deeper dents and hollows where the larvae occurred (1,5 -2,5 m under the ice surface) where taken and melted in filtered (0.2 μm) seawater. The community of ice algae was investigated under the microscope. Large diatoms like *Rhizosolenia sp*., *Fragilariopsis cylindrus*, *Corethron sp*., and *Chaetoceros sp*. where found in a very good physiological condition with highly active chloroplasts and chrysolaminarin and lipids containing vacuoles. A large amount of these diatoms were in the state of early mitosis, accumulating amorphic silica in golgi vesicles in the middle of the cell. The algae can be described as a vital and growing diatom dominated community.

Conclusions / Diving

Diving was carried out in extreme winter conditions. The equipment used was suitable for the described conditions. Even during diving times of 65 min per dive in the -1.8 °C seawater the diver felt warm and comfortable. Technical problems occurred only to the frequently used diving regulators due to freezing (occurred 3 times) and to the telephone line, which sometimes showed short electrical failures due to humidity and freezing. For future activities it is highly recommended to have a second telephone system. The heated igloos and the Scott-tents with the gas heater are essential for diving during winter conditions due to the low air temperature and high wind velocities.

The rubber boat on *Polarstern* is a good diving platform, but has its limitations when thicker layers of sea ice occur in the polynias because the ice can tear the rubber. A boat of similar size with an aluminium keel and better wind protection in combination with an integrated Diesel engine could significantly enhance the diving possibilities.

Concerning the Skidoo used it turned out that two Skidoos would be much more appropriate because the single skidoo was always located in the ice camp connected to the emergency sledge while diving, so that no other transport could be carried out.
During the four diving days at the ice station we completed 21 dives with a total of 673 min diving time. Eight dives with 282 min diving time from the zodiac were made at different transect stations.

This cruise has clearly shown that diving and under ice work is possible even under extreme winter conditions. No accidents and no dangerous situations occurred at any time.

Leopard seal observation

Helicopter flights and bridge observations were efficient during daylight and good weather conditions. However, krill and krill larvae occurred in higher abundances during dusk and at night when these kinds of observations were not possible due to darkness.

Hydrophone observations of the acoustic group as required by the internal AWI-regulations for the detection of the presence of leopard seals are no option in the area surrounding *Polarstern*. The noise emissions of *Polarstern* (machines and propellers) are so loud that almost no other noises could be recorded. soll dieser Absatz so bestehen bleiben?

The 24h observation at the dive hole with the under-water DigiCam turned out to be a very effective tool for possible leopard seal appearance. The camera gave clear information about the situation at the dive hole and changes in the direction of the water current.

From these results it is highly recommended to reconsider the internal AWI-diving regulations for the presence of leopard seals in Antarctic waters.

Weather and Drift

Due to the wind directions and water currents the entire ice float with *Polarstern* moved in the five ice station days over a distance of 46 nm, circling from the north to the south and back north with an average speed of 21,3 cm/s (Fig.17.7: data: Boris Cisewski/*Polarstern*).

During the drift of the ice float the abundance of krill and other zooplankton species as well as the zooplankton composition changed drastically indicating a change in water body under the float. Comparatively lower abundance of larval krill corresponded with small changes in salinity. In future, nutrients should be analysed in addition to temperature and salinity for a better characterization and detection of changing water bodies.

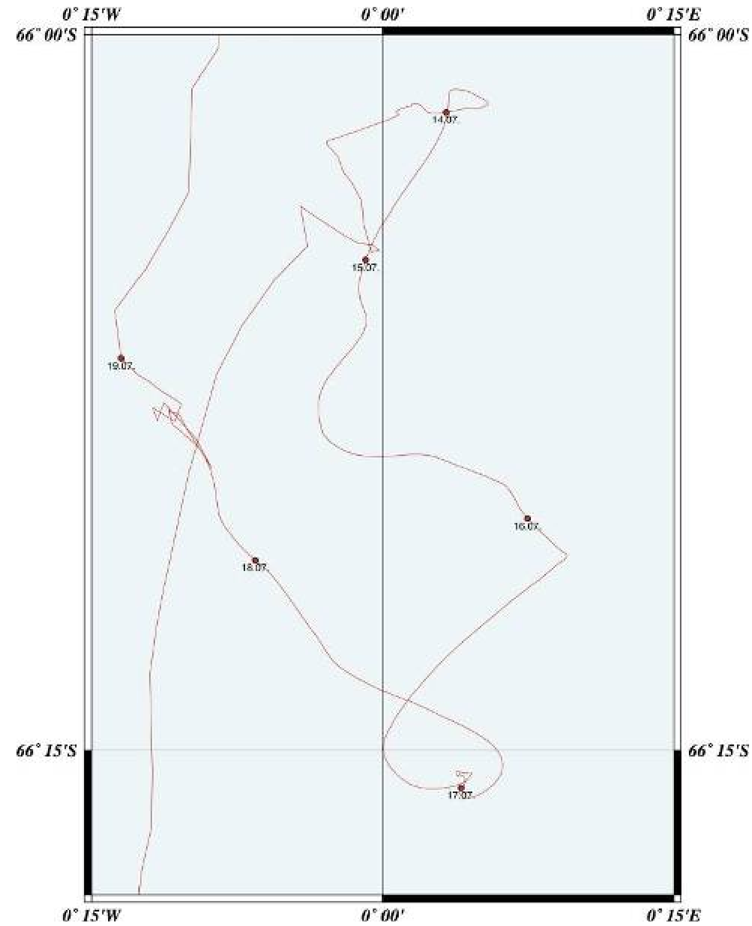

Fig. 17.7: Drift of the ice float/ice camp (data Polarstern)

APPENDIX

A.1 PARTICIPATING INSTITUTES

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION LIST PS 69

A1. PARTICIPATING INSTITUTES

	Address	No. of Participants
ALTERRA	ALTERRA Marine and Coastal Zone Research POBox 167 1790 AD Den Burg (Texel) The Netherlands	5
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven/Germany	18
BFA Fisch	Bundesforschungsanstalt für Fischerei Institut für Seefischerei Palmaille 9 22767 Hamburg/Germany	3
DWD	Deutscher Wetterdienst Hamburg Abteilung Seeschifffahrt Bernhard-Nocht-Str. 76 20359 Hamburg/Germany	2
FIELAX	FIELAX Gesellschaft für wissenschaftliche Datenverarbeitung mbH Schiffer-Str. 10 - 14 27568 Bremerhaven/Germany	1
HeliTransair	Heli Transair GmbH Flugplatz 63329 Egelsbach/Germany	4
IWC	Whale Ecology Group – Southern Ocean School of Ecology and Environment Deakin University P.O. Box 423 Warmambool/Australia	1

	Address	No. of Participants
LAEISZ	Reederei F. Laeisz GmbH Brückenstr. 25 27568 Bremerhaven/Germany	see crew list
LAE	Laboratory of Aquatic Ecology Deberiotstraat 32 3000 Leuven / Belgium	2
OPTIMARE	Optimare Sensorsysteme AG Am Luneort 15A 27572 Bremerhaven/Germany	1
University St. Petersburg	The White Sea Biological Station Zoological Institute Russian Academy of Sciences Universitetskaya nab., 1 St.Petersburg, 199034/Russia	1
University Bremen	Marine Zoologie Universität Bremen Postfach 33 04 40 28334 Bremen Germany	6
UCT	Zoology Department University of Cape Town Rondebosch 7701 South Africa	1
UBC	University of British Columbia Department of Earth and Ocean Science 6339 Stores Road Vancouver, B.C. Canada V6T 1Z4	1

A.2 CRUISE PARTICIPANTS ANT-XXIII/6

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
Alheit	Ruth	AWI	Technician
Auerswald	Lutz	UCT	Biologist
Bathmann	Ulrich	AWI	Biologist
Buldt	Klaus	DWD	Technician
Burkhardt	Elke	AWI	Biologist
Cisewski	Boris	AWI	Oceanographer
Dorssen	Michiel van	ALTERRA	Biologist
Ewe	Daniela	Uni HB	Student, physics
Fijn	Rin	ALTERRA	Biologist
Flores	Hauke	ALTERRA	Biologist
Franeker	Jan van	ALTERRA	Biologist
Freier	Ulrich	AWI	Diver
Fuentes	Veronica	AWI	Biologist
Garcia	Maria	IWC	Biologist
Hager	Julia	Uni HB	Student, physics
Haraldsson	Matilda	BFA Fisch	Student, biology
Herrmann	Sarah	AWI	Student, biology
Klinck	Holger	AWI	Scientist
Kruse	Svenja	AWI	Biologist
Lenderink	Andrea	Uni HB	Student, physics
Rogenhagen	Johannes	FIELAX	Acoustics
Rudolf	Anton	HTA	Pilot
NN	-	HTA	Pilot
Stimac	Mihail	HTA	Technician
Fuhs	Elisabeth	HTA	Technician
Martynova	Daria	Uni St. Petersburg	Biologist
Meijboom	Andre	ALTERRA	Biologist
Meyer	Bettina	AWI	Biologist
Michels	Jan	AWI	Biologist

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
Miller	Max	DWD	Meteorologist
Nunez-Riboni	Ismael	AWI	Student, phyiscs
Olariaga	Alejandro	AWI	Student, technique
Pakhomov	Evgeny	UBC	Biologist
Pape	Carsten	AWI	Biologist
Risch	Sarah	LAE	Biologist
Sahlmann	Christian	Uni HB	Student, physics
Schreiber	Karolin	AWI	Technician
Schukat	Anna	Uni HB	Student, biology
Spahic	Susanne	AWI	Technician
Stübing	Dorothea	Uni HB	Biologist
Tadday	Lilo		Photographer
Van de Putte	Anton	LAE	Biologist
Vortkamp	Martina	BFA Fisch	Technician
Wend	Britta	AWI	Biologist
Witte	Timo	OPTIMARE	Technician
Würzberg	Laura	BFA Fisch	Biologist
Yasseri	Michael S.	AWI	Diver

A.3 SHIP'S CREW

No.	Name	Rank
01.	Schwarze, Stefan	Master
02.	Spielke, Steffen	1.Offc.
03.	Ziemann, Olaf	Ch. Eng.
04.	Hering, Igor	2.Offc./L.
05.	Birnbaum, Tilo	2.Offc.
06.	Bratz, Herbert	2.Offc.
07.	Kleyheeg, Jörg	Doctor
08.	Koch, Georg	R.Offc.
09.	Simon, Wolfgang	1.Eng.
10.	Schnürch, Helmut	3.Eng.
11.	Westphal, Henning	3.Eng.
12.	Holtz, Hartmut	Elec Eng.
13.	Dimmler, Werner	Electron.
14.	Riess, Felix	Electron.
15.	Fröb, Martin	Elec.Tech
16.	Feiertag, Thomas	Electron.
17.	Clasen, Burkhard	Boatsw.
18.	Neisner, Winfried	Carpenter
19.	Kreis, Reinhard	A.B.
20.	Schultz, Ottomar	A.B.
21.	Burzan, G.-Ekkehard	A.B.
22.	Schröder, Norbert	A.B.
23.	Moser, Siegried	A.B.
24.	Pousada, Martinez	A.B.
25.	Hartwig-L., Andreas	A.B.
26.	Schmidt, Uwe	A.B.
27.	Beth, Detlef	Storek.

No.	Name	Rank
28.	Fritz, Günter	Mot-man
29.	Krösche, Eckard	Mot-man
30.	Dinse, Horst	Mot-man
31.	Watzel, Berhard	Mot-man
32.	Hoppe, Kurt	Mot-man
33.	Fischer, Matthias	Cook
34.	Martens, Michael	Cooksmate
35.	Tupy, Mario	Cooksmate
36.	Dinse, Petra	1.Stwdess
37.	Tillmann, Barbara	Stwdss/Kr
38.	Streit, Christina	2.Stwdess
39.	Schmidt, Maria	2.Steward
40.	Deuß, Stefanie	2.Steward
41.	Wu, Chi Lung	2.Stward
42.	Sun, Yong Shang	2. Stward
43.	Yu, Chung Leung	Laundrym
44.	Woeckner, Nikolas	Apprent.
45.	Benditz, Heiko	Trainee

A.4 STATIONSLISTE / STATION BOOK PS69

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/470-1	18.06.06	16:45	37° 3,22' S	15° 55,35' E	4701,2	WHW	begin	
PS69/470-1	19.06.06	05:21	39° 11,41' S	14° 15,76' E	4859,2	WHW	end	
PS69/471-1	19.06.06	06:27	39° 21,98' S	14° 7,38' E	0,0	CPR	into water	
PS69/471-1	20.06.06	15:55	43° 27,19' S	10° 47,48' E	0,0	CPR		Filterwechsel
PS69/471-1	22.06.06	15:00	50° 50,74' S	6° 29,34' E	0,0	CPR	on deck	
PS69/472-1	22.06.06	15:04	50° 51,62' S	6° 29,21' E	0,0	WHW	begin	beginn aussetzen des streamers
PS69/472-1	22.06.06	15:18	50° 54,63' S	6° 28,76' E	0,0	WHW	begin	beginn streamern
PS69/472-1	24.06.06	10:42	59° 27,99' S	4° 56,19' E	0,0	WHW	end	
PS69/473-1	26.06.06	09:44	60° 59,52' S	3° 4,36' E	0,0	CTD/RO	at depth	Tiefe 5676
PS69/473-1	26.06.06	09:47	60° 59,59' S	3° 4,33' E	0,0	CTD/RO	Information	Hieven
PS69/473-1	26.06.06	10:58	61° 0,34' S	3° 5,05' E	0,0	CTD/RO	on deck	
PS69/473-1	26.06.06	11:29	61° 0,55' S	3° 5,22' E	0,0	CTD/RO	Information	CTD an Deck
PS69/473-2	26.06.06	20:35	60° 59,68' S	3° 1,17' E	5400,0	RMT	surface	Multi-RMT
PS69/473-2	26.06.06	20:37	60° 59,80' S	3° 0,60' E	5400,0	RMT	Begin Trawling	72.1: 350 m ausgestecckt
PS69/473-2	26.06.06	20:50	60° 59,90' S	2° 59,90' E	5410,0	RMT	heave	
PS69/473-2	26.06.06	21:15	61° 0,20' S	2° 57,90' E	5403,0	RMT	on deck	
PS69/474-1	27.06.06	02:21	61° 29,96' S	2° 59,95' E	0,0	RMT	surface	
PS69/474-1	27.06.06	02:37	61° 30,40' S	2° 58,79' E	0,0	RMT	Begin Trawling	
PS69/474-1	27.06.06	03:01	61° 31,07' S	2° 57,13' E	0,0	RMT	End of Trawl	
PS69/474-1	27.06.06	03:09	61° 31,21' S	2° 56,86' E	0,0	RMT	on deck	
PS69/474-2	27.06.06	03:19	61° 31,35' S	2° 56,13' E	0,0	RMT	surface	
PS69/474-2	27.06.06	03:22	61° 31,37' S	2° 55,91' E	0,0	RMT	Begin Trawling	winch stop 74m, trawl 10 min
PS69/474-2	27.06.06	03:32	61° 31,44' S	2° 55,18' E	0,0	RMT	heave	
PS69/474-2	27.06.06	03:35	61° 31,45' S	2° 54,95' E	0,0	RMT	action	winch stop 35m, trawl 10 min
PS69/474-2	27.06.06	03:43	61° 31,50' S	2° 54,36' E	0,0	RMT	heave	
PS69/474-2	27.06.06	03:45	61° 31,52' S	2° 54,19' E	0,0	RMT	End of Trawl	
PS69/474-2	27.06.06	03:52	61° 31,54' S	2° 53,82' E	0,0	RMT	on deck	
PS69/474-3	27.06.06	04:39	61° 30,10' S	2° 59,91' E	5382,0	CTD/RO	surface	
PS69/474-3	27.06.06	06:19	61° 29,67' S	3° 1,23' E	5383,0	CTD/RO	at depth	Die Tiefe 5350 m, EL 31
PS69/474-3	27.06.06	07:53	61° 29,27' S	3° 2,41' E	5386,0	CTD/RO	on deck	
PS69/474-4	27.06.06	08:30	61° 29,11' S	3° 2,86' E	5386,0	BONGO	surface	
PS69/474-4	27.06.06	08:43	61° 29,07' S	3° 3,00' E	0,0	BONGO	at depth	200m, SE32.2
PS69/474-4	27.06.06	08:55	61° 29,04' S	3° 3,13' E	0,0	BONGO	on deck	
PS69/474-5	27.06.06	09:03	61° 29,02' S	3° 3,23' E	5386,0	BONGO	surface	
PS69/474-5	27.06.06	09:17	61° 28,99' S	3° 3,46' E	0,0	BONGO	at depth	SE32.2, 200m
PS69/474-5	27.06.06	09:29	61° 29,00' S	3° 3,62' E	5386,0	BONGO	on deck	
PS69/474-6	27.06.06	09:46	61° 29,00' S	3° 3,76' E	5386,0	CTD	surface	
PS69/474-6	27.06.06	09:53	61° 28,99' S	3° 3,82' E	0,0	CTD	at depth	251 m
PS69/474-6	27.06.06	10:11	61° 28,98' S	3° 4,05' E	5386,0	CTD	on deck	
PS69/474-7	27.06.06	11:09	61° 30,10' S	3° 0,55' E	5386,0	MN	surface	
PS69/474-7	27.06.06	13:00	61° 29,91' S	3° 2,58' E	0,0	MN	at depth	Auf Tiefe: 3211m, EL 30

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/474-7	27.06.06	14:57	61° 29,77' S	3° 5,39' E	0,0	MN	on deck	
PS69/474-8	27.06.06	15:15	61° 29,72' S	3° 5,84' E	0,0	MN	surface	
PS69/474-8	27.06.06	15:55	61° 29,61' S	3° 6,85' E	0,0	MN	at depth	Tiefe: 1127m, EL 30
PS69/474-8	27.06.06	16:39	61° 29,45' S	3° 8,04' E	0,0	MN	on deck	
PS69/474-9	27.06.06	20:36	61° 28,64' S	3° 14,00' E	0,0	MN	surface	MN-50
PS69/474-9	27.06.06	21:07	61° 28,56' S	3° 14,74' E	0,0	MN	at depth	276m, EL 30
PS69/474-9	27.06.06	21:21	61° 28,52' S	3° 15,10' E	0,0	MN	on deck	
PS69/475-1	28.06.06	03:42	62° 0,21' S	3° 0,86' E	0,0	RMT	surface	
PS69/475-1	28.06.06	03:56	62° 0,08' S	2° 59,55' E	0,0	RMT	Begin Trawling	395m, GE 72.1
PS69/475-1	28.06.06	04:21	62° 0,12' S	2° 57,69' E	0,0	RMT	End of Trawl	
PS69/475-1	28.06.06	04:24	62° 0,13' S	2° 57,58' E	0,0	RMT	on deck	
PS69/475-2	28.06.06	05:12	61° 59,85' S	3° 0,60' E	5390,0	CTD/RO	surface	
PS69/475-2	28.06.06	07:10	61° 59,29' S	3° 4,55' E	5388,0	CTD/RO	at depth	Die Tiefe 5703 m, EL 31
PS69/475-2	28.06.06	08:47	61° 58,77' S	3° 7,40' E	0,0	CTD/RO	on deck	
PS69/475-3	28.06.06	10:36	62° 0,16' S	2° 59,01' E	0,0	MN	surface	
PS69/475-3	28.06.06	10:50	62° 0,06' S	2° 59,31' E	0,0	MN	at depth	EL30, 277m
PS69/475-3	28.06.06	11:06	61° 59,94' S	2° 59,61' E	0,0	MN	on deck	
PS69/475-4	28.06.06	11:17	61° 59,84' S	2° 59,86' E	0,0	HN	surface	
PS69/475-4	28.06.06	11:27	61° 59,74' S	3° 0,10' E	0,0	HN	on deck	
PS69/475-5	28.06.06	11:32	61° 59,70' S	3° 0,20' E	0,0	BONGO	surface	
PS69/475-5	28.06.06	11:45	61° 59,59' S	3° 0,44' E	0,0	BONGO	at depth	200m, SE 32.2
PS69/475-5	28.06.06	12:08	61° 59,41' S	3° 0,82' E	0,0	BONGO	on deck	
PS69/475-6	28.06.06	12:30	61° 59,24' S	3° 1,26' E	5390,0	CTD/RO	surface	
PS69/475-6	28.06.06	12:46	61° 59,12' S	3° 1,58' E	0,0	CTD/RO	at depth	Tiefe: 247m, EL31
PS69/475-6	28.06.06	13:00	61° 59,01' S	3° 1,89' E	0,0	CTD/RO	on deck	
PS69/475-7	28.06.06	13:23	61° 58,81' S	3° 2,39' E	0,0	MN	surface	
PS69/475-7	28.06.06	13:34	61° 58,71' S	3° 2,64' E	0,0	MN	at depth	Tiefe: 284m, EL 30
PS69/475-7	28.06.06	13:52	61° 58,54' S	3° 3,02' E	0,0	MN	on deck	
PS69/475-8	28.06.06	15:37	62° 0,33' S	2° 59,41' E	0,0	MN	surface	
PS69/475-8	28.06.06	16:20	61° 59,87' S	3° 0,28' E	0,0	MN	at depth	Die Tiefe 1198 m, EL 30
PS69/475-8	28.06.06	17:03	61° 59,45' S	3° 1,23' E	0,0	MN	on deck	
PS69/475-9	28.06.06	17:20	61° 59,28' S	3° 1,62' E	0,0	MN	surface	
PS69/475-9	28.06.06	19:27	61° 58,04' S	3° 4,20' E	0,0	MN	at depth	Die Tiefe 3590 m, EL 30
PS69/475-9	28.06.06	21:31	61° 56,84' S	3° 6,77' E	0,0	MN	on deck	
PS69/475-10	28.06.06	21:58	61° 57,05' S	3° 5,76' E	0,0	RMT	surface	
PS69/475-10	28.06.06	22:13	61° 57,23' S	3° 4,53' E	0,0	RMT	Begin Trawling	SE72.1 453m ausgesteckt
PS69/475-10	28.06.06	22:41	61° 57,69' S	3° 2,16' E	0,0	RMT	End of Trawl	
PS69/475-10	28.06.06	22:45	61° 57,72' S	3° 2,02' E	1,0	RMT	on deck	
PS69/475-11	28.06.06	22:53	61° 57,83' S	3° 1,58' E	0,0	RMT	surface	
PS69/475-11	28.06.06	22:58	61° 57,89' S	3° 1,21' E	0,0	RMT	Begin Trawling	GE72.1 103m ausgesteckt
PS69/475-11	28.06.06	23:07	61° 57,99' S	3° 0,55' E	0,0	RMT	heave	
PS69/475-11	28.06.06	23:10	61° 58,03' S	3° 0,31' E	0,0	RMT	Begin Trawling	
PS69/475-11	28.06.06	23:18	61° 58,14' S	2° 59,84' E	0,0	RMT	heave	
PS69/475-11	28.06.06	23:20	61° 58,17' S	2° 59,69' E	0,0	RMT	End of Trawl	
PS69/475-11	28.06.06	23:25	61° 58,23' S	2° 59,45' E	0,0	RMT	on deck	
PS69/476-1	29.06.06	03:37	62° 30,24' S	3° 2,77' E	0,0	RMT	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/476-1	29.06.06	03:42	62° 30,15' S	3° 2,37' E	0,0	RMT	heave	Netz unklar
PS69/476-1	29.06.06	03:52	62° 30,03' S	3° 1,80' E	0,0	RMT	on deck	
PS69/476-1	29.06.06	04:00	62° 29,99' S	3° 1,29' E	0,0	RMT	surface	
PS69/476-1	29.06.06	04:10	62° 29,91' S	3° 0,41' E	0,0	RMT	heave	
PS69/476-1	29.06.06	04:12	62° 29,89' S	3° 0,22' E	0,0	RMT	Begin Trawling	
PS69/476-1	29.06.06	04:43	62° 29,65' S	2° 57,28' E	0,0	RMT	End of Trawl	
PS69/476-1	29.06.06	04:44	62° 29,64' S	2° 57,21' E	0,0	RMT	on deck	
PS69/476-2	29.06.06	05:00	62° 29,58' S	2° 57,18' E	5297,0	CTD/RO	surface	
PS69/476-2	29.06.06	06:44	62° 28,77' S	2° 59,33' E	5377,0	CTD/RO	at depth	Die Tiefe 5490 m, EL 31
PS69/476-2	29.06.06	08:16	62° 27,79' S	3° 0,98' E	0,0	CTD/RO	on deck	
PS69/476-3	29.06.06	08:35	62° 27,55' S	3° 1,30' E	0,0	MN	surface	
PS69/476-3	29.06.06	09:56	62° 26,61' S	3° 2,57' E	0,0	MN	at depth	2340m, EL 30
PS69/476-3	29.06.06	11:17	62° 25,62' S	3° 3,83' E	0,0	MN	on deck	
PS69/476-4	29.06.06	11:32	62° 25,47' S	3° 4,01' E	0,0	MN	surface	
PS69/476-4	29.06.06	12:11	62° 25,09' S	3° 4,68' E	0,0	MN	at depth	auf Tiefe: 1000m EL 30
PS69/476-4	29.06.06	12:48	62° 24,79' S	3° 5,01' E	0,0	MN	on deck	
PS69/476-5	29.06.06	12:58	62° 24,68' S	3° 5,09' E	0,0	CTD/RO	surface	
PS69/476-5	29.06.06	13:05	62° 24,59' S	3° 5,18' E	5378,0	CTD/RO	at depth	EL31, 246m
PS69/476-5	29.06.06	13:22	62° 24,39' S	3° 5,39' E	0,0	CTD/RO	on deck	
PS69/476-6	29.06.06	13:35	62° 24,22' S	3° 5,51' E	0,0	BONGO	surface	
PS69/476-6	29.06.06	13:47	62° 24,07' S	3° 5,61' E	0,0	BONGO	at depth	SE 32.2
PS69/476-6	29.06.06	14:02	62° 23,89' S	3° 5,71' E	0,0	BONGO	on deck	
PS69/476-7	29.06.06	14:14	62° 23,73' S	3° 5,76' E	0,0	MN	surface	
PS69/476-7	29.06.06	14:25	62° 23,62' S	3° 5,76' E	0,0	MN	at depth	Tiefe: 278, EL 30
PS69/476-7	29.06.06	14:36	62° 23,48' S	3° 5,82' E	0,0	MN	on deck	
PS69/476-8	29.06.06	15:12	62° 24,25' S	3° 4,72' E	0,0	RMT	surface	RMT-M
PS69/476-8	29.06.06	15:13	62° 24,28' S	3° 4,67' E	0,0	RMT	Begin Trawling	
PS69/476-8	29.06.06	15:33	62° 24,98' S	3° 3,60' E	0,0	RMT	heave	
PS69/476-8	29.06.06	16:15	62° 26,55' S	3° 1,46' E	0,0	RMT	End of Trawl	
PS69/476-8	29.06.06	16:24	62° 26,76' S	3° 1,32' E	0,0	RMT	on deck	
PS69/477-1	29.06.06	21:58	62° 59,45' S	3° 1,79' E	0,0	RMT	surface	
PS69/477-1	29.06.06	22:13	62° 59,55' S	3° 0,46' E	5369,2	RMT	Begin Trawling	
PS69/477-1	29.06.06	22:40	62° 59,97' S	2° 58,24' E	0,0	RMT	End of Trawl	
PS69/477-1	29.06.06	22:42	62° 59,98' S	2° 58,18' E	5369,0	RMT	on deck	
PS69/477-2	29.06.06	23:13	63° 0,29' S	2° 57,98' E	5369,0	CTD	surface	
PS69/477-2	30.06.06	00:40	62° 59,48' S	2° 59,43' E	0,0	CTD	at depth	Tiefe: 5411m, EL 31
PS69/477-2	30.06.06	02:18	62° 58,58' S	3° 0,73' E	0,0	CTD	on deck	
PS69/477-3	30.06.06	02:47	62° 58,33' S	3° 1,06' E	0,0	MN	surface	
PS69/477-3	30.06.06	03:24	62° 58,02' S	3° 1,44' E	0,0	MN	at depth	Tiefe: 1078m, EL 30
PS69/477-3	30.06.06	04:05	62° 57,70' S	3° 1,84' E	0,0	MN	on deck	
PS69/477-4	30.06.06	04:30	62° 57,99' S	3° 0,42' E	0,0	RMT	surface	RMT B'haven
PS69/477-4	30.06.06	04:34	62° 58,06' S	3° 0,11' E	0,0	RMT	Begin Trawling	
PS69/477-4	30.06.06	04:42	62° 58,19' S	2° 59,48' E	0,0	RMT	End of Trawl	
PS69/477-4	30.06.06	04:43	62° 58,20' S	2° 59,41' E	0,0	RMT	heave	
PS69/477-4	30.06.06	04:45	62° 58,22' S	2° 59,24' E	0,0	RMT	Begin Trawling	
PS69/477-4	30.06.06	04:54	62° 58,36' S	2° 58,56' E	0,0	RMT	End of Trawl	
PS69/477-4	30.06.06	04:54	62° 58,36' S	2° 58,56' E	0,0	RMT	heave	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/477-4	30.06.06	04:57	62° 58,39' S	2° 58,40' E	0,0	RMT	on deck	
PS69/478-1	30.06.06	10:13	63° 29,30' S	2° 55,20' E	4742,4	CTD	surface	
PS69/478-1	30.06.06	11:29	63° 28,58' S	2° 55,69' E	0,0	CTD	at depth	4745 m EL31
PS69/478-1	30.06.06	12:54	63° 27,87' S	2° 56,25' E	0,0	CTD	on deck	
PS69/478-2	30.06.06	13:10	63° 27,68' S	2° 56,63' E	0,0	MN	surface	
PS69/478-3	30.06.06	14:12	63° 27,15' S	2° 57,32' E	0,0	HN	surface	
PS69/478-3	30.06.06	14:17	63° 27,11' S	2° 57,38' E	0,0	HN	on deck	
PS69/478-2	30.06.06	14:23	63° 27,05' S	2° 57,46' E	0,0	MN	at depth	Tiefe: 2198m, EL 30
PS69/478-2	30.06.06	15:42	63° 26,47' S	2° 57,64' E	0,0	MN	on deck	
PS69/478-4	30.06.06	15:52	63° 26,38' S	2° 57,73' E	0,0	MN	surface	
PS69/478-4	30.06.06	16:29	63° 26,00' S	2° 58,04' E	0,0	MN	at depth	Die Tiefe 1107 m, EL30
PS69/478-4	30.06.06	17:09	63° 25,58' S	2° 58,44' E	0,0	MN	on deck	
PS69/478-5	30.06.06	17:24	63° 25,42' S	2° 58,62' E	0,0	BONGO	surface	
PS69/478-5	30.06.06	17:37	63° 25,28' S	2° 58,76' E	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/478-5	30.06.06	17:51	63° 25,13' S	2° 58,92' E	0,0	BONGO	on deck	
PS69/478-6	30.06.06	17:54	63° 25,09' S	2° 58,95' E	0,0	BONGO	surface	
PS69/478-6	30.06.06	18:05	63° 24,97' S	2° 59,07' E	0,0	BONGO	at depth	Die Tie fe 200 m, SE 32.2
PS69/478-6	30.06.06	18:16	63° 24,85' S	2° 59,19' E	1,0	BONGO	on deck	
PS69/478-7	30.06.06	19:05	63° 24,34' S	2° 59,46' E	0,0	SUIT	surface	
PS69/478-7	30.06.06	19:41	63° 24,08' S	2° 59,31' E	0,0	SUIT	on deck	Abbruch
PS69/478-8	30.06.06	20:19	63° 23,86' S	2° 59,22' E	4783,0	RMT	surface	
PS69/478-8	30.06.06	20:36	63° 24,38' S	2° 58,10' E	0,0	RMT	Begin Trawling	
PS69/478-8	30.06.06	21:05	63° 25,19' S	2° 56,17' E	0,0	RMT	End of Trawl	
PS69/478-8	30.06.06	21:08	63° 25,24' S	2° 56,03' E	4783,0	RMT	on deck	
PS69/478-9	30.06.06	21:13	63° 25,32' S	2° 55,77' E	0,0	RMT	surface	
PS69/478-9	30.06.06	21:16	63° 25,38' S	2° 55,58' E	0,0	RMT	heave	
PS69/478-9	30.06.06	21:29	63° 25,69' S	2° 54,84' E	0,0	RMT	Begin Trawling	
PS69/478-9	30.06.06	21:38	63° 25,87' S	2° 54,19' E	0,0	RMT	End of Trawl	
PS69/478-9	30.06.06	21:43	63° 25,96' S	2° 53,96' E	4783,0	RMT	on deck	
PS69/479-1	01.07.06	03:53	63° 59,56' S	3° 0,95' E	0,0	RMT	surface	
PS69/479-1	01.07.06	04:01	63° 59,67' S	3° 0,54' E	0,0	RMT	heave	
PS69/479-1	01.07.06	04:25	63° 59,77' S	2° 59,53' E	0,0	RMT	on deck	Abbruch
PS69/479-2	01.07.06	05:40	64° 0,90' S	3° 0,41' E	2824,0	CTD/RO	surface	
PS69/479-2	01.07.06	06:35	64° 0,23' S	3° 0,54' E	2829,0	CTD/RO	at depth	Die Tiefe 2785 m, EL31
PS69/479-2	01.07.06	07:33	63° 59,58' S	3° 0,57' E	0,0	CTD/RO	on deck	
PS69/479-3	01.07.06	07:53	63° 59,37' S	3° 0,55' E	0,0	MN	surface	
PS69/479-3	01.07.06	08:23	63° 59,07' S	3° 0,50' E	0,0	MN	at depth	EL30, 1091m
PS69/479-3	01.07.06	09:09	63° 58,65' S	3° 0,41' E	0,0	MN	on deck	
PS69/479-4	01.07.06	09:25	0° 0,00' N	0° 0,00' E	0,0	NFLOAT	surface	
PS69/479-5	01.07.06	10:30	63° 59,50' S	3° 5,00' E	0,0	RMT	surface	RMT-HH
PS69/479-5	01.07.06	11:30	63° 59,60' S	3° 1,80' E	0,0	RMT	on deck	
PS69/479-6	01.07.06	12:50	63° 58,46' S	3° 6,80' E	0,0	RMT	surface	RMT-Bh
PS69/479-6	01.07.06	13:08	63° 58,55' S	3° 5,32' E	0,0	RMT	Begin Trawling	FN 62.2
PS69/479-6	01.07.06	13:55	63° 58,52' S	3° 2,71' E	0,0	RMT	on deck	
PS69/479-7	01.07.06	14:03	63° 58,93' S	3° 0,06' E	0,0	SUIT	surface	
PS69/479-7	01.07.06	14:07	63° 58,96' S	2° 59,97' E	0,0	SUIT	Information	Gewicht zu Wasser, FN 62.2

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/479-7	01.07.06	14:47	63° 58,81' S	2° 57,13' E	0,0	SUIT	Information	Gewicht an Deck
PS69/479-7	01.07.06	14:53	63° 58,78' S	2° 57,00' E	0,0	SUIT	on deck	
PS69/480-1	01.07.06	21:30	64° 30,19' S	2° 59,67' E	0,0	RMT	surface	
PS69/480-1	01.07.06	21:45	64° 30,72' S	2° 59,07' E	0,0	RMT	Begin Trawling	
PS69/480-1	01.07.06	22:07	64° 31,48' S	2° 58,38' E	0,0	RMT	End of Trawl	
PS69/480-1	01.07.06	22:09	64° 31,51' S	2° 58,35' E	2000,0	RMT	on deck	
PS69/480-2	01.07.06	22:52	64° 32,10' S	2° 57,10' E	2127,0	CTD	surface	
PS69/480-2	01.07.06	23:25	64° 32,11' S	2° 57,09' E	0,0	CTD	at depth	2054m, EL31
PS69/480-2	02.07.06	00:09	64° 32,06' S	2° 56,83' E	0,0	CTD	on deck	
PS69/480-3	02.07.06	00:24	64° 32,09' S	2° 56,79' E	0,0	MN	surface	
PS69/480-4	02.07.06	00:55	64° 32,11' S	2° 56,78' E	0,0	HN	surface	
PS69/480-3	02.07.06	00:58	64° 32,11' S	2° 56,77' E	0,0	MN	at depth	Tiefe: 1000m, EL 30
PS69/480-4	02.07.06	00:59	64° 32,11' S	2° 56,77' E	0,0	HN	on deck	
PS69/480-3	02.07.06	01:35	64° 32,19' S	2° 56,73' E	0,0	MN	on deck	
PS69/480-5	02.07.06	01:44	64° 32,22' S	2° 56,73' E	0,0	CTD/RO	surface	
PS69/480-5	02.07.06	01:51	64° 32,24' S	2° 56,73' E	0,0	CTD/RO	at depth	Tiefe: 246m, EL 31
PS69/480-5	02.07.06	02:07	64° 32,28' S	2° 56,73' E	0,0	CTD/RO	on deck	
PS69/480-6	02.07.06	02:13	64° 32,30' S	2° 56,73' E	0,0	MN	surface	
PS69/480-6	02.07.06	02:30	64° 32,35' S	2° 56,74' E	0,0	MN	at depth	Tiefe: 261m , EL 30
PS69/480-6	02.07.06	02:48	64° 32,41' S	2° 56,76' E	0,0	MN	on deck	
PS69/480-7	02.07.06	02:58	64° 32,44' S	2° 56,78' E	0,0	BONGO	surface	
PS69/480-7	02.07.06	03:12	64° 32,48' S	2° 56,81' E	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/480-7	02.07.06	03:25	64° 32,53' S	2° 56,84' E	0,0	BONGO	on deck	
PS69/480-8	02.07.06	03:39	64° 32,62' S	2° 56,98' E	0,0	NFLOAT	surface	
PS69/480-9	02.07.06	03:47	64° 32,71' S	2° 57,42' E	0,0	RMT	surface	
PS69/480-9	02.07.06	03:51	64° 32,73' S	2° 57,49' E	0,0	RMT	Begin Trawling	kabellänge: 100m
PS69/480-9	02.07.06	04:05	64° 32,86' S	2° 58,60' E	0,0	RMT	End of Trawl	
PS69/480-9	02.07.06	04:11	64° 32,89' S	2° 59,03' E	0,0	RMT	on deck	
PS69/481-1	02.07.06	10:36	65° 1,10' S	0° 0,00' E	0,0	RMT	surface	
PS69/481-1	02.07.06	10:54	65° 1,70' S	2° 56,50' E	0,0	RMT	Begin Trawling	GE72.1, 460m
PS69/481-1	02.07.06	11:18	65° 2,70' S	2° 58,10' E	0,0	RMT	End of Trawl	
PS69/481-1	02.07.06	11:22	65° 2,50' S	2° 58,30' E	0,0	RMT	on deck	
PS69/481-2	02.07.06	11:52	65° 2,50' S	2° 59,00' E	0,0	CTD	surface	
PS69/481-2	02.07.06	12:31	65° 2,50' S	2° 58,70' E	14,0	CTD	at depth	EL31, 1554m
PS69/481-2	02.07.06	13:02	65° 2,60' S	2° 58,29' E	1407,6	CTD	on deck	
PS69/481-1	02.07.06	13:02	65° 2,60' S	2° 58,29' E	1407,6	RMT	surface	
PS69/481-3	02.07.06	13:12	65° 2,66' S	2° 58,26' E	0,0	MN	surface	
PS69/481-3	02.07.06	13:47	65° 2,89' S	2° 58,19' E	0,0	MN	at depth	Tiefe: 1062m, EL 30
PS69/481-3	02.07.06	14:31	65° 3,19' S	2° 58,16' E	0,0	MN	on deck	
PS69/481-4	02.07.06	14:41	65° 3,25' S	2° 58,16' E	0,0	MN	surface	
PS69/481-4	02.07.06	15:27	65° 3,55' S	2° 58,27' E	1756,8	MN	at depth	Tiefe: 1328m, EL 30
PS69/481-4	02.07.06	16:14	65° 3,86' S	2° 58,33' E	1838,0	MN	on deck	
PS69/481-5	02.07.06	16:23	65° 3,94' S	2° 58,36' E	0,0	BONGO	surface	
PS69/481-5	02.07.06	16:37	65° 4,00' S	2° 58,42' E	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/481-5	02.07.06	16:51	65° 4,08' S	2° 58,48' E	0,0	BONGO	on deck	
PS69/481-6	02.07.06	17:02	65° 4,15' S	2° 58,54' E	0,0	RMT	surface	RMT-B'haven
PS69/481-6	02.07.06	17:05	65° 4,12' S	2° 58,59' E	0,0	RMT	Begin Trawling	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/481-6	02.07.06	17:20	65° 3,62' S	2° 58,51' E	0,0	RMT	End of Trawl	
PS69/481-6	02.07.06	17:27	65° 3,44' S	2° 58,27' E	0,0	RMT	on deck	
PS69/482-1	02.07.06	22:38	65° 29,14' S	2° 56,23' E	0,0	SUIT	surface	
PS69/482-1	02.07.06	22:39	65° 29,13' S	2° 56,30' E	0,0	SUIT	Information	Gewicht zu Wasser
PS69/482-1	02.07.06	22:43	65° 29,11' S	2° 56,53' E	0,0	SUIT	stop trawl	
PS69/482-1	02.07.06	23:22	65° 27,68' S	2° 56,98' E	0,0	SUIT	Information	Gewicht an Deck
PS69/482-1	02.07.06	23:29	65° 27,64' S	2° 57,13' E	2422,0	SUIT	on deck	
PS69/482-2	03.07.06	00:34	65° 30,52' S	3° 2,99' E	0,0	RMT	surface	
PS69/482-2	03.07.06	00:52	65° 30,48' S	3° 1,60' E	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/482-2	03.07.06	01:21	65° 30,20' S	2° 59,27' E	0,0	RMT	on deck	
PS69/482-3	03.07.06	01:43	65° 30,21' S	2° 58,85' E	1981,6	CTD/RO	surface	
PS69/482-3	03.07.06	02:34	65° 30,49' S	2° 59,28' E	2646,8	CTD/RO	at depth	Tiefe: 2578m, EL31
PS69/482-3	03.07.06	03:23	65° 30,70' S	2° 59,27' E	2636,8	CTD/RO	on deck	
PS69/482-4	03.07.06	03:48	65° 30,87' S	2° 59,38' E	0,0	MN	surface	
PS69/482-4	03.07.06	05:02	65° 31,33' S	3° 0,73' E	0,0	MN	at depth	Die Tiefe 2151 m, EL 30
PS69/482-4	03.07.06	06:19	65° 31,77' S	3° 2,13' E	0,0	MN	on deck	
PS69/482-5	03.07.06	06:28	65° 31,81' S	3° 2,29' E	0,0	MN	surface	
PS69/482-5	03.07.06	07:05	65° 31,94' S	3° 2,98' E	0,0	MN	at depth	Die Tiefe 1071 m, EL 30
PS69/482-5	03.07.06	07:42	65° 32,02' S	3° 3,64' E	0,0	MN	on deck	
PS69/483-1	03.07.06	14:25	66° 0,57' S	2° 58,25' E	0,0	BONGO	surface	
PS69/483-2	03.07.06	14:39	66° 0,56' S	2° 58,25' E	0,0	HN	surface	
PS69/483-1	03.07.06	14:40	66° 0,57' S	2° 58,25' E	0,0	BONGO	at depth	Tiefe: 195m, SE 32.2
PS69/483-2	03.07.06	14:43	66° 0,59' S	2° 58,22' E	0,0	HN	on deck	
PS69/483-1	03.07.06	14:54	66° 0,65' S	2° 58,19' E	0,0	BONGO	on deck	
PS69/483-3	03.07.06	15:05	66° 0,68' S	2° 58,44' E	3448,8	CTD/RO	surface	
PS69/483-3	03.07.06	16:01	66° 0,87' S	2° 59,75' E	3366,0	CTD/RO	at depth	Die Tiefe 3214 m, EL 31
PS69/483-3	03.07.06	17:02	66° 1,08' S	3° 1,15' E	0,0	CTD/RO	on deck	
PS69/483-4	03.07.06	17:17	66° 1,12' S	3° 1,48' E	0,0	MN	surface	
PS69/483-4	03.07.06	17:53	66° 1,26' S	3° 2,16' E	0,0	MN	at depth	Die Tiefe 1073 m, EL 30
PS69/483-4	03.07.06	18:30	66° 1,37' S	3° 2,95' E	0,0	MN	on deck	
PS69/483-5	03.07.06	18:43	66° 1,42' S	3° 3,21' E	0,0	MN	surface	
PS69/483-5	03.07.06	18:57	66° 1,45' S	3° 3,48' E	0,0	MN	at depth	Die Tiefe 265 m, EL 30
PS69/483-5	03.07.06	19:15	66° 1,47' S	3° 3,84' E	0,0	MN	Error - Restart	
PS69/483-5	03.07.06	19:29	66° 1,48' S	3° 4,14' E	0,0	MN	at depth	Die Tiefe 266 m, EL 30
PS69/483-5	03.07.06	19:47	66° 1,48' S	3° 4,51' E	0,0	MN	on deck	
PS69/483-6	03.07.06	19:54	66° 1,48' S	3° 4,61' E	3554,0	CTD/RO	surface	
PS69/483-6	03.07.06	20:02	66° 1,47' S	3° 4,74' E	3665,2	CTD/RO	at depth	EL31,245m
PS69/483-6	03.07.06	20:19	66° 1,44' S	3° 4,97' E	3544,0	CTD/RO	on deck	
PS69/483-7	03.07.06	20:35	66° 1,35' S	3° 5,79' E	3544,0	NFLOAT	surface	
PS69/483-8	03.07.06	21:01	66° 1,75' S	3° 6,35' E	0,0	RMT	surface	
PS69/483-8	03.07.06	21:18	66° 1,37' S	3° 4,88' E	0,0	RMT	heave	FN62.2, 462m
PS69/483-8	03.07.06	21:47	66° 0,86' S	3° 3,22' E	0,0	RMT	on deck	
PS69/483-9	03.07.06	22:37	66° 0,89' S	3° 5,37' E	0,0	RMT	surface	
PS69/483-9	03.07.06	22:41	66° 0,85' S	3° 5,17' E	0,0	RMT	Begin Trawling	70 m
PS69/483-9	03.07.06	22:55	66° 0,64' S	3° 4,02' E	0,0	RMT	End of Trawl	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/483-9	03.07.06	23:03	66° 0,41' S	3° 3,58' E	3544,0	RMT	on deck	
PS69/484-1	04.07.06	05:25	66° 29,89' S	3° 1,69' E	0,0	RMT	surface	
PS69/484-1	04.07.06	05:42	66° 29,68' S	3° 0,26' E	0,0	RMT	heave	
PS69/484-1	04.07.06	06:08	66° 29,52' S	2° 57,62' E	0,0	RMT	on deck	
PS69/484-2	04.07.06	06:25	66° 29,50' S	2° 57,49' E	3738,4	CTD/RO	surface	
PS69/484-2	04.07.06	07:35	66° 29,58' S	2° 58,44' E	3760,0	CTD/RO	at depth	Die Tiefe 3679 m, EL31
PS69/484-2	04.07.06	08:36	66° 29,62' S	2° 59,20' E	0,0	CTD/RO	on deck	
PS69/484-3	04.07.06	08:53	66° 29,63' S	2° 59,42' E	0,0	MN	surface	
PS69/484-3	04.07.06	09:28	66° 29,66' S	2° 59,88' E	0,0	MN	at depth	EL30,1060m
PS69/484-3	04.07.06	10:05	66° 29,66' S	3° 0,31' E	0,0	MN	on deck	
PS69/484-4	04.07.06	10:19	66° 30,06' S	3° 0,32' E	0,0	NFLOAT	surface	
PS69/485-1	04.07.06	16:51	66° 59,30' S	3° 2,32' E	3291,6	CTD/RO	surface	
PS69/485-2	04.07.06	17:24	66° 59,31' S	3° 2,40' E	3286,4	HN	surface	
PS69/485-1	04.07.06	17:53	66° 59,32' S	3° 2,50' E	3280,0	CTD/RO	at depth	Die Tiefe 3202 m, EL 31
PS69/485-2	04.07.06	18:02	66° 59,32' S	3° 2,54' E	3277,6	HN	on deck	
PS69/485-1	04.07.06	18:58	66° 59,36' S	3° 2,85' E	0,0	CTD/RO	on deck	
PS69/485-3	04.07.06	19:19	66° 59,38' S	3° 2,99' E	0,0	MN	surface	
PS69/485-3	04.07.06	19:55	66° 59,39' S	3° 3,25' E	0,0	MN	at depth	Die TIe fe 1052 m, EL30
PS69/485-3	04.07.06	20:36	66° 59,38' S	3° 3,56' E	0,0	MN	on deck	
PS69/485-4	04.07.06	20:39	66° 59,38' S	3° 3,59' E	0,0	MN	surface	
PS69/485-4	04.07.06	22:05	66° 59,27' S	3° 4,34' E	0,0	MN	at depth	EL30, 2096m
PS69/485-4	04.07.06	23:22	66° 59,07' S	3° 4,85' E	0,0	MN	on deck	
PS69/485-5	04.07.06	23:39	66° 59,02' S	3° 4,92' E	0,0	BONGO	surface	
PS69/485-5	04.07.06	23:52	66° 58,98' S	3° 4,97' E	0,0	BONGO	at depth	EL30, 200m
PS69/485-5	05.07.06	00:07	66° 58,92' S	3° 5,01' E	0,0	BONGO	on deck	
PS69/485-6	05.07.06	00:14	66° 58,90' S	3° 5,03' E	0,0	MN	surface	
PS69/485-6	05.07.06	00:29	66° 58,84' S	3° 5,06' E	0,0	MN	at depth	Tiefe: 263, EL 30
PS69/485-6	05.07.06	00:47	66° 58,78' S	3° 5,08' E	0,0	MN	on deck	
PS69/485-7	05.07.06	00:55	66° 58,75' S	3° 5,09' E	0,0	CTD/RO	surface	
PS69/485-7	05.07.06	01:02	66° 58,72' S	3° 5,10' E	0,0	CTD/RO	at depth	Tiefe: 246m, EL31
PS69/485-7	05.07.06	01:17	66° 58,66' S	3° 5,10' E	0,0	CTD/RO	on deck	
PS69/486-1	05.07.06	07:41	67° 27,50' S	2° 55,17' E	0,0	RMT	surface	
PS69/486-1	05.07.06	07:58	67° 28,23' S	2° 54,68' E	0,0	RMT	heave	
PS69/486-1	05.07.06	08:31	67° 28,85' S	2° 51,71' E	0,0	RMT	on deck	
PS69/486-2	05.07.06	09:12	67° 27,19' S	2° 54,47' E	0,0	RMT	surface	
PS69/486-2	05.07.06	09:16	67° 27,30' S	2° 54,46' E	0,0	RMT	Begin Trawling	
PS69/486-2	05.07.06	09:29	67° 27,76' S	2° 54,17' E	0,0	RMT	heave	FN62.2, 101m
PS69/486-2	05.07.06	09:36	67° 27,95' S	2° 53,87' E	0,0	RMT	on deck	
PS69/486-3	05.07.06	09:58	67° 27,93' S	2° 53,48' E	0,0	CTD	surface	
PS69/486-4	05.07.06	10:43	67° 27,52' S	2° 54,01' E	4564,0	HN	surface	
PS69/486-4	05.07.06	11:00	67° 27,39' S	2° 53,97' E	4563,6	HN	on deck	
PS69/486-3	05.07.06	11:11	67° 27,31' S	2° 53,95' E	4563,6	CTD	at depth	EL31, 4508m
PS69/486-3	05.07.06	12:24	67° 26,78' S	2° 53,87' E	0,0	CTD	on deck	
PS69/486-5	05.07.06	12:31	67° 26,72' S	2° 53,86' E	0,0	MN	surface	
PS69/486-5	05.07.06	13:09	67° 26,39' S	2° 53,74' E	0,0	MN	at depth	Tiefe: 1084, EL30
PS69/486-5	05.07.06	13:47	67° 26,09' S	2° 53,63' E	0,0	MN	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/486-6	05.07.06	14:02	67° 26,09' S	2° 53,23' E	0,0	SUIT	surface	
PS69/486-6	05.07.06	14:04	67° 26,10' S	2° 53,03' E	0,0	SUIT	slipped	
PS69/486-6	05.07.06	14:07	67° 26,12' S	2° 52,83' E	0,0	SUIT	Information	Gewicht zu Wasser
PS69/486-6	05.07.06	14:12	67° 26,15' S	2° 52,47' E	0,0	SUIT	start trawl	Kabellänge: 120m
PS69/486-6	05.07.06	14:34	67° 26,66' S	2° 51,34' E	0,0	SUIT	stop trawl	
PS69/486-6	05.07.06	14:41	67° 26,64' S	2° 51,27' E	0,0	SUIT	Information	Gewicht an Deck
PS69/486-6	05.07.06	14:48	67° 26,59' S	2° 51,23' E	0,0	SUIT	on deck	
PS69/487-1	05.07.06	21:58	67° 56,50' S	2° 57,69' E	0,0	RMT	surface	
PS69/487-1	05.07.06	22:00	67° 56,54' S	2° 57,88' E	0,0	RMT	Begin Trawling	
PS69/487-1	05.07.06	22:04	67° 56,61' S	2° 58,28' E	0,0	RMT	heave	FN62.2, 458m
PS69/487-1	05.07.06	22:32	67° 57,27' S	3° 0,89' E	0,0	RMT	on deck	
PS69/487-2	05.07.06	22:46	67° 57,27' S	3° 1,05' E	4548,8	CTD/RO	surface	
PS69/487-3	05.07.06	23:28	67° 57,23' S	3° 1,31' E	4548,0	HN	surface	
PS69/487-3	05.07.06	23:40	67° 57,21' S	3° 1,36' E	4548,0	HN	on deck	
PS69/487-2	05.07.06	23:57	67° 57,18' S	3° 1,42' E	4547,6	CTD/RO	at depth	EL31, 4470m
PS69/487-2	06.07.06	01:15	67° 57,00' S	3° 1,54' E	0,0	CTD/RO	on deck	
PS69/487-4	06.07.06	01:23	67° 56,95' S	3° 1,47' E	0,0	MN	surface	
PS69/487-4	06.07.06	01:59	67° 56,88' S	3° 1,49' E	0,0	MN	at depth	Tiefe: 1053m, EL30
PS69/487-4	06.07.06	02:39	67° 56,82' S	3° 1,41' E	0,0	MN	on deck	
PS69/487-5	06.07.06	02:48	67° 56,77' S	3° 1,38' E	0,0	MN	surface	
PS69/487-5	06.07.06	03:57	67° 56,61' S	3° 1,02' E	0,0	MN	at depth	Tiefe: 2096m, EL 30
PS69/487-5	06.07.06	05:12	67° 56,48' S	3° 0,47' E	0,0	MN	on deck	
PS69/487-6	06.07.06	05:20	67° 56,48' S	3° 0,40' E	0,0	BONGO	surface	
PS69/487-6	06.07.06	05:33	67° 56,47' S	3° 0,27' E	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/487-6	06.07.06	05:47	67° 56,47' S	3° 0,15' E	0,0	BONGO	on deck	
PS69/487-7	06.07.06	05:56	67° 56,45' S	3° 0,10' E	0,0	MN	surface	
PS69/487-7	06.07.06	06:05	67° 56,45' S	3° 0,00' E	0,0	MN	at depth	Die Tiefe 263 m, EL 30
PS69/487-7	06.07.06	06:18	67° 56,45' S	2° 59,90' E	0,0	MN	on deck	
PS69/487-8	06.07.06	06:28	67° 56,45' S	2° 59,82' E	0,0	CTD/RO	surface	
PS69/487-8	06.07.06	06:36	67° 56,45' S	2° 59,75' E	4548,4	CTD/RO	at depth	Die Tiefe 245 m, EL31
PS69/487-8	06.07.06	06:52	67° 56,46' S	2° 59,61' E	0,0	CTD/RO	on deck	
PS69/487-9	06.07.06	07:26	67° 57,79' S	3° 1,60' E	0,0	RMT	surface	
PS69/487-9	06.07.06	07:54	67° 57,10' S	3° 0,01' E	0,0	RMT	Begin Trawling	
PS69/487-9	06.07.06	08:54	67° 56,11' S	2° 56,85' E	0,0	RMT	on deck	
PS69/488-1	06.07.06	16:02	68° 32,08' S	2° 55,77' E	0,0	RMT	surface	
PS69/488-1	06.07.06	16:20	68° 32,43' S	2° 57,35' E	0,0	RMT	heave	
PS69/488-1	06.07.06	16:48	68° 33,23' S	2° 59,20' E	0,0	RMT	on deck	
PS69/488-2	06.07.06	17:47	68° 32,19' S	2° 55,20' E	4121,2	CTD/RO	surface	
PS69/488-2	06.07.06	19:11	68° 32,32' S	2° 53,94' E	4135,2	CTD/RO	at depth	Die Tiefe 4061 m, EL 31
PS69/488-2	06.07.06	20:26	68° 32,50' S	2° 52,84' E	0,0	CTD/RO	on deck	
PS69/488-3	06.07.06	20:35	68° 32,53' S	2° 52,73' E	0,0	MN	surface	
PS69/488-3	06.07.06	21:12	68° 32,64' S	2° 52,25' E	0,0	MN	at depth	EL30,1044m
PS69/488-3	06.07.06	21:51	68° 32,77' S	2° 51,80' E	0,0	MN	on deck	
PS69/488-4	06.07.06	22:05	68° 32,64' S	2° 51,44' E	0,0	SUIT	surface	
PS69/488-4	06.07.06	22:06	68° 32,63' S	2° 51,42' E	0,0	SUIT	slipped	
PS69/488-4	06.07.06	22:16	68° 32,49' S	2° 51,06' E	0,0	SUIT	start trawl	FN62.2, 120m
PS69/488-4	06.07.06	22:38	68° 32,11' S	2° 50,20' E	0,0	SUIT	stop trawl	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/488-4	06.07.06	22:53	68° 32,11' S	2° 49,95' E	0,0	SUIT	on deck	
PS69/489-1	07.07.06	06:17	68° 58,10' S	2° 59,89' E	0,0	RMT	surface	
PS69/489-1	07.07.06	06:37	68° 57,97' S	2° 58,02' E	0,0	RMT	heave	
PS69/489-1	07.07.06	07:07	68° 57,57' S	2° 55,07' E	0,0	RMT	on deck	
PS69/489-2	07.07.06	07:33	68° 57,68' S	2° 55,07' E	3763,6	CTD/RO	surface	
PS69/489-3	07.07.06	08:13	68° 57,72' S	2° 54,45' E	3768,4	HN	surface	
PS69/489-3	07.07.06	08:23	68° 57,72' S	2° 54,31' E	3767,2	HN	on deck	
PS69/489-2	07.07.06	08:47	68° 57,71' S	2° 54,00' E	3770,4	CTD/RO	at depth	EL31, 3687m
PS69/489-2	07.07.06	09:53	68° 57,68' S	2° 53,14' E	0,0	CTD/RO	on deck	
PS69/489-4	07.07.06	10:39	68° 57,66' S	2° 52,59' E	0,0	MN	surface	
PS69/489-4	07.07.06	11:14	68° 57,64' S	2° 52,20' E	0,0	MN	at depth	El30, 1051m
PS69/489-4	07.07.06	11:53	68° 57,60' S	2° 51,78' E	0,0	MN	on deck	
PS69/490-1	07.07.06	18:45	69° 31,05' S	3° 12,73' E	0,0	SUIT	surface	
PS69/490-1	07.07.06	18:55	69° 31,24' S	3° 11,11' E	0,0	SUIT	start trawl	
PS69/490-1	07.07.06	19:25	69° 30,41' S	3° 10,01' E	0,0	SUIT	stop trawl	
PS69/490-1	07.07.06	19:27	69° 30,38' S	3° 9,91' E	0,0	SUIT	slipped	Gewicht aus dem Wasser
PS69/490-1	07.07.06	19:41	69° 30,20' S	3° 9,52' E	0,0	SUIT	on deck	
PS69/490-2	07.07.06	20:28	69° 28,85' S	3° 9,11' E	0,0	RMT	surface	
PS69/490-2	07.07.06	20:43	69° 29,46' S	3° 9,15' E	0,0	RMT	heave	FN62.2, 460m
PS69/490-2	07.07.06	21:15	69° 30,37' S	3° 9,33' E	0,0	RMT	on deck	
PS69/490-3	07.07.06	21:48	69° 31,28' S	3° 10,07' E	0,0	CTD/RO	surface	
PS69/490-4	07.07.06	21:53	69° 31,28' S	3° 10,06' E	0,0	HN	surface	
PS69/490-4	07.07.06	22:08	69° 31,25' S	3° 10,13' E	0,0	HN	on deck	
PS69/490-3	07.07.06	22:21	69° 31,23' S	3° 10,15' E	1924,0	CTD/RO	at depth	1864m, EL31
PS69/490-3	07.07.06	22:57	69° 31,17' S	3° 10,25' E	0,0	CTD/RO	on deck	
PS69/490-5	07.07.06	23:05	69° 31,15' S	3° 10,27' E	0,0	MN	surface	
PS69/490-5	07.07.06	23:36	69° 31,11' S	3° 10,28' E	0,0	MN	at depth	EL30, 1051m
PS69/490-5	08.07.06	00:11	69° 31,04' S	3° 10,32' E	0,0	MN	on deck	
PS69/491-1	08.07.06	12:45	70° 0,40' S	3° 4,00' E	0,0	RMT	surface	
PS69/491-1	08.07.06	13:02	70° 0,40' S	3° 2,00' E	0,0	RMT	heave	
PS69/491-1	08.07.06	13:27	70° 0,17' S	2° 59,06' E	0,0	RMT	on deck	
PS69/491-2	08.07.06	14:02	69° 59,89' S	3° 0,31' E	492,4	CTD/RO	surface	
PS69/491-3	08.07.06	14:06	69° 59,89' S	3° 0,26' E	493,2	HN	surface	
PS69/491-2	08.07.06	14:11	69° 59,89' S	3° 0,22' E	494,4	CTD/RO	at depth	Tiefe:337m, EL31
PS69/491-3	08.07.06	14:12	69° 59,89' S	3° 0,22' E	494,0	HN	on deck	
PS69/491-2	08.07.06	14:18	69° 59,89' S	3° 0,17' E	492,0	CTD/RO	on deck	
PS69/491-4	08.07.06	14:45	69° 59,91' S	3° 0,02' E	483,6	BONGO	surface	
PS69/491-4	08.07.06	14:58	69° 59,91' S	2° 59,93' E	480,4	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/491-4	08.07.06	15:12	69° 59,89' S	2° 59,85' E	479,2	BONGO	on deck	
PS69/491-5	08.07.06	15:20	69° 59,90' S	2° 59,80' E	479,2	CTD/RO	surface	
PS69/491-5	08.07.06	15:31	69° 59,90' S	2° 59,74' E	476,8	CTD/RO	at depth	Tiefe: 442m, EL31
PS69/491-5	08.07.06	15:45	69° 59,90' S	2° 59,61' E	477,6	CTD/RO	on deck	
PS69/491-6	08.07.06	16:15	70° 0,71' S	3° 1,19' E	441,2	SUIT	surface	
PS69/491-6	08.07.06	16:16	70° 0,71' S	3° 1,21' E	441,2	SUIT	slipped	
PS69/491-6	08.07.06	16:20	70° 0,72' S	3° 1,32' E	442,8	SUIT	Information	Gewicht zu Wasser
PS69/491-6	08.07.06	16:25	70° 0,80' S	3° 1,69' E	442,0	SUIT	start trawl	
PS69/491-6	08.07.06	16:42	70° 0,79' S	3° 2,99' E	466,0	SUIT	stop trawl	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/491-6	08.07.06	16:48	70° 0,77' S	3° 3,18' E	474,4	SUIT	Information	Gewicht an Deck
PS69/491-6	08.07.06	18:04	70° 0,84' S	3° 3,55' E	480,4	SUIT	on deck	
PS69/491-7	08.07.06	19:09	70° 0,74' S	3° 3,40' E	487,2	CTD/RO	surface	
PS69/491-7	08.07.06	19:17	70° 0,74' S	3° 3,33' E	484,4	CTD/RO	at depth	Die Tiefe 250 m, EL 31
PS69/491-7	08.07.06	19:33	70° 0,74' S	3° 3,18' E	476,8	CTD/RO	on deck	
PS69/491-8	08.07.06	19:39	70° 0,74' S	3° 3,14' E	474,8	MN	surface	
PS69/491-8	08.07.06	19:49	70° 0,74' S	3° 3,08' E	474,8	MN	at depth	Die Tiefe 275m, EL 30
PS69/491-8	08.07.06	20:04	70° 0,74' S	3° 2,95' E	471,2	MN	on deck	
PS69/491-9	08.07.06	20:17	70° 0,74' S	3° 2,90' E	0,0	MN	surface	
PS69/491-9	08.07.06	20:32	70° 0,73' S	3° 2,83' E	0,0	MN	at depth	EL30, 421m
PS69/491-9	08.07.06	20:49	70° 0,73' S	3° 2,77' E	0,0	MN	on deck	
PS69/491-10	08.07.06	20:59	70° 0,73' S	3° 2,73' E	0,0	MN	surface	
PS69/491-10	08.07.06	21:16	70° 0,73' S	3° 2,71' E	0,0	MN	at depth	460m,EL30
PS69/491-10	08.07.06	21:30	70° 0,72' S	3° 2,67' E	0,0	MN	on deck	
PS69/491-11	08.07.06	21:49	70° 0,63' S	3° 3,38' E	0,0	RMT	surface	
PS69/491-11	08.07.06	21:51	70° 0,63' S	3° 3,47' E	0,0	RMT	Begin Trawling	FN62.2,70m
PS69/491-11	08.07.06	22:10	70° 0,59' S	3° 5,32' E	0,0	RMT	End of Trawl	
PS69/491-11	08.07.06	22:14	70° 0,58' S	3° 5,75' E	0,0	RMT	on deck	
PS69/492-1	11.07.06	11:12	68° 28,70' S	0° 4,94' E	0,0	RMT	surface	
PS69/492-1	11.07.06	11:20	68° 28,93' S	0° 5,21' E	0,0	RMT	Begin Trawling	
PS69/492-1	11.07.06	11:28	68° 29,18' S	0° 5,51' E	0,0	RMT	heave	FN62.2, 460m
PS69/492-1	11.07.06	11:57	68° 29,67' S	0° 7,65' E	0,0	RMT	on deck	
PS69/492-2	11.07.06	12:25	68° 29,49' S	0° 7,27' E	4286,0	CTD/RO	surface	
PS69/492-2	11.07.06	12:45	68° 29,38' S	0° 7,21' E	0,0	CTD/RO	at depth	Tiefe: 986m, EL 31
PS69/492-3	11.07.06	12:46	68° 29,38' S	0° 7,20' E	0,0	HN	surface	
PS69/492-3	11.07.06	12:52	68° 29,35' S	0° 7,19' E	0,0	HN	on deck	
PS69/492-2	11.07.06	13:06	68° 29,28' S	0° 7,13' E	0,0	CTD/RO	on deck	
PS69/492-4	11.07.06	13:24	68° 29,19' S	0° 7,06' E	0,0	MN	surface	
PS69/492-4	11.07.06	14:00	68° 29,02' S	0° 6,91' E	0,0	MN	at depth	Tiefe: 1052m, EL 30
PS69/492-4	11.07.06	14:42	68° 28,84' S	0° 6,71' E	0,0	MN	on deck	
PS69/492-5	11.07.06	14:51	68° 28,80' S	0° 6,66' E	0,0	MN	surface	
PS69/492-5	11.07.06	16:33	68° 28,43' S	0° 6,05' E	0,0	MN	at depth	Die Tiefe 2097 m, EL 30
PS69/492-5	11.07.06	17:50	68° 28,17' S	0° 5,68' E	0,0	MN	on deck	
PS69/492-6	11.07.06	18:02	68° 28,10' S	0° 5,70' E	0,0	CTD/RO	surface	
PS69/492-6	11.07.06	18:11	68° 28,07' S	0° 5,60' E	0,0	CTD/RO	at depth	EL31 244m ausgesteckt
PS69/492-6	11.07.06	18:28	68° 28,05' S	0° 5,55' E	0,0	CTD/RO	on deck	
PS69/492-7	11.07.06	18:37	68° 28,02' S	0° 5,51' E	0,0	BONGO	surface	
PS69/492-7	11.07.06	18:50	68° 27,99' S	0° 5,48' E	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/492-7	11.07.06	19:04	68° 27,95' S	0° 5,44' E	0,0	BONGO	on deck	
PS69/493-1	11.07.06	23:44	68° 3,67' S	0° 5,52' E	0,0	RMT	surface	
PS69/493-1	11.07.06	23:45	68° 3,67' S	0° 5,48' E	0,0	RMT	Begin Trawling	
PS69/493-1	12.07.06	00:02	68° 3,35' S	0° 4,31' E	0,0	RMT	heave	FN62.2, 460m
PS69/493-1	12.07.06	00:33	68° 2,58' S	0° 2,46' E	0,0	RMT	on deck	
PS69/493-2	12.07.06	00:56	68° 2,51' S	0° 2,21' E	4505,6	CTD/RO	surface	
PS69/493-2	12.07.06	02:20	68° 2,46' S	0° 2,69' E	4507,6	CTD/RO	at depth	Tiefe: 4430m; EL 31
PS69/493-2	12.07.06	03:38	68° 2,51' S	0° 2,69' E	0,0	CTD/RO	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/493-3	12.07.06	03:49	68° 2,52' S	0° 2,66' E	0,0	MN	surface	
PS69/493-3	12.07.06	04:28	68° 2,58' S	0° 2,48' E	0,0	MN	at depth	Die Tiefe 1054 m, EL30
PS69/493-3	12.07.06	05:10	68° 2,70' S	0° 2,20' E	0,0	MN	on deck	
PS69/493-4	12.07.06	05:20	68° 2,73' S	0° 2,13' E	0,0	MN	surface	
PS69/493-4	12.07.06	06:30	68° 2,98' S	0° 1,53' E	0,0	MN	at depth	Die Tiefe 2092 m, EL 30
PS69/493-4	12.07.06	07:47	68° 3,24' S	0° 0,76' E	0,0	MN	on deck	
PS69/493-5	12.07.06	07:55	68° 3,19' S	0° 0,47' E	0,0	BONGO	surface	
PS69/493-5	12.07.06	08:10	68° 3,24' S	0° 0,29' E	0,0	BONGO	at depth	EL30, 200m
PS69/493-5	12.07.06	08:24	68° 3,29' S	0° 0,14' E	0,0	BONGO	on deck	
PS69/493-6	12.07.06	08:39	68° 3,32' S	0° 0,10' W	0,0	SUIT	surface	
PS69/493-6	12.07.06	08:39	68° 3,32' S	0° 0,10' W	0,0	SUIT	slipped	
PS69/493-6	12.07.06	09:02	68° 3,08' S	0° 0,62' W	0,0	SUIT	stop trawl	Abbruch
PS69/493-6	12.07.06	09:09	68° 3,10' S	0° 0,71' W	0,0	SUIT	Information	Gewicht an deck
PS69/493-6	12.07.06	09:17	68° 3,13' S	0° 0,82' W	0,0	SUIT	on deck	
PS69/493-7	12.07.06	09:40	68° 3,27' S	0° 1,11' W	0,0	MN	surface	
PS69/493-7	12.07.06	09:54	68° 3,32' S	0° 1,29' W	0,0	MN	at depth	EL30, 262m
PS69/493-7	12.07.06	10:14	68° 3,38' S	0° 1,53' W	0,0	MN	on deck	
PS69/493-8	12.07.06	10:23	68° 3,42' S	0° 1,64' W	4499,2	CTD/RO	surface	
PS69/493-9	12.07.06	10:24	68° 3,42' S	0° 1,65' W	4499,2	HN	surface	
PS69/493-8	12.07.06	10:30	68° 3,44' S	0° 1,72' W	4498,8	CTD/RO	at depth	EL31, 245m
PS69/493-9	12.07.06	10:35	68° 3,45' S	0° 1,78' W	4499,2	HN	on deck	
PS69/493-8	12.07.06	10:45	68° 3,49' S	0° 1,88' W	4499,2	CTD/RO	on deck	
PS69/494-1	12.07.06	16:54	67° 31,15' S	0° 3,49' W	0,0	SUIT	surface	
PS69/494-1	12.07.06	16:55	67° 31,14' S	0° 3,58' W	0,0	SUIT	slipped	
PS69/494-1	12.07.06	17:00	67° 31,11' S	0° 3,97' W	0,0	SUIT	Information	Das Gewicht im Wasser
PS69/494-1	12.07.06	17:07	67° 31,03' S	0° 4,34' W	0,0	SUIT	Information	Das Gewicht an Deck
PS69/494-1	12.07.06	17:12	67° 31,03' S	0° 4,54' W	0,0	SUIT	Information	Das Gewicht zu Wasser
PS69/494-1	12.07.06	17:20	67° 30,94' S	0° 5,08' W	0,0	SUIT	start trawl	
PS69/494-1	12.07.06	17:40	67° 30,69' S	0° 6,31' W	0,0	SUIT	stop trawl	
PS69/494-1	12.07.06	17:46	67° 30,67' S	0° 6,51' W	0,0	SUIT	Information	Das Gewicht an Deck
PS69/494-1	12.07.06	17:58	67° 30,60' S	0° 7,00' W	0,0	SUIT	on deck	
PS69/494-2	12.07.06	18:29	67° 31,60' S	0° 9,62' W	4649,2	CTD/RO	surface	
PS69/494-3	12.07.06	18:37	67° 31,64' S	0° 9,88' W	4649,6	HN	surface	
PS69/494-3	12.07.06	18:48	67° 31,68' S	0° 9,99' W	4649,6	HN	on deck	
PS69/494-2	12.07.06	18:50	67° 31,68' S	0° 10,00' W	4649,6	CTD/RO	at depth	Die Tiefe 984 m, EL 31
PS69/494-2	12.07.06	19:14	67° 31,85' S	0° 10,68' W	4650,4	CTD/RO	on deck	
PS69/494-4	12.07.06	19:25	67° 32,12' S	0° 10,66' W	0,0	RMT	surface	
PS69/494-4	12.07.06	19:43	67° 31,82' S	0° 12,26' W	0,0	RMT	heave	
PS69/494-4	12.07.06	20:14	67° 31,40' S	0° 15,20' W	0,0	RMT	on deck	
PS69/495-1	13.07.06	02:40	67° 0,48' S	0° 5,82' W	0,0	RMT	surface	
PS69/495-1	13.07.06	02:57	67° 0,15' S	0° 4,47' W	0,0	RMT	heave	Kabellänger 460m, FN 62.2
PS69/495-1	13.07.06	03:50	67° 0,26' S	0° 2,90' W	0,0	RMT	on deck	
PS69/495-2	13.07.06	04:32	67° 0,66' S	0° 3,61' W	4712,0	CTD/RO	surface	
PS69/495-2	13.07.06	06:02	67° 1,51' S	0° 5,09' W	4716,4	CTD/RO	at depth	Die Tiefe 4693 m, EL 31

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/495-2	13.07.06	07:30	67° 2,36' S	0° 6,76' W	0,0	CTD/RO	on deck	
PS69/496-1	13.07.06	09:55	67° 3,27' S	0° 12,21' W	0,0	MN	surface	
PS69/496-1	13.07.06	10:29	67° 3,62' S	0° 12,72' W	0,0	MN	at depth	EL30, 1090m
PS69/496-2	13.07.06	10:30	67° 3,63' S	0° 12,74' W	0,0	HN	surface	auf Scholle
PS69/496-2	13.07.06	11:08	67° 4,00' S	0° 13,27' W	0,0	HN	on deck	
PS69/496-1	13.07.06	11:08	67° 4,00' S	0° 13,27' W	0,0	MN	on deck	
PS69/497-1	13.07.06	18:15	66° 32,08' S	0° 0,07' E	0,0	RMT	surface	
PS69/497-1	13.07.06	18:31	66° 32,48' S	0° 1,13' E	0,0	RMT	heave	
PS69/497-1	13.07.06	19:04	66° 33,69' S	0° 2,44' E	0,0	RMT	on deck	
PS69/497-2	13.07.06	19:17	66° 33,96' S	0° 3,04' E	0,0	RMT	surface	
PS69/497-2	13.07.06	19:21	66° 33,92' S	0° 2,82' E	0,0	RMT	Begin Trawling	
PS69/497-2	13.07.06	19:41	66° 33,60' S	0° 1,30' E	0,0	RMT	End of Trawl	
PS69/497-2	13.07.06	19:48	66° 33,55' S	0° 0,95' E	0,0	RMT	on deck	
PS69/497-3	13.07.06	20:03	66° 33,54' S	0° 0,48' E	0,0	CTD/RO	surface	
PS69/497-3	13.07.06	20:24	66° 33,69' S	0° 0,11' E	4638,0	CTD/RO	at depth	EL31, 989m
PS69/497-3	13.07.06	20:49	66° 33,87' S	0° 0,33' W	4647,6	CTD/RO	on deck	
PS69/497-4	13.07.06	21:08	66° 33,81' S	0° 0,95' W	0,0	NFLOAT	surface	
PS69/498-1	14.07.06	03:37	66° 4,03' S	0° 0,97' W	0,0	RMT	surface	
PS69/498-1	14.07.06	03:54	66° 3,34' S	0° 1,22' W	0,0	RMT	heave	460m; FN 62.2
PS69/498-1	14.07.06	04:28	66° 2,35' S	0° 2,83' W	0,0	RMT	on deck	
PS69/498-2	14.07.06	04:52	66° 2,20' S	0° 2,45' W	3700,0	CTD/RO	surface	
PS69/498-2	14.07.06	06:00	66° 1,91' S	0° 0,45' W	3668,4	CTD/RO	at depth	Die Tiefe 3670 m, EL 31
PS69/498-2	14.07.06	07:06	66° 1,69' S	0° 0,84' E	0,0	CTD/RO	on deck	
PS69/498-3	14.07.06	08:45	66° 1,47' S	0° 1,51' E	0,0	MN	surface	
PS69/498-3	14.07.06	09:58	66° 1,49' S	0° 1,94' E	0,0	MN	at depth	EL30,2090m
PS69/498-3	14.07.06	11:11	66° 1,66' S	0° 2,49' E	3669,0	MN	on deck	
PS69/498-4	14.07.06	11:23	66° 1,66' S	0° 2,67' E	0,0	BONGO	surface	
PS69/498-4	14.07.06	11:39	66° 1,65' S	0° 2,93' E	0,0	BONGO	at depth	SE32.2,200m
PS69/498-4	14.07.06	11:54	66° 1,64' S	0° 3,17' E	0,0	BONGO	on deck	
PS69/498-5	14.07.06	11:59	66° 1,64' S	0° 3,24' E	0,0	MN	surface	
PS69/498-5	14.07.06	12:34	66° 1,60' S	0° 3,71' E	0,0	MN	at depth	Tiefe: 1045m, EL 30
PS69/498-5	14.07.06	13:13	66° 1,57' S	0° 4,17' E	0,0	MN	on deck	
PS69/498-6	14.07.06	13:23	66° 1,56' S	0° 4,27' E	0,0	MN	surface	
PS69/498-6	14.07.06	13:40	66° 1,55' S	0° 4,43' E	0,0	MN	at depth	Tiefe: 263m; EL 30
PS69/498-6	14.07.06	13:58	66° 1,55' S	0° 4,58' E	0,0	MN	on deck	
PS69/498-7	14.07.06	14:04	66° 1,55' S	0° 4,63' E	0,0	CTD/RO	surface	
PS69/498-7	14.07.06	14:11	66° 1,55' S	0° 4,69' E	0,0	CTD/RO	at depth	Tiefe: 246m, EL 31
PS69/498-7	14.07.06	14:27	66° 1,55' S	0° 4,81' E	0,0	CTD/RO	on deck	
PS69/498-8	14.07.06	14:34	66° 1,55' S	0° 4,86' E	0,0	BONGO	surface	
PS69/498-8	14.07.06	14:46	66° 1,54' S	0° 4,94' E	0,0	BONGO	at depth	Tiefe: 200m; SE 32.2
PS69/498-8	14.07.06	14:58	66° 1,54' S	0° 5,02' E	0,0	BONGO	on deck	
PS69/498-9	14.07.06	15:04	66° 1,53' S	0° 5,05' E	0,0	MN	surface	
PS69/498-9	14.07.06	15:41	66° 1,52' S	0° 5,24' E	0,0	MN	at depth	Tiefe: 1052m, EL30
PS69/498-9	14.07.06	16:22	66° 1,49' S	0° 5,37' E	0,0	MN	on deck	
PS69/498-10	14.07.06	16:30	66° 1,48' S	0° 5,38' E	0,0	MN	surface	
PS69/498-10	14.07.06	17:45	66° 1,42' S	0° 5,39' E	0,0	MN	at depth	EL30 2091m ausgesteckt
PS69/498-10	14.07.06	19:00	66° 1,36' S	0° 5,18' E	0,0	MN	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/498-11	14.07.06	19:09	66° 1,36' S	0° 5,15' E	0,0	BONGO	surface	
PS69/498-11	14.07.06	19:22	66° 1,35' S	0° 5,09' E	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/498-11	14.07.06	19:35	66° 1,33' S	0° 5,03' E	0,0	BONGO	on deck	
PS69/498-12	14.07.06	19:40	66° 1,33' S	0° 5,01' E	0,0	MN	surface	
PS69/498-12	14.07.06	20:15	66° 1,29' S	0° 4,83' E	0,0	MN	at depth	EL30,1048m
PS69/498-12	14.07.06	20:54	66° 1,24' S	0° 4,63' E	0,0	MN	on deck	
PS69/498-13	14.07.06	21:02	66° 1,23' S	0° 4,59' E	3610,4	CTD/RO	surface	
PS69/498-13	14.07.06	22:08	66° 1,18' S	0° 4,19' E	3629,2	CTD/RO	surface	EL31, 3550m
PS69/498-13	14.07.06	23:00	66° 1,16' S	0° 3,88' E	0,0	CTD/RO	on deck	
PS69/498-14	14.07.06	23:07	66° 1,15' S	0° 3,84' E	0,0	MN	surface	
PS69/498-14	15.07.06	00:17	66° 1,18' S	0° 3,52' E	0,0	MN	at depth	Tiefe: 2094m, EL 30
PS69/498-14	15.07.06	01:32	66° 1,25' S	0° 3,40' E	0,0	MN	on deck	
PS69/498-15	15.07.06	01:44	66° 1,28' S	0° 3,39' E	0,0	MN	surface	
PS69/498-15	15.07.06	02:19	66° 1,35' S	0° 3,38' E	0,0	MN	at depth	Tiefe: 1053m, EL 30
PS69/498-15	15.07.06	02:59	66° 1,48' S	0° 3,37' E	0,0	MN	on deck	
PS69/498-16	15.07.06	08:05	66° 3,09' S	0° 1,43' E	0,0	MN	surface	
PS69/498-16	15.07.06	08:46	66° 3,39' S	0° 0,91' E	0,0	MN	at depth	EL30m, 1061m
PS69/498-16	15.07.06	09:23	66° 3,66' S	0° 0,48' E	0,0	MN	on deck	
PS69/498-17	15.07.06	09:36	66° 3,75' S	0° 0,33' E	0,0	BONGO	surface	
PS69/498-17	15.07.06	09:50	66° 3,85' S	0° 0,18' E	0,0	BONGO	at depth	Se32.2, 200m
PS69/498-17	15.07.06	10:13	66° 4,01' S	0° 0,07' W	0,0	BONGO	on deck	
PS69/498-18	15.07.06	11:05	66° 4,38' S	0° 0,50' W	0,0	MN	surface	
PS69/498-18	15.07.06	11:43	66° 4,63' S	0° 0,77' W	0,0	MN	at depth	EL30, 1060m
PS69/498-18	15.07.06	12:21	66° 4,87' S	0° 0,98' W	0,0	MN	on deck	
PS69/498-19	15.07.06	12:29	66° 4,92' S	0° 1,02' W	0,0	MN	surface	
PS69/498-19	15.07.06	13:39	66° 5,31' S	0° 1,24' W	0,0	MN	at depth	Teife: 2104m, EL 30
PS69/498-19	15.07.06	14:53	66° 5,59' S	0° 1,12' W	0,0	MN	on deck	
PS69/498-20	15.07.06	15:04	66° 5,63' S	0° 1,09' W	0,0	MN	surface	
PS69/498-20	15.07.06	15:40	66° 5,75' S	0° 1,00' W	0,0	MN	at depth	Tiefe: 1053m, EL 30
PS69/498-20	15.07.06	16:19	66° 5,87' S	0° 0,88' W	0,0	MN	on deck	
PS69/498-21	15.07.06	16:41	66° 5,94' S	0° 0,84' W	0,0	BONGO	surface	
PS69/498-21	15.07.06	16:55	66° 5,99' S	0° 0,83' W	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/498-21	15.07.06	17:10	66° 6,04' S	0° 0,83' W	0,0	BONGO	on deck	
PS69/498-22	15.07.06	17:11	66° 6,04' S	0° 0,83' W	0,0	BONGO	surface	
PS69/498-22	15.07.06	17:32	66° 6,13' S	0° 0,87' W	0,0	BONGO	at depth	Die Tiefe 300 m, SE 32.2
PS69/498-22	15.07.06	17:50	66° 6,20' S	0° 0,94' W	0,0	BONGO	on deck	
PS69/498-23	15.07.06	18:04	66° 6,26' S	0° 1,01' W	0,0	MN	surface	
PS69/498-23	15.07.06	19:14	66° 6,64' S	0° 1,66' W	0,0	MN	at depth	Die Tiefe 2110 m, EL 30
PS69/498-23	15.07.06	20:28	66° 7,15' S	0° 2,70' W	0,0	MN	on deck	
PS69/498-24	15.07.06	21:56	66° 7,81' S	0° 3,32' W	0,0	BONGO	surface	
PS69/498-24	15.07.06	22:53	66° 8,24' S	0° 3,18' W	0,0	BONGO	on deck	Abbruch, 200m, EL30
PS69/498-25	16.07.06	10:44	66° 9,67' S	0° 6,70' E	0,0	MN	surface	
PS69/498-25	16.07.06	11:53	66° 10,11' S	0° 7,39' E	0,0	MN	at depth	EL30, 2133m
PS69/498-25	16.07.06	13:10	66° 10,51' S	0° 8,34' E	0,0	MN	on deck	
PS69/498-26	16.07.06	13:30	66° 10,59' S	0° 8,56' E	0,0	BONGO	surface	
PS69/498-26	16.07.06	13:48	66° 10,66' S	0° 8,74' E	0,0	BONGO	at depth	Tiefe: 300m, SE 32.2

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/498-26	16.07.06	14:08	66° 10,73' S	0° 8,92' E	0,0	BONGO	on deck	
PS69/498-27	16.07.06	14:23	66° 10,77' S	0° 9,05' E	0,0	CTD/RO	surface	
PS69/498-27	16.07.06	14:30	66° 10,80' S	0° 9,11' E	0,0	CTD/RO	at depth	Tiefe: 246m, EL 31
PS69/498-27	16.07.06	14:46	66° 10,83' S	0° 9,22' E	0,0	CTD/RO	on deck	
PS69/498-28	16.07.06	14:52	66° 10,84' S	0° 9,25' E	0,0	HN	surface	
PS69/498-28	16.07.06	15:02	66° 10,86' S	0° 9,31' E	0,0	HN	on deck	
PS69/498-29	16.07.06	16:01	66° 10,93' S	0° 9,50' E	0,0	MN	surface	
PS69/498-29	16.07.06	16:37	66° 10,98' S	0° 9,44' E	0,0	MN	at depth	Die Tiefe 1052 m, EL 30
PS69/498-29	16.07.06	17:17	66° 11,06' S	0° 9,18' E	0,0	MN	on deck	
PS69/498-30	16.07.06	19:53	66° 11,86' S	0° 6,70' E	0,0	MN	surface	
PS69/498-30	16.07.06	20:26	66° 12,12' S	0° 5,93' E	0,0	MN	at depth	EL30,1100m
PS69/498-30	16.07.06	21:08	66° 12,49' S	0° 4,84' E	0,0	MN	on deck	
PS69/498-31	17.07.06	11:42	66° 15,75' S	0° 4,09' E	0,0	CTD/RO	surface	
PS69/498-32	17.07.06	11:46	66° 15,76' S	0° 4,08' E	0,0	HN	surface	
PS69/498-32	17.07.06	11:56	66° 15,77' S	0° 4,05' E	3838,8	HN	on deck	
PS69/498-31	17.07.06	12:05	66° 15,78' S	0° 4,02' E	3840,4	CTD/RO	at depth	Tiefe: 985m, EL 31
PS69/498-31	17.07.06	12:27	66° 15,81' S	0° 3,97' E	0,0	CTD/RO	on deck	
PS69/498-33	17.07.06	12:34	66° 15,82' S	0° 3,96' E	0,0	MN	surface	
PS69/498-33	17.07.06	13:46	66° 15,95' S	0° 4,04' E	0,0	MN	at depth	Tiefe: 2090m, EL 30
PS69/498-33	17.07.06	15:00	66° 15,99' S	0° 4,32' E	0,0	MN	on deck	
PS69/498-34	17.07.06	15:07	66° 15,99' S	0° 4,35' E	0,0	BONGO	surface	
PS69/498-34	17.07.06	15:18	66° 15,98' S	0° 4,41' E	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/498-34	17.07.06	15:31	66° 15,98' S	0° 4,48' E	0,0	BONGO	on deck	
PS69/498-35	17.07.06	15:32	66° 15,98' S	0° 4,49' E	0,0	BONGO	surface	
PS69/498-35	17.07.06	15:41	66° 15,97' S	0° 4,55' E	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/498-35	17.07.06	15:55	66° 15,96' S	0° 4,65' E	0,0	BONGO	on deck	
PS69/498-36	17.07.06	21:28	66° 14,91' S	0° 5,70' E	0,0	MN	surface	
PS69/498-36	17.07.06	22:37	66° 14,68' S	0° 4,95' E	0,0	MN	at depth	EL30,2087m
PS69/498-36	17.07.06	23:49	66° 14,43' S	0° 3,77' E	0,0	MN	on deck	
PS69/498-37	17.07.06	23:59	66° 14,39' S	0° 3,55' E	0,0	MN	surface	
PS69/498-37	18.07.06	00:34	66° 14,24' S	0° 2,78' E	0,0	MN	at depth	Tiefe: 1078m, EL 30
PS69/498-37	18.07.06	01:12	66° 14,07' S	0° 1,91' E	0,0	MN	on deck	
PS69/498-38	18.07.06	01:24	66° 14,03' S	0° 1,64' E	0,0	CTD/RO	surface	
PS69/498-38	18.07.06	01:31	66° 14,00' S	0° 1,48' E	0,0	CTD/RO	at depth	Tiefe: 248m, EL 31
PS69/498-38	18.07.06	01:44	66° 13,95' S	0° 1,19' E	0,0	CTD/RO	on deck	
PS69/498-39	18.07.06	03:53	66° 13,54' S	0° 1,09' W	0,0	MN	surface	
PS69/498-39	18.07.06	04:31	66° 13,41' S	0° 1,63' W	0,0	MN	at depth	Die Tiefe 1060 m, EL 30
PS69/498-39	18.07.06	05:10	66° 13,28' S	0° 2,12' W	0,0	MN	on deck	
PS69/498-40	18.07.06	05:19	66° 13,25' S	0° 2,23' W	0,0	MN	surface	
PS69/498-40	18.07.06	06:30	66° 12,91' S	0° 2,96' W	0,0	MN	at depth	Die Tiefe 2115 m, EL 30
PS69/498-40	18.07.06	07:44	66° 12,45' S	0° 3,76' W	0,0	MN	on deck	
PS69/498-41	18.07.0	07:52	66° 12,40' S	0° 3,84' W	0,0	MN	surface	
PS69/498-41	18.07.06	08:30	66° 12,16' S	0° 4,24' W	0,0	MN	at depth	EL30,1068m
PS69/498-41	18.07.06	09:09	66° 11,91' S	0° 4,67' W	0,0	MN	on deck	
PS69/498-42	18.07.06	09:17	66° 11,86' S	0° 4,76' W	0,0	CTD/RO	surface	
PS69/498-42	18.07.06	09:48	66° 11,67' S	0° 5,11' W	0,0	CTD/RO	at depth	EL31, 986m
PS69/498-42	18.07.06	10:10	66° 11,53' S	0° 5,35' W	0,0	CTD/RO	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/498-43	18.07.06	10:18	66° 11,49' S	0° 5,44' W	0,0	MN	surface	
PS69/498-43	18.07.06	10:32	66° 11,40' S	0° 5,60' W	0,0	MN	at depth	EL30,265m
PS69/498-43	18.07.06	10:50	66° 11,31' S	0° 5,80' W	0,0	MN	on deck	
PS69/498-44	18.07.06	12:02	66° 11,02' S	0° 6,59' W	0,0	MN	surface	
PS69/498-44	18.07.06	12:37	66° 10,91' S	0° 6,91' W	0,0	MN	at depth	Tiefe: 1062m,EL 30
PS69/498-44	18.07.06	13:15	66° 10,79' S	0° 7,21' W	0,0	MN	on deck	
PS69/498-45	18.07.06	13:24	66° 10,76' S	0° 7,27' W	0,0	BONGO	surface	
PS69/498-46	18.07.06	13:28	66° 10,75' S	0° 7,30' W	0,0	HN	surface	
PS69/498-46	18.07.06	13:35	66° 10,73' S	0° 7,35' W	0,0	HN	on deck	
PS69/498-45	18.07.06	13:38	66° 10,72' S	0° 7,37' W	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/498-45	18.07.06	13:53	66° 10,67' S	0° 7,47' W	0,0	BONGO	on deck	
PS69/498-47	19.07.06	06:03	66° 8,04' S	0° 10,96' W	0,0	SUIT	surface	
PS69/498-47	19.07.06	06:04	66° 8,03' S	0° 10,97' W	0,0	SUIT	slipped	
PS69/498-47	19.07.06	06:08	66° 7,96' S	0° 11,00' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/498-47	19.07.06	06:35	66° 7,85' S	0° 11,04' W	0,0	SUIT	Information	Gewicht an Deck
PS69/498-47	19.07.06	06:45	66° 7,84' S	0° 11,04' W	0,0	SUIT	on deck	Abbruch - dickes Eis
PS69/498-48	19.07.06	07:15	66° 7,95' S	0° 10,57' W	0,0	SUIT	surface	
PS69/498-48	19.07.06	07:16	66° 7,96' S	0° 10,54' W	0,0	SUIT	slipped	
PS69/498-48	19.07.06	07:20	66° 8,01' S	0° 10,48' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/498-48	19.07.06	07:26	66° 8,20' S	0° 10,22' W	0,0	SUIT	start trawl	
PS69/498-48	19.07.06	07:46	66° 8,66' S	0° 9,51' W	0,0	SUIT	stop trawl	
PS69/498-48	19.07.06	07:54	66° 8,74' S	0° 9,38' W	0,0	SUIT	Information	Gewicht an Deck
PS69/498-48	19.07.06	08:01	66° 8,82' S	0° 9,24' W	0,0	SUIT	on deck	
PS69/498-49	19.07.06	10:54	66° 7,71' S	0° 10,52' W	0,0	SUIT	surface	
PS69/498-49	19.07.06	10:55	66° 7,71' S	0° 10,54' W	0,0	SUIT	slipped	
PS69/498-49	19.07.06	10:59	66° 7,68' S	0° 10,69' W	0,0	SUIT	start trawl	
PS69/498-49	19.07.06	11:37	66° 7,13' S	0° 12,72' W	0,0	SUIT	stop trawl	
PS69/498-49	19.07.06	11:47	66° 7,11' S	0° 12,76' W	0,0	SUIT	on deck	
PS69/499-1	19.07.06	18:34	65° 29,87' S	0° 0,45' E	0,0	RMT	surface	
PS69/499-1	19.07.06	18:50	65° 29,42' S	0° 1,46' E	0,0	RMT	heave	
PS69/499-1	19.07.06	19:22	65° 28,47' S	0° 1,05' E	0,0	RMT	on deck	
PS69/499-2	19.07.06	20:05	65° 29,22' S	0° 1,68' E	0,0	CTD/RO	surface	
PS69/499-3	19.07.06	20:16	65° 29,17' S	0° 1,71' E	0,0	HN	surface	
PS69/499-3	19.07.06	20:25	65° 29,13' S	0° 1,72' E	0,0	HN	on deck	
PS69/499-2	19.07.06	20:29	65° 29,12' S	0° 1,74' E	0,0	CTD/RO	at depth	EL31,983m
PS69/499-2	19.07.06	20:54	65° 29,02' S	0° 1,75' E	0,0	CTD/RO	on deck	
PS69/500-1	20.07.06	02:40	64° 58,23' S	0° 1,24' E	0,0	RMT	surface	
PS69/500-1	20.07.06	02:57	64° 58,11' S	0° 0,06' W	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/500-1	20.07.06	03:27	64° 58,80' S	0° 1,74' W	0,0	RMT	on deck	
PS69/500-2	20.07.06	03:44	64° 59,17' S	0° 1,98' W	3751,0	CTD/RO	surface	
PS69/500-2	20.07.06	04:05	64° 59,15' S	0° 1,96' W	3750,0	CTD/RO	at depth	Die Tiefe 981 m, EL 31
PS69/500-2	20.07.06	04:29	64° 59,14' S	0° 1,94' W	0,0	CTD/RO	on deck	
PS69/500-3	20.07.06	04:34	64° 59,13' S	0° 1,93' W	0,0	MN	surface	
PS69/500-3	20.07.06	05:11	64° 59,10' S	0° 1,87' W	0,0	MN	at depth	Die Tiefe 1053 m, EL 30
PS69/500-3	20.07.06	05:50	64° 59,08' S	0° 1,78' W	0,0	MN	on deck	
PS69/500-4	20.07.06	06:08	64° 59,31' S	0° 1,17' W	0,0	SUIT	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/500-4	20.07.06	06:09	64° 59,31' S	0° 1,10' W	0,0	SUIT	slipped	
PS69/500-4	20.07.06	06:12	64° 59,32' S	0° 0,89' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/500-4	20.07.06	06:21	64° 59,32' S	0° 0,22' W	0,0	SUIT	start trawl	
PS69/500-4	20.07.06	06:49	64° 59,34' S	0° 0,93' E	0,0	SUIT	stop trawl	
PS69/500-4	20.07.06	06:56	64° 59,41' S	0° 0,96' E	0,0	SUIT	Information	Gewicht an Deck
PS69/500-4	20.07.06	07:05	64° 59,41' S	0° 1,01' E	0,0	SUIT	on deck	
PS69/501-1	20.07.06	12:43	64° 33,56' S	0° 4,96' W	0,0	RMT	surface	
PS69/501-1	20.07.06	12:59	64° 33,27' S	0° 4,29' W	0,0	RMT	heave	Länge: 460m, FN 62.2
PS69/501-1	20.07.06	13:27	64° 32,54' S	0° 3,38' W	0,0	RMT	on deck	
PS69/501-2	20.07.06	13:48	64° 32,44' S	0° 3,14' W	0,0	CTD/RO	surface	
PS69/501-3	20.07.06	13:53	64° 32,45' S	0° 3,10' W	0,0	HN	surface	
PS69/501-3	20.07.06	14:07	64° 32,50' S	0° 3,03' W	0,0	HN	on deck	
PS69/501-2	20.07.06	14:12	64° 32,51' S	0° 2,98' W	0,0	CTD/RO	at depth	Tiefe: 983m, EL 31
PS69/501-2	20.07.06	14:35	64° 32,60' S	0° 2,78' W	0,0	CTD/RO	on deck	
PS69/502-1	20.07.06	21:21	63° 58,03' S	0° 3,22' W	0,0	CTD/RO	surface	
PS69/502-1	20.07.06	23:04	63° 58,81' S	0° 1,29' W	0,0	CTD/RO	at depth	EL31, 5207m
PS69/502-1	21.07.06	00:38	63° 58,70' S	0° 0,85' E	0,0	CTD/RO	on deck	
PS69/502-2	21.07.06	00:48	63° 58,66' S	0° 1,06' E	0,0	MN	surface	
PS69/502-2	21.07.06	01:24	63° 58,54' S	0° 1,78' E	0,0	MN	at depth	Tiefe: 1083m, EL 30
PS69/502-2	21.07.06	02:07	63° 58,29' S	0° 2,57' E	0,0	MN	on deck	
PS69/502-3	21.07.06	02:35	63° 58,20' S	0° 3,19' E	0,0	MN	surface	
PS69/502-3	21.07.06	03:50	63° 57,76' S	0° 4,34' E	0,0	MN	at depth	Tiefe: 2138m, EL 30
PS69/502-3	21.07.06	05:06	63° 57,40' S	0° 5,58' E	0,0	MN	on deck	
PS69/502-4	21.07.06	05:16	63° 57,34' S	0° 5,77' E	0,0	MN	surface	
PS69/502-4	21.07.06	05:28	63° 57,27' S	0° 6,01' E	0,0	MN	at depth	Die Tiefe 273 m, EL 30
PS69/502-4	21.07.06	05:40	63° 57,21' S	0° 6,25' E	0,0	MN	on deck	
PS69/502-5	21.07.06	05:51	63° 57,14' S	0° 6,49' E	0,0	CTD/RO	surface	
PS69/502-5	21.07.06	06:05	63° 57,06' S	0° 6,80' E	0,0	CTD/RO	at depth	Die Tiefe 248 m, EL 31
PS69/502-5	21.07.06	06:22	63° 56,95' S	0° 7,26' E	0,0	CTD/RO	on deck	
PS69/503-1	21.07.06	10:58	63° 32,39' S	0° 0,09' E	0,0	SUIT	surface	
PS69/503-1	21.07.06	10:58	63° 32,39' S	0° 0,09' E	0,0	SUIT	slipped	
PS69/503-1	21.07.06	11:09	63° 32,20' S	0° 0,38' W	0,0	SUIT	start trawl	
PS69/503-1	21.07.06	11:34	63° 31,44' S	0° 0,75' W	0,0	SUIT	stop trawl	
PS69/503-1	21.07.06	11:35	63° 31,41' S	0° 0,75' W	0,0	SUIT	Information	Gewicht an Deck
PS69/503-1	21.07.06	11:46	63° 31,27' S	0° 0,43' W	0,0	SUIT	on deck	
PS69/503-2	21.07.06	12:42	63° 31,18' S	0° 4,42' E	0,0	CTD/RO	surface	
PS69/503-2	21.07.06	12:50	63° 31,11' S	0° 4,63' E	0,0	CTD/RO	at depth	Tiefe: 237m, EL 31
PS69/503-2	21.07.06	13:13	63° 30,83' S	0° 5,33' E	0,0	CTD/RO	at depth	Tiefe: 1035m, EL 31
PS69/503-2	21.07.06	13:40	63° 30,51' S	0° 6,15' E	0,0	CTD/RO	on deck	
PS69/504-1	21.07.06	21:46	62° 59,86' S	0° 2,09' W	0,0	RMT	surface	
PS69/504-1	21.07.06	21:54	62° 59,84' S	0° 2,49' W	0,0	RMT	Begin Trawling	
PS69/504-1	21.07.06	22:03	62° 59,81' S	0° 3,14' W	0,0	RMT	heave	FN62.2, 460m
PS69/504-1	21.07.06	22:35	62° 59,75' S	0° 4,91' W	0,0	RMT	on deck	
PS69/504-2	21.07.06	23:15	62° 59,86' S	0° 2,77' W	3882,0	CTD/RO	surface	
PS69/504-2	21.07.06	23:39	62° 59,72' S	0° 2,28' W	1016,8	CTD/RO	at depth	ÊL31, 985m
PS69/504-2	22.07.06	00:03	62° 59,60' S	0° 1,81' W	0,0	CTD/RO	on deck	
PS69/504-3	22.07.06	00:09	62° 59,56' S	0° 1,70' W	4022,4	MN	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/504-3	22.07.06	00:46	62° 59,37' S	0° 1,04' W	0,0	MN	at depth	Tiefe: 1056m, EL 30
PS69/504-3	22.07.06	01:27	62° 59,16' S	0° 0,36' W	0,0	MN	on deck	
PS69/504-4	22.07.06	01:36	62° 59,12' S	0° 0,22' W	0,0	MN	surface	
PS69/504-4	22.07.06	02:47	62° 58,81' S	0° 0,77' E	0,0	MN	at depth	Tiefe: 2115m, EL 30
PS69/504-4	22.07.06	04:02	62° 58,55' S	0° 1,65' E	0,0	MN	on deck	
PS69/504-5	22.07.06	04:14	62° 58,51' S	0° 1,79' E	0,0	MN	surface	
PS69/504-5	22.07.06	04:28	62° 58,46' S	0° 1,95' E	0,0	MN	at depth	Die Tiefe 263 m, EL30
PS69/504-5	22.07.06	04:46	62° 58,40' S	0° 2,15' E	0,0	MN	on deck	
PS69/504-6	22.07.06	05:00	62° 58,35' S	0° 2,30' E	0,0	BONGO	surface	
PS69/504-6	22.07.06	05:11	62° 58,32' S	0° 2,42' E	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/504-6	22.07.06	05:28	62° 58,27' S	0° 2,60' E	0,0	BONGO	on deck	
PS69/504-7	22.07.06	05:40	62° 58,23' S	0° 2,72' E	0,0	CTD/RO	surface	
PS69/504-7	22.07.06	05:53	62° 58,19' S	0° 2,85' E	0,0	CTD/RO	at depth	Die Tiefe 246 m, EL 31
PS69/504-7	22.07.06	06:10	62° 58,15' S	0° 3,01' E	0,0	CTD/RO	on deck	
PS69/504-8	22.07.06	07:17	62° 57,52' S	0° 4,69' E	0,0	RMT	surface	
PS69/504-8	22.07.06	07:35	62° 57,57' S	0° 3,80' E	0,0	RMT	heave	
PS69/504-8	22.07.06	08:00	62° 57,68' S	0° 2,10' E	0,0	RMT	on deck	
PS69/504-9	22.07.06	08:54	62° 57,41' S	0° 5,61' E	0,0	RMT	surface	
PS69/504-9	22.07.06	08:57	62° 57,40' S	0° 5,54' E	0,0	RMT	Begin Trawling	FN62.2, 100m
PS69/504-9	22.07.06	09:17	62° 57,47' S	0° 4,17' E	0,0	RMT	End of Trawl	
PS69/504-9	22.07.06	09:24	62° 57,50' S	0° 3,89' E	0,0	RMT	on deck	
PS69/505-1	22.07.06	14:15	62° 34,79' S	0° 4,26' E	0,0	RMT	surface	
PS69/505-1	22.07.06	14:30	62° 35,03' S	0° 3,90' E	0,0	RMT	heave	
PS69/505-1	22.07.06	14:57	62° 35,56' S	0° 2,63' E	0,0	RMT	on deck	
PS69/505-2	22.07.06	15:18	62° 35,48' S	0° 3,03' E	0,0	CTD/RO	surface	
PS69/505-2	22.07.06	15:45	62° 35,44' S	0° 3,29' E	0,0	CTD/RO	at depth	Tiefe: 984m, EL 31
PS69/505-2	22.07.06	16:12	62° 35,39' S	0° 3,57' E	0,0	CTD/RO	on deck	
PS69/506-1	22.07.06	23:56	62° 0,23' S	0° 5,51' E	0,0	CTD/RO	surface	
PS69/506-1	23.07.06	01:36	62° 0,32' S	0° 5,63' E	5370,4	CTD/RO	at depth	Tiefe: 5294m, EL 31
PS69/506-1	23.07.06	03:07	62° 0,41' S	0° 5,72' E	0,0	CTD/RO	on deck	
PS69/506-2	23.07.06	03:22	62° 0,43' S	0° 5,73' E	0,0	MN	surface	
PS69/506-2	23.07.06	04:34	62° 0,49' S	0° 5,74' E	0,0	MN	at depth	Die Tiefe 2096 m, EL 30
PS69/506-2	23.07.06	05:47	62° 0,42' S	0° 5,68' E	0,0	MN	on deck	
PS69/506-3	23.07.06	05:59	62° 0,43' S	0° 5,67' E	0,0	MN	surface	
PS69/506-3	23.07.06	06:33	62° 0,44' S	0° 5,54' E	0,0	MN	at depth	Die Tiefe 1054 m, EL 30
PS69/506-3	23.07.06	07:12	62° 0,40' S	0° 5,28' E	0,0	MN	on deck	
PS69/506-4	23.07.06	07:21	62° 0,39' S	0° 5,26' E	0,0	MN	surface	
PS69/506-4	23.07.06	07:37	62° 0,34' S	0° 5,06' E	0,0	MN	at depth	Die Tiefe 264 m, EL 30
PS69/506-4	23.07.06	07:56	62° 0,27' S	0° 4,87' E	0,0	MN	on deck	
PS69/506-5	23.07.06	08:06	62° 0,21' S	0° 4,78' E	0,0	BONGO	surface	
PS69/506-5	23.07.06	08:16	62° 0,11' S	0° 4,75' E	0,0	BONGO	at depth	SE32.2, 200m
PS69/506-5	23.07.06	08:30	61° 60,00' S	0° 4,61' E	0,0	BONGO	on deck	
PS69/506-6	23.07.06	08:43	61° 59,97' S	0° 4,45' E	0,0	CTD/RO	surface	
PS69/506-6	23.07.06	08:57	61° 59,95' S	0° 4,25' E	0,0	CTD/RO	at depth	EL31, 245m
PS69/506-6	23.07.06	09:11	61° 59,89' S	0° 4,06' E	0,0	CTD/RO	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/506-7	23.07.06	09:27	62° 0,09' S	0° 3,85' E	0,0	RMT	surface	
PS69/506-7	23.07.06	09:44	62° 0,69' S	0° 3,35' E	0,0	RMT	heave	FN62.2, 460m
PS69/506-7	23.07.06	10:10	62° 1,45' S	0° 1,71' E	0,0	RMT	on deck	
PS69/506-8	23.07.06	11:40	61° 58,48' S	0° 1,56' W	0,0	RMT	surface	
PS69/506-8	23.07.06	13:53	61° 55,18' S	0° 1,29' W	5370,8	RMT	heave	kabellänge: 5000m, FN 62.2
PS69/506-8	23.07.06	18:35	61° 46,38' S	0° 4,69' W	0,0	RMT	on deck	
PS69/506-9	23.07.06	18:55	61° 46,09' S	0° 4,62' W	0,0	SUIT	surface	
PS69/506-9	23.07.06	18:57	61° 46,11' S	0° 4,59' W	0,0	SUIT	slipped	
PS69/506-9	23.07.06	19:01	61° 46,13' S	0° 4,58' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/506-9	23.07.06	19:07	61° 46,23' S	0° 4,34' W	0,0	SUIT	start trawl	
PS69/506-9	23.07.06	19:31	61° 46,61' S	0° 3,46' W	0,0	SUIT	stop trawl	
PS69/506-9	23.07.06	19:37	61° 46,59' S	0° 3,51' W	0,0	SUIT	Information	Gewicht an Deck
PS69/506-9	23.07.06	19:45	61° 46,56' S	0° 3,63' W	0,0	SUIT	on deck	
PS69/507-1	23.07.06	22:24	61° 31,57' S	0° 1,01' W	0,0	CTD/RO	surface	
PS69/507-1	23.07.06	22:51	61° 31,29' S	0° 1,54' W	0,0	CTD/RO	at depth	EL31, 999m
PS69/507-1	23.07.06	23:16	61° 31,02' S	0° 1,78' W	0,0	CTD/RO	on deck	
PS69/507-2	23.07.06	23:35	61° 31,19' S	0° 2,21' W	0,0	RMT	surface	
PS69/507-2	23.07.06	23:52	61° 31,62' S	0° 3,22' W	0,0	RMT	Begin Trawling	FN 62.2, 460m
PS69/507-2	24.07.06	00:19	61° 32,05' S	0° 4,89' W	0,0	RMT	End of Trawl	
PS69/507-2	24.07.06	00:23	61° 32,09' S	0° 5,14' W	0,0	RMT	on deck	
PS69/508-1	24.07.06	07:44	61° 2,54' S	0° 1,41' W	5378,0	CTD/RO	surface	
PS69/508-1	24.07.06	09:26	61° 2,08' S	0° 2,22' W	5377,2	CTD/RO	at depth	EL31,5328m
PS69/508-2	24.07.06	09:58	61° 1,90' S	0° 2,52' W	5377,2	HN	surface	
PS69/508-2	24.07.06	10:17	61° 1,79' S	0° 2,72' W	5377,2	HN	on deck	
PS69/508-1	24.07.06	10:58	61° 1,49' S	0° 3,18' W	5378,0	CTD/RO	on deck	
PS69/508-3	24.07.06	11:10	61° 1,40' S	0° 3,33' W	0,0	MN	surface	
PS69/508-3	24.07.06	11:46	61° 1,11' S	0° 3,82' W	0,0	MN	at depth	EL 30, 1091m
PS69/508-3	24.07.06	12:24	61° 0,77' S	0° 4,39' W	0,0	MN	on deck	
PS69/508-4	24.07.06	12:41	61° 0,62' S	0° 4,67' W	0,0	MN	surface	
PS69/508-4	24.07.06	13:38	61° 0,13' S	0° 5,65' W	0,0	MN	at depth	Tiefe: 1656m, EL 30
PS69/508-4	24.07.06	14:40	60° 59,65' S	0° 6,76' W	0,0	MN	on deck	
PS69/508-5	24.07.06	14:50	60° 59,56' S	0° 6,88' W	0,0	MN	surface	
PS69/508-6	24.07.06	14:51	60° 59,55' S	0° 6,89' W	0,0	HN	surface	
PS69/508-5	24.07.06	15:01	60° 59,47' S	0° 7,06' W	0,0	MN	at depth	Tiefe: 272m, EL 30
PS69/508-6	24.07.06	15:08	60° 59,42' S	0° 7,19' W	0,0	HN	on deck	
PS69/508-5	24.07.06	15:19	60° 59,35' S	0° 7,39' W	0,0	MN	on deck	
PS69/508-7	24.07.06	15:25	60° 59,31' S	0° 7,50' W	0,0	BONGO	surface	
PS69/508-7	24.07.06	15:40	60° 59,21' S	0° 7,77' W	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/508-7	24.07.06	15:58	60° 59,09' S	0° 8,08' W	0,0	BONGO	on deck	
PS69/508-8	24.07.06	16:05	60° 59,05' S	0° 8,20' W	0,0	CTD/RO	surface	
PS69/508-8	24.07.06	16:16	60° 58,98' S	0° 8,38' W	0,0	CTD/RO	at depth	Die Tiefe 245 m, EL 31
PS69/508-8	24.07.06	16:34	60° 58,87' S	0° 8,65' W	0,0	CTD/RO	on deck	
PS69/508-9	24.07.06	17:09	60° 55,92' S	0° 7,50' W	0,0	RMT	surface	
PS69/508-9	24.07.06	17:26	60° 56,45' S	0° 8,26' W	0,0	RMT	heave	
PS69/508-9	24.07.06	17:53	60° 57,44' S	0° 9,51' W	0,0	RMT	on deck	
PS69/508-10	24.07.06	18:20	60° 56,45' S	0° 8,76' W	0,0	RMT	surface	
PS69/508-10	24.07.06	18:23	60° 56,46' S	0° 8,93' W	0,0	RMT	Begin Trawling	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/508-10	24.07.06	18:38	60° 56,77' S	0° 9,73' W	0,0	RMT	End of Trawl	
PS69/508-10	24.07.06	18:45	60° 56,81' S	0° 10,02' W	0,0	RMT	on deck	
PS69/508-11	24.07.06	19:00	60° 57,34' S	0° 10,05' W	0,0	SUIT	surface	
PS69/508-11	24.07.06	19:02	60° 57,37' S	0° 10,02' W	0,0	SUIT	slipped	
PS69/508-11	24.07.06	19:05	60° 57,39' S	0° 9,99' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/508-11	24.07.06	19:15	60° 57,60' S	0° 9,72' W	0,0	SUIT	start trawl	
PS69/508-11	24.07.06	19:35	60° 58,01' S	0° 8,87' W	0,0	SUIT	stop trawl	
PS69/508-11	24.07.06	19:42	60° 58,04' S	0° 8,71' W	0,0	SUIT	Information	Gewicht an Deck
PS69/508-11	24.07.06	19:52	60° 58,00' S	0° 8,67' W	0,0	SUIT	on deck	
PS69/509-1	29.07.06	00:02	69° 22,50' S	2° 39,10' W	0,0	SUIT	surface	
PS69/509-1	29.07.06	00:04	69° 22,40' S	2° 39,10' W	0,0	SUIT	slipped	
PS69/509-1	29.07.06	00:25	69° 21,88' S	2° 39,88' W	0,0	SUIT	start trawl	FN62.2, 120m
PS69/509-1	29.07.06	00:33	69° 21,76' S	2° 40,46' W	0,0	SUIT	stop trawl	
PS69/509-1	29.07.06	00:35	69° 21,76' S	2° 40,58' W	0,0	SUIT	on deck	Gewicht
PS69/509-1	29.07.06	00:40	69° 21,78' S	2° 40,83' W	0,0	SUIT	on deck	
PS69/509-2	29.07.06	01:17	69° 22,24' S	2° 42,18' W	3314,8	CTD/RO	surface	
PS69/509-2	29.07.06	02:26	69° 22,25' S	2° 41,43' W	3311,6	CTD/RO	at depth	Tiefe: 3230m, EL 31
PS69/509-2	29.07.06	03:26	69° 22,28' S	2° 41,04' W	0,0	CTD/RO	on deck	
PS69/509-3	29.07.06	03:57	69° 23,73' S	2° 37,90' W	0,0	RMT	surface	
PS69/509-3	29.07.06	04:14	69° 23,33' S	2° 39,33' W	0,0	RMT	heave	
PS69/509-3	29.07.06	04:45	69° 22,53' S	2° 41,66' W	0,0	RMT	on deck	
PS69/509-4	29.07.06	05:20	69° 22,98' S	2° 40,06' W	0,0	MN	surface	
PS69/509-4	29.07.06	05:58	69° 23,03' S	2° 40,15' W	0,0	MN	at depth	Die Tiefe 1054 m, EL 30
PS69/509-4	29.07.06	06:36	69° 23,09' S	2° 40,28' W	0,0	MN	on deck	
PS69/509-5	29.07.06	06:45	69° 23,10' S	2° 40,31' W	0,0	MN	surface	
PS69/509-5	29.07.06	07:00	69° 23,12' S	2° 40,37' W	0,0	MN	at depth	Die Tiefe 263 m, EL 30
PS69/509-5	29.07.06	07:17	69° 23,15' S	2° 40,44' W	0,0	MN	on deck	
PS69/509-6	29.07.06	07:24	69° 23,16' S	2° 40,47' W	0,0	BONGO	surface	
PS69/509-6	29.07.06	07:41	69° 23,18' S	2° 40,54' W	0,0	BONGO	at depth	Die Tiefe 250 m, SE 32.2
PS69/509-6	29.07.06	07:59	69° 23,22' S	2° 40,58' W	0,0	BONGO	on deck	
PS69/509-7	29.07.06	08:13	69° 23,24' S	2° 40,62' W	0,0	CTD/RO	surface	
PS69/509-7	29.07.06	08:25	69° 23,26' S	2° 40,64' W	0,0	CTD/RO	at depth	EL31, 245m
PS69/509-7	29.07.06	08:41	69° 23,29' S	2° 40,69' W	0,0	CTD/RO	on deck	
PS69/509-8	29.07.06	09:39	69° 22,83' S	2° 43,73' W	0,0	SUIT	surface	
PS69/509-8	29.07.06	09:39	69° 22,83' S	2° 43,73' W	0,0	SUIT	slipped	
PS69/509-8	29.07.06	09:52	69° 23,02' S	2° 44,48' W	0,0	SUIT	start trawl	FN62.2, 120m
PS69/509-8	29.07.06	10:23	69° 23,16' S	2° 45,09' W	0,0	SUIT	on deck	
PS69/510-1	29.07.06	16:03	69° 1,50' S	2° 53,32' W	0,0	RMT	surface	
PS69/510-1	29.07.06	16:22	69° 1,59' S	2° 54,09' W	0,0	RMT	heave	Die elektronische Verbindung ist abgebrochen
PS69/510-1	29.07.06	16:43	69° 1,69' S	2° 55,14' W	0,0	RMT	on deck	
PS69/510-2	29.07.06	17:09	69° 1,72' S	2° 55,62' W	3566,8	CTD/RO	surface	
PS69/510-3	29.07.06	17:21	69° 1,74' S	2° 55,63' W	3568,0	HN	surface	
PS69/510-2	29.07.06	17:34	69° 1,77' S	2° 55,65' W	3570,0	CTD/RO	at depth	Die Tiefe 983 m, EL 31
PS69/510-3	29.07.06	17:48	69° 1,80' S	2° 55,68' W	0,0	HN	on deck	
PS69/510-2	29.07.06	17:58	69° 1,83' S	2° 55,71' W	0,0	CTD/RO	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/510-4	29.07.06	18:07	69° 1,85' S	2° 55,74' W	0,0	MN	surface	
PS69/510-4	29.07.06	18:42	69° 1,96' S	2° 55,91' W	0,0	MN	at depth	Die Tiefe 1052 m, EL 30
PS69/510-4	29.07.06	19:21	69° 2,09' S	2° 56,11' W	0,0	MN	on deck	
PS69/510-5	29.07.06	19:28	69° 2,12' S	2° 56,15' W	0,0	BONGO	surface	
PS69/510-5	29.07.06	19:44	69° 2,18' S	2° 56,26' W	0,0	BONGO	at depth	Die Tiefe 250 m, SE 32.2
PS69/510-5	29.07.06	20:00	69° 2,24' S	2° 56,38' W	0,0	BONGO	on deck	
PS69/510-6	29.07.06	20:42	69° 2,35' S	2° 54,65' W	0,0	RMT	surface	
PS69/510-6	29.07.06	20:59	69° 2,38' S	2° 56,31' W	0,0	RMT	heave	FN62.2,460m
PS69/510-6	29.07.06	21:27	69° 2,65' S	2° 59,25' W	0,0	RMT	on deck	
PS69/510-7	29.07.06	21:53	69° 2,81' S	2° 59,91' W	0,0	RMT	surface	
PS69/510-7	29.07.06	21:56	69° 2,81' S	2° 59,80' W	0,0	RMT	Begin Trawling	FN62.2,41m
PS69/510-7	29.07.06	22:09	69° 2,81' S	2° 58,77' W	0,0	RMT	End of Trawl	
PS69/510-7	29.07.06	22:16	69° 2,82' S	2° 58,61' W	0,0	RMT	on deck	
PS69/511-1	30.07.06	11:00	68° 36,30' S	2° 57,90' E	0,0	RMT	surface	
PS69/511-1	30.07.06	11:23	68° 35,49' S	2° 58,91' W	0,0	RMT	heave	
PS69/511-1	30.07.06	11:49	68° 34,83' S	3° 0,41' W	0,0	RMT	on deck	
PS69/511-2	30.07.06	12:24	68° 33,46' S	3° 1,72' W	0,0	CTD/RO	surface	
PS69/511-2	30.07.06	12:49	68° 33,49' S	3° 1,60' W	0,0	CTD/RO	at depth	Tiefe: 983m, EL31
PS69/511-2	30.07.06	13:12	68° 33,54' S	3° 1,41' W	0,0	CTD/RO	on deck	
PS69/512-1	30.07.06	20:05	68° 0,34' S	2° 54,29' W	0,0	SUIT	surface	
PS69/512-1	30.07.06	20:05	68° 0,34' S	2° 54,29' W	0,0	SUIT	slipped	
PS69/512-1	30.07.06	20:15	68° 0,12' S	2° 54,80' W	0,0	SUIT	start trawl	62.2: 120 m
PS69/512-1	30.07.06	20:40	67° 59,56' S	2° 55,28' W	0,0	SUIT	stop trawl	
PS69/512-1	30.07.06	20:55	67° 59,49' S	2° 55,56' W	0,0	SUIT	on deck	
PS69/512-2	30.07.06	21:39	67° 59,00' S	2° 51,95' W	0,0	CTD/RO	surface	
PS69/512-3	30.07.06	22:20	67° 59,04' S	2° 52,58' W	4089,6	HN	surface	
PS69/512-3	30.07.06	22:38	67° 59,08' S	2° 52,86' W	4089,6	HN	on deck	
PS69/512-2	30.07.06	22:58	67° 59,12' S	2° 53,21' W	4090,8	CTD/RO	at depth	EL31, 4017m
PS69/512-2	31.07.06	00:14	67° 59,32' S	2° 54,67' W	0,0	CTD/RO	on deck	
PS69/512-4	31.07.06	00:23	67° 59,35' S	2° 54,86' W	0,0	MN	surface	
PS69/512-4	31.07.06	01:01	67° 59,49' S	2° 55,72' W	0,0	MN	at depth	Tiefe: 1081m, EL 30
PS69/512-4	31.07.06	01:42	67° 59,65' S	2° 56,73' W	0,0	MN	on deck	
PS69/512-5	31.07.06	01:49	67° 59,68' S	2° 56,90' W	0,0	MN	surface	
PS69/512-5	31.07.06	03:07	68° 0,09' S	2° 58,91' W	0,0	MN	at depth	Tiefe: 2229m, EL 30
PS69/512-5	31.07.06	04:28	68° 0,62' S	3° 1,35' W	0,0	MN	on deck	
PS69/513-1	31.07.06	13:14	67° 29,84' S	3° 4,65' W	0,0	CTD/RO	surface	
PS69/513-1	31.07.06	13:40	67° 30,00' S	3° 5,91' W	0,0	CTD/RO	at depth	Tiefe:1019m, EL 31
PS69/513-2	31.07.06	13:50	67° 30,06' S	3° 6,39' W	0,0	HN	surface	
PS69/513-2	31.07.06	14:04	67° 30,15' S	3° 7,05' W	0,0	HN	on deck	
PS69/513-1	31.07.06	14:05	67° 30,16' S	3° 7,10' W	0,0	CTD/RO	on deck	
PS69/514-1	31.07.06	22:50	67° 0,81' S	3° 1,20' W	4480,4	CTD/RO	surface	
PS69/514-1	31.07.06	23:27	67° 1,43' S	3° 0,69' W	4478,0	CTD/RO	on deck	
PS69/514-2	01.08.06	09:29	67° 4,84' S	2° 57,60' W	0,0	RMT	surface	
PS69/514-2	01.08.06	09:46	67° 4,38' S	2° 58,28' W	0,0	RMT	heave	FN62.2, 460m
PS69/514-2	01.08.06	10:16	67° 3,50' S	3° 0,15' W	0,0	RMT	on deck	
PS69/514-3	01.08.06	10:37	67° 3,43' S	3° 0,83' W	0,0	CTD/RO	surface	
PS69/514-4	01.08.06	10:58	67° 3,41' S	3° 1,46' W	0,0	HN	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/514-3	01.08.06	11:01	67° 3,41' S	3° 1,53' W	0,0	CTD/RO	surface	EL31,985m
PS69/514-3	01.08.06	11:30	67° 3,42' S	3° 2,30' W	0,0	CTD/RO	on deck	
PS69/514-5	01.08.06	11:42	67° 3,39' S	3° 2,51' W	0,0	BONGO	surface	
PS69/514-5	01.08.06	11:55	67° 3,37' S	3° 2,70' W	0,0	BONGO	at depth	Se32.2, 200m
PS69/514-5	01.08.06	12:09	67° 3,35' S	3° 2,91' W	0,0	BONGO	on deck	
PS69/514-4	01.08.06	12:10	67° 3,35' S	3° 2,94' W	0,0	HN	on deck	
PS69/515-1	01.08.06	23:26	66° 33,30' S	3° 5,95' W	4514,8	CTD/RO	surface	
PS69/515-1	02.08.06	00:57	66° 33,44' S	3° 5,70' W	4512,4	CTD/RO	at depth	Tiefe: 4432m, EL 31
PS69/515-1	02.08.06	02:18	66° 33,71' S	3° 5,65' W	0,0	CTD/RO	on deck	
PS69/515-2	02.08.06	02:28	66° 33,75' S	3° 5,66' W	0,0	MN	surface	
PS69/515-2	02.08.06	03:39	66° 34,03' S	3° 5,78' W	0,0	MN	at depth	Tiefe: 2100m, EL 30
PS69/515-2	02.08.06	04:52	66° 34,48' S	3° 6,15' W	0,0	MN	on deck	
PS69/515-3	02.08.06	05:01	66° 34,54' S	3° 6,20' W	0,0	MN	surface	
PS69/515-3	02.08.06	05:38	66° 34,79' S	3° 6,41' W	0,0	MN	at depth	Die Tiefe 1066 m, EL30
PS69/515-3	02.08.06	06:16	66° 35,06' S	3° 6,61' W	0,0	MN	on deck	
PS69/515-4	02.08.06	06:27	66° 35,13' S	3° 6,66' W	0,0	MN	surface	
PS69/515-4	02.08.06	06:40	66° 35,22' S	3° 6,72' W	0,0	MN	at depth	Die Tiefe 266 m, EL 30
PS69/515-4	02.08.06	07:00	66° 35,35' S	3° 6,82' W	0,0	MN	on deck	
PS69/515-5	02.08.06	07:06	66° 35,39' S	3° 6,85' W	0,0	BONGO	surface	
PS69/515-5	02.08.06	07:24	66° 35,50' S	3° 6,94' W	0,0	BONGO	at depth	Die Tiefe 300 m, SE 32.2
PS69/515-5	02.08.06	07:48	66° 35,64' S	3° 7,08' W	0,0	BONGO	on deck	
PS69/515-6	02.08.06	07:59	66° 35,71' S	3° 7,15' W	0,0	CTD/RO	surface	
PS69/515-6	02.08.06	08:12	66° 35,79' S	3° 7,23' W	0,0	CTD/RO	at depth	EL31, 245m
PS69/515-6	02.08.06	08:24	66° 35,85' S	3° 7,31' W	0,0	CTD/RO	on deck	
PS69/515-7	02.08.06	12:07	66° 36,43' S	3° 10,09' W	0,0	BONGO	surface	
PS69/515-7	02.08.06	12:13	66° 36,44' S	3° 10,21' W	0,0	BONGO	at depth	Tiefe: 75m, SE 32.2
PS69/515-7	02.08.06	12:20	66° 36,48' S	3° 10,35' W	0,0	BONGO	on deck	
PS69/515-8	02.08.06	12:22	66° 36,49' S	3° 10,38' W	0,0	BONGO	surface	
PS69/515-8	02.08.06	12:28	66° 36,51' S	3° 10,51' W	0,0	BONGO	at depth	Tiefe: 100m, SE 32.2
PS69/515-8	02.08.06	12:36	66° 36,54' S	3° 10,67' W	0,0	BONGO	on deck	
PS69/515-9	02.08.06	12:38	66° 36,54' S	3° 10,72' W	0,0	BONGO	surface	
PS69/515-10	02.08.06	13:01	66° 36,63' S	3° 11,23' W	0,0	HN	surface	
PS69/515-9	02.08.06	13:06	66° 36,65' S	3° 11,34' W	0,0	BONGO	at depth	Tiefe: 500m, SE 32.2
PS69/515-9	02.08.06	13:40	66° 36,75' S	3° 12,16' W	0,0	BONGO	on deck	
PS69/515-11	02.08.06	13:41	66° 36,76' S	3° 12,18' W	0,0	BONGO	surface	
PS69/515-10	02.08.06	13:42	66° 36,76' S	3° 12,21' W	0,0	HN	on deck	
PS69/515-11	02.08.06	13:58	66° 36,81' S	3° 12,63' W	0,0	BONGO	at depth	Tiefe: 300m, SE 32.2
PS69/515-11	02.08.06	14:20	66° 36,89' S	3° 13,29' W	0,0	BONGO	on deck	
PS69/515-12	02.08.06	21:51	66° 20,77' S	2° 55,73' W	0,0	RMT	surface	
PS69/515-12	02.08.06	22:09	66° 20,36' S	2° 55,11' W	0,0	RMT	heave	FN62.2, 460m
PS69/515-12	02.08.06	22:39	66° 19,47' S	2° 54,24' W	0,0	RMT	on deck	
PS69/515-13	02.08.06	23:16	66° 20,40' S	2° 55,75' W	0,0	RMT	surface	
PS69/515-13	02.08.06	23:19	66° 20,36' S	2° 55,72' W	0,0	RMT	Begin Trawling	FN62.2,80m
PS69/515-13	02.08.06	23:35	66° 19,95' S	2° 55,25' W	0,0	RMT	End of Trawl	
PS69/515-13	02.08.06	23:39	66° 19,92' S	2° 55,26' W	0,0	RMT	on deck	
PS69/516-1	03.08.06	05:00	66° 1,76' S	3° 6,97' E	4769,0	CTD/RO	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/516-1	03.08.06	06:44	66° 2,27' S	3° 6,12' W	4755,2	CTD/RO	at depth	Die Tiefe 4699 m, EL 31
PS69/516-1	03.08.06	08:13	66° 2,62' S	3° 4,93' W	0,0	CTD/RO	on deck	
PS69/516-2	03.08.06	08:27	66° 2,66' S	3° 4,75' W	0,0	MN	surface	
PS69/516-2	03.08.06	09:02	66° 2,73' S	3° 4,36' W	0,0	MN	at depth	EL30, 1058m
PS69/516-3	03.08.06	09:37	66° 2,78' S	3° 3,91' W	0,0	HN	surface	
PS69/516-2	03.08.06	09:41	66° 2,79' S	3° 3,88' W	0,0	MN	on deck	
PS69/516-4	03.08.06	09:53	66° 2,81' S	3° 3,77' W	0,0	MN	surface	
PS69/516-3	03.08.06	10:09	66° 2,82' S	3° 3,62' W	0,0	HN	on deck	
PS69/516-4	03.08.06	10:59	66° 2,81' S	3° 3,28' W	0,0	MN	at depth	EL 30, 2100m
PS69/516-4	03.08.06	12:12	66° 2,72' S	3° 3,21' W	0,0	MN	on deck	
PS69/516-5	03.08.06	12:23	66° 2,69' S	3° 3,23' W	0,0	MN	surface	
PS69/516-5	03.08.06	12:38	66° 2,65' S	3° 3,24' W	0,0	MN	at depth	Tiefe: 276m, EL 30
PS69/516-5	03.08.06	12:54	66° 2,61' S	3° 3,26' W	0,0	MN	on deck	
PS69/516-6	03.08.06	13:01	66° 2,59' S	3° 3,27' W	0,0	BONGO	surface	
PS69/516-6	03.08.06	13:14	66° 2,56' S	3° 3,30' W	0,0	BONGO	at depth	200 m 32.2
PS69/516-6	03.08.06	13:27	66° 2,54' S	3° 3,34' W	0,0	BONGO	on deck	
PS69/516-7	03.08.06	13:35	66° 2,54' S	3° 3,37' W	0,0	CTD/RO	surface	
PS69/516-7	03.08.06	13:46	66° 2,53' S	3° 3,41' W	0,0	CTD/RO	at depth	245 m; EL 31
PS69/516-7	03.08.06	13:59	66° 2,52' S	3° 3,48' W	0,0	CTD/RO	on deck	
PS69/516-8	03.08.06	14:56	66° 5,15' S	3° 4,20' W	0,0	RMT	surface	
PS69/516-8	03.08.06	15:13	66° 4,65' S	3° 3,56' W	0,0	RMT	heave	FN62.2 460 m ausgesteckt
PS69/516-8	03.08.06	15:49	66° 3,47' S	3° 3,69' W	0,0	RMT	on deck	
PS69/516-9	03.08.06	16:11	66° 3,49' S	3° 3,75' W	0,0	SUIT	surface	
PS69/516-9	03.08.06	16:14	66° 3,46' S	3° 3,76' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/516-9	03.08.06	16:21	66° 3,27' S	3° 3,83' W	0,0	SUIT	start trawl	
PS69/516-9	03.08.06	16:46	66° 2,69' S	3° 3,54' W	0,0	SUIT	stop trawl	
PS69/516-9	03.08.06	16:51	66° 2,66' S	3° 3,50' W	0,0	SUIT	Information	Gewicht an Deck
PS69/516-9	03.08.06	16:58	66° 2,63' S	3° 3,47' W	0,0	SUIT	on deck	
PS69/517-1	04.08.06	00:00	0° 0,00' N	0° 0,00' E	0,0	RMT	surface	
PS69/517-1	04.08.06	00:16	65° 29,38' S	2° 57,91' W	0,0	RMT	heave	Länge: 460m, FN 62.2
PS69/517-1	04.08.06	00:41	65° 29,95' S	2° 59,32' W	0,0	RMT	End of Trawl	
PS69/517-1	04.08.06	00:42	65° 29,94' S	2° 59,37' W	0,0	RMT	on deck	
PS69/517-2	04.08.06	01:04	65° 29,78' S	2° 58,93' W	0,0	CTD/RO	surface	
PS69/517-2	04.08.06	01:29	65° 29,73' S	2° 59,02' W	0,0	CTD/RO	at depth	Tiefe: 982m, EL 31
PS69/517-2	04.08.06	01:55	65° 29,69' S	2° 59,15' W	0,0	CTD/RO	on deck	
PS69/518-1	04.08.06	08:40	65° 4,29' S	2° 52,38' W	0,0	RMT	surface	
PS69/518-1	04.08.06	08:56	65° 4,49' S	2° 52,57' W	0,0	RMT	heave	FN62.2, 460m
PS69/518-1	04.08.06	09:24	65° 5,02' S	2° 54,28' W	0,0	RMT	on deck	
PS69/518-2	04.08.06	09:47	65° 5,10' S	2° 55,36' W	0,0	RMT	surface	
PS69/518-2	04.08.06	09:53	65° 5,11' S	2° 55,12' W	0,0	RMT	Begin Trawling	NF62.2, 150m
PS69/518-2	04.08.06	10:19	65° 5,08' S	2° 53,20' W	0,0	RMT	on deck	
PS69/518-3	04.08.06	10:45	65° 5,00' S	2° 52,00' E	0,0	CTD/RO	surface	
PS69/518-4	04.08.06	10:50	65° 5,08' S	2° 52,72' W	0,0	HN	surface	
PS69/518-3	04.08.06	11:11	65° 5,10' S	2° 52,52' W	0,0	CTD/RO	at depth	EL31, 982m
PS69/518-4	04.08.06	11:21	65° 5,10' S	2° 52,42' W	0,0	HN	on deck	
PS69/518-3	04.08.06	11:34	65° 5,10' S	2° 52,30' W	0,0	CTD/RO	on deck	
PS69/518-5	04.08.06	11:44	65° 5,10' S	2° 52,22' W	0,0	MN	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/518-5	04.08.06	12:55	65° 5,11' S	2° 51,72' W	0,0	MN	at depth	Tiefe: 2100m, EL 30
PS69/518-5	04.08.06	14:10	65° 5,11' S	2° 51,48' W	0,0	MN	on deck	
PS69/518-6	04.08.06	14:22	65° 5,11' S	2° 51,46' W	0,0	MN	surface	
PS69/518-6	04.08.06	15:00	65° 5,13' S	2° 51,39' W	0,0	MN	at depth	Tiefe: 1053m, EL 30
PS69/518-6	04.08.06	15:39	65° 5,15' S	2° 51,38' W	0,0	MN	on deck	
PS69/518-7	04.08.06	15:46	65° 5,15' S	2° 51,39' W	0,0	MN	surface	
PS69/518-7	04.08.06	16:02	65° 5,16' S	2° 51,41' W	0,0	MN	at depth	Die Tiefe 263 m, EL 30
PS69/518-7	04.08.06	16:18	65° 5,17' S	2° 51,45' W	0,0	MN	on deck	
PS69/518-8	04.08.06	16:24	65° 5,18' S	2° 51,45' W	0,0	BONGO	surface	
PS69/518-8	04.08.06	16:38	65° 5,19' S	2° 51,47' W	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/518-8	04.08.06	16:53	65° 5,22' S	2° 51,49' W	0,0	BONGO	on deck	
PS69/518-9	04.08.06	17:00	65° 5,23' S	2° 51,50' W	0,0	CTD/RO	surface	
PS69/518-9	04.08.06	17:13	65° 5,25' S	2° 51,51' W	0,0	CTD/RO	at depth	Die Tiefe 245 m, EL 31
PS69/518-9	04.08.06	17:25	65° 5,29' S	2° 51,47' W	0,0	CTD/RO	on deck	
PS69/518-10	04.08.06	17:33	65° 5,27' S	2° 51,15' W	0,0	SUIT	surface	
PS69/518-10	04.08.06	17:34	65° 5,27' S	2° 51,08' W	0,0	SUIT	slipped	
PS69/518-10	04.08.06	17:37	65° 5,28' S	2° 50,92' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/518-10	04.08.06	17:42	65° 5,27' S	2° 50,50' W	0,0	SUIT	start trawl	
PS69/518-10	04.08.06	18:08	65° 5,05' S	2° 49,02' W	0,0	SUIT	stop trawl	
PS69/518-10	04.08.06	18:13	65° 5,04' S	2° 48,88' W	0,0	SUIT	Information	Gewicht an Deck
PS69/518-10	04.08.06	18:21	65° 5,05' S	2° 48,78' W	0,0	SUIT	on deck	
PS69/519-1	05.08.06	01:12	64° 30,22' S	3° 0,04' W	0,0	RMT	surface	
PS69/519-1	05.08.06	01:30	64° 29,66' S	2° 59,12' W	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/519-1	05.08.06	01:58	64° 28,64' S	2° 58,08' W	0,0	RMT	End of Trawl	
PS69/519-1	05.08.06	02:01	64° 28,57' S	2° 58,06' W	0,0	RMT	on deck	
PS69/519-2	05.08.06	02:23	64° 28,52' S	2° 58,38' W	0,0	CTD/RO	surface	
PS69/519-2	05.08.06	02:49	64° 28,46' S	2° 58,90' W	0,0	CTD/RO	at depth	Tiefe: 985m, EL 31
PS69/519-2	05.08.06	03:15	64° 28,41' S	2° 59,47' W	0,0	CTD/RO	on deck	
PS69/520-1	05.08.06	09:05	63° 60,00' S	2° 59,10' W	0,0	RMT	surface	
PS69/520-1	05.08.06	09:36	64° 0,11' S	2° 59,68' W	0,0	RMT	on deck	Abbruch
PS69/520-2	05.08.06	10:10	63° 59,89' S	3° 0,19' W	5202,8	CTD/RO	surface	
PS69/520-3	05.08.06	10:45	63° 59,83' S	3° 1,06' W	5203,6	HN	surface	
PS69/520-3	05.08.06	11:06	63° 59,78' S	3° 1,58' W	5204,8	HN	on deck	
PS69/520-2	05.08.06	11:46	63° 59,67' S	3° 2,61' W	5205,2	CTD/RO	at depth	EL31, 5189m
PS69/520-2	05.08.06	13:22	63° 59,29' S	3° 5,35' W	0,0	CTD/RO	on deck	
PS69/520-4	05.08.06	13:29	63° 59,26' S	3° 5,57' W	0,0	MN	surface	
PS69/520-4	05.08.06	14:45	63° 58,94' S	3° 8,02' W	0,0	MN	at depth	Tiefe: 2269m, EL 30
PS69/520-4	05.08.06	16:02	63° 58,68' S	3° 10,60' W	0,0	MN	on deck	
PS69/520-5	05.08.06	16:08	63° 58,66' S	3° 10,80' W	0,0	MN	surface	
PS69/520-5	05.08.06	16:47	63° 58,56' S	3° 12,09' W	0,0	MN	at depth	Die Tiefe 1134 m, EL 30
PS69/520-5	05.08.06	17:25	63° 58,49' S	3° 13,32' W	0,0	MN	on deck	
PS69/520-6	05.08.06	17:33	63° 58,47' S	3° 13,57' W	0,0	MN	surface	
PS69/520-6	05.08.06	17:43	63° 58,45' S	3° 13,89' W	0,0	MN	at depth	Die Tiefe 278 m, EL 30
PS69/520-6	05.08.06	18:00	63° 58,43' S	3° 14,44' W	0,0	MN	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/520-7	05.08.06	18:09	63° 58,42' S	3° 14,72' W	0,0	CTD/RO	surface	
PS69/520-7	05.08.06	18:19	63° 58,40' S	3° 15,03' W	0,0	CTD/RO	at depth	Die Tiefe 247 m, EL 31
PS69/520-7	05.08.06	18:33	63° 58,39' S	3° 15,46' W	0,0	CTD/RO	on deck	
PS69/520-8	05.08.06	18:44	63° 58,41' S	3° 15,30' W	0,0	SUIT	surface	
PS69/520-8	05.08.06	18:45	63° 58,43' S	3° 15,29' W	0,0	SUIT	slipped	
PS69/520-8	05.08.06	18:48	63° 58,46' S	3° 15,27' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/520-8	05.08.06	18:53	63° 58,56' S	3° 15,10' W	0,0	SUIT	start trawl	
PS69/520-8	05.08.06	19:18	63° 59,12' S	3° 14,45' W	0,0	SUIT	stop trawl	
PS69/520-8	05.08.06	19:25	63° 59,20' S	3° 14,43' W	0,0	SUIT	Information	Gewicht an Deck
PS69/520-8	05.08.06	19:33	63° 59,27' S	3° 14,49' W	0,0	SUIT	on deck	
PS69/521-1	05.08.06	23:56	63° 35,65' S	3° 4,18' W	0,0	RMT	surface	
PS69/521-1	06.08.06	00:11	63° 35,97' S	3° 4,80' W	0,0	RMT	heave	Länge: 460m, FN 62.2
PS69/521-1	06.08.06	00:36	63° 36,38' S	3° 6,38' W	0,0	RMT	End of Trawl	
PS69/521-1	06.08.06	00:39	63° 36,42' S	3° 6,51' W	0,0	RMT	on deck	
PS69/521-2	06.08.06	01:00	63° 35,97' S	3° 5,77' W	0,0	CTD/RO	surface	
PS69/521-2	06.08.06	01:26	63° 35,89' S	3° 5,99' W	0,0	CTD/RO	at depth	Tiefe: 984m, EL 31
PS69/521-2	06.08.06	01:50	63° 35,86' S	3° 6,25' W	0,0	CTD/RO	on deck	
PS69/522-1	06.08.06	08:10	63° 4,69' S	2° 58,98' W	0,0	RMT	surface	
PS69/522-1	06.08.06	08:24	63° 4,39' S	2° 59,26' W	0,0	RMT	heave	FN62.2, 460m
PS69/522-1	06.08.06	08:51	63° 3,66' S	2° 59,28' W	0,0	RMT	on deck	
PS69/522-2	06.08.06	09:16	63° 3,36' S	2° 59,74' W	0,0	CTD/RO	surface	
PS69/522-2	06.08.06	09:38	63° 3,44' S	2° 59,88' W	0,0	CTD/RO	at depth	EL31, 983m
PS69/522-2	06.08.06	10:04	63° 3,68' S	3° 0,15' W	0,0	CTD/RO	on deck	
PS69/522-3	06.08.06	10:09	63° 3,74' S	3° 0,23' W	0,0	MN	surface	
PS69/522-3	06.08.06	10:45	63° 4,08' S	3° 0,65' W	0,0	MN	at depth	EL30,1072m
PS69/522-3	06.08.06	11:23	63° 4,38' S	3° 1,02' W	0,0	MN	on deck	
PS69/522-4	06.08.06	11:30	63° 4,44' S	3° 1,09' W	0,0	BONGO	surface	
PS69/522-4	06.08.06	11:42	63° 4,52' S	3° 1,21' W	0,0	BONGO	at depth	SE32.2, 200m
PS69/522-4	06.08.06	11:57	63° 4,63' S	3° 1,36' W	0,0	BONGO	on deck	
PS69/523-1	06.08.06	18:56	62° 30,58' S	3° 1,21' W	0,0	RMT	surface	
PS69/523-1	06.08.06	19:13	62° 30,29' S	3° 0,92' W	0,0	RMT	heave	
PS69/523-1	06.08.06	20:11	62° 30,19' S	3° 1,63' W	0,0	RMT	on deck	
PS69/523-2	06.08.06	20:42	62° 29,68' S	3° 1,68' W	0,0	CTD/RO	surface	
PS69/523-2	06.08.06	21:03	62° 29,81' S	3° 2,02' W	0,0	CTD/RO	at depth	EL31, 988m
PS69/523-2	06.08.06	21:35	62° 30,01' S	3° 2,50' W	0,0	CTD/RO	on deck	
PS69/524-1	07.08.06	03:00	62° 2,60' S	3° 5,91' W	0,0	RMT	surface	
PS69/524-1	07.08.06	03:17	62° 2,74' S	3° 4,53' W	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/524-1	07.08.06	03:43	62° 2,93' S	3° 2,34' W	0,0	RMT	End of Trawl	
PS69/524-1	07.08.06	03:46	62° 2,93' S	3° 2,25' W	0,0	RMT	on deck	
PS69/524-2	07.08.06	04:13	62° 2,63' S	3° 3,25' W	0,0	MN	surface	
PS69/524-2	07.08.06	04:51	62° 2,44' S	3° 3,56' W	0,0	MN	at depth	Die Tiefe 1061 m, EL 30
PS69/524-2	07.08.06	05:31	62° 2,24' S	3° 3,98' W	0,0	MN	on deck	
PS69/524-3	07.08.06	06:00	62° 2,15' S	3° 4,05' W	0,0	SUIT	surface	
PS69/524-3	07.08.06	06:01	62° 2,16' S	3° 4,05' W	0,0	SUIT	slipped	
PS69/524-3	07.08.06	06:04	62° 2,17' S	3° 4,05' W	0,0	SUIT	Information	Gewicht zu Wasser

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/524-3	07.08.06	06:09	62° 2,31' S	3° 3,82' W	0,0	SUIT	start trawl	
PS69/524-3	07.08.06	06:34	62° 2,71' S	3° 3,27' W	0,0	SUIT	stop trawl	
PS69/524-3	07.08.06	06:40	62° 2,73' S	3° 3,29' W	0,0	SUIT	Information	Gewicht an Deck
PS69/524-3	07.08.06	06:50	62° 2,71' S	3° 3,44' W	0,0	SUIT	on deck	
PS69/524-4	07.08.06	07:41	62° 3,55' S	3° 0,79' W	5348,0	CTD/RO	surface	
PS69/524-4	07.08.06	09:22	62° 3,55' S	3° 2,61' W	5346,4	CTD/RO	at depth	El31,5317m
PS69/524-5	07.08.06	10:56	62° 3,75' S	3° 3,74' W	0,0	HN	surface	
PS69/524-4	07.08.06	10:56	62° 3,75' S	3° 3,74' W	0,0	CTD/RO	on deck	
PS69/524-6	07.08.06	11:00	62° 3,80' S	3° 3,80' W	0,0	MN	surface	
PS69/524-6	07.08.06	11:15	62° 3,80' S	3° 3,90' W	0,0	MN	at depth	Die Tiefe 263 m, EL 30
PS69/524-5	07.08.06	11:33	62° 3,80' S	3° 4,00' E	0,0	HN	on deck	
PS69/524-6	07.08.06	11:33	62° 3,80' S	3° 4,00' W	0,0	MN	on deck	
PS69/524-7	07.08.06	11:40	62° 3,90' S	3° 4,00' W	0,0	BONGO	surface	
PS69/524-7	07.08.06	11:54	62° 3,90' S	3° 4,10' W	0,0	BONGO	at depth	Die Tiefe 200 m, SE 32.2
PS69/524-7	07.08.06	12:07	62° 3,90' S	3° 4,10' W	0,0	BONGO	on deck	
PS69/524-8	07.08.06	12:17	62° 3,90' S	3° 4,10' W	0,0	CTD/RO	surface	
PS69/524-8	07.08.06	12:27	62° 3,90' S	3° 4,20' W	0,0	CTD/RO	at depth	Die Tiefe 245, EL 31
PS69/524-8	07.08.06	12:40	62° 3,90' S	3° 4,30' W	0,0	CTD/RO	on deck	
PS69/524-9	07.08.06	12:47	62° 3,90' S	3° 4,20' W	0,0	SUIT	surface	
PS69/524-9	07.08.06	12:48	62° 3,90' S	3° 4,20' W	0,0	SUIT	slipped	
PS69/524-9	07.08.06	12:56	62° 4,20' S	3° 3,80' W	0,0	SUIT	start trawl	
PS69/524-9	07.08.06	13:21	62° 4,50' S	3° 0,30' W	0,0	SUIT	stop trawl	
PS69/524-9	07.08.06	13:38	62° 4,50' S	3° 0,20' W	0,0	SUIT	on deck	
PS69/525-1	07.08.06	18:53	61° 32,95' S	3° 0,19' W	0,0	RMT	surface	
PS69/525-1	07.08.06	19:10	61° 33,39' S	3° 0,24' W	0,0	RMT	heave	
PS69/525-1	07.08.06	19:38	61° 34,14' S	3° 0,40' W	0,0	RMT	on deck	
PS69/525-2	07.08.06	20:19	61° 33,82' S	3° 1,27' W	0,0	CTD/RO	surface	
PS69/525-3	07.08.06	20:23	61° 33,81' S	3° 1,32' W	0,0	HN	surface	
PS69/525-2	07.08.06	20:40	61° 33,75' S	3° 1,52' W	0,0	CTD/RO	at depth	EL31,985m
PS69/525-3	07.08.06	20:41	61° 33,74' S	3° 1,53' W	0,0	HN	on deck	
PS69/525-2	07.08.06	21:06	61° 33,67' S	3° 1,83' W	0,0	CTD/RO	on deck	
PS69/526-1	08.08.06	03:15	60° 59,10' S	2° 51,49' W	0,0	RMT	surface	
PS69/526-1	08.08.06	03:32	60° 59,33' S	2° 52,40' W	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/526-1	08.08.06	03:59	60° 59,68' S	2° 53,83' W	0,0	RMT	End of Trawl	
PS69/526-1	08.08.06	04:02	60° 59,67' S	2° 53,80' W	0,0	RMT	on deck	
PS69/526-2	08.08.06	04:29	60° 59,18' S	2° 53,20' W	0,0	MN	surface	
PS69/526-2	08.08.06	05:03	60° 58,98' S	2° 52,61' W	0,0	MN	at depth	Die Tiefe 1099 m, EL 30
PS69/526-2	08.08.06	05:42	60° 58,67' S	2° 52,08' W	0,0	MN	on deck	
PS69/526-3	08.08.06	05:58	60° 58,55' S	2° 51,91' W	0,0	SUIT	surface	
PS69/526-3	08.08.06	05:59	60° 58,55' S	2° 51,91' W	0,0	SUIT	slipped	
PS69/526-3	08.08.06	06:02	60° 58,54' S	2° 51,92' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/526-3	08.08.06	06:07	60° 58,64' S	2° 52,09' W	0,0	SUIT	start trawl	
PS69/526-3	08.08.06	06:32	60° 58,98' S	2° 52,60' W	0,0	SUIT	stop trawl	
PS69/526-3	08.08.06	06:39	60° 58,98' S	2° 52,62' W	0,0	SUIT	Information	Gewicht an Deck
PS69/526-3	08.08.06	06:46	60° 58,94' S	2° 52,63' W	0,0	SUIT	on deck	
PS69/526-4	08.08.06	07:08	60° 58,83' S	2° 52,09' W	5346,0	CTD/RO	surface	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/526-4	08.08.06	08:56	60° 57,72' S	2° 52,83' W	5349,2	CTD/RO	at depth	5356m, EL31
PS69/526-4	08.08.06	10:37	60° 57,23' S	2° 54,52' W	0,0	CTD/RO	on deck	
PS69/526-5	08.08.06	10:44	60° 57,24' S	2° 54,66' W	0,0	MN	surface	
PS69/526-6	08.08.06	10:56	60° 57,21' S	2° 54,88' W	0,0	HN	surface	
PS69/526-6	08.08.06	11:15	60° 57,25' S	2° 55,22' W	0,0	HN	on deck	
PS69/526-5	08.08.06	12:00	60° 57,38' S	2° 55,96' W	0,0	MN	at depth	Tiefe: 2133m, EL 30
PS69/526-5	08.08.06	13:14	60° 57,83' S	2° 56,82' W	0,0	MN	on deck	
PS69/526-7	08.08.06	13:23	60° 57,91' S	2° 56,88' W	0,0	MN	surface	
PS69/526-7	08.08.06	13:33	60° 57,99' S	2° 56,92' W	0,0	MN	at depth	Tiefe: 266m, EL 30
PS69/526-7	08.08.06	13:51	0° 0,00' N	0° 0,00' E	0,0	MN	on deck	
PS69/526-8	08.08.06	14:04	60° 58,24' S	2° 56,94' W	0,0	BONGO	surface	
PS69/526-8	08.08.06	14:15	60° 58,33' S	2° 56,92' W	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/526-8	08.08.06	14:30	60° 58,45' S	2° 56,86' W	0,0	BONGO	on deck	
PS69/526-9	08.08.06	14:40	60° 58,53' S	2° 56,80' W	0,0	CTD/RO	surface	
PS69/526-9	08.08.06	14:50	60° 58,61' S	2° 56,73' W	0,0	CTD/RO	at depth	Tiefe: 246m, EL 31
PS69/526-9	08.08.06	15:07	60° 58,74' S	2° 56,58' W	0,0	CTD/RO	on deck	
PS69/526-10	08.08.06	15:13	60° 58,87' S	2° 56,54' W	0,0	SUIT	surface	
PS69/526-10	08.08.06	15:14	60° 58,89' S	2° 56,52' W	0,0	SUIT	slipped	
PS69/526-10	08.08.06	15:22	60° 59,18' S	2° 56,39' W	0,0	SUIT	start trawl	Kabellänge: 120m, FN 62.2
PS69/526-10	08.08.06	15:48	60° 59,99' S	2° 55,90' W	0,0	SUIT	stop trawl	
PS69/526-10	08.08.06	15:54	61° 0,03' S	2° 55,80' W	0,0	SUIT	Information	Gewicht
PS69/526-10	08.08.06	16:05	61° 0,08' S	2° 55,61' W	0,0	SUIT	on deck	
PS69/527-1	08.08.06	20:29	60° 29,77' S	3° 0,57' W	0,0	RMT	surface	
PS69/527-1	08.08.06	20:44	60° 29,56' S	3° 1,43' W	0,0	RMT	heave	
PS69/527-1	08.08.06	21:12	60° 29,02' S	3° 3,03' W	0,0	RMT	on deck	
PS69/527-2	08.08.06	21:52	60° 28,82' S	3° 3,28' W	0,0	CTD/RO	surface	
PS69/527-2	08.08.06	22:14	60° 28,59' S	3° 3,17' W	0,0	CTD/RO	at depth	EL31, 989m
PS69/527-2	08.08.06	22:43	60° 28,32' S	3° 3,11' W	0,0	CTD/RO	on deck	
PS69/527-3	08.08.06	22:50	60° 28,26' S	3° 3,12' W	0,0	MN	surface	
PS69/527-3	08.08.06	23:28	60° 28,00' S	3° 3,24' W	0,0	MN	at depth	EL30,1063m
PS69/527-3	09.08.06	00:07	60° 27,82' S	3° 3,64' W	0,0	MN	on deck	
PS69/527-4	09.08.06	00:16	60° 27,80' S	3° 3,75' W	0,0	BONGO	surface	
PS69/527-4	09.08.06	00:27	60° 27,78' S	3° 3,88' W	0,0	BONGO	at depth	Tiefe: 200m, SE 32.2
PS69/527-4	09.08.06	00:42	60° 27,78' S	3° 4,05' W	0,0	BONGO	on deck	
PS69/528-1	09.08.06	05:19	60° 2,19' S	3° 0,27' W	0,0	RMT	surface	
PS69/528-1	09.08.06	05:37	60° 2,63' S	2° 58,92' W	0,0	RMT	heave	
PS69/528-1	09.08.06	06:05	60° 3,35' S	2° 57,24' W	0,0	RMT	on deck	
PS69/528-2	09.08.06	06:26	60° 3,00' S	2° 56,84' W	4789,6	CTD/RO	surface	
PS69/528-2	09.08.06	08:00	60° 2,97' S	2° 57,35' W	4812,8	CTD/RO	at depth	EL,31, 4765m
PS69/528-2	09.08.06	09:34	60° 2,19' S	2° 57,75' W	0,0	CTD/RO	on deck	
PS69/528-3	09.08.06	09:43	60° 2,09' S	2° 57,77' W	0,0	MN	surface	
PS69/528-4	09.08.06	10:11	60° 1,74' S	2° 57,83' W	0,0	HN	surface	
PS69/528-3	09.08.06	10:18	60° 1,64' S	2° 57,84' W	0,0	MN	at depth	EL30,1128m
PS69/528-4	09.08.06	10:32	60° 1,43' S	2° 57,84' W	0,0	HN	on deck	
PS69/528-3	09.08.06	10:48	60° 1,16' S	2° 57,82' W	0,0	MN	on deck	Abbruch
PS69/528-5	09.08.06	11:39	60° 0,26' S	2° 57,59' W	0,0	MN	surface	
PS69/528-5	09.08.06	12:27	59° 59,21' S	2° 57,56' W	0,0	MN	at depth	Tiefe: 1373m, EL 30
PS69/528-5	09.08.06	13:18	59° 58,15' S	2° 57,60' W	0,0	MN	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/528-6	09.08.06	13:26	59° 58,00' S	2° 57,61' W	0,0	MN	surface	
PS69/528-6	09.08.06	13:38	59° 57,77' S	2° 57,64' W	0,0	MN	at depth	Tiefe: 294m, EL 30
PS69/528-6	09.08.06	13:58	59° 57,40' S	2° 57,73' W	0,0	MN	on deck	
PS69/528-7	09.08.06	14:12	59° 57,13' S	2° 57,76' W	0,0	CTD/RO	surface	
PS69/528-7	09.08.06	14:34	59° 56,80' S	2° 57,88' W	0,0	CTD/RO	at depth	Tiefe: 250m, EL 31
PS69/528-7	09.08.06	14:42	59° 56,67' S	2° 57,92' W	0,0	CTD/RO	on deck	
PS69/528-8	09.08.06	14:49	59° 56,61' S	2° 57,97' W	0,0	MN	surface	
PS69/528-8	09.08.06	16:02	59° 55,77' S	2° 58,49' W	0,0	MN	at depth	Die Tiefe 2202 m, EL 30
PS69/528-8	09.08.06	17:19	59° 55,38' S	2° 58,96' W	0,0	MN	on deck	
PS69/528-9	09.08.06	17:58	59° 55,57' S	2° 59,57' W	0,0	SUIT	surface	
PS69/528-9	09.08.06	18:00	59° 55,59' S	2° 59,61' W	0,0	SUIT	slipped	
PS69/528-9	09.08.06	18:03	59° 55,65' S	2° 59,73' W	0,0	SUIT	Information	Gewicht zu Wasser
PS69/528-9	09.08.06	18:06	59° 55,75' S	2° 59,96' W	0,0	SUIT	start trawl	
PS69/528-9	09.08.06	18:32	59° 56,33' S	3° 1,19' W	0,0	SUIT	stop trawl	
PS69/528-9	09.08.06	18:40	59° 56,40' S	3° 1,28' W	0,0	SUIT	Information	Gewicht an Deck
PS69/528-9	09.08.06	18:48	59° 56,41' S	3° 1,23' W	0,0	SUIT	on deck	
PS69/529-1	10.08.06	06:34	60° 1,75' S	0° 0,21' E	0,0	RMT	surface	
PS69/529-1	10.08.06	06:58	60° 2,65' S	0° 0,68' E	0,0	RMT	heave	
PS69/529-1	10.08.06	07:45	60° 4,20' S	0° 2,04' E	0,0	RMT	on deck	
PS69/529-2	10.08.06	08:28	60° 4,68' S	0° 0,00' W	0,0	CTD/RO	surface	
PS69/529-2	10.08.06	10:09	60° 3,98' S	0° 0,04' W	5392,4	CTD/RO	at depth	EL31, 5352m
PS69/529-2	10.08.06	11:51	60° 3,14' S	0° 0,32' W	5390,8	CTD/RO	on deck	
PS69/529-3	10.08.06	11:54	60° 3,12' S	0° 0,34' W	0,0	MN	surface	
PS69/529-3	10.08.06	12:33	60° 2,78' S	0° 0,46' W	0,0	MN	at depth	Tiefe: 1069m, EL 30
PS69/529-3	10.08.06	13:12	60° 2,44' S	0° 0,58' W	0,0	MN	on deck	
PS69/529-4	10.08.06	13:23	60° 2,34' S	0° 0,62' W	0,0	MN	surface	
PS69/529-4	10.08.06	13:35	60° 2,20' S	0° 0,67' W	0,0	MN	at depth	Tiefe: 273m, EL 30
PS69/529-4	10.08.06	13:55	60° 2,03' S	0° 0,71' W	0,0	MN	on deck	
PS69/529-5	10.08.06	13:59	60° 1,99' S	0° 0,72' W	0,0	BONGO	surface	
PS69/529-5	10.08.06	14:15	60° 1,86' S	0° 0,74' W	0,0	BONGO	at depth	SE32.2, 200m
PS69/529-5	10.08.06	14:28	60° 1,73' S	0° 0,77' W	0,0	BONGO	on deck	
PS69/529-6	10.08.06	14:36	60° 1,65' S	0° 0,80' W	0,0	CTD/RO	surface	
PS69/529-6	10.08.06	14:47	60° 1,58' S	0° 0,80' W	0,0	CTD/RO	at depth	Tiefe: 246m, EL 31
PS69/529-6	10.08.06	15:03	60° 1,43' S	0° 0,86' W	0,0	CTD/RO	on deck	
PS69/529-7	10.08.06	15:18	60° 1,31' S	0° 0,93' W	0,0	RMT	surface	
PS69/529-7	10.08.06	17:24	60° 4,80' S	0° 5,72' W	0,0	RMT	heave	5000 m, FN 62.2
PS69/529-7	10.08.06	21:49	60° 12,84' S	0° 15,63' W	0,0	RMT	on deck	
PS69/529-8	10.08.06	22:03	60° 12,86' S	0° 15,68' W	0,0	RMT	surface	
PS69/529-8	10.08.06	22:18	60° 13,17' S	0° 16,34' W	0,0	RMT	heave	FN62.2,460m
PS69/529-8	10.08.06	22:43	60° 13,63' S	0° 17,47' W	0,0	RMT	on deck	
PS69/529-9	10.08.06	22:54	60° 13,78' S	0° 17,78' W	0,0	SUIT	surface	
PS69/529-9	10.08.06	22:55	60° 13,79' S	0° 17,78' W	0,0	SUIT	slipped	
PS69/529-9	10.08.06	22:58	60° 13,81' S	0° 17,80' W	0,0	SUIT	Information	Gewicht zu wasser
PS69/529-9	10.08.06	23:04	60° 13,98' S	0° 17,97' W	0,0	SUIT	start trawl	FN62.2, 120m
PS69/529-9	10.08.06	23:29	60° 14,57' S	0° 18,18' W	0,0	SUIT	stop trawl	
PS69/529-9	10.08.06	23:36	60° 14,63' S	0° 18,09' W	0,0	SUIT	Information	Gewichaan Deck
PS69/529-9	10.08.06	23:49	60° 14,60' S	0° 17,84' W	0,0	SUIT	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/530-1	11.08.06	02:53	60° 26,33' S	0° 1,55' E	0,0	RMT	surface	
PS69/530-1	11.08.06	03:10	60° 26,75' S	0° 1,16' E	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/530-1	11.08.06	03:37	60° 27,34' S	0° 0,23' W	0,0	RMT	End of Trawl	
PS69/530-1	11.08.06	03:41	60° 27,37' S	0° 0,38' W	0,0	RMT	on deck	
PS69/530-2	11.08.06	04:18	60° 25,80' S	0° 2,22' E	0,0	RMT	surface	
PS69/530-2	11.08.06	04:24	60° 25,95' S	0° 2,14' E	0,0	RMT	Begin Trawling	
PS69/530-2	11.08.06	04:40	60° 26,32' S	0° 1,65' E	0,0	RMT	End of Trawl	
PS69/530-2	11.08.06	04:53	60° 26,43' S	0° 1,56' E	0,0	RMT	on deck	
PS69/530-3	11.08.06	05:12	60° 26,21' S	0° 1,74' E	5372,8	CTD/RO	surface	
PS69/530-3	11.08.06	05:34	60° 26,11' S	0° 1,83' E	5374,8	CTD/RO	at depth	Die Tiefe 986 m, EL 31
PS69/530-3	11.08.06	06:01	60° 25,99' S	0° 1,93' E	0,0	CTD/RO	on deck	
PS69/530-4	11.08.06	06:08	60° 26,07' S	0° 1,83' E	0,0	SUIT	surface	
PS69/530-4	11.08.06	06:12	60° 26,09' S	0° 1,71' E	0,0	SUIT	Information	Gewicht zu Wasser
PS69/530-4	11.08.06	06:18	60° 26,15' S	0° 1,18' E	0,0	SUIT	start trawl	
PS69/530-4	11.08.06	06:43	60° 26,27' S	0° 0,40' W	0,0	SUIT	stop trawl	
PS69/530-4	11.08.06	06:50	60° 26,25' S	0° 0,49' W	0,0	SUIT	Information	Gewicht an Deck
PS69/530-4	11.08.06	07:00	60° 26,22' S	0° 0,45' W	0,0	SUIT	on deck	
PS69/530-5	11.08.06	07:30	60° 26,80' S	0° 0,08' W	0,0	MN	surface	
PS69/530-5	11.08.06	08:04	60° 26,77' S	0° 0,07' E	0,0	MN	at depth	El30, 1054m
PS69/530-5	11.08.06	08:41	60° 26,80' S	0° 0,30' E	0,0	MN	on deck	
PS69/530-6	11.08.06	08:56	60° 26,82' S	0° 0,42' E	0,0	MN	surface	
PS69/530-6	11.08.06	09:07	60° 26,84' S	0° 0,51' E	0,0	MN	at depth	EL30, 268m
PS69/530-6	11.08.06	09:24	60° 26,88' S	0° 0,64' E	0,0	MN	on deck	
PS69/530-7	11.08.06	09:35	60° 26,91' S	0° 0,74' E	0,0	BONGO	surface	
PS69/530-7	11.08.06	09:49	60° 26,96' S	0° 0,87' E	0,0	BONGO	at depth	SE32.2, 205m
PS69/530-7	11.08.06	10:06	60° 27,03' S	0° 1,04' E	0,0	BONGO	on deck	
PS69/530-8	11.08.06	10:13	60° 27,06' S	0° 1,12' E	0,0	CTD/RO	surface	
PS69/530-8	11.08.06	10:23	60° 27,10' S	0° 1,23' E	0,0	CTD/RO	at depth	EL31, 245m
PS69/530-8	11.08.06	10:39	0° 0,00' N	0° 0,00' E	0,0	CTD/RO	on deck	
PS69/530-9	11.08.06	11:26	60° 28,22' S	0° 4,45' E	0,0	RMT	surface	
PS69/530-9	11.08.06	11:54	60° 27,84' S	0° 2,76' E	0,0	RMT	heave	GE72.1, 650m
PS69/530-9	11.08.06	12:41	60° 27,34' S	0° 0,34' E	0,0	RMT	on deck	
PS69/530-10	11.08.06	13:30	60° 29,00' S	0° 8,60' E	5374,0	WHW	begin	
PS69/530-10	12.08.06	00:58	60° 30,20' S	2° 54,70' E	5402,0	WHW	end	
PS69/531-1	12.08.06	02:10	60° 29,53' S	2° 50,33' E	0,0	RMT	surface	
PS69/531-1	12.08.06	02:32	60° 28,97' S	2° 49,31' E	0,0	RMT	heave	Kabellänge: 616m,GE 72.1
PS69/531-1	12.08.06	03:21	60° 28,18' S	2° 46,40' E	0,0	RMT	on deck	
PS69/531-2	12.08.06	04:01	60° 28,84' S	2° 42,78' E	5406,8	CTD/RO	surface	
PS69/531-2	12.08.06	05:47	60° 28,25' S	2° 44,84' E	5402,8	CTD/RO	at depth	Die Tiefe 5440 m, EL 31
PS69/531-2	12.08.06	07:27	60° 27,92' S	2° 46,14' E	0,0	CTD/RO	on deck	
PS69/531-3	12.08.06	07:34	60° 27,91' S	2° 46,22' E	0,0	MN	surface	
PS69/531-3	12.08.06	08:09	60° 27,81' S	2° 46,56' E	0,0	MN	at depth	EL30, 1060m
PS69/531-3	12.08.06	08:47	60° 27,80' S	2° 46,60' E	0,0	MN	on deck	
PS69/532-1	12.08.06	14:40	59° 56,94' S	3° 0,46' E	0,0	RMT	surface	
PS69/532-1	12.08.06	15:08	59° 56,73' S	2° 58,94' E	0,0	RMT	heave	Kabellänge: 741m, GE 72.1
PS69/532-1	12.08.06	15:59	59° 56,21' S	2° 55,97' E	0,0	RMT	on deck	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/532-2	12.08.06	16:27	59° 55,67' S	2° 55,11' E	5381,6	CTD/RO	surface	
PS69/532-2	12.08.06	18:09	59° 55,01' S	2° 56,80' E	5378,8	CTD/RO	at depth	EL31 5401m ausgesteckt
PS69/532-2	12.08.06	19:49	59° 54,19' S	2° 57,87' E	0,0	CTD/RO	on deck	
PS69/532-3	12.08.06	19:56	59° 54,12' S	2° 57,96' E	0,0	MN	surface	
PS69/532-3	12.08.06	20:30	59° 53,86' S	2° 58,20' E	0,0	MN	at depth	EL30, 1076m
PS69/532-3	12.08.06	21:09	59° 53,62' S	2° 58,18' E	0,0	MN	on deck	
PS69/532-4	12.08.06	21:20	59° 53,55' S	2° 58,22' E	0,0	MN	surface	
PS69/532-4	12.08.06	21:29	59° 53,50' S	2° 58,24' E	0,0	MN	at depth	EL30, 268m
PS69/532-4	12.08.06	21:47	59° 53,39' S	2° 58,26' E	0,0	MN	on deck	
PS69/532-5	12.08.06	21:55	59° 53,34' S	2° 58,26' E	0,0	BONGO	surface	
PS69/532-5	12.08.06	22:07	59° 53,28' S	2° 58,25' E	0,0	BONGO	at depth	SE32.2, 200m
PS69/532-5	12.08.06	22:22	59° 53,22' S	2° 58,23' E	0,0	BONGO	on deck	
PS69/532-6	12.08.06	22:29	59° 53,18' S	2° 58,22' E	0,0	CTD/RO	surface	
PS69/532-6	12.08.06	22:38	59° 53,15' S	2° 58,22' E	0,0	CTD/RO	at depth	EL31,246m
PS69/532-6	12.08.06	22:53	59° 53,10' S	2° 58,19' E	0,0	CTD/RO	on deck	
PS69/532-7	12.08.06	23:03	59° 53,19' S	2° 57,86' E	0,0	SUIT	surface	
PS69/532-7	12.08.06	23:03	59° 53,19' S	2° 57,86' E	0,0	SUIT	slipped	
PS69/532-7	12.08.06	23:07	59° 53,25' S	2° 57,73' E	0,0	SUIT	Information	Gewicht zu Wasser
PS69/532-7	12.08.06	23:14	59° 53,34' S	2° 57,21' E	0,0	SUIT	start trawl	
PS69/532-7	12.08.06	23:38	59° 53,29' S	2° 55,87' E	0,0	SUIT	stop trawl	
PS69/532-7	12.08.06	23:45	59° 53,26' S	2° 55,67' E	0,0	SUIT	Information	Gewicht an Deck, FN 62.2, 120m
PS69/532-7	12.08.06	23:56	59° 53,22' S	2° 55,57' E	0,0	SUIT	on deck	
PS69/532-8	13.08.06	00:23	59° 53,31' S	2° 54,49' E	0,0	RMT	surface	
PS69/532-8	13.08.06	00:40	59° 53,48' S	2° 53,83' E	0,0	RMT	heave	Kabellänge: 460m, FN 62.2
PS69/532-8	13.08.06	01:09	59° 54,08' S	2° 52,96' E	0,0	RMT	on deck	
PS69/532-9	13.08.06	01:34	59° 54,31' S	2° 52,70' E	0,0	RMT	surface	
PS69/532-9	13.08.06	03:46	59° 56,35' S	2° 45,75' E	0,0	RMT	heave	Kabellänge: 5000m, FN 62.2
PS69/532-9	13.08.06	08:54	60° 0,08' S	2° 26,07' E	0,0	RMT	on deck	
PS69/533-1	14.08.06	01:25	57° 42,89' S	3° 6,85' E	0,0	SUIT	surface	
PS69/533-1	14.08.06	01:30	57° 42,77' S	3° 7,00' E	0,0	SUIT	Information	Gewicht geslippt
PS69/533-1	14.08.06	01:35	57° 42,61' S	3° 7,25' E	0,0	SUIT	start trawl	
PS69/533-1	14.08.06	02:24	57° 42,47' S	3° 9,33' E	0,0	SUIT	stop trawl	
PS69/533-1	14.08.06	02:29	57° 42,56' S	3° 9,48' E	0,0	SUIT	Information	Gewicht an Deck
PS69/533-1	14.08.06	02:35	57° 42,62' S	3° 9,64' E	0,0	SUIT	on deck	
PS69/534-1	14.08.06	18:00	56° 0,82' S	3° 20,07' E	0,0	RMT	surface	
PS69/534-1	14.08.06	18:30	56° 0,89' S	3° 22,12' E	0,0	RMT	heave	800 m, FN 62.2
PS69/534-1	14.08.06	19:18	56° 0,21' S	3° 25,41' E	0,0	RMT	on deck	
PS69/535-1	15.08.06	08:40	54° 2,60' S	4° 9,40' E	0,0	CPR	into water	
PS69/535-1	16.08.06	12:03	50° 7,41' S	7° 19,80' E	0,0	CPR	on deck	
PS69/535-1	16.08.06	12:10	50° 6,44' S	7° 20,55' E	0,0	CPR	into water	
PS69/535-1	17.08.06	12:01	46° 53,96' S	9° 45,87' E	0,0	CPR	on deck	
PS69/535-1	17.08.06	12:23	46° 50,73' S	9° 48,23' E	0,0	CPR	into water	
PS69/535-2	18.08.06	20:01	42° 10,05' S	13° 3,99' E	4514,8	ADCP	Start Profile	
PS69/535-2	18.08.06	20:35	42° 5,08' S	13° 4,24' E	4483,2	ADCP	alter course	
PS69/535-2	18.08.06	20:43	42° 5,44' S	13° 5,40' E	4492,8	ADCP	alter course	
PS69/535-2	18.08.06	21:16	42° 9,95' S	13° 5,70' E	4581,6	ADCP	alter course	

Station	Date	Time	Position Lat	Position Lon	Depth [m]	Gear Abb-reviation	Action	Comment
PS69/535-2	18.08.06	21:33	42° 8,32' S	13° 6,73' E	4559,6	ADCP	alter course	
PS69/535-2	18.08.06	21:56	42° 5,28' S	13° 6,70' E	4530,0	ADCP	alter course	
PS69/535-2	18.08.06	21:58	42° 5,10' S	13° 6,91' E	4544,4	ADCP	alter course	
PS69/535-2	18.08.06	22:07	42° 5,64' S	13° 7,99' E	4569,2	ADCP	alter course	
PS69/535-2	18.08.06	22:38	42° 9,90' S	13° 8,13' E	4606,0	ADCP	alter course	
PS69/535-2	18.08.06	22:45	42° 9,83' S	13° 9,27' E	4661,6	ADCP	alter course	
PS69/535-2	18.08.06	23:33	42° 4,95' S	13° 9,26' E	4660,4	ADCP	alter course	
PS69/535-2	19.08.06	00:10	42° 5,39' S	13° 4,05' E	4484,0	ADCP	alter course	
PS69/535-2	19.08.06	00:42	42° 10,28' S	13° 3,97' E	4512,4	ADCP	alter course	
PS69/535-2	19.08.06	01:30	42° 4,99' S	13° 9,30' E	4659,2	ADCP	Finish profile	
PS69/535-1	19.08.06	07:31	41° 4,62' S	13° 48,17' E	2166,0	CPR	on deck	
PS69/535-1	19.08.06	07:38	41° 3,49' S	13° 48,92' E	2146,0	CPR	into water	
PS69/535-1	20.08.06	08:40	37° 4,39' S	16° 22,47' E	4582,4	CPR	on deck	

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