ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

EXPEDITION PROGRAMME PS112

# Polarstern

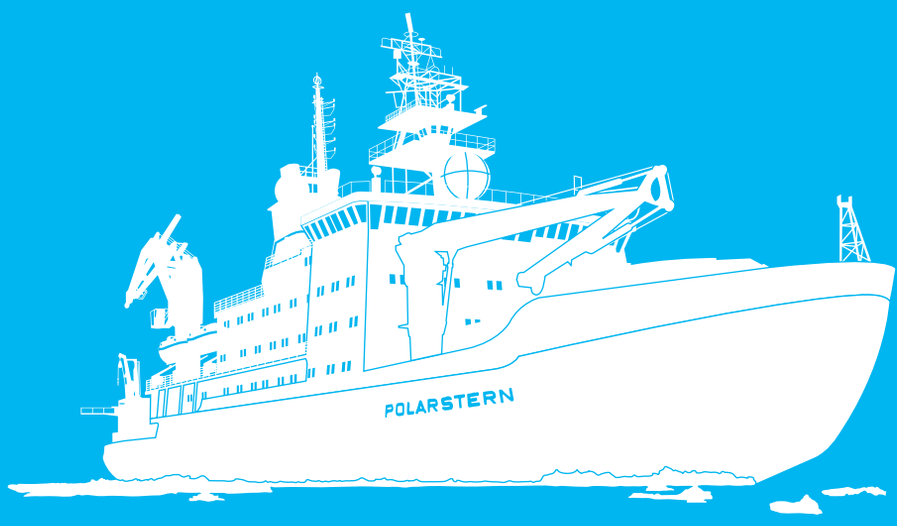
**PS112**

**Punta Arenas - Punta Arenas**

**17 March 2018- 06 May 2018**

Coordinator: Rainer Knust

Chief Scientist: Bettina Meyer



Bremerhaven, Februar 2018

**Alfred-Wegener-Institut**
**Helmholtz-Zentrum**
**für Polar- und Meeresforschung**
**Am Handelshafen 12**
**D-27570 Bremerhaven**

Telefon: ++49 471 4831- 0
Telefax: ++49 471 4831 – 1149
E-Mail: info@awi.de
Website: http://www.awi.de

Email Coordinator: rainer.knust@awi.de
Email Chief Scientist: bettina.meyer@awi.de

# PS112

## (ANT-XXIX/10)

## 17 March - 06 May 2018

## Punta Arenas - Punta Arenas

## Population Shift and Ecosystem Response
## Krill vs. Salps

## (POSER)

**Chief Scientist**
**Bettina Meyer**

**Coordinator**
**Rainer Knust**

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# 1. ÜBERBLICK UND FAHRTVERLAUF

Bettina Meyer
Alfred-Wegener-Institut

Der Fahrtabschnitt PS112 *Polarstern* beginnt am 17. März 2018 in Punta Arenas (Chile) und endet am 6. Mai 2018 in Punta Arenas (Chile). Die Expedition und Forschungsschwerpunkte werden von drei Projekten bestimmt, die aus Drittmitteln finanziert werden: 1. POSER (POpulation Shift and Ecosystem Response – Krill vs. Salps) ist finanziert vom Niedersächsischen Ministerium für Wissenschaft und Kultur (MWK); 2. PEKRIS (The performance of Krill vs. Salps to withstand in a warming Southern Ocean) ist finanziert vom Ministerium für Bildung und Forschung (BMBF) und 3. KrillBIS (Krill stock assessment in the Southern Ocean) läuft im Rahmen von CCAMLR (Commission of the Conservation of Marine Leaving Resources) und ist finanziert vom Ministerium für Ernährung und Landwirtschaft (BMEL).

Ziel des POSER Projektes ist es, durch den Klimawandel verursachte Folgen des Temperaturanstiegs im Atlantischen Sektor des Südpolarmeeres zu verstehen. Augenmerkt liegt hier auf möglichen Populationsveränderungen von Krill im Vergleich zu Salpen und deren Konsequenzen für Planktongemeinschaften, -biodiversität und biochemische Zyklen. Im Zusammenhang mit POSER untersucht PEKRIS physiologische und genetische Eigenschaften von Krill und Salpen, um Unterschiede in der Anpassungsfähigkeit beider Arten aufsteigende Temperaturen zu verstehen. Bisher gibt es nur wenige Studien, die den Effekt von äußerlichen Stressfaktoren auf Krill untersucht haben und so gut wie keine Studien liegen vor für Salpen. KrillBIS repräsentiert den deutschen Beitrag zu CCAMLR und dient der Sammlung von Abundanzinformationen von Krill und Salpen nördlich der Antarktischen Halbinsel, die in die Umsetzung eines „feedback management“ des Krillbestandes im Atlantischen Sektor des Südpolarmeers einfließen.

PS112 ist ein Baustein in einer Reihe von Forschungsprojekten, die zusammen eine umfassende Einschätzung der möglichen Konsequenzen des Klimawandels auf Krill und die Krill-assoziierten Ökosysteme liefern (Fig. 1.1). KrillBIS setzt Langzeitstudien zur akustischen Bestandsaufnahme von Krill im Zusammenhang mit Populationsparameter und der geo-physischen Umwelt fort. Verschiedene Lebensräume werden beprobt, einschließlich Küsten,- Schelf- und pelagische Systeme, um die Ursachen von Krillbiomasse-Variabilität in unterschiedlichen Habitaten zu untersuchen und um zwischen natürlicher und Klimawandel-induzierten Veränderung zu unterscheiden. Das POSER Projekt untersucht wie sich der Klimawandel auf Populationsstrukturen von Krill und Salpen auswirkt und welche Folgen diese Änderungen für Planktongemeinschaft, -diversität und biochemische Zyklen hat. PEKRIS untersucht Adaptionsfähigkeiten von Krill und Salpen auf der genetischen und physiologischen Ebene, um Unterschiede in deren Reaktionsfähighkeit auf den Klimawandel zu verstehen. Die Ergebnisse aller drei Studien werden in die Entwicklung eines Individual-based Model (IBM) für Krill einfließen, welches helfen soll Änderungen des Krillbestandes in Reaktion auf verschiedene Klima-Szenarien vorauszuberechnen. Das IBM wird zudem die Entwicklung eines „dynamic feedback models“ für eine nachhaltige Fischerei im Südpolarmeer unterstützen, wie von CCAMLR vorhergesehen.

Der Zeitplan für PS112 ist aus zwei alternierenden Phasen zusammengesetzt (Fig. 1.2):

a) Das KrillBIS-Grid: dient zur Erfassung akustischer Krillbiomasse und den sammeln von Populationsparametern von Salpen und Krill. Es befindet sich in CCAMLR Subarea 48.1 und stellt eine Replikation des US.AMLR- Grids (US Antarctic Marine Living Resources, hereafter “AMLR”) dar. Für weitere Informationen zum AMLR Grid siehe folgenden Absatz.
b) POSER und PEKRIS: Das KrillBis-Grid wird 4 mal an verschiedenen Stellen durch 4 Tage lange Drift-Phasen unterbrochen werden um die im POSER und PEKRIS geplanten Prozesstudien mit Krill und Salpen durchzuführen.

Das AMLR Grid wurde konzipiert, um das Beproben verschiedener Krillhabitate in der Nähe von Prädatorenkolonien zu ermöglichen. In Zusammenarbeit mit dem US Amerikanischen Antarktis Programm wird während PS112 das AMLR-Grid repliziert, um saisonale Unterschiede in Krillbiomasse und -Populationsparametern mit AMLR Ausfahrten aus Sommer und Winter zu untersuchen. Wegen des engen Zeitplans während PS112 ist es unwahrscheinlich, dass alle Stationen des ursprünglichen AMLR-Grids beprobt werden können. Ziel ist es, eine ausgeglichene Beprobung verschiedener Habitate zu erreichen.

## SUMMARY AND ITINERARY

Cruise leg PS112 of RV *Polarstern* will commence on 17 March 2017 in Punta Arenas (Chile) and end on 6 May 2017 in Punta Arenas (Chile) The main aim of the voyage based on three third party funded projects POSER (POpulation Shift and Ecosystem Response – Krill vs. Salps) funded by the Ministry of Science and Culture of Lower Saxony (MWK), PEKRIS (The performance of Krill vs. Salps to withstand in a warming Southern Ocean), funded by the German Ministry of Education and Research (BMBF), and KrillBIS (Krill stock assessment in the Southern Ocean) under the umbrella of CCAMLR (Commission of the Conservation of Marine Leaving Resources), funded by the German Ministry of Nutrition and Aquaculture (BMEL).

In the project POSER (POpulation Shift and Ecosystem Response – Krill vs. Salps), we aim to understand population shifts in krill versus salps due to anthropogenic warming in the western Atlantic sector of the Southern Ocean, and the consequences of such shifts on plankton community structure, biodiversity and biogeochemical cycles. PEKRIS act as complementary project to POSER and will investigate the physiological and genetic traits of krill vs. salps supporting potential adaptation to temperature rise. Up to now, only few studies on the response of krill to anthropogenic stressors exist. Almost no equivalent data are available for salps. The overall goal of KrillBIS is the collection of krill and salp stock data for CCAMLR, north of the Antarctic Peninsula to fulfill the objectives set by CCAMLR for developing an adaptive management of the Antarctic krill stock in the Atlantic sector of the Southern Ocean.

The PS112 cruise is one building block in a set of research projects that will conduct a combination of the above-mentioned scientific tasks and bring them together in one overarching, synoptic assessment of the effect of climate change on krill and associated ecosystem processes (Fig. 1.1). The KRILBIS project continues long-term acoustic krill biomass surveys and the collection of population parameters in relation to the bio-geophysical environment. A range of habitats is surveyed, including coast, shelf and deep water to identify drivers of krill biomass variability in different environments. The POSER project concerns

population shifts of krill versus salps in response to climate change and consequences of this shift on plankton community structure, biodiversity and biogeochemical cycles. PEKRIS examines the differences in genetic and physiological traits of krill versus salps in order to study their potential to adapt to warming temperatures. The results of these three projects will feed into a newly developed individual-based model for krill to predict responses of krill to different climate change scenarios and will be useful for the development of a dynamic feedback model for a sustainable Southern Ocean as anticipated by CCAMLR.

The itinerary of PS 112 consists of 2 parts (Fig. 1.2):

a) the CCAMLR grid in CCAMLR Subarea 48.1, which will be a replication of the US.AMLR (US Antarctic Marine Living Resources, hereafter "AMLR") survey grid. The research conducted here feeds into KRILBIS.

b) 4 drift phases of 4 days each, after performing abundance studies on krill and salps at different regions on the grid. The process oriented research studies conducted during the drift phases feed into POSER and PEKRIS.

The AMLR survey grid was designed to provide repeated transects over a range of krill habitats and in close proximity to predator colonies. In a collaborative effort between Germany and the US Antarctic program, we will replicate the AMLR survey grid in order to compare seasonal differences in krill biomass and population parameters collected during PS112 (autumn) with previous AMLR summer and winter cruises. It is unlikely that all stations oft he grid will be covered during the PS112 expedition due to time constrains. However, we will anticipate to sample an equal amount of stations from each of the different types of habitat (e.g. coast, shelf, shelf break, deep water).

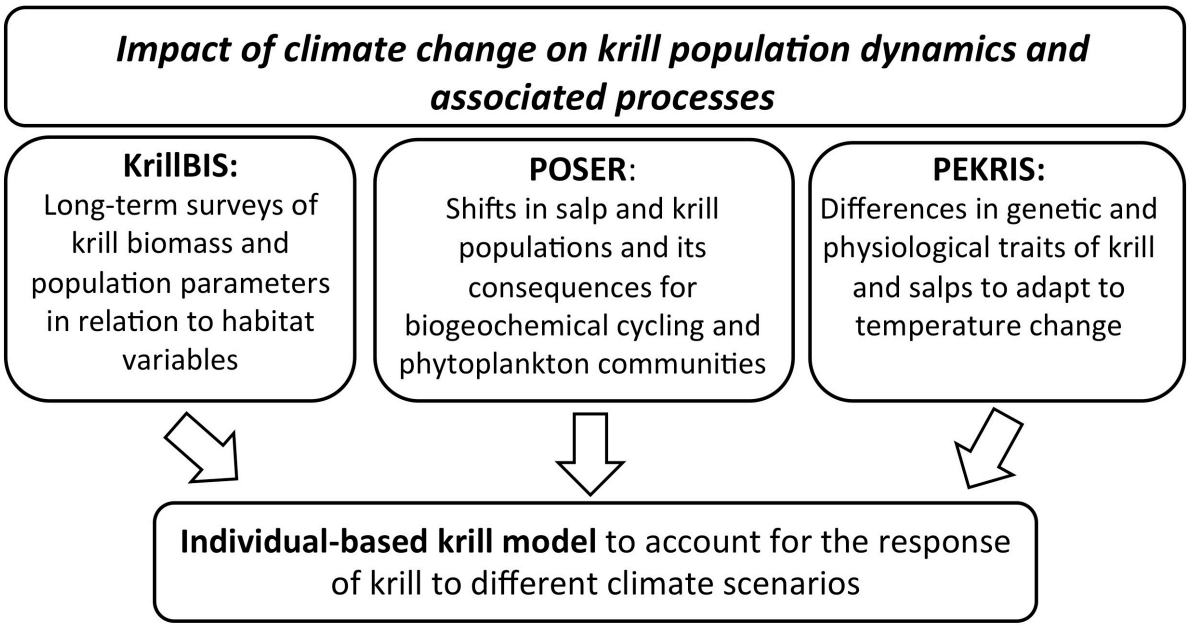


*Abb. 1.1: Übersicht der Forschungsprojekte während PS112*
*Fig. 1.1: Overview of research projects conducted during PS112*

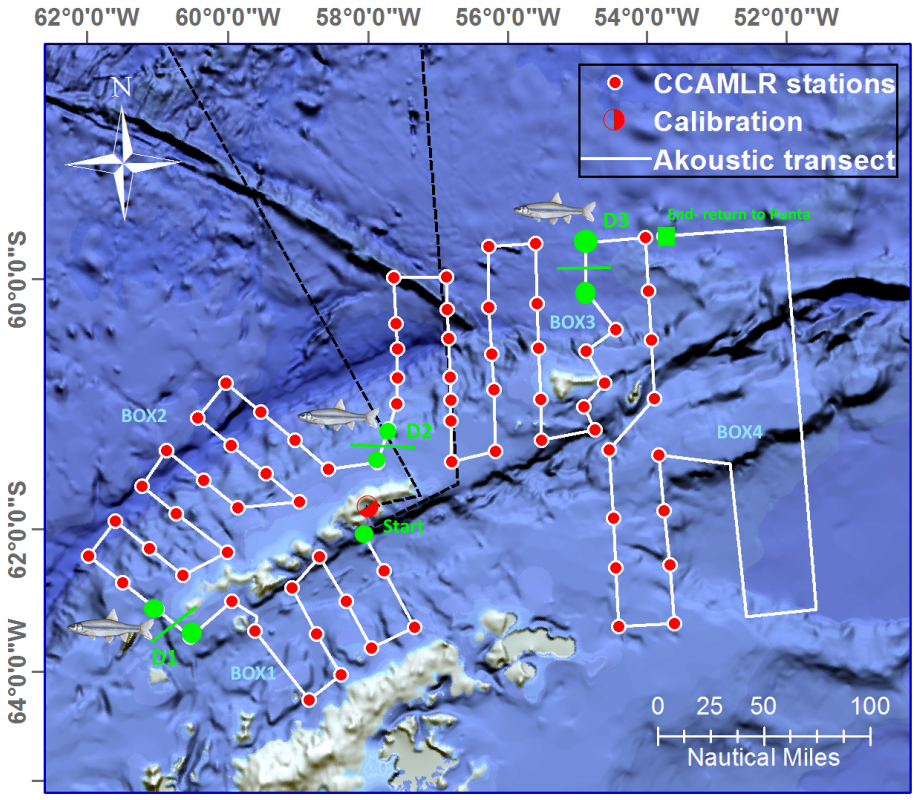


*Abb. 1.2: Übersichtskarte der Transekte und Stationen. Die Drift-Phasen (Markierung: grüne D's) beziehen sich auf POSER und PEKRIS. Rote Punkte sind Fangstationen und weiße Linien Akustiktransekte für KrillBIS. Der rote Halbkreis markiert Admiralty Bay und die dortige Kalibrierung des Echolots.*

*Fig. 1.2: Map of stations and transects. Drift phases (marked with green D's) refer to POSER and PEKRIS related research. Red dots are net sampling stations and white lines acoustic transects for KrillBIS. Red half circle represents location for echosounder calibration in Admiralty Bay.*

# 2. MICROBIAL FOOD WEB

S. Moorthi (ICBM, Uni Oldenburg), C. Plum (ICBM, Uni Oldenburg), D. Bahlburg (ICBM), P. Wenta(ICBM, Uni Oldenburg), Dive team CBM, Uni Oldenburg: U. Freier, S. Rhode, S.J. Müller, N. Göbeler, S.Kerwath, L. Auerswald

## Objectives

In our project POSER (POpulation Shift and Ecosystem Response – Krill vs. Salps), we aim at understanding population shifts in krill versus salps due to anthropogenic warming in the western Atlantic sector of the Southern Ocean, and the consequences of such shifts on plankton community structure, biodiversity and biogeochemical cycles. The overall goal of our part project is to investigate the role of krill and salps in controlling phytoplankton and microbial food web composition and trophic interactions, productivity (through the (re)cycling of macronutrients), as well as nutrient fluxes and stoichiometry. These goals will be achieved by

combining field sampling with on-board experiments manipulating the presence or absence of salps and krill, which will allow us to investigate a whole suite of factors controlling plankton and nutrient dynamics in patches with high krill or salp abundances. In comparison to observed large-scale patterns in the field, the experiments can disentangle direct and indirect consequences of these grazer shifts.

*Central hypotheses:*
A shift from krill to salp dominance will

1) alter plankton community structure through selective grazing (higher grazing pressure of salps on bacteria and picoplankton), thus affecting process rates such as grazing and net community production (direct effects)
2) alter macronutrient concentrations and ratios due to altered nutrient recycling, thus affecting a) the stoichiometry of dissolved nutrients, b) primary production, and c) phytoplankton food quality (indirect effects).

**Work at sea**

During the expedition with RV *Polarstern* water samples will be taken from different depths at a minimum of 2 stations within each of the drift studies (total of at least 8 stations). Furthermore, short-term incubations (2-3 days) will be conducted using seawater with ambient macronutrient and trace metal concentrations in order to gain a mechanistic understanding of the linkage between the upper (metazooplankton) and the lower (phytoplankton, microbes, protists) food web. The presence of adult krill and salps will be manipulated in seawater from the field in 70 l aquaria. At least 6 experiments will be conducted to integrate over variation in starting conditions and to increase the generality of observed patterns. Samples will be taken at the beginning and at the end of each experiment from all experimental units.

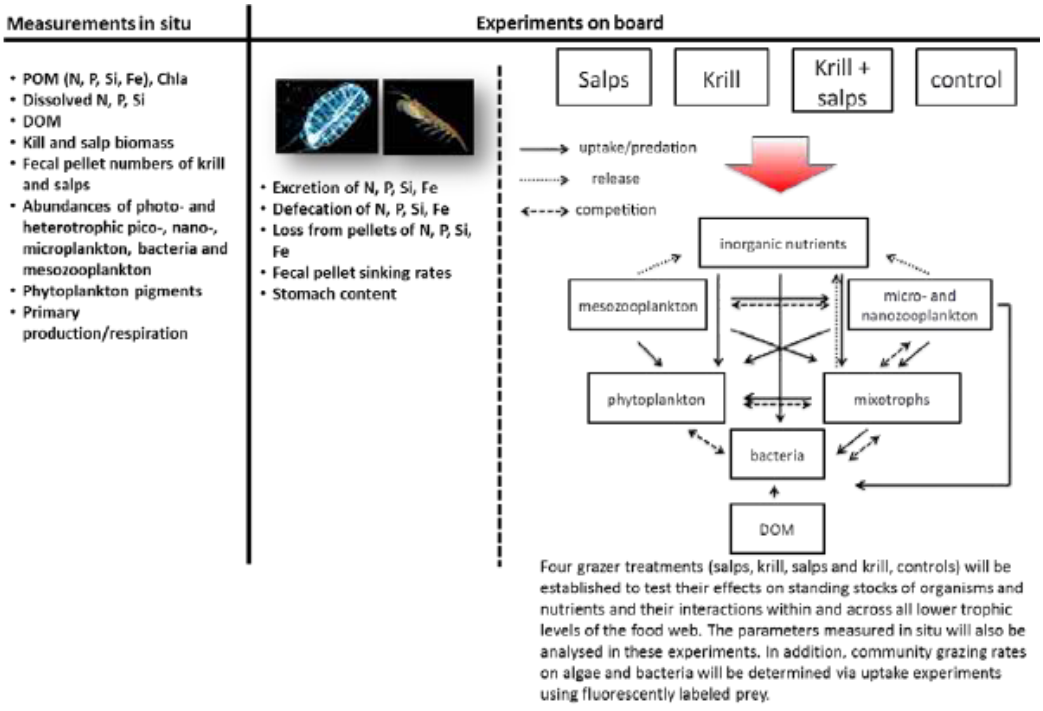


*Fig. 2.1: Parameters that will be sampled and experimental set-up*

Krill for experimental work will be sampled with a RMT net equipped with a closed cod end using short target tows in the upper 50 m, while salps will be sampled by Scuba divers with a specific pump sampler, that will be operated from the zodiac.

All samples derived from field sampling and from the experiments will be analyzed for dissolved macronutrients ($NO_2$+$NO_3$, $NH_4$, $PO_4$, $SiOH_4$), Chl. a, phytoplankton pigments, DOM, and elemental composition of particulate matter (POC, PON, POP). Abundance and dynamics of photo- and heterotrophic pico- and nanoplankton will be measured by Flow-Cytometry. Moreover, molecular 16S/18S rDNA-based techniques (Illumina sequencing of selected samples) will be used to determine the diversity of major phylotypes and relative shifts in pico- and nanoplankton community structure at different stations / in different experimental treatments. Phyto- and zooplankton > 20 µm will be analyzed by microscopy. Parallel short-term incubations (24h) will be conducted with fluorescently labeled bacteria/beads in order to investigate grazing processes of heterotrophic and mixotrophic nanoplankton.

**Preliminary (expected) results**

Following the dynamics of nutrients, bacterio-, phyto- and smaller zooplankton in krill and salp dominated waters and in the experimental incubations will enable us to detect differences in feeding preferences and rates, nutrient recycling, carbon export and respective consequences for microbial food web dynamics for the two dominant zooplankton consumers. These results will substantially enhance our understanding of the consequences of the shift from krill to salps for the lower food web in the target area.

**Data management**

We will fulfill all requirements of a good scientific practice laid out e.g. by the German Science Foundation (DFG). Results of our project will be published in peer-reviewed journals, if possible under the open access policy. Data will be provided to publisher databases such as Dryad. In addition, we will share all original data with the mathematical modelers within the project in order to allow for modeling and synthetic analyses.

**References**

none

# 3. HOW WILL A POPULATION SHIFT FROM KRILL TO SALPS IMPACT THE EXPORT AND RECYCLING OF ORGANIC MATTER IN THE SOUTHERN OCEAN?

M. H. Iversen (AWI, Uni Bremen, MARUM), C. Konrad (AWI, Uni Bremen, MARUM), C. Flintrop (AWI, Uni Bremen, MARUM), K. Metfies (AWI, not on board), B. Meyer (AWI, ICBM, Uni Oldenburg), N. Pauli (ICBM, Uni Oldenburg), Dive team CBM, Uni Oldenburg: U. Freier, S. Rhode, S.J. Müller, N. Göbeler, S.Kerwath, L. Auerswald

**Objectives**

In recent years, salp abundances have been increasing in the Southern Ocean where they seem to be replacing krill as the dominant grazers on phytoplankton. Both salp and krill fecal pellets are rich in organic matter and have been shown to sink at very high velocities. As salps can form large swarms with high pellet production rates, it has been suggested that they will become increasingly important for the vertical export of particulate organic matter in the

Southern Ocean. However, detailed studies combining both investigations of krill and salp pellet production rates, turnover, and export are still needed in order to elucidate what impact a shift from krill to salps will have on upper water column ecosystems and deep ocean export. Recent investigations have demonstrated that krill and salp fecal pellets differ substantially in composition and sinking rates due to different metabolic requirements and feeding activities of the two organism groups (Atkinson et al. 2012, Philips et al. 2009). However, due to the few studies so far their contribution to recycling of important nutrients for phytoplankton growth and for export from the surface layer is largely unclear. It has recently been suggested that the fragile nature of salp pellets make them more important for recycling of organic matter in the upper mesopelagic layer rather than as a conduit for export of particulate organic matter to the seafloor (Iversen et al. 2017).

**Aims**

Our main objective during the cruise is to study the impact of krill and salps in controlling productivity and mechanisms for attenuation and export of organic carbon flux through the water column. This will be done by detailed investigations of particle dynamics through the water column in relations to the upper ocean plankton community structure of phytoplankton, krill, and salps. We will do this by looking at both large and small scale, i.e. on a whole water perspective using *in-situ* optics, drifting traps, and plankton nets for large grid areas and as drifting stations following a specific water mass. These studies will elucidate how the presence of krill versus salps will impact the plankton community structure in the surface ocean through selective grazing and what impact that will have on net community production. Further, we will study how these upper ocean processes affect recycling and export of organic matter.

**Work at sea**

We will perform both large grid surveys where deployments of plankton nets, *in-situ* camera systems, and CTDs will map water masses and presence of krill, salps, and settling aggregates over large areas. For each of the grid areas, we will perform detailed drifting studies where we follow and study a specific water mass over a longer period. During the drift studies we will deploy drifting sediment trap arrays in combination with different optical, biological, and physical sensors to capture particle and water mass dynamics through the water column. These studies will be accompanied by laboratory experiments to investigate specific mechanisms responsible for carbon, nutrient, and Fe turnover within marine settling aggregates. These studies will be done with *in-situ* collections of settling aggregates (using the marine snow catcher) and with on board produced fecal pellets from salps and krill. Each drifting sediment trap consists of three trap arrays (e.g. 100, 200, 400 m depths) each with four collection cylinders. At every trap depth, one of the collection cylinders is filled with a special gel to preserve fragile marine snow aggregates and fecal pellets sinking into the cylinders. The deployment times will be over a day-night cycle.

We will measured size-specific sinking velocities of krill and salp fecal pellets during on board experiments using a vertical flow chamber. The flow chamber will be filled with filtered seawater at ambient surface temperature and salinity. By applying a vertical flow balancing the sinking velocity of the pellets, the sinking velocity of the pellets can be measured from the flow rate of the flow chamber. We will also measure the respiration of the microbial community associated with the pellets using oxygen-microsensors on the suspended fecal pellets in the flow chamber. Direct video observations of the feeding behavior from krill and salps will be made to study their feeding activity on both phytoplankton bloom and individual large settling aggregates such as marine snow and krill and salp fecal pellets. These investigations will be complemented with stomach content analysis of freshly caught krill with genetic and microscopic techniques. We have previously observe large fragmentation of both krill and salp fecal pellets, preventing

their export to the deep ocean, but it is unclear whether krill and salps are responsible for this high fragmentation rate (Iversen et al. 2017).

The vertically changing particle concentrations and size distribution determined with the *in-situ* camera systems in combination with the drifting traps can be used to derive high resolution carbon fluxes and remineralisation rates in various depth ranges. These high resolution carbon fluxes will enable determinations carbon-specific turnover rates in different water layers through the water column. Together, the *in-situ* and on board studies will provide a detailed full water column perspective of production, recycling, and export as a function of different ecosystem and plankton community structures in the Southern Ocean. Such studies are essential in order to understand the consequences of changes in the dominance from krill to salps for the cycling of elements and energy, productivity and biodiversity in the pelagic food web of the Southern Ocean?

**Preliminary (expected) results**

We expect to be able to quantify the role from krill versus salps on the production and recycling in the upper ocean, as well as quantify the export fluxes through the upper mesopelagic zone.

**Data management**

Data will be submitted to PANGAEA after quality assessment.

**References**

Atkinson A., Schmidt K., Fielding S., Kawaguchi S., Geissler P.A. (2012). Variable food absorption by Antartic krill: Relationships between diet, egestion rate and the composition and sinking rates of thier fecal pellets. Deep-Sea Res II 59-60, 147-158.

Phillips B., Kremer P., Madin L.P. (2009). Defecation by Salpa Thompsoni and its contribution to vertical flux in the Southern Ocean. Mar. Biol. 156, 455-467, doi:410.1007/s00227-00008-01099-00224.

Iversen M.H., Pakhomov E., Hunt B.P.V., van der Jagt H., Wolf-Gladrow D., Klaas C. (2017). Sinkers or floaters? Contribution from salp fecal pellets to the export flux during a large bloom event in the Southern Ocean. Deep sea Res II 138, 116-125.

# 4. SALP ECOLOGY

E.A. Pakhomov (UBC), L. Pakhomov (UBC)

**Objectives**

Recently, much effort has been directed to understand factors controlling the transformation of organic matter in the ocean. Metazoan plankton is recognized to be a cornerstone of the biological pump occupying an important intermediate position between primary producers and secondary consumers as well as critical “gatekeepers” for the carbon leaving the euphotic zone into the mesopelagic realm. Processes associated with aggregation of particles, grazing and active vertical migrations of metazoan zooplankton play significant role in the dynamics of the organic matter vertical flux in the ocean. Pelagic tunicates (*Salpa thompsoni*) and Antarctic krill (*Euphausia superba*) are two most abundant large metazoans that contribute significantly but differently to the Southern Ocean biological pump. Moreover, their contribution to carbon flux may be altered due to climate change.

**Aims**

The main objectives are to focus on the *S. thompsoni* population characterization to assess its contribution to total zooplankton and estimate its grazing impact and contribution to carbon flux. The main aims during the voyage will be

- to study salp feeding ecophysiology (ingestion, egestion, assimilation...)
- to assess the *in-situ* growth rates (jointly with salp biology group) and
- to reconcile potential and realized salp contribution to the vertical flux and fecal pellet fragmentation (jointly with the carbon flux group).

**Work at sea**

For biology, salps will be taken from RMT-8s, Bongo and Multi-nets conducted during both process-study and grid work. All salps (large catches would be subsampled) will be counted, measured and analyzed for the biology (size, sex, developmental stage and so on). The grazing studies will be undertaken during the process-study part of the voyage. Grazing work would require a 24-h cycle coverage (at least 5 tows over that cycle). This ideally should be collected during the course of first 48 hours, sampling top 300 m layer using Bongo. If there will be sufficient salp concentration, gut pigment evacuation rates will have to be estimated at least twice a day, during daytime and night time. Besides process work, animals for gut fluorescence will be collected from the top 200 m at every station possible, using any gear type available. Their length will be measured, the pigment content will be extracted in 90 % acetone for 24-36 hours and measured fluorometrically. Healthy animals will be used for gut evacuation as well as for fecal pellet production experiments. Freshly produced fecal pellets will be collected in eppendorf tubes and frozen at -80$^{o}$ C for subsequent C/N and pigment content as well as for genetic analyses. Salp diel vertical migrations will be studied on their aggregations by completing depth stratified sampling within top 1000 m using Multinet around midday and midnight.

**Preliminary (expected) results**

1) Detailed spatio-temporal information on density, size distribution and developmental stage composition of *Salpa thompsoni*;
2) Size dependent ingestions rates and grazing impact of *S. thomosoni*;
3) Fecal pellet production rates of *S. thompsoni*;
4) Information on the magnitude of the diel vertical migration of various stages of *S. thompsoni*;
5) Obtain potential *in-situ* growth and filtration rates of *S. thompsoni*;
6) Will be able to assess the fragmentation rates of salp pellets in the epipelagic layer and their contribution to the vertical carbon flux.

Overall, we will be able to link salp distribution to the environmental parameters in the region and estimate their role in the pelagic ecosystem around the Antarctic Peninsula.

**Data management**

Most data will be obtained through laboratory analyses after the cruise. Processed data will be uploaded to the databases PANGAEA and/or SCAR-MarBIN.

**References**

none

# 5. CCAMLR ACOUSTIC KRILL BIOMASS SURVEY (KRILLBIS)

B. Meyer (AWI/ ICBM, Uni Oldenburg), E. Sulanke (AWI), M. Vortkamp (AWI), R. Driscoll (Uni CA), A. Panasiuk (Uni Gdansk), J. Wawrzynek (Uni Gdansk), M. Bernasconi (Uni St. Andrews)

**Objectives**

Member states of Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) are responsible for regular *Euphausia superba* ("krill") biomass surveys. These surveys enable us to monitor natural variability in krill abundance as well as climate change-induced variations, which is essential for a sustainable krill fisheries management and subsequently, to ensure the health of the krill-dependent ecosystem. The Antarctic Peninsula is one of the most rapidly warming regions in the Southern Ocean. It is crucial to closely observe spatio-temporal alterations of the krill population in response to its changing habitat throughout all seasons. As part of the German contribution to CCAMLR, the PS112 survey will continue a long-running time series of acoustic krill biomass and population parameters in relation to the bio-geophysical environment in compliance with CCAMLR goals. Additional focus is aimed at salp occurrence as past studies have indicated a potential biological response to recent warming trends in form of increasing salp numbers, which could affect food quality of krill-dependent predator species.

**Aims**

- Obtain an acoustic krill biomass estimate for autumn 2018 in the Antarctic Peninsula region
- Relate krill biomass to environmental parameters
- Collection of krill and salp specimen for experiments of concurrent projects

**Work at sea**

Acoustic surveys will be carried out along 2645 nm of transects of varying length with an EK80 at frequencies of 38, 120 and 200 kHz. Information on krill population parameters, e.g. sex, stage and length, will be obtained from krill samples, collected with multi RMT8+1 (Rectangular Midwater Trawl) at fixed stations (maximum of 127) and three depth layers ranging from the surface down to 200 m. Simultaneously, CTD casts and water samples will be taken down to at least net sampling depth. We will be covering a range of habitats including coast, shelf and deep sea.

**Preliminary (expected) results**

We expect to obtain detailed krill and salp population parameters and acoustic krill biomass for the entire region and for each of the sampled habitats to compare krill variability in relation to environmental parameters and to data collected by the US.AMLR program during previous winter and summer surveys.

**Data management**

Data on krill biomass and population parameters and salp occurrence will be entered into a combined German-US-American database. Data from water samples and CTDs will be uploaded to the databases PANGAEA.

**References**

None

# 6. THE PERFORMANCE OF KRILL VERSUS SALPS TO WITHSTAND IN A WARMING SOUTHERN OCEAN (PEKRIS)

B. Meyer (AWI, ICBM, Uni Oldenburg), W. Wessels (ICBM, Uni Oldenburg),L. Halbach (AWI), L. Pitzschler (AWI), T. Waller (AAD), K. Michael (ICBM, Uni Oldenburg, not on board), Dive team (ICBM, Uni Oldenburg)

**Objectives**

The Western Antarctic Peninsula (WAP) ecosystem is facing severe alterations due to climate change, including rising temperatures, a decline in sea-ice and shifts in phytoplankton composition (Montes-Hugo et al., 2009). As a highly adapted cold-water species, the Antarctic krill is believed to be sensitive to rapid changes of its habitat (Flores et al., 2012). Long-running time series already provide some indication of a biological response to recent warming trends and its effects, such as a decline in krill abundance and an increase in salp numbers, which in turn, affect food quality and quantity of dependent predator species (Atkinson et al., 2004; Reid et al., 2005; Trivelpiece et al., 2011). The PEKRIS project examines the differences in genetic and physiological traits of krill versus salps to study their distinct potential to adapt to warming temperatures. Results will feed into a newly developed individual-based model for krill to predict its response to different climate change scenarios and provide new insights into potential consequences for krill-dependent ecosystem components. In addition, PEKRIS will provide further insights into the possibility of a proposed ecosystem shift from krill to salp-centered, based on the potentially higher capacity of salps to deal with increasing temperatures and changes in phytoplankton community.

**Aims**

- Investigate the physiological capacities of krill versus salps to cope with increasing temperatures
- Collect krill and salp samples for molecular analysis of temperature adaptation at the genetic level

**Work at sea**

We will use divers and net sampling to collect salps from known hotspots around the Antarctic Peninsula. Specimen will be transferred to Salpenkreisel and incubated at different temperatures on board to investigate their potential to adapt to climate change induced temperature alterations. In addition, a set of salp specimen will be kept for future molecular analysis at the genetic level in Bremerhaven.

**Preliminary (expected) results**

We expect to obtain a information on the physiological and genetical temperature adaptation capacitates of salps to compare with those of krill.

**Data management**

Upon publication, all data will be made available on PANGEA.

**References**

none

# 7. MICROZOOPLANKTON

M. Monti (OGS), A. Sabbatini (UPM, not on board), C. Morigi (UPI, not on board), A. Pallavicini (UTS, not on board), T. Diociaiuti (UTS, not on board), A. Bartolini (MNHN, not on board)

**Objectives**

Microzooplankton consist of heterotrophic organisms in the 20-200 µm size range including ciliates (naked, tintinnids), heterotrophic dinoflagellates, first larval stage of micrometazoans (e.g. copepod nauplia) and other protozoans (e.g. Foraminifera, Radiozoa). Microzooplankton organisms are considered one of the first links of the trophic system in consumer terms and, in Antarctica, they are an important food sources for krill and salps. A modification in their composition and quantity might trigger a cascade of short- and long-term changes in ecosystem structure and function, affecting both biodiversity and biogeochemical cycles in the pelagic system. Integrating the data we already have from the sea-ice (previous winter cruise) with the data obtained in the next cruise we will assess the importance of microzooplankton as food source for krill and salps in two different seasons.

Microplankton (microphytoplankton and microzooplankton) that is not grazed in the ice, or at the ice water interface, is released into the water column, where it can be exploited by pelagic grazers or potentially seed the following microplankton growth. Although all the material incorporated in the ice matrix will ultimately be released into the water column during ice melt, and it is an important part of Antarctic biomass, little is known about its fate. Water and sediment samples will be analysed to assess the possible fate of sympagic organisms.

Particular attention will be payed to foraminifera as they were one of the most abundant group present in the sea-ice during the winter cruise. Foraminifera is the only group among microzooplankton capable to secrete a calcareous test and they can be used as proxy for both past changes and surface ocean variations of sea-water conditions. In particular the study of foraminiferal biomass will be associated to the analyses of shell isotopic ($d^{18}O$, $d^{44}Ca$) and trace elements (Mg/Ca) to understand if the various environmental factors (namely [$CO_3^{2-}$], temperature) passing from seasonal variations and ice to ice-free water, could affect foraminiferal biomineralization (and consequently biomass).

**Aims**

- To study the distribution and biomass of microzooplankton in the ice free sea-water in the austral summer from the Scotia Sea and Western Antarctic Sea.
- To compare the microzooplankton assemblages from ice free water with the one found in the stomach and gut content of krill and salps in order to assess any possible selection of krill and salps on microzooplankton.
- To compare the microplankton assemblages from the sediment traps with the one found in the ice and in the ice free sea water, to assess the possible fate of sympagic organisms.
- To assess the biological and chemical origin of proxy signals related to sea-ice (winter) and ice free sea water (summer) for foraminifera.

**Work at sea**

Sea-water samples will be collected by using a rosette water sampler. Microzooplankton samples, 10-15 liters of seawater, will be collected at discrete depths, immediately filtered on a 10 µm mesh to reduce it to a volume of 250 ml. Samples will be preserved with 4 % formaldehyde solution buffered with $CaCO_3$. Samples for Dissolved Inorganic Carbon from the same microzooplankton sampling will be collected in 40 ml glass vials, added with $HgCl_2$ and stored at 4°C. Samples from deep sea-water will be collected for metagenomics analysis. Microplankton samples from the sediment traps will be collected by using cylindrical 10 cm

traps free drifting or anchor to float ice. The samples will be preserved with formaldehyde or frozen directly without fixing.

**Preliminary (expected) results**

It is expected to implement the knowledge of microzooplankton trophic role in the polar food webs. All the samples will be back in the participating institutions and data will be obtained through laboratory analyses after the cruise.

**Data management**

It is expected to implement the knowledge of microzooplankton trophic role in the polar food webs. All the samples will be back in the participating institutions and data will be obtained through laboratory analyses after the cruise. All the data generated from these activities will be likely submitted to the NODC - National Oceanographic Data Center, following the data restriction of the Italian Antarctic Programme PNRA (*Programma Nazionale di Ricerca in Antartide*).

**References**

None

# 8. CLIMATE SENSITIVITY IN VARIOUS FISHES FROM THE ANTARCTIC PENINSULA: MOLECULAR ECOLOGY AND CELLULAR MECHANISMS

M. Lucassen (AWI), C. Papetti (Uni Padova), N. Koschnick (AWI), G. Lannig-Bock (AWI, not on board), F. Mark (AWI, not on board), C. Bock (AWI, not on board)

**Objectives**

The ongoing release of the greenhouse gas $CO_2$ into the atmosphere is believed to cause both, global warming and ocean acidification. The changes largely differ between regions, and the Antarctic Peninsula is one area of the globe that is currently experiencing rapid warming. Temperature as a main abiotic factor comprises every aspect of the biochemistry and physiology of ectothermal organisms putatively culminating in shifting geographical distribution on a larger scale. Although limits may become manifested at the whole organism first, all levels of organisation from the genetic interior to functional physiological levels, i.e. the integration of molecules into functional units and networks up to the whole animal, must be taken into account for an understanding of climate-driven evolution and response to ongoing change.

To continue our comprehensive physiological and molecular genetic studies of high and low Antarctic fish species and populations, live fish in the most pristine condition possible is indispensible for our physiological work. Especially the Antarctic eelpout (*Pachycara brachycephalum*) became an ideal model for our research resulting in a reasonable number of comparative studies during the past (cf. Windisch et al. 2014). Moreover, endemic Notothenioids were included more recently to expand our evidences to larger scales. During the upcoming campaign we aim to catch fish from several fish orders and bring them alive to the home institute for physiological analyses. We aim to (i) estimate acclimatory capacities/sensitivity towards combined treatments of warming, hypoxia and hypercapnia, (ii) determine the level of cold adaptation, and (iii) compare these laboratory treated samples to *in-situ* samples from the field. The analyses comprise global (RNA-Seq) and targeted (qPCR)

gene expression techniques on the background of the population genetic structure, assessment of cellular energy budgets and allocation, as well as metabolic profiling (by means of untargeted nuclear magnetic resonance spectroscopy, NMR). Harmed fish will be used to isolate cells for direct analyses on board and for establishing permanent cell lines for later use at the home institute. Besides, from all specimens tissue samples will be taken and flash-frozen for later molecular physiological and phylogenetic analyses (together with our cooperation partners).

**Work at sea**

To investigate the sensitivity, resilience and capacity for acclima(tisa)tion of fish species from the coldest regions of our planet, good fish material in the most pristine condition possible is needed.

Using baited traps will allow us to catch unharmed and comparably unstressed specimens of the Antarctic eelpout, which became a model system for our studies due to its close relationship to non-Antarctic sister species and to its easy handling. The baited traps will be deployed for about 48 hours preferably at Admiralty Bay, King-George-Island, to catch reasonable amounts of fish.

For catching notothenioid species a commercially–sized 140' bottom trawl will be used alongside the cruise plot given by the CCAMLR project (Fig.1.2). As catching by net causes usually more physical stress to the animals we are going to employ a fish lift. A fish lift is a device that is connected to the cod end of a typical trawl net, which allows sorting fish from unwanted larger items (eg. sponges in the Antarctic case) and which reduces the physical pressure on the catch by moving it out of the water flow (Holst & McDonald, 2000). Such a fish lift has been used by our group during ANT-XXXI/2 the first time and will be further modified to meet our needs.

From each catch basic ecological parameters (species composition, biomass, length and weight distribution, etc.) will be determined. After catch all fish will be first placed into the aquaria systems and then sorted by quality. Harmed fish will be sampled directly, whereas all other fish will be kept alive and controlled regularly. By-catch (invertebrates) will be sampled for collaboration partners at the home institutes.

For *in-situ* profiling of gene expression and physiological parameters fish will be sampled by isolating all available tissues together with blood and serum from undamaged fish directly after short recovery from the howl. Tissue samples will be excised, flash-frozen in liquid nitrogen and stored until Bremerhaven at -80°C. These samples will also serve for the long-term molecular genetic and physiological sample archive of our working group started in 2003 for the eastern Weddell Sea and the Antarctic Peninsula. This will allow on the long-term for detection of spatio-temporal shifts and comparison to the less stable and most rapidly changing region of the Antarctic realm.

For population genetics fin-clips will be taken from all available specimens (together with basic parameters).

From harmed fish different tissues will be taken and cell cultures will be isolated directly on board:

Isolated hepatocytes will be prepared on board of *Polarstern* and incubated with and without $^{13}$C-labelled substrates under different temperatures. The effects of temperature on hepatic cell respiration and cellular energy budget will be investigated during acute warming. The cells will be frozen at -80°C rapidly after different incubation periods and different temperatures, then shipped to the AWI for subsequent molecular and biochemical (metabolic profiling, enzyme activities) analyses. Uptake rates of the specific substrates and incorporation into the glycolytic pathway or TCA-cycle will be determined using NMR spectroscopy at the AWI.

Primary cell cultures from different tissues and species will be prepared and kept alive as long as possible to establish a permanent cell line. The cultures will be observed regularly and media have to be exchanged on a regularly basis until Bremerhaven.

**Preliminary (expected) results**

The present project will contribute to our major research questions aiming at deciphering the molecular and phyisiological basis of climate-driven evolution and responsiveness/sensitivity of Antarctic ectotherms to ongoing climate change.

**Data management**

All data will be made available by publication in scientific journals und subsequent storage in PANGAEA. The molecular data will be submitted to the respective database (NCBI; EMBL).

**References**

Holst JC, McDonald A (2000). FISH-LIFT: a device for sampling live fish with trawls. Fisheries Research 48: 87-91.

Windisch, H. S., Frickenhaus, S. , John, U. , Knust, R. , Pörtner, H. O. and Lucassen, M. (2014). Stress response or beneficial temperature acclimation: Transcriptomic signatures in Antarctic fish (Pachycara brachycephalum). Molecular Ecology 23 (14), 3469-3482.

# 9. FIN WHALE ABUNDANCE

H. Herr (Uni tHamburg), S. Viquerat (TiHo)

**Objectives**

Fin whales (*Balaenoptera physalus*) were the most numerously hunted whale species in the Southern Ocean during the era of industrial whaling, reduced to 2 % of their pristine population size. Today, their recovery status is unknown; ecology and habitat use in the Southern Hemisphere are poorly understood. Recently, sighting numbers of fin whales in the West Antarctic Peninsula area have been increasing and large feeding aggregations have been observed. Robust information on abundance is required to evaluate these re-occurring aggregations and to relate them to current population estimates. Moreover, drivers of fin whale distribution in the area need to be identified to understand why fin whales have returned to an area from which they have been absent for a long time. Fine-scale spatial data are necessary to relate fin whale densities to environmental parameters in order to identify important habitat and its geographical extent. Dependencies on prey species, relationships between krill distribution and fin whales are essential to evaluate vulnerabilities and threats in the rapidly changing environment of the West Antarctic Peninsula (WAP) for a potentially recovering fin whale population.

**Aims**

We will conduct an aerial line-transect distance sampling survey in order to

- provide a robust minimum abundance estimate of fin whales in the WAP
- produce a model surface of fin whale distribution in the WAP
- identify drivers of fin whale distribution by relating observed densities to static and variable habitat parameters

**Work at sea**

We will use the on-board helicopters for our survey. The survey flights will be conducted following line-transect distance sampling methodology for marine mammal surveys, collecting sighting and environmental information along pre-designed track lines. The track lines will be designed *ad-hoc* shortly before each survey flight, adapting to the ship's position, weather conditions and logistic requirements. Surveys will be flown at 80 - 90 kts at an altitude of 600 ft, covering track lines of app. 160 nm in total per flight in a rectangular shape around the ship. The survey team of each flight will consist of two observers. Position data will be continuously recorded on a laptop computer running customised survey software connected to a gps device, recording sighting events and environmental conditions. All sightings of marine mammals will be documented including at least species ID, group size, position and distance to the track line (via the declination angle). If the species or group size cannot be identified immediately, or photos are deemed necessary, the survey will be halted and the sighting approached (so called 'closing-mode'). After collection of all important information, the helicopter will return to the track line and the survey will be resumed. Up to three flights at 2.5 h each per day are planned, pending ship logistics and weather conditions.

**Preliminary (expected) results**

Our project will

(1) provide a robust minimum abundance estimate of fin whales at the WAP

(2) produce a model surface of fin whale distribution at the WAP

(3) identify drivers of fin whale distribution at the WAP

These results will be used for comparisons of whale and krill distribution patterns, will contribute to investigations of the recovery status of fin whales in the Southern Ocean and will provide baseline information for ecosystem management at the West Antarctic Peninsula.

**Data management**

Upon publication or after 3 years at the latest, all data will be made available on appropriate platforms, such as PANGEA, GBIF (http://www.gbif.org, Global Biodiversity Information Facility) or ANTABIF (http://www.biodiversity.aq).

**References**

none

# 10. TRACE METAL BIOGEOCHEMISTRY

F. Koch (Hochschule Bremerhaven,AWI), M. Fourquez (UNIGE), F. Pausch (AWI,Uni Bremen), D. Wilhelms-Dick (AWI),S. Böckmann (Uni Bremen), C. Hassler (UNIGE, not on board), S. Trimborn (AWI, Uni Bremen, not on board)

**Objectives**

Southern Ocean phytoplankton are major drivers of global carbon cycling accounting for 20 % of the global annual primary production. One of the most challenging issues is to understand how the limitation and recycling of trace metals influence the Southern Ocean ecosystem. The availability of trace metals, in particular iron (Fe), is considered the key factor governing Southern Ocean phytoplankton productivity and community composition. In this context, Fe sources are key determinant of Fe bioavailability, but the capacity of autotrophic as well as

heterotrophic microorganisms to access different chemical forms of Fe is barely known. Since phytoplankton are part of a complex food web, their interactions with other trophic levels can have profound effects on the dynamics of the system. This project aims to study the interconnected processes that are driving the biogeochemical cycles of carbon as well as of trace metals such as Fe, zinc (Zn), cobalt (Co) and manganese (Mn).

**Work at sea**

The proposed work involves a suite of different chemical and biological methods to characterize trace metal dynamics with their important implications for Southern Ocean productivity. Next to *in-situ* sampling, several grazing experiments will shed light on the relative importance of grazing (krill, salps, copepods) in resupplying these trace elements.

*In-situ trace metal dynamics and cycling*

It is planned to assess the cycling of trace metals and vitamins at 15 stations using a Teflon-coated 25 L Go-Flo bottle deployed on a Dyneema line. For all sampling stations, a multifaceted approach will be used. To characterize the community composition (virus, bacteria, phytoplankton), samples for light microscopy, size fractionated pigments (HPLC), particulate organic carbon (POC), biogenic silica (BSi) as well as flow cytometry will be taken. To shed light on the trace metal requirements of the plankton community, samples for the cellular content of Fe, Zn, Co and Mn will be taken and stored frozen for subsequent analysis by ICP-MS. In addition, concentrations of dissolved metals (Fe, Mn, Zn, Co), Fe chemical speciation, ligands, humic acid-like substances, macronutrient and dissolved organic carbon will be determined. Removal rates of the dissolved trace metals Fe, Zn, Co as well as primary and bacterial production rates will be estimated.

*Influence of krill and salp grazing products on iron bioavailability to phytoplankton*

To quantify the effect of grazing products from krill and salps on Fe chemistry and bioavailability to phytoplankton, naturally Fe-deplete seawater will be collected from 30 m depth using a membrane pump (Almatec). The seawater will be plumbed to a shipboard laminar flow hood inside of a trace metal clean (TMC) container. Unfiltered naturally Fe-deplete seawater including phytoplankton will be collected and transferred into 9 acid-washed 4 L polycarbonate bottles. While to 3 bottles an aliquot of krill or salp grazing products will be added, the remaining 3 bottles without grazers will serve as control. In addition to this, seawater will be also filtered using a 0.2 µm acid-cleaned Acropak capsule to remove the bacteria and phytoplankton present. As for the unfiltered seawater, an aliquot of krill or salp grazing products will be added to each of the 3 bottles filled with filtered seawater, the remaining 3 bottles without grazers will serve as control. After 24-48 h of incubation, samples will be taken to characterize species biomass and composition as well as trace metal chemistry, organic ligands and material present as described before. To also assess the effect of grazing products on Fe bioavailability, the initial phytoplankton community (40 L unfiltered seawater) will be gently concentrated by gravity filtration onto 2.0 µm polycarbonate filters by the use of special filtration units (Millipore, stirred ultrafiltration cells, model Amicon 8400). 10 mL of the concentrated phytoplankton will be added to 1 L filtered seawater of each incubation, from which primary and bacterial production as well as Fe uptake rates will be determined.

*Influence of micro- and mesozooplankton grazing on trace metal and vitamin cycling*

In order to measure the impacts of grazing of the micro- and mesozooplankton grazing, trace metal and vitamin cycling rates will be measured via the dilution technique and zooplankton addition experiments at 6 stations. Using dilution series recycling/remineralization rates of trace metals, due to grazing by microzooplankton will be determined. For this method, seawater will be collected at each station and diluted in triplicate to 15, 30, 50, 75 and 100 % of the whole seawater using 0.2 µm filtered water from the same location. Growth rates of the various plankton groups and concentration changes of trace metals and vitamins will be assed

for each dilution allowing calculation of grazing rates on the plankton community as well as remineralization rates of trace metals and vitamins. In addition, the meszozooplankton for the experiments will be collected in each of the experimental regions. Individuals of the most common genera will be sorted out, carefully rinsed with naturally Fe-deplete seawater, and maintained at *in-situ* temperatures for 24 h, allowing them to expel any previous food. A yet to be determined number of individuals, depending on size, will then be added to triplicate bottles at three densities. The experiment will be terminated after 24-48 hours assessing the plankton community including copepods as well as measuring concentrations of dissolved inorganic nutrients, trace metals, ligands and vitamins. Sampling various regions of the SO, in combination with the detailed characterization of the plankton community and the importance of grazing as well as the use of the mass balance approach will shed new light on the trace metal and vitamin dynamics of the Southern Ocean.

*Revisiting the influence of different Fe sources on iron bioavailability to phytoplankton*

The bioavailability of Fe to the bacterio- and phytoplankton community from whale faeces, sea-ice environments (fast-ice, snow), hydrothermal vents, dusts, and upwelled seawater will be also investigated at 2-3 naturally Fe-limited locations of the Southern Ocean. Bioavailability for the bacterio- and size-fractionated phytoplankton community of the different forms of Fe will be determined using $^{55}$Fe uptake experiments and sequential filtration. Kinetics of Fe uptake will complement primary and bacterial production as well as dissolved trace metal concentrations of the sampled seawater. The assessment of Fe bioavailability to the natural bacterio- and phytoplankton population will help to revisit the SO budget as we will here consider various forms of bioavailable Fe and not only the dissolved Fe concentrations preferentially employed to parametrize climate models. To this end, also the influence of two different dusts and inorganic Fe ($FeSO_4$) on a longer term (10-14 days) on productivity and species composition (bacteria, virus, phytoplankton) of a naturally Fe-limited phytoplankton community will be undertaken. Next to the characterization of biomass (POC, pigments, BSi), samples for dissolved trace metal concentrations, humic acid like substances and Fe chemical and redox speciation will be taken. This is to explore the link between Fe chemistry and its bioavailability. By considering different sources of Fe, we aim to complement the outputs of the grazing experiments on the role of trophic levels in Fe recycling.

**Preliminary (expected) results**

The research scheduled at sea will address several outstanding challenges with respect to trace metal biogeochemistry and their implications for ecosystem functioning of the Southern Ocean. Our results will help to better understand the role of different grazers on iron bioavailability to phytoplankton and put them into the context of other Fe sources to evaluate their role in Southern ocean ecosystem functioning.

**Data management**

All data obtained will be prepared for publication and will be made available via PANGAEA.

**References**

none

# 11. PHYSICAL OCEANOGRAPHY AND BIO-OPTICAL PARAMETER

T. H. Badewien (ICBM, Uni Oldenburg), M. Butter (ICBM, Uni Oldenburg), H. Winkler (ICBM, Uni Oldenburg, not ), A. Friedrichs (ICBM, Uni Oldenburg), A.-C. Schulz (ICBM, Uni Oldenburg)

**Objectives**

Data on the physical oceanography of the study area is essential for being able to analyse the dynamics of the biological and chemical processes observed during the cruise. Parameters such as temperature and salinity are used to identify water masses, stratification of the water column as well as circulation patterns and mixing processes. Data derived from the ferryz-box allow a more detailed view at the processes occurring at the sea surface. Using underway and profiling systems data will be used to identify:

**Aims**

Observe changes compared to earlier cruises, especially 2012;

- Relationship between hydrographical data and bio-optical parameters such as coloured dissolved organic matter (CDOM). These parameters are – in combination with temperature, salinity and oxygen – a significant tracer for water masses. The relationship can be determined via
  a. a horizontal-spatial range within the surface layer;
  b. a vertical distribution in different water depth.

**Work at sea**

The vertical distribution of the oceanographic parameters will be measured using a CTD (Conductivity-Temperature-depth) probe attached to a custom-built ICBM-rosette water sampler with 24 Niskin bottles 20 liter each and equipped with additional sensors for oxygen, fluorescence and turbidity. Therefore, several CTD casts will be conducted not only for the purpose of gathering oceanographic data but also for obtaining large volumes of water samples for further analysis by all other research groups on board. Additionally, underway systems will be applied continuously to obtain current measurements (acoustic-doppler-current-profiler), remote sensing reflectance and hydrographical data. In order to calibrate the CTD and underway system salinity and oxygen samples will be taken and analysed by using a salinometer and by using the titration method according to Winkler, respectively. CDOM is obtained by filtering 300 ml of sea water through 0.2 µm pore size filters. The filtrate will be subsequently measured with photospectrometer.

**Preliminary (expected) results**

Characterization of the vertical Chl a and POC profile and the light spectrum and intensity in the water column as well as the water masses and currents encountered during the expedition.

**Data management**

After calibration, the validated salinity and oxygen data will be made available at PANGAEA. All other parameters will also be checked in terms of quality and will also be available at PANGAEA, 18 months after the cruise by the latest.

**References**

none

# 12. MEDIA:BBC

A Lees (BBC), R Hawthrone (BBC), B. Gregory (BBC)

**Objectives**

*Seven Worlds* is a new landmark wildlife documentary series produced by the world-renowned *BBC Natural History Unit*. The series will examine, in detail, the unique natural history of each of the seven continents, and how their geographic position and geologic histories have influenced the physiological and behavioural adaptations of the wildlife living there. The series will first be broadcast in 2019 and subsequently be televised in nearly every country around the world.

*Capturing fin whale aggregations from the air*

The Antarctic is a unique continent governed by ice and extreme weather, where most of its life occurs on the periphery and in the biomass-rich waters of the Southern Ocean. With climate changing rapidly in the region, questions remain as to what impact it will have on wildlife. On this expedition we hope to highlight the global importance of the Southern Ocean by showing how its productivity can fuel spectacular fin whale feeding aggregations.

The footage captured by the BBC team will help shed light on the fin whale population size, their spatial and temporal distribution, and help determine what they are feeding on. By focusing on one of Antarctica's high trophic-level predators, we hope to interrogate a higher question: What are the prospects for wildlife in the Southern Ocean if climate change results in a significant decrease in sea ice coverage?

**Aims**

This expedition offers up the chance to film arguably one of the biggest wildlife spectacles on the planet for the very first time. Wildlife filmmakers have long wanted to film large whale aggregations feeding on a krill bait ball, and this voyage gives us an unparalleled opportunity to do this.

In collaboration with marine mammal ecologist Dr Helena Herr, our specialist aerial camera operator will film fin whale feeding aggregations from the air, using the latest stabilized 8K camera technology. Dr Herr will conduct transects to document whale numbers, and their spatial and temporal distribution. The BBC will join Dr Herr and her team during these transects to capture high-resolution footage that will bolster her research. In addition, bespoke helicopter time will allow the BBC camera operator to return to any large feeding aggregations and film this spectacle in more detail. All footage will be available to Dr Herr for analysis.

Furthermore, this expedition provides the unusual opportunity to record the expansion of the sea ice as winter approaches. We will be able to film landscape imagery from this region at a time of year when it has not been well documented.

**Work at sea**

*Technology*

The BBC Natural History Unit set the precedent industry-wide in the United Kingdom by delivering their multi-award winning *Planet Earth II* series in Ultra High Definition. *Seven Worlds* hopes to push the technology boundaries further by delivering at even higher resolutions (Fig. 12.1, Table 12.1).

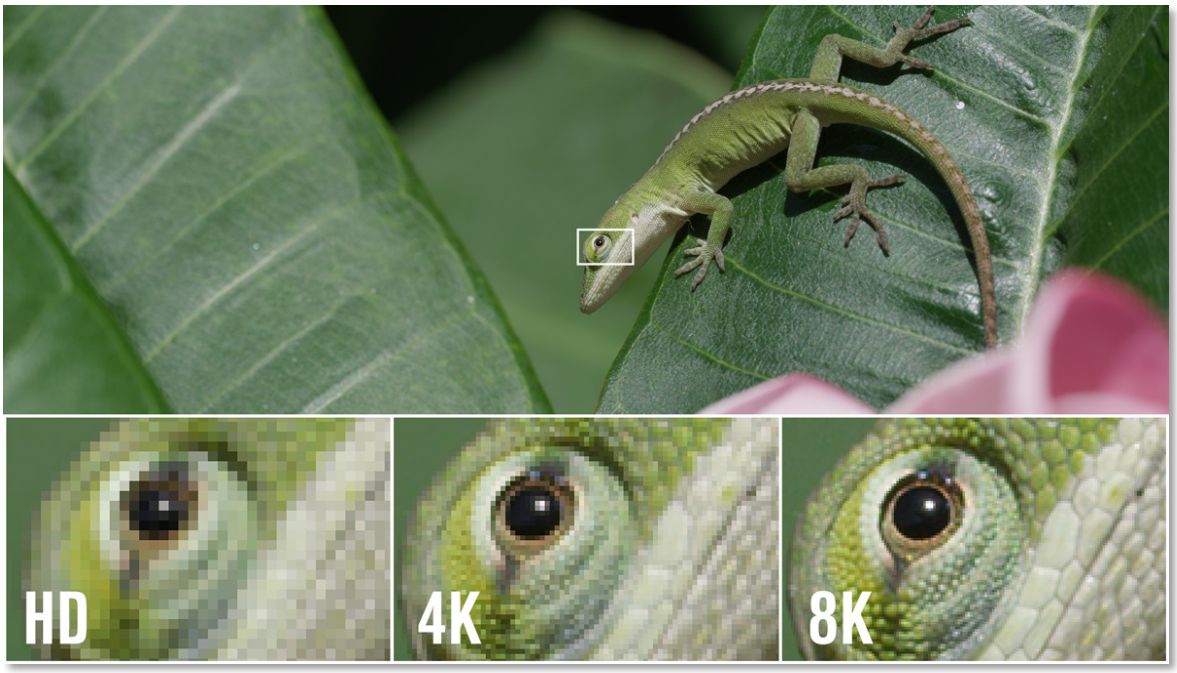


*Fig 12.1: Demonstration of picture quality at different resolutions*

**Preliminary (expected) results**

Video footage of fin whale aggregations for the BBC documentary *Seven Worlds.*

**Data management**

Not applicable

**References**

none

**Tab. 12.1:** Different types technologies used during making of documentary

| Technology | Picture |
|---|---|
| ***Gyro-stabilised camera rig for helicopter filming: The GSS C520***<br>The *GSS C520* is the most flexible and stable platform on the market. A multi-axis gyro-stabilisation system ensures smooth shots via self-calibration, and captures the action at all angles, with the ability to rotate 360°. A top of the range 8K camera fits inside the system to deliver outstanding image quality. |  |
| ***UAV: The Inspire 2***<br>The *Inspire 2* shoots in 5K, has slow motion capabilities, and works well in cold conditions due to its in-built battery self-heating system. It has many safety features including an obstacle avoidance system capable of detecting hazards 30 metres ahead. |  |
| ***8K RED Camera with Helium sensor***<br>The Helium is the first 8K sensor with a super35 sensor size - meaning that the pixels are now twice as dense as before, creating an image sharper and more detailed than ever. 8K allows filmmakers to 'zoom in' on an image, without compromising on picture quality. This ability will greatly help individual whale identification from footage captured from the helicopter operating at distance. This will allow us to limit the disturbance to animals we film. |  |

# 13. TEILNEHMENDE INSTITUTE /PARTICIPATING INSTITUTIONS

| Institute | Address |
|---|---|
| AAD | Australian Antarctic Division<br>203 Channel Highway<br>Kingston Tasmania 7050<br>Australia |
| AWI | Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung<br>Postfach 120161<br>27515 Bremerhaven<br>Germany |
| BBC | British Broadcasting Corporation<br>Broadcasting House<br>Egton Wing<br>Portland Place<br>London<br>W1A 1AA<br>United Kingdom |
| DAFF | Department of Agriculture, Forestry and Fisheries<br>Inshore Resources Research<br>Branch: Fisheries<br>Private Bag X2, Rogge Bay 8012<br>Cape Town, South Africa |
| DWD | Deutscher Wetterdienst<br>Geschäftsbereich Wettervorhersage<br>Seeschifffahrtsberatung<br>Bernhard Nocht Str. 76<br>20359 Hamburg<br>Germany |
| Hochschule Brhv. | Hochschule Bremerhaven<br>An der Karlstadt 8<br>27568 Bremerhaven<br>Germany |
| ICBM | Institut für Chemie und Biologie des Meeres<br>Carl-von-Ossietzky-Straße 911<br>26133 Oldenburg<br>Germany |
| MARUM | Zentrum für Marine Umweltwissenschaften<br>Leobener Straße 8<br>28359 Bremen<br>Germany |

| Institute | Address |
|---|---|
| OGS | Istituto Nazionale di Oceanografia e di Geofisica Sperimentale<br>Via Auguste Piccard 54<br>34151 Trieste TS<br>Italy |
| TiHo | Tierärztliche Hochschule Hannover<br>Bünteweg 2<br>30559 Hannover<br>Germany |
| UBC | University of British Columbia<br>2329 West Mall<br>Vancouver, BC V6T 1Z4<br>Canada |
| UNIGE | Université de Genève<br>1205 Genf<br>Switzerland |
| Uni Bremen | Universität Bremen<br>Bibliothekstraße 1<br>28359 Bremen<br>Germany |
| Uni CA | University of California, Santa Cruz<br>1156 High St<br>Santa Cruz<br>CA 95064<br>USA |
| Uni Gdansk | University of Gdansk<br>Jana Bażyńskiego 8<br>80-309 Gdańsk<br>Poland |
| Uni Hamburg | Universität Hamburg<br>Mittelweg 177<br>20148 Hamburg<br>Germany |
| Uni Oldenburg | Universität Oldenburg<br>Ammerländer Heerstraße 114<br>26129 Oldenburg<br>Germany |
| Uni Padova | Universita di Padova<br>Via 8 Febbraio 1848, 2,<br>35122 Padova PD<br>Italy |
| Uni St. Andrews | University of St. Andrews<br>St Andrews KY16 9AJ<br>United Kingdom |

# 14. FAHRTTEILNEHMER/ CRUISE PARTICIPANTS

| No. | Name/ Last name | Vorname/ First name | Institut/ Institute | Beruf/ Profession | Scientific Field |
|---|---|---|---|---|---|
| 1 | Auerswald | Lutz | DAFF | Scientist | Biology |
| 2 | Badewien | Thomas | ICBM | Scientist | Oceanography |
| 3 | Bahlburg | Dominik | AWI | Student | Biology |
| 4 | Bernasconi | Matteo | Uni St. Andrews | Scientist | Acoustic |
| 5 | Böckmann | Sebastian | Uni Bremen | PhD Student | Biology |
| 6 | Butter | Michael | ICBM | Student | Oceanography |
| 7 | Diociaiuti | Tommaso | OGS Triest | PhD Student | Biology |
| 8 | Driscoll | Ryan | Uni CA | Scientist | Biology |
| 9 | Fernandez | Victor Santos | Heli Service Int. | Mechanic | |
| 10 | Flintrop | Clara | MARUM, AWI | PhD student | Biology |
| 11 | Fourquez | Marion | Uni Geneva | Scientist | Biology |
| 12 | Freier | Ulrich | ICBM | Scientist | Biology |
| 13 | Friedrichs | Anna | ICBM | Scientist | Oceanography |
| 14 | Göbeler | Norman | ICBM | Student | Biology |
| 15 | Gregory | Bertie | BBC | Camera operator | |
| 16 | Halbach | Laura | AWI | Studentin | Biology |
| 17 | Hawthone | Robert | BBC | Camera operator | |
| 18 | Heim | Thomas | Heli Service Int. | Mechanic | |
| 19 | Hempel | Julia | DWD | Technician | Meteorology |
| 20 | Herr | Helena | Uni Hamburg | Scientist | Biology |
| 21 | Iversen | Morten | MARUM, AWI | Scientist | Biology |
| 22 | Jager | Harold | Heli Service Int. | Pilot | |
| 23 | Kenzia | Jan | Heli Service Int. | Pilot | |
| 24 | Kerwath | Sven | DAFF | Scientist | Biology |
| 25 | Koch | Florian | Hochschule Brhv./AWI | Scientist | Biology |
| 26 | Konrad | Christian | MARUM | Engineer | Biology |
| 27 | Koschnick | Nils | AWI | Engineer | Biology |
| 28 | Lees | Abigail | BBC | TV Director | |
| 29 | Lucassen | Magnus | AWI | Scientist | Biology |
| 30 | Meyer | Bettina | AWI, ICBM | Scientist | Biology |
| 31 | Monti | Marina | OGS Triest | Scientist | Biology |
| 32 | Moorthi | Stefanie | ICBM | Scientist | Biology |
| 33 | Müller | Max | DWD | Scientist | Meteorology |
| 34 | Müller | Svenja Julica | ICBM | Student | Biology |
| 35 | Pakhomov | Evgeny | UBC Vancouver | Scientist | Biology |
| 36 | Pakhomov | Larysa | UBC Vancouver | Technician | Biology |
| 37 | Panasiuk | Anna | Uni Gdansk | Scientist | Biology |
| 38 | Papetti | Chiara | Uni Padua | Scientist | Biology |
| 39 | Pauli | Nora | ICBM, AWI | PhD Student | Biology |

| No. | Name/ Last name | Vorname/ First name | Institut/ Institute | Beruf/ Profession | Scientific Field |
|---|---|---|---|---|---|
| 40 | Pausch | Franziska | AWI | PhD Student | Biology |
| 41 | Pitzschler | Lisa | AWI | Student | Biology |
| 42 | Plum | Christoph | ICBM | Scientist | Biology |
| 43 | Rhode | Sven | ICBM | Scientist | Biology |
| 44 | Schulz | Anne-Christin | ICBM | Scientist | Oceanography |
| 45 | Sulanke | Erik | AWI | Student | Biology |
| 46 | Viquerat | Sacha | TiHo Hannover | Scientist | Biology |
| 47 | Vortkamp | Martina | AWI | Technician | Biology |
| 48 | Waller | Tash | AAD | Technician | Biology |
| 49 | Wawrzynek | Justyna | Uni Gdansk | PhD Student | Biology |
| 50 | Wenta | Philipp | ICBM | PhD Student | Biology |
| 51 | Wessels | Wiebke | ICBM, AWI | Scientist | Biology |
| 52 | Wilhelms-Dick | Dorothee | AWI | Engineer | Biology |

# 15. SCHIFFSBESATZUNG / SHIP'S CREW

| | **Name** | **Rank** |
|---|---|---|
| 01. | Wunderlich, Thomas | Master |
| 02. | Lauber, Felix | 1.Offc. |
| 03. | Westphal, Henning | Ch.Eng. |
| 04. | Kentges, Felix | 1.Offc.Lad. |
| 05. | Fischer, Tibor | 2.Offc. |
| 06. | Peine, Lutz | 2.Offc. |
| 07. | NN Doctor | |
| 08. | Christian, Boris | Comm.Offc. |
| 09. | Schnürch, Helmut | 2.Eng. |
| 10. | Buch, Erik-Torsten | 2.Eng. |
| 11. | Rusch, Torben 2. | Eng. |
| 12. | Brehme, Andreas | Elec.Tech. |
| 13. | Frank, Gerhard | Electron. |
| 14. | Markert, Winfried | Electron. |
| 15. | Winter, Andreas | Electron. |
| 16. | Feiertag, Thomas | Electron. |
| 17. | Sedlak, Andreas | Boatsw. |
| 18. | Neisner,Winfried | Carpenter |
| 19. | Clasen, Nils | A.B. |
| 20. | Schröder, Norbert | A.B. |
| 21. | Burzan, Gerd-Ekkehard | A.B. |
| 22. | Hartwig-Labahn, Andreas | A.B. |
| 23. | Fölster, Michael | A.B. |
| 24. | Müller, Steffen | A.B. |
| 25. | Brickmann, Peter | A.B. |
| 26. | NN | A.B. |
| 27. | | |
| 28. | Beth, Detlef | Storekeep. |
| 29. | Plehn, Markus | Mot-man |
| 30. | Klein, Gert | Mot-man |
| 31. | Krösche, Eckard | Mot-man |
| 32. | Dinse, Horst | Mot-man |
| 33. | Watzel, Bernhard | Mot-man |
| 34. | Meißner, Jörg | Cook |
| 35. | Tupy,Mario | Cooksmate |
| 36. | Martens, Michael | Cooksmate |
| 37. | Wartenberg, Irina | 1. Stwdess |
| 38. | Leue, Andreas Georg | Stwd/KS |
| 39. | Hischke, Peggy | 2. Stwdess |
| 40. | Duka, Maribel | 2. Stwdess |
| 41. | Krause, Tomasz | 2. Steward |
| 42. | NN | 2. Steward |
| 43. | Chen, Quan Lun | 2. Steward |
| 44. | Ruan, Hui Guang | Laundrym. |