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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2012 (ANT-XXVIII/4)

**Edited by
Magnus Lucassen
with contributions of the participants**

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GEMEINSCHAFT

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Punta Arenas – Punta Arenas

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Contents

1. FAHRTVERLAUF UND ZUSAMMENFASSUNG

Magnus Lucassen
AWI

In der Antarktis hat sich trotz der extrem kalten Temperaturen ein produktives marines Ökosystem entwickeln können, auf das große Säuger- und Vogelpopulationen zugreifen, die sich intensiv von Fischen und Krill ernähren. Die einzigartige Fischfauna auf dem antarktischen Schelf und den angrenzenden Inseln ist durch eine vergleichsweise geringe Artenvielfalt und einem hohen Maß an endemischen Arten gekennzeichnet. Die Anpassung an die extreme Kälte scheint sich dabei auf Kosten einer hohen thermischen Sensitivität entwickelt zu haben.

Die fortdauernde Freisetzung des Treibhausgases Kohlendioxid in die Atmosphäre wird für eine globale Temperaturerhöhung und eine Versauerung der Weltmeere verantwortlich gemacht. Die Veränderungen unterscheiden sich lokal beträchtlich, und die Antarktische Halbinsel wurde weltweit als eine der Regionen identifiziert, in der die stärksten Erwärmungen nachgewiesen wurden. Zudem lassen sich mittlerweile auch persistente, bioakkumulierende Substanzen im antarktischen Ökosystem nachweisen. Insgesamt scheint es daher naheliegend, dass die Summe der sich ändernden Umweltfaktoren kumulativ einzelne Arten bedroht, was sich letztendlich bis hin zu Lebensgemeinschaften und dem gesamten Ökosystem auswirken kann.

Menschliche Aktivitäten haben aber schon wesentlich direkter in das antarktische Ökosystem eingegriffen. Die Fischbestände in der Region Elephant Island – Südliche Shetland Inseln – Antarktische Halbinsel wurden zwischen dem Ende der Siebziger und 1989/90 kommerziell ausgebeutet, bis die Fischerei schließlich 1990 durch die "Convention for the Conservation of Antarctic Marine Living Resources" (CCAMLR) solange verboten wurde, bis eine Erholung der Fischbestände von der Überfischung nachgewiesen ist.

Den Ausgangspunkt für die Arbeitsgebiete dieses Fahrtabschnittes stellten daher die Untersuchungen zum Zustand der Fischbestände und der heterotrophen, benthischen Lebensgemeinschaften im Umfeld der Antarktischen Halbinsel im Rahmen früherer Erhebungen von CCAMLR dar (Kapitel 3). Die Proben, die mittels Grundschleppfischerei gewonnen wurden, wurden von einer Vielzahl von übergreifenden Projekten weiter verarbeitet, die sich mit der Populationsstruktur (Kapitel 7, 9), Wachstums- und Vermehrungsparametern verschiedener Fischgruppen (Kapitel 6, 8) beschäftigen oder den Befall mit Parasiten und deren Biologie untersuchen (Kapitel 10). Zudem soll die Eignung von verschiedenen Fischarten als Bioindikatoren persistenter Umweltgifte untersucht werden (Kapitel 4). Mittels molekularphysiologischer Ansätze sollen funktionelle Merkmale identifiziert werden, die für die Anpassungsfähigkeit bzw. Empfindlichkeit diverser Fischgruppen gegenüber den Klimafaktoren Temperatur und CO_2 verantwortlich sind (Kapitel 5). Sämtliche Fänge wurden mit Blick auf Invertebraten untersucht, um beispielsweise besonders bedrohte Ökosysteme, (VME: *vulnerable marine* *ecosystems*) entsprechend den Statuten von CCAMLR zu klassifizieren (Kapitel 11). Die Abundanz und trophische Ökologie von Cephalopoden wurde in einem weiteren Projekt untersucht (Kapitel 12).

Das antarktische Tiefenwasser gilt als eine der größten marinen Senken von atmosphärischen CO_2 während der letzten Eiszeit. Tiefsee-Sedimente wurden daher mit Hilfe eines Multicorer beprobt, um Foraminiferen in Hochdruckaquarien zu kultivieren, die eine Kalibrierung von Spurenelementverhältnissen, wie sie zur Abschätzung des Paleoklimas verwendet werden, zu ermöglichen (Kapitel 15).

Ein weiterer Schwerpunkt dieses Fahrtabschnittes lag in der umfassenden Charakterisierung des Roseobacter-Stamms, einer bedeutenden Komponente des antarktischen Bakterioplanktons. Dazu wurden Proben in der Wassersäule und aus dem Sediment entlang der Drake-Passage und der Halbinsel genommen (Kapitel 13, 14, 18). Wale und andere Meeressäuger wurden entlang des Kurses visuell und mittels automatisiertem Infrarot-Kamera-System erfasst (Kapitel 16). Eine weitere Gruppe registrierte Seevögel (Kapitel 17).

Der 4. Fahrtabschnitt der 28. *Polarstern*-Reise in die Antarktis startete am 14. März 2012 um 12:00 Uhr in Punta Arenas mit 18 stündiger Verspätung auf Grund starker Überschwemmungen im Stadt- und Hafengebiet von Punta Arenas. Dank günstiger Wind- und Strömungsverhältnisse konnte diese Verspätung bis zum Eintreffen im ersten Arbeitsgebiet um Elephant Island auf etwa 8 Stunden reduziert werden. Auf dem Weg durch die Drake Passage wurden zuvor zwei CTD-Stationen vor und in der antarktischen Konvergenzzone durchgeführt. Der Rahmen für den täglichen Stationsplan wurde von der Fischerei vorgegeben, um eine Vergleichbarkeit mit früheren Erhebungen zu gewährleisten. Gefischt wurde ab 06:00 Uhr Ortszeit bis maximal 18:00 Uhr. Durchschnittlich zwei CTD-Stationen pro Tag im Bereich der Fischereistationen wurden zur Charakterisierung der ozeanischen Basis-Parameter durchgeführt. Anschließend wurden im Bereich des Schelfs oder am Kontinentalhang Wasser bzw. Sedimentproben gewonnen. In einem Nebenprojekt wurden von Christopher Jones (NOAA) Langzeit-Drifter zur Beobachtung der Strömungsverhältnisse außerhalb der nationalen Hoheitsgebiete und Wirtschaftszonen entlang des Kurses ausgesetzt. In den Nachtstunden wurden dann -sofern zeitlich möglich- die Fischereistriche des darauffolgenden Tages ausgelotet. Dieser Rhythmus wurde während der gesamten Expedition eingehalten. Auf Grund der überwiegend schwierigen und wechselhaften Wetterlage mußten die Route und der Stationsplan ständig überarbeitet werden, um beispielsweise im Schutz der Inseln zu arbeiten.

Im Gebiet um Elephant Island wurde zunächst vom 17.03. bis zum 25.03.2012 gearbeitet. Anschließend bewegte sich *Polarstern* entlang der südlichen Shetland Inseln (King George Island) in Richtung Süd-West. Auf Grund der Wetterprognose entschieden wir uns dann am 27. März, die Stationen dieses Untersuchungsgebietes von Südwesten aus abzufahren. Dieser Plan ging allerdings nicht auf, so dass wir im Verlauf des 28. März mit teils schwierigen Arbeitsverhältnissen zu kämpfen hatten. In der darauffolgenden Nacht wurde zur Kalibrierung des Fischereilotes EK-60 ein Kursstrich westlich von Snow Island abgefahren (PS79/250-1). Anschließend ging es dann nördlich von Livingston und King George Island zurück zu unserer Ausgangsposition. In der Nacht zum 1. April passierten wir dann die Bransfield Straße, um nördlich von Joinville Island unser drittes Untersuchungsgebiet zu erreichen. Auf Grund der vorherrschenden südlichen Strömungsverhältnisse und sehr niedriger Temperaturen waren große Teile dieses Gebietes schon durch

Neueis und verdriftetem mehrjährigen Eis bedeckt. So konnten wir nur wenige der geplanten Fischreistationen erreichen, und die Besatzung hatte auf Grund von Eisbergkratzern häufig mit Netz-Hakern zu kämpfen. Daher wurden Alternativstriche bis zum 3. April befischt. In der Nacht setzte *Polarstern* ihren Kurs in östliche Richtung fort, um im Bereich des Kontinentalhangs Wasser des Weddellmeeres für die Mikrobiologen zu beproben. Am 4. Und 5. April wurden dann weitere Stationen im Bereich von Elephant Island abgearbeitet. Die Stationsarbeiten wurden am Nachmittag des 5. April mit einer CTD abgeschlossen. Anschließend ging es bei stürmischer See durch die Drake Passage zurück nach Punta Arenas, Chile, wo die Expedition pünktlich am Morgen des 09. April 2012 endete.

Insgesamt wurden 76 Stationen mit Hilfe von Grundschleppnetzen beprobt, was angesichts der fortgeschrittenen Jahreszeit und dem damit einhergehenden Wetterverhältnissen als großer Erfolg gewertet werden kann. Vor allem die gute Abdeckung der vorrangigen Untersuchungsgebiete um Elephant Island und entlang der südlichen Shetland Inseln erlauben substantielle Aussagen. Erste Ergebnisse deuten darauf hin, dass sich die Bestände von *Notothenia rossii* (Marmorbarsch) und *Champsocephalus gunnari* (Bändereisfisch) deutlich erholt haben. Neben den fischereibiologischen Parametern konnte wertvolles Probenmaterial für eine Vielzahl von übergreifenden Projekten und Forschungsarbeiten gesammelt werden, deren Aufarbeitung auch in Hinblick auf Langzeitreihen in diesem, von starken klimatischen Änderungen betroffenen antarktischen Sektor äußerst interessant sein dürfte. Sämtliche Fänge wurden mit Blick auf Invertebraten quantitativ und qualitativ untersucht, um insbesondere VMEs zu klassifizieren. Entlang der Fahrtroute konnte der südöstliche Schelf von Elephant Island als ein solches VME identifiziert werden, die beabsichtigte Registrierung durch CCAMLR schließt eine kommerzielle Fischerei in solchen Schutzgebieten zukünftig aus.

Für die Charakterisierung des Roseobacter-Stamms wurden Wasserproben mittels CTD-Rosette und Sedimentkerne, die mit Hilfe des Multicorer gewonnen wurden, aufgearbeitet. Insgesamt wurden für alle Arbeitsgruppen 51 CTD- und 20 Multicorer-Stationen beprobt. Die Sedimentproben bildeten zudem die Grundlage für die erfolgreiche Kultivierung von Tiefsee-Foraminiferen unter verschiedenen Umweltbedingungen an Bord *Polarstern*.

Der Schelf um Elephant Island stellte sich im Verlauf der Expedition -trotz der späten Saison- als besonders produktiv heraus. Dies spiegelte sich auf allen Organismen-Ebenen wider, sei es in Form der großen Zahl an Sichtungen von Walen und Seevögeln, den teils sehr ergiebigen Fischfängen oder der Produktivität des Bakterioplankton. Dieser Zustand hielt auch noch nach unserer Rückkehr in das Untersuchungsgebiet an. Als Ursache für dieses beeindruckende Ereignis dürfte das Auftreten großer Krill-Schwärme, die mit Hilfe des Fischereilotes erfasst wurden, naheliegend sein.

Insgesamt konnten alle Projekte die Beprobungen und Messungen weitestgehend im beabsichtigten Umfang durchführen. Auch wenn die Bearbeitung der Proben und die vollständige Auswertung noch Jahre in Anspruch nehmen dürfte, kann die Expedition damit als sehr erfolgreich gewertet werden. Zu diesem Erfolg haben wesentlich die große Einsatzfreude der gesamten Mannschaft und insbesondere die der Deckscrew, die unter teils schwierigen äußeren Bedingungen den Fischereibetrieb sicher durchgeführt hat, beigetragen. Die gute logistische Vorbereitung hat sicher ihren Teil dazu geleistet, dass die unwetter-bedingten Verzögerungen in Punta Arenas sich nur minimal auf das Programm ausgewirkt haben. Besondere

Erwähnung verdient die vertrauensvolle Zusammenarbeit von Schiffsführung und Fahrtleitung. Nicht zuletzt sei dem Enthusiasmus aller Wissenschaftler gedankt, die die Bearbeitung des enormen Probenaufkommen mit großem Engagement erlaubt haben.

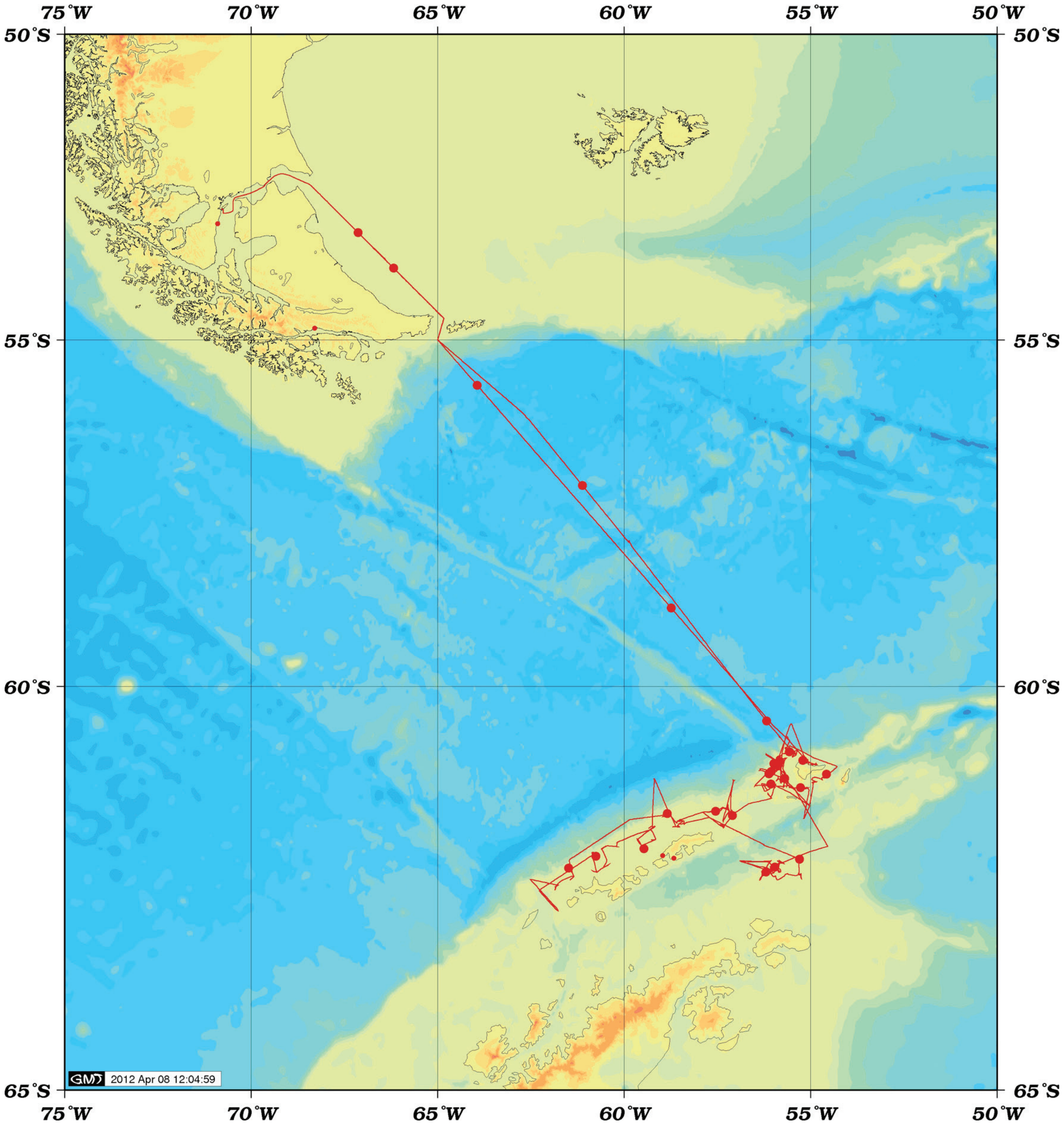

Abb. 1.1: Fahrtroute der Polarstern während der Expedition ANT-XXVIII/4

Fig. 1.1: Cruise plot of Polarstern during the expedition ANT-XXVIII/4

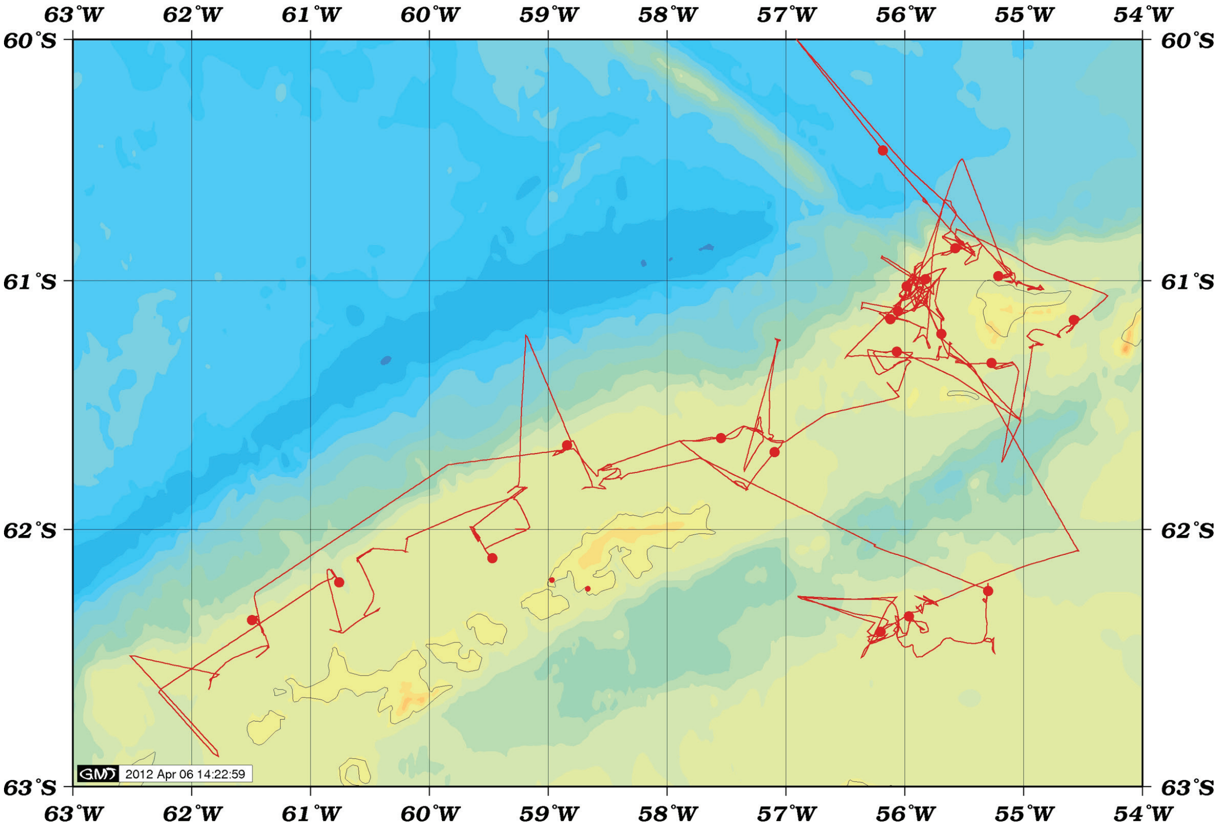

Abb. 1.2: Detailausschnitt der Fahrtroute in den Arbeitsgebieten von ANT-XXVIII/4

Fig. 1.2: Detailed cruise plot in the working areas of ANT-XXVIII/4

SUMMARY AND ITINERARY

The Antarctic marine ecosystem is quite productive despite the frigid temperatures, and supports large populations of mammals and birds that feed extensively on fish and krill. Within this environment a unique fish fauna developed on the shelves of the Antarctic continent and adjacent islands showing low species diversity and high levels of endemism. Adaptations to this environment appear to be evolved at the expense of high thermal sensitivity.

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. Increasing contamination with persistent bio accumulating compounds is reported for the aquatic ecosystems of Antarctica. Together, the sum of changing environmental factors is thought to cumulatively threaten individual species, thereby ultimately affecting the community and ecosystem levels.

Human activities have already threatened the Antarctic ecosystem even more obviously. The finfish stocks in the area of Elephant Island – South Shetland Islands – Antarctic Peninsula have been commercially exploited from the late seventies until 1989/90. Fishery was only profitable in the very beginning, and fishing was closed in 1990 by the "Convention for the Conservation of Antarctic Marine Living Resources" (CCAMLR), until the recovery of the fish stocks from overexploitation have been demonstrated.

The framework of the present cruise ANT-XXVIII/4 was given by investigating the state of the fish stocks and the benthic heterotrophic community by means of bottom trawls on behalf of CCAMLR at Elephant Island, the South Shetland Islands and the Antarctic Peninsula in continuation of earlier surveys (chapter 3). The samples from all bottom trawls were further processed by a number of projects focusing on population structure (chapter 7, 9), growth and reproduction parameters in several fish groups (6, 8), and the affection with and the biology of fish parasites (chapter 10). Further samples were taken to test the use of several fish species as bioindicators for xenobiotics (chapter 4). By use of molecular physiological approaches functional traits defining physiological responsiveness and sensitivity towards the climate factors temperature and CO_2 should be identified in diverse fish groups (chapter 5). Invertebrate indicator taxa have been assessed during the cruise to detect vulnerable marine ecosystems (VME) according to the specification given by CCAMLR (chapter 11). The abundance and trophic ecology of cephalopods have been investigated in another project (chapter 12).

The Antarctic deep water has been described as the largest marine sink of atmospheric CO_2 during the last glacial. Sediments from deep waters have been sampled by multi corer to successfully cultivate foraminifera as environmental controls of trace metal ratios recorded in calcareous tests of Antarctic deep-sea benthic foraminifera (chapter 15).

Another focus of the cruise leg was the comprehensive assessment of the Roseobacter clade, a prominent component of the Antarctic bacterioplankton, in the water column and sediments of the Drake Passage and the Antarctic Peninsula region (chapter 13, 14, 18). Whales and other marine mammals were sighted along the cruise track by visual inspection and by an automated infrared camera system (chapter 16). Another group registered seabirds (chapter 17).

The 4th leg of the 28th *Polarstern* cruise to Antarctica started in Punta Arenas, Chile, March 14, 2012 at noon. Due to a flash flood in Punta Arenas the start was delayed by 18 hours. This delay could be reduced to about 8 hours when arriving our first working area at Elephant Island due to favourable conditions of wind and currents. On our way through the Drake Passage two CTD stations were performed before and during passage of the Polar front. The framework of the daily station schedule was given by the fishery to ensure comparability to earlier surveys. Fishing was done between 06:00 am and 06:00 pm. In average two CTD stations were done over the day in vicinity of the fishing stations to determine basic oceanic parameters. Thereafter, water and sediment samples were taken on the shelf and on the continental slope, respectively. Aside, long-time drifter buoys were deployed outside national exclusive zones along the course in a side project of Christopher Jones (NOAA). During the night the fishing tracks of the next day were fathomed whenever possible. This rhythm was kept during the entire expedition. Due to the challenging and unsettled weather conditions the course and the station schedule had to be adapted on a daily basis, such as to work in the shelter of the islands.

In the area of Elephant Island the station work was done firstly between March 17 and 25. Thereafter, *Polarstern* moved along the South Shetland Islands (King George Island) to Southwest. Based on the weather forecast we decided on March 27 to transfer to the south-westerly end of this working area and to complete the stations in opposite direction. This plan did not work well, as we faced heavy working conditions during the day of March 28. In the following night a calibration of the fish echo sounder EK-60 was done on a transect West of Snow Island (PS79/250-1). The following days *Polarstern* went northerly of Livingston and King George Island back to our starting position from a few days before. During the night to April 1, we passed the Bransfield Strait and reached our third working area North of Joinville Island. Due to prevailing south-easterly winds and deep temperatures large areas were already covered by new sea ice and drifted multiyear ice fields. Therefore, we could only reach few planned stations, and the fishing was hampered furthermore due to iceberg scrapers. Alternative trawling tracks were used instead until April 3. During the night *Polarstern* moved eastward to sample water at the continental slope of the Weddell Sea for the microbiologists. On April 4 and 5 further station work was done in the Area of Elephant Island. Station work was closed in the afternoon of April 5 with a final CTD. At stormy weather *Polarstern* turned back to Punta Arenas, Chile, where it arrived on time schedule in the morning of April 09, 2012.

76 stations were sampled by means of bottom trawls in total, which was a great result considering the time of the season and the concomitant difficult weather conditions. Especially the coverage in the two primary target areas at Elephant Island and the South Shetland Islands were sufficient for meaningful evidences. First results indicate a recovery of the stocks of *Notothenia rossii* (marbled rockcod) and *Champsocephalus gunnari* (mackerel icefish). Besides fish biology related parameters precious material from all bottom trawls were sampled by a number of joint and overlapping projects. Furthermore, these samples are extremely useful

in the view of long-term observations within this Antarctic area of rapid climate change. Invertebrate indicator taxa were assessed during the cruise in all hauls to detect VME. Along the cruise track the south-easterly shelf of Elephant Island could be identified as VME, the projected registration by CCMALR will protect this area against commercial fishery in future.

For the comprehensive assessment of the Roseobacter clade, the bacterioplankton was isolated from water samples and sediments by use of CTD rosette and multicorer, respectively. In total 51 CTD and 20 multi corer stations have been performed. Furthermore, the multi corer work formed the basis for the isolation and successful cultivation of deep-sea foraminifers under different environmental conditions on board *Polarstern*.

It turned out that the shelf of Elephant Island was very productive at this time of the year. This became evident at all levels of organisms, by huge numbers of sighted whales and birds, by a considerable number of large fish hauls, and by the productivity of the bacterioplankton. This situation remained stable at least until our second stay at Elephant Island. It seems reasonable to suggest that large krill swarms, which could be detected by echo sounder in this area, caused this impressive event.

In total, all projects could process samples and perform measurements mostly until the desired extent. Thus the expedition can already be judged to be very successful even though the progress on the samples and the final data analyses may need several years. This achievement was largely supported by the entire *Polarstern* crew and especially by the decks crew, which performed the fishery safely even under severe conditions. Thanks to the precise logistic preparation the delayed start in Punta Arenas due to the flash flood affected the scientific programme only minimal. The trustfully cooperation between master and chief scientist is worth mentioning. Finally, owing to the enthusiasm of all scientists the enormous amount of samples could be processed with huge success.

2. WEATHER CONDITIONS

Harald Rentsch DWD

Polarstern set sail on March 14, 2012 at 12:30 local time. The local weather situation around Punta Arenas was characterized by a low slowly entering the Antarctic Peninsula from the southern Pacific Ocean. At the same time a high pressure system was dominant close to the ships track to *Isla de Los Estados*. As a result weak northerly, later moderate northwesterly winds of Bft 4 to 5 were dominant, and the wind speed increased during the next two days up to Bft 6 - 7. During the first two days the wind force generated waves of nearly 2 - 3 m on our course towards Elephant Island. Afterwards a cyclone moved over parts of the South Shetland Islands towards Weddell Sea causing wave heights of 4 to 5 m together with rain showers, and air temperatures between 3 and 6°C were measured. The temperature decreased with every mile of our cruise towards Antarctica. During the 17th of March a lee-cyclone was build up nearby the northern South Shetland Islands causing unstable layered air masses from the Drake Passage, and the wind increased to average values of Bft 8 (gusts up to 9 - 10 Bft). This forced the ship to change the planned ships track and to work in areas, which were wind-protected by Elephant Island. Thus, on the following Sunday all tasks could be done properly at southwesterly winds up to wind force 7 and a sea below 3 m.

The second working week started within an area of a high pressure ridge in front of an approaching secondary low. Southwesterly winds reached Bft 7 - 8, and waves were measured up to 4.5 m. On the following Tuesday a low (L), see Fig. 2.1) passed tightly north of Elephant Island touching our fishery-area and causing south-easterly winds up to Bft 7, the waves were limited to around 4 m. The following days a ridge of high pressure caused nearly calmed southerly winds and swell conditions between 2 and 4 m, depending on the ship position relative to Elephant Island.

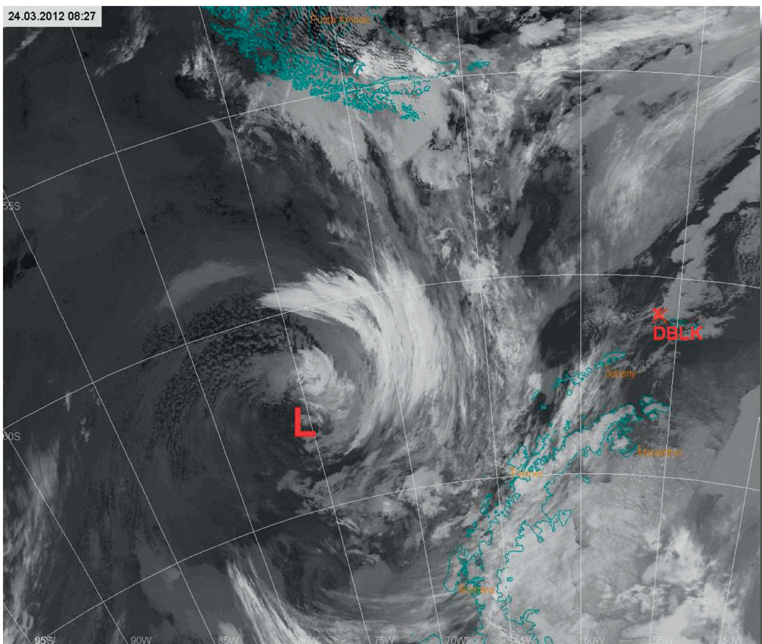

Fig. 2.1: Movement of a low (L) from the south-eastern Pacific to areas north of Elephant Island, on March 24, 08:27 utc; DBLK: Call-sign Polarstern

From Sunday, March 25, a new low was building up in the Southern Pacific causing a weak south-westerly air stream of wind force 5 - 6 Bft. Together with isolated snow showers the sea reached not more than 3.5 m. Due to the movement of this low north-eastward the wind speed increased up to 8 Bft on the next day, nevertheless all fishery work north-easterly of King George Island could be done at wave heights up to 4 m.

On the following Tuesday, as the air pressure raised in Drake Passage and large-scale falling pressure were seen over the South Shetland Islands, wind forces were measured up to 9 Bft coming from Northwest. One day later the sea model from EZMW (*Europäische Zentrum für Mittelfristige Vorhersage*) simulated some processes which produced new lows over south-easterly Pacific Ocean. Accordingly, we changed our scheduled cruise track to prevent high seas up to 6 m, which were forecasted for the next 2 days for our operation area.

On Wednesday, March 28, we faced the expected wave conditions, but only with maximum heights up to 5 m. In front of the low the north-easterly wind speed reached 7 - 8 Bft for a period of 8 hours. In this case fishery were performed with some restrictions. On the back side of this gale and together with building up of an anticyclone North of Signy Island the weather conditions improved continually day by day between March 29 and 31. Some light snow showers occurred, the sea calmed nearly down, and the westerly winds decreased to 5 Bft. At the same time Antarctic air masses caused an air temperature between -4°C at night and 0°C during daylight. At this time longer sunny periods could be registered on board, the only ones during this cruise.

At the change to April an unstable stratification of the atmosphere in connection with weak troughs caused many snow showers, and snowfalls for a longer time span on Saturday. At this time the weather was characterized by fresh easterly winds up to 7 Bft and a swell up to 3.5 m outside the sea ice, which we reached on Sunday (April 1) on our course to Joinville Island. Many crawlers and some huge icebergs (~ 100 x 100 m) were crossing our track. In vicinity to one- and multiyear ice fields we had calmed sea conditions, but minimal temperatures of -14°C during the day in connection with frozen snow caused slippery ice areas on deck. The south-easterly winds brought Antarctic air masses from Weddell Sea in our operation area for a short time. The wind chill temperatures felt even down to -35°C at this time, despite, fishery were not disturbed significantly by this.

Between April 2 and 5 we got some more fronts and more snow in the working areas close to Joinville Island and Elephant Island, respectively. This frontal influence had a relay to a low located west of the Antarctic Peninsula, and its movement and extension towards southern Atlantic. In front of the low, north-easterly winds up to Bft 7 dominated (sea below 3 m), and after one day of calmed wind conditions (April 4), the gale forced south-easterly winds up to Bft 9 an 10, fortunately blowing directly from the back side of the ship. On our way during the Drake Passage back to Punta Arenas the sea swelled up to 6 m, often we had covered skies with snowfalls, and sunshine was totally absent. Nevertheless, we approached our final destination, Punta Arenas, on April 9 in the morning at the scheduled time without remarkable weather influences.

The statistics of the measured wind speed on board indicate clear patterns for this cruise (Fig. 2.2): This cruise belongs to one of the journeys with most and constant wind forces 5 to 8, despite the wave heights (Fig. 2.4) were mostly lower compared to what normally could be expected at such high wind forces.

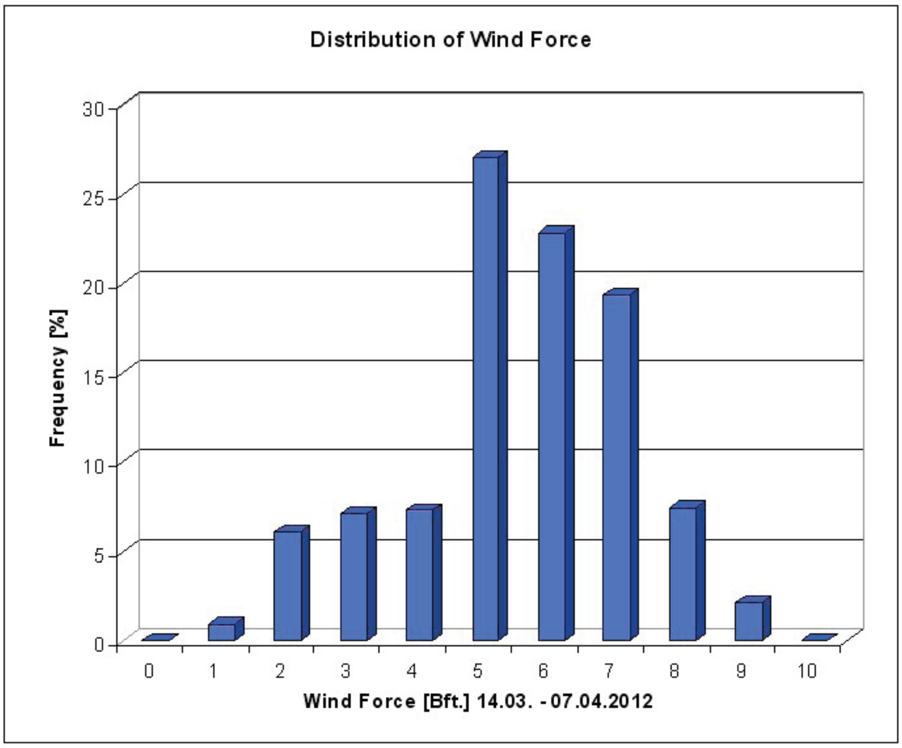

Fig. 2.2: Distribution of wind force for the period March 14 to April 7, 2012, on board of Polarstern

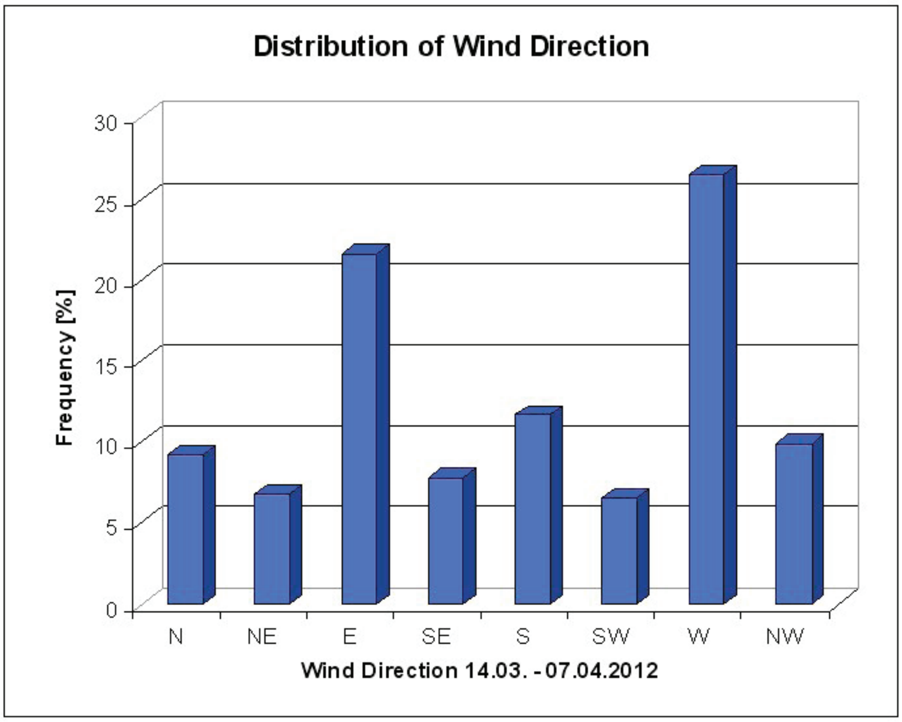

Fig. 2.3: Distribution of wind direction for the period March 14 to April 7, 2012, on board of Polarstern

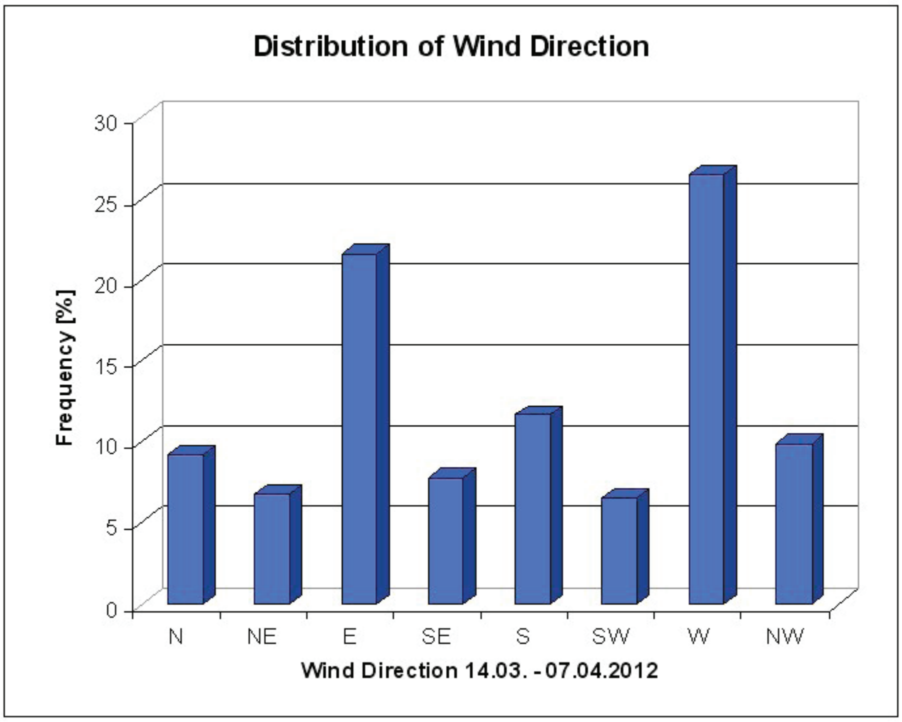

Fig. 2.4: Distribution of wave heights for the period March 14 to April 7, 2012, on board of Polarstern

3. THE COMPOSITION, ABUNDANCE AND BIOLOGY OF THE DEMERSAL FISH FAUNA IN THE ELEPHANT ISLAND – SOUTH SHETLAND ISLAND REGION AND AT THE TIP OF THE ANTARCTIC PENINSULA (CCAMLR SUBAREA 48.1)

Karl-Hermann Kock[1], Markus Busch[2], Annika Elsheimer[1], Sebastian Emde[2], Christopher Jones[3], Sven Klimpel[2], Thomas Kuhn[2], Volker Siegel[1], Julia Wolske[1]

[1]vTI
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Objectives

Fish stocks in the Elephant Island/South Shetland Islands/Antarctic Peninsula region (CCAMLR Statistical Subarea 48.1) were exploited by fishing fleets from former Eastern Bloc countries from 1977/78 to 1989/90. Target species were mackerel icefish (*Champsocephalus gunnari*) and marbled notothenia (*Notothenia rossii*) in the Elephant Island/South Shetland Islands region and the spiny ice fish (*Chaenodraco wilsoni*) in the Antarctic Peninsula region. Yellow Notothenia (*Gobionotothen gibberifrons*), two icefish species (*Chaenocephalus aceratus*, *Chionodraco rastrospinosus*), and the yellowbelly rockcod (*Notothenia coriiceps*) were either by–catch species or became target species in cases when larger concentrations were found. Catches of the target species (mackerel ice fish) were in the order of more than 100,000 tonnes in the first season and several 10,000 tonnes in the two seasons thereafter. Since then, stocks of the two target species appeared to be exhausted and the fishery was continued on a level of a few thousand tonnes annually. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) closed the fishery after the 1989/90 season.

Work at sea

Our survey was based on the same stratified random survey design as utilized during surveys conducted in collaboration with the Southwest Fisheries Science Centre of the National Marine Fisheries Survey of the US in 1998 – 2007 with *Yuzhmorgeologiya* and *Polarstern*. The gear used was the same 140’ bottom trawl, which had been used in 2002 and 2007. The mouth opening of the trawl was 2.5 – 3.2 m x 16 – 18 m. Trawling time was 30 min net on the bottom. A total of 71 hauls was conducted around Elephant Island, off the South Shetland Islands and the tip of the Antarctic Peninsula from 17 March to 5 April 2011 (Table 3.1) with a focus on the depth range 100 – 300m where most of the fish biomass occurred.

Tab. 3.1: Number of hauls conducted around Elephant Island, in a 'box' west of Elephant Island, off the South Shetland Islands and at the northern tip of the Antarctic Peninsula.

Depth stratum (m)	Elephant Island	South Shetland Island	Tip of the Antarctic Peninsula
50 - 100	4	1	0
101 - 200	19	7	0
201 - 300	14	5	1
301 - 400	6	4	3
401 - 500	1	3	2

The net became damaged on two occasions when becoming hooked on the bottom. These two hauls were considered invalid.

Prevailing southeasterly winds pushed large amounts of floating ice out of the western Weddell Sea. As a consequence, the tip of the Antarctic Peninsula was largely covered in drifting ice. Trawling in the shallower parts of the shelf became largely impossible. With one exception, only the deeper part of the shelf (>350m) could be fished, and given the difficult fishing conditions less hauls were conducted than intended. The location of fishing stations is provided in Fig. 3.1. Trawling was conducted only during daylight hours from 6 o'clock in the morning to 6 o'clock in the evening.

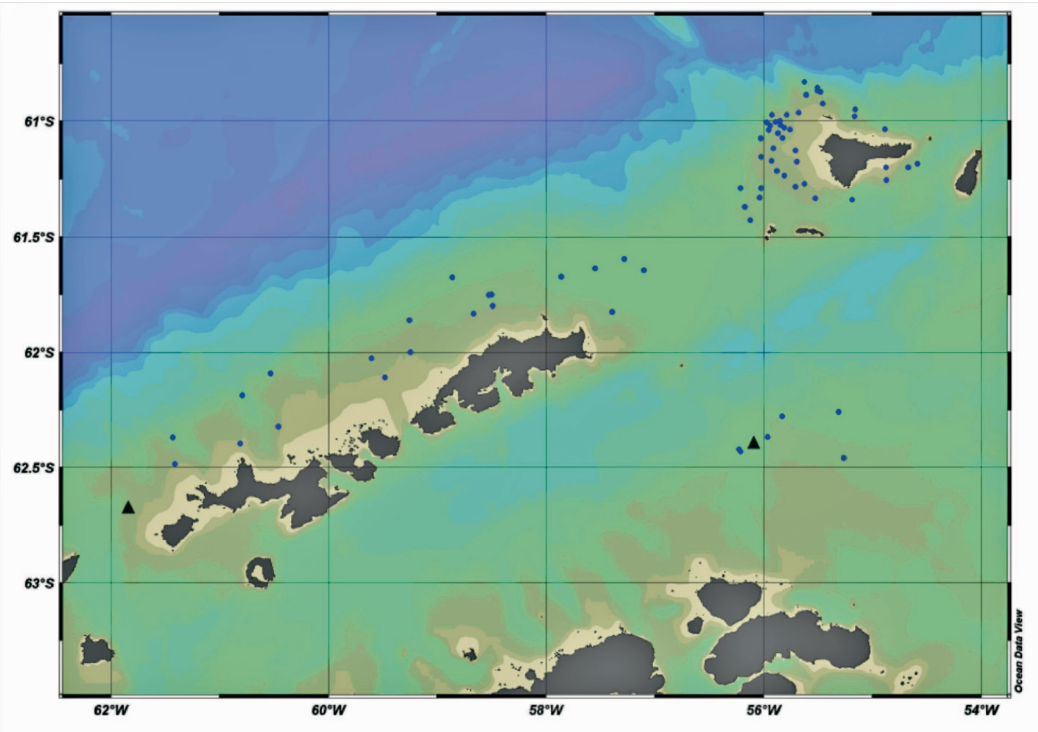

Fig. 3.1: Area of investigation. Circles: valid hauls; triangles: invalid hauls

Preliminary results

Catch composition of each tow was recorded in terms of weight and number of individuals per species. The by–catch of benthos was recorded in terms of weight. Fifty-five fish species were caught in the 70 valid hauls.

Our catches in the area Elephant Island – South Shetland Islands suggested that *N. rossii* and *C. gunnari*, which had been depleted during commercial fishing in the second half of the 1970s/early 1980s, had further increased since the last survey in 2006/07. No recruitment has been observed in *Gobionotothen gibberifrons* since almost 10 years. Biomass of the stock has declined substantially. Most fish in the stock are more than 40 cm long indicating an age of 15 years and older. Causes for the lack of recruitment are currently unknown.

Tab. 3.2: List of species caught in the course of the bottom trawl survey in the Elephant Island – South Shetland Island region and the northern tip of the Antarctic Peninsula.

Family	Species	Elephant Island, the South Shetland Is. and tip of the Antarctic Peninsula
Nototheniidae	*Dissostichus mawsoni*	+
	Aethotaxis mitopteryx	+
	Notothenia rossii	+++
	N. coriiceps	+++
	Gobionotothen gibberifrons	+++
	Lepidonotothen larseni	+++
	L. nudifrons	+++
	L. squamifrons	++
	Trematomus bernacchii	+
	T. eulepidotus	+++
	T. hansoni	+
	T. tokarevi	+
	T. scotti	+
	Pleuragramma antarcticum	+
	Pagothenia brachysoma	+
Harpagiferidae	*Harpagifer antarcticus*	+
Artedidraconidae	*Artedidraco skottsbergi*	+
	Pogonophryne phyllopogon	+
	Pogonophryne scotti	+
	Pogonophryne barsukovi	+
	Pogonophryne marmorata	
	Dolloidraco longedorsalis	+
Bathydraconidae	*Parachaenichthys charcoti*	++
	Gerlachea australis	+
	Gymnodraco acuticeps	+

Family	Species	Elephant Island, the South Shetland Is. and tip of the Antarctic Peninsula
	Akarotaxis nudiceps	+
	Racovitzia glacialis	+
Channichthyidae	*Champsocephalus gunnari*	+++
	Chaenocephalus aceratus	+++
	Pseudochaenichthys georgianus	++
	Chionodraco rastrospinosus	+++
	Cryodraco antarcticus	+++
	Chaenodraco wilsoni	++
	Pagetopsis macropterus	+
	Neopagetopsis ionah	+
	Chionobathyscus dewitti	+
	Pagetopsis macropterus	+
Rajidae	*Bathyraja maccaini*	+
	Bathyraja sp. 2	+
	Bathyraja eatonii	+
Muraenolepidae	*Muraenolepis microps*	++
Gempylidae*	*Paradiplospinus gracilis*	+
Myctophidae*	*Electrona antarctica*	+++
	Krefftichthys anderssoni	+
	Protomyctophum tenisoni	
	Gymnoscopelus nicholsi	+++
	G. braueri	+
Liparididae	*Paraliparis spec. (1 spec.)*	
Zoardidae	*Ophthalmolycus amberensis*	+++
	Pachycara brachycephalum	+++
	Lycodichthys antarcticus	+
Liparididae	*Paraliparis sp.*	+
Macrouridae	*Macrourus whitsoni*	+
Paralepididae*	*Notolepis coatsi*	
Bathylagidae*	*Bathylagus antarcticus*	+

*) mesopelagic fish

The reproductive state of the most abundant fish species is provided in table 3.3 and Fig.3.2.

Tab. 3.3: Reproductive state and estimated spawning time in some abundant nototheniids and channichthyids.

Species	Reproductive state	Estimated start of spawning
Champsocephalus gunnari	Gonad development advanced in most fish > 38 cm. Fish 32-37 cm were sexually mature but showed no sign of gonad development	April
Chaenocephalus aceratus	Gonad development well advanced	March
Cryodraco antarcticus, *Chionodraco rastrospinosus*	Gonad development well advanced, spawning fish	February
Chaenodraco wilsoni	Gonads in regression state	October
Notothenia rossii, *N. coriiceps*	Gonad development advanced	End of March/Beginning of April
Gobionotothen gibberifrons	Gonads in resting stage	August-September

The food composition of the abundant species was analysed in 3633 fish in the Elephant Island – South Shetland Islands – Joinville Island area. An overview of thwe number of stomachs investigated per species was provided in table 3.4.

Tab. 3.4: Number of fish investigated for length, sex and maturity and stomach content

Species	length investigated	+ sex and maturity	+ stomach content
Notothenia coriiceps	685	681	297
Notothenia rossii	1502	1480	379
Champsocephalus gunnari	5006	4947	956
Chaenocephalus aceratus	877	791	582
Chionodraco rastrospinosus	850	842	611
Cryodraco antarcticus	305	302	273
Lepidonotothen larseni	4540	316	11
L. squamifrons	441	374	248
L. nudifrons	903	194	0
Gobionotothen gibberifrons	1364	1352	276

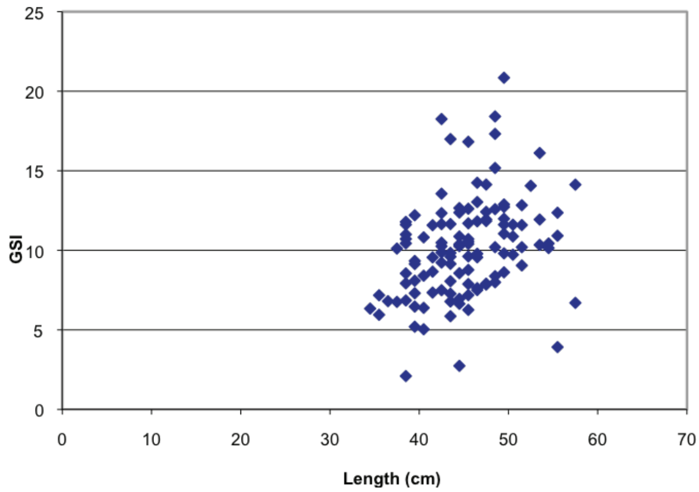

Fig. 3.2: Gonado-somatic index of Notothenia coriiceps

Data management

All results from the survey will be present to CCAMLR at its meeting of the Fish Stock Assessment Working Group in October 2012. Furtehrmore, all data will be made available by publication in scientific journals.

4. DISCOVER THE COLD: ARE ANTARCTIC FISH CAPABLE OF COPING WITH ANTHROPOGENIC CHEMICALS?

Patricia Burkhardt-Holm[1], Helmut Segner[2], Peter Schmid[3](not on board)

[1]University of Basel
[2]University of Bern
[3]EMPA

Objectives

The physiology of Antarctic notothenioid fish departs in many aspects from the physiology of temperate fish species. The adaptation to their extreme environment with stably cold, oxygen-rich waters comprises both gains (e.g., anti-freeze protection) and losses (e.g., inability to mount a heat shock response) of physiological capabilities. A more recent stress factor Antarctic fishes are confronted with is environmental contamination with anthropogenic chemicals. Antarctica receives immissions of persistent halogenated aromatic hydrocarbons (HAHs) by long-range atmospheric transport and global distillation of pollutants in high latitudes. Current trends point to increasing chemical contamination of the Antarctic environment due to the appearance of emerging contaminants, as well as consequences of global warming such as altered atmospheric transport and precipitation and melting of the ice cover. It is known that Antarctic fish accumulate HAHs, however, no knowledge at all is available on the capability of Antarctic fishes to cope with these chemicals, and how vulnerable they are to the toxic activity of these chemicals. The investigation started during the *Polarstern* cruise ANT-XVIII/4 is the first systematic study to relate chemical body burdens to molecular capabilities and possible adverse outcomes in Antarctic fish species. To this end, the project will study

(i) accumulation of dioxin-like, coplanar HAHs in Antarctic fish species in relation to trophic level. We expect that HAH body burdens in Antarctic fishes are more diverse and higher than currently known.

(ii) biotransformation capabilities of Antarctic fish species. We hypothesize that Antarctic fish have limited metabolic capabilities to reduce HAH bioaccumulation.

(iii) expression and functional properties of the arylhydrocarbon (AhR) receptor, as this receptor mediates HAH toxicity and determines HAH sensitivity. We hypothesize that genetic diversity and expression of AhR in Antarctic fish species is comparable to what is known from temperate fish species.

(iv) changes in reproductive parameters of Antarctic fish as possible adverse outcome of the biological action of dioxin-like HAHs. According to the literature from temperate fish species, there exists a robust link between accumulation of dioxin-like HAHs and reproductive disruption. We hypothesize that co-transfer of bioaccumulated HAHs together with body lipids into maturing ovaries and eggs poses a risk to the reproduction of Antarctic fish.

Work at sea

The sampling was conducted in the course of cruise ANT-XXVIII/4, which was a fishery-focused survey using a scientifically sound sampling plan (randomized survey). Fish was sampled by bottom trawl. To minimize the handling stress, only fish netted alive and without macroscopically visible damage was used for our sampling. Fish was anesthetized and dissected immediately to avoid necrotic tissue alterations.

To verify or reject our hypotheses, we applied two sampling designs, design A which examines relationships between HAH accumulation and biological effect indices, and design B which aims to reveal basic molecular and physiological capabilities of the Antarctic fish to cope with dioxin-like HAHs.

Sampling design (A) was applied to find associations between body burdens of compounds with dioxin like- activity, expression of exposure marker CYP1A (early response) and reproductive endpoints (apical response), in relation to physiological and ecological traits (age, sex, lipid contents, position in food web). Two fish species were selected for design A, the mackerel icefish, *Champsocephalus gunnari*, and the Scotia Sea icefish (or blackfin icefish), *Chaenocephalus aceratus*. *C. gunnari* is one of the most important krill feeders of the Antarctic fish community. *C. aceratus* is a rather sedentary form, and a fish feeder when adult. At the time of sampling for our project, it was in final maturation stage, shortly before spawning so that the conditions are ideal to check for gonadal effects as well as for transfer of HAHs into the eggs.

Sampling design (B) aims to provide a comprehensive assessment of metabolic capabilities and AhR properties of Antarctic fish species, including red- and white-blooded notothenioids. We sampled four species of the Nototheniidae (red-blooded) with different feeding habits - the marbled rockcod *Notothenia rossii*, feeding mainly on krill, *Notothenia coriiceps*, a benthic feeder, the Antarctic toothfish, *Dissostichus mawsoni* which is a fish feeder when adult, and the benthos feeding humped rockcod, *Gobionotothen gibberifrons*. For comparison with species of a different systematic affiliation but also an endemic notothenioid family, we sampled three species of *Channichthyidae* (white-blooded icefish) mentioned above – the mackerel icefish, *C. gunnari*, and the Scotia Sea icefish *C. aceratus*, as well as *Chaenodraco wilsoni*. All these species were object of fisheries surveys since 1975/6 in the Scotia Arc region (CCAMLR). High quality long-term data are available on their biology and ecology, such as geographic distribution, bathymetric range, and life cycle parameters, such as growth, feeding habits, age at maturity, gonadosomatic indices, spawning season, etc. (for review: Kock 2005 a,b).

In addition, we took samples of the following species deviating from the aforementioned species in several aspects of their physiology and ecology. The Antarctic eelpout *Pachycara brachycephalum* is a confamilial species to our native species *Zoarces viviparus* of the North Sea. This Antarctic species is known for cold compensation in enzyme activities and it is suggested that its acclimation pathways are different from those in temperate species and possibly also from the cold-stenothermic notothenioids (Lucassen et al. 2003). Antarctic silverfish *Pleuragramma antarcticum* is a pelagic plankton feeding notothenioid key species in the Antarctic food web. *P. antarcticum* is a member of the Pleurogramminae, the most phylogeneticaly derived subfamily of the notothenioids (Gon & Heemstra 1990). Currently, it was detected that the larvae have insufficient antifreeze capabilities, which are necessary to survive the temperature in their habitat, namely the lower layer of the platelet ice (Cziko et al. 2006). *Gymnoscopelus nicholsi* belongs to the lanternfishes (Myctophidae). It feeds mainly on euphausiids and is interesting also because it stores lipid extensively subcutaneously and serves as prey for *D. mawsoni* (Gon & Heemstra 1990).

From all species sampled under design B, we collected liver samples for RNA and DNA extraction, for preparation of S9 extracts (to measure biotransformation rates of HAHs) and for biotransformation enzyme analyses.

The selected sampling areas are identical for both sampling designs. They include the Scotia Sea with Elephant Island and the South Shetland Islands as well as areas in Bransfield Strait (CCAMLR Subarea 48.1). Due to the vicinity to South America, this region is supposed to be stronger exposed to anthropogenic chemicals than other areas of Antarctica. For example, atmospheric transport of PCBs from Southern America to the Antarctic Peninsula has been reported (Montone et al. 2003). A further argument supporting the selection of these sampling areas is that they have been studied on xenobiotic contamination in former years (Weber & Goerke 2003, Corsolini et al. 2005).

Preliminary (expected) results

On board of *Polarstern*, we acquired the following data: species, length, weight, sex, weigth of liver, weight of ovary, stage of maturation. For further analyses in the home laboratory, we sampled from fish, according to our sampling designs A and B, respectively: muscle (for chemical analysis), liver (for RT-PCR/cloning/ sequencing/heterologous expression, chemical analysis, histology) and gonads (for chemical analysis and histology). For statistical analysis of the associations between HAH accumulation, effect indices, species traits and environmental parameters, multivariate statistics will be employed.

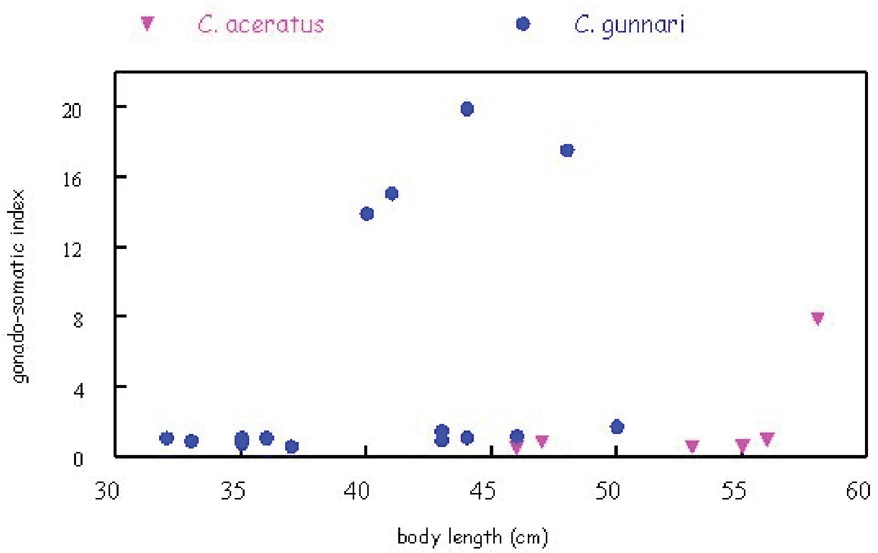

Fig. 4.1: Relationship between gonado-somatic index and body length of C. aceratus *and* C. gunnari*.*

In total, we sampled 55 *C. gunnari* and 49 *C. aceratus* under sampling design A. Of these, 30 specimen (*C. gunnari*) and 41 specimen (*C. aceratus*), respectively, were sampled off Elephant Island, the other specimen were sampled off South Shetland Islands. For sampling design B, we acquired tissue samples and length-weight data from *Pachycara brachycephalum* (n=3); *Gymnoscopelus nicholsi* (n=10), *Lepidonotothen squamifrons* (n=4), *Chaenodraco wilsoni* (n=12), *Notothenia rossii* (n=15), *Dissostichus mawsoni* (n=7), *Champsocephalus gunnari* (n=15), *Gobionotothen gibberifrons* (n=13), *Notothenia coriiceps* (n=10), *Chaenocephalus aceratus* (n=13), *Pleuragramma antarcticum* (n=45).

Preliminary analysis of the gonado-somatic indices among the fishes of the effect study (sampling design A) revealed that female *C. gunnari* of the same age class are at differing stages of ovarian maturity: while one fraction of the females possessed immature ovaries, the other fraction displayed mature ovaries (Fig. 4.1). Ovarian maturation was paralleled by an increase of liver size, indicative of the role of the liver to provide lipids and lipoprotein for the developing eggs (Fig. 4.2). As ovarian maturation is associated with a major mobilisation and re-distribution of body lipids, and as lipophilic contaminants such as HAHs co-segregate with body lipids, we expect that the two female groups show distinct differences in their levels of HAH levels in the ovaries. This provides an excellent opportunity to study HAH dynamics in relation to fish physiological status, and – as the two female groups belong to the same age class – independent of age-related differences of HAH bioaccumulation.

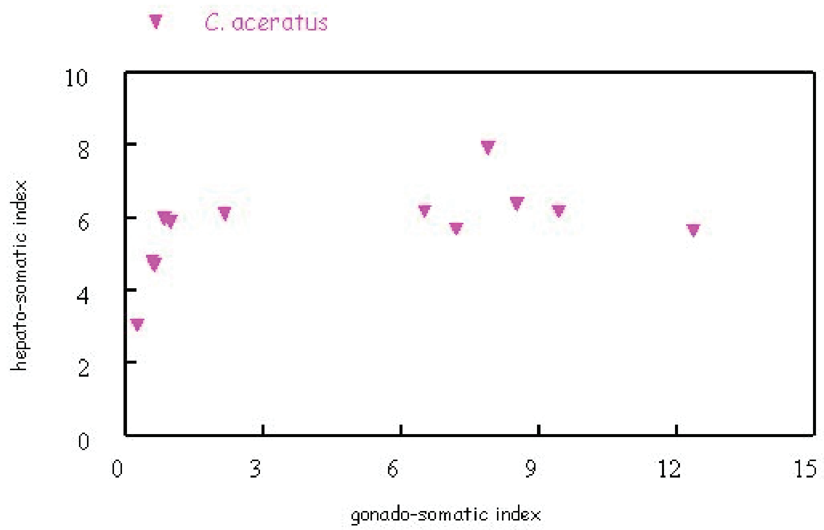

Fig. 4.2: Relationship between hepato-somatic index and gonado-somatic index of C. aceratus*.*

Data management

All data will be made available by publication in scientific journals. Chemical analyses of tissue samples will be done at EMPA, Dübendorf, molecular and histological examinations will be done at MGU Basel and Centre for Fish and Wildlife Health

Bern. Histological tissue samples will be available upon request from Centre for Fish and Wildlife Health, University Bern, and MGU, University of Basel.

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5. MOLECULAR BASIS OF CLIMATE SENSITIVITY IN ANTARCTIC FISH: MITOCHONDRIAL FUNCTIONING AND ITS IMPLICATION FOR IONIC AND OSMOTIC REGULATION

Magnus Lucassen, Nils Koschnick, Tina Sandersfeld — AWI

Objectives

Increasing CO_2 in the atmosphere causes both, ocean warming and acidification. Due to its pervasive impact on all biological processes, temperature is a crucial abiotic factor limiting geographical distribution of marine ectothermal animals on large scales (Pörtner and Farrell, 2010). Additional environmental factors like increasing PCO_2 and the concomitant drop in water pH are thought to narrow the thermal window, as they are believed to act on the same physiological mechanisms (Pörtner et al. 2011). Thermal adaptation and phenotypic plasticity, which define the thermal niche and the responses to fluctuating environmental factors, are ultimately set by the genetic interior of the organisms. Adaptations to the extreme cold appear to be evolved at the expense of high thermal sensitivity (Sidell et al. 1997; Hoffmann et al. 2000). Mitochondrial functioning and maintenance resemble a key functional trait, as it is directly related to the aerobic performance windows of animals. Example studies on mitochondria from Antarctic fish suggest that mitochondrial functioning underwent significant adaptations upon evolution to extreme cold. Our findings of elevated capacities of respiratory chain components and uncoupling proteins in Antarctic eelpouts upon warm acclimation suggests the use of acclimation pathways different from those in temperate fish (Mark et al. 2006; Windisch et al. 2011). Furthermore, we identified a molecular network, responding sensitively to warming beyond the realized ecological niche and mediating large rearrangements in energy metabolism.

The allocation of energy through mitochondria limits the main energy demanding processes like protein and RNA synthesis and ion and pH regulation. The interrelation of ion regulation and energy demand becomes obvious in branchial mitochondrial-rich cells, where the main ion pump, the Na^+/K^+-ATPase, is concentrated, too. Tight regulation of this process with a strong impact on whole animal energy budget has been shown both in response to temperature and CO_2. Ocean acidification is compensated for by an efficient ion regulatory system (Deigweiher et al. 2008; 2010). With respect to temperature effects, different strategies in the use of active and passive strategies of pH regulation are discussed for cold-adapted and temperate species. As hemoglobin-less icefishes are characterized by larger blood volume and flow due to limited oxygen transport capacity, consequences for the passive transepithelial transport of ions may be postulated.

Thus, we aim to characterise the branchial energy budget and ion regulatory system in gills in relation to the allocation of energy by mitochondria upon relevant environmental factors in an array of different Antarctic fish groups, to distinguish common principles and specific climate sensitivities in the light of the ongoing climate change.

Work at sea

The cruise provided access to a large number of fresh tissue samples from all Antarctic fish groups, and thus an excellent basis for comparative tissue and cellular analyses. Fish from bottom trawls of all sample areas have been processed directly after the haul by taking gills and other tissues after anaesthetizing and killing. All tissues have been frozen in liquid nitrogen for analyses of the branchial energy budget and its molecular regulation at AWI.

By use of baited traps we aimed to catch animals of best quality for physiological and ecological experiments at the institute. As the number of captured fish by this method was quite limited we also took specimen from short bottom trawls (10 min on ground). All these fish were kept in the aquarium container on board *Polarstern* at environmental temperature conditions, and will be transported alive to the AWI during ANT-XXVIII/5.

On occasion alive cephalopod specimens of good quality were sampled from the bottom trawls for further experimentations at the AWI.

Furthermore, during past cruises we have already collected a reasonable number of tissue samples from a broad set of fish species within the study area. Samples for molecular genetic and phylogenetic studies of various tissues been taken from anaesthetized fish directly after catching and frozen instantaneously in liquid nitrogen. The new molecular analyses tools (in-depth pyrosequencing, etc.) present a quantum leap in analysing environmental samples from individual specimens. The continuous sampling of these samples will allow for holistic analyses of active genomes in a changing environment over time.

Preliminary (expected) results

Catching of alive fish

The new designed baited traps were only used on two occasions around Elephant Island (table 5.1) due to the rough weather conditions and the consequences for distances to the other stations. At the tip of the Antarctic Peninsula the ice coverage prohibited the use of traps. In total only two *N. rossii* were caught. As the fish density was very high and the water depths we have chosen were in agreement with the catch results of the bottom trawls, we have to speculate that the success of this method was hampered by the large amount of food (krill), which was present around Elephant Island at the time of deployment.

Tab. 5.1: List of baited traps

No.	Station	Working area	PositionLat	PositionLon	Depth
1	PS79/201-1	Elephant Island	61° 9.27' S	56° 5.96' W	127 m
2	PS79/201-2	Elephant Island	61° 9.33' S	56° 5.33' W	126 m
3	PS79/223-1	Elephant Island	61° 5.46' S	55° 49.76' W	212 m
4	PS79/223-2	Elephant Island	61° 5.68' S	55° 49.40' W	211 m

Therefore sampling of alive animals was mainly done from the bottom trawls. The animals were allowed to recover in the aquarium system, and their healthiness was checked daily. A total of about 150 individuals from eight different fish species (*Ophtalmulycus amberensis, Champsocephalus gunnari, Gobionotothen gibberifrons, Notothenia coriiceps, Notothenia rossii, Lepidonotothen nudifrons, L. larseni, Trematomus eulepidotus*) and 250 specimen of three different octopod species (*Paraledone* spec.) were finally collected for transportation to the AWI, Bremerhaven (Fig. 5.1). Depending on sufficient specimen numbers these fish will be used for temperature dependent growth experiments. These experiments shall contribute to understand temperature sensitivity of Antarctic fish and the effect of temperature on the Antarctic fish energy budgets in the framework of climate change. Furthermore, different organismic levels will be analyzed by physiological and molecular tools to characterise performance-limiting processes at elevated temperatures and different CO_2 concentrations.

Fig.5.1: Macerel icefish Champsocephalus gunnari *(after successful transport to the polar aquarium at the AWI (Photo: Felix C. Mark, AWI)*

Sampling of tissues

For molecular physiological studies tissue at the home institute samples were instantaneously isolated after the haul from selected species (table 5.2).

Tab. 5.2: List of fish species sampled for molecular physiological analyses

No	Species	Quantity	Weight (g)	Length (cm)
1	*Chaenocephalus aceratus*	2	179.2 ± 29.2	27.0 ± 1.0
2	*Champsocephalus gunnari*	6	290.9 ± 45.8	33.2 ± 1.8
3	*Chionodraco rastrospinosus*	6	261.5 ± 31.0	31.8 ±1.3
4	*Cryodraco antarcticus*	6	184.8 ± 58.6	32.7 ± 3.5
5	*Gobionotothen gibberifrons*	7	685.6 ± 139.5	38.1 ± 2.0
6	*Lepidonotothen larseni*	6	37.1 ± 2.0	16.5 ±0.2
7	*Ophtalmolycus amberensis*	3	n.d.	27.0 ± 1.0
8	*Parachaenichthys charcoti*	1	40.3	22.0
9	*Trematomus eulepidotus*	6	119.0 ± 14.7	22.5 ± 0.6

Data for total length and weight are given as mean ±SE.

From each specimen the following samples were taken and flash frozen in liquid nitrogen: blood, gills, liver, heart ventricle, atrium, white and red muscle, spleen, kidney and brain. Furthermore, otholiths were taken together with all basic fish biological and sampling parameters. These samples from a number of red-blooded Notothenioids and several icefishes will allow the projected comparative analyses at the home institute.

Data management

All results of the current cruise will be published in publically available journals. The molecular data will be submitted to the respective data base (NCBI; EMBL), all other data will be stored at Pangaea.

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6. REPRODUCTIVE FEATURES OF ANTARCTIC SILVERFISH *PLEURAGRAMMA ANTARCTICUM* IN THE ATLANTIC SECTOR OF SOUTHERN OCEAN

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Objectives

The Antarctic silverfish *Pleuragramma antarcticum*, is the dominant pelagic fish inhabiting both ice-free and pack ice waters over the Antarctic continental shelf. Despite its abundance and key role as a major item in the food web, knowledge about its reproductive biology is still lacking. Recently the first spawning sites have been identified in Terra Nova Bay (western Ross Sea) where large amounts of fertilized eggs were found entangled in the platelet ice. This discovery indicates a life history linked to sea ice, with relevant biological and ecological implications. The reproductive features of *P. antarcticum* are presently part of extensive research carried out in the East Antarctic sectors, in collaboration among Italy, New Zealand and France, according to the experience accumulated over the past 15 years by the respective scientific teams.

The present project aims the enlargement of information on the life cycle of the Antarctic silverfish *P. antarcticum,* trough the analysis of the reproductive condition of adult fish samples collected in other Antarctic sectors. The *Polarstern* cruise ANT-XXVIII/4 carried out between March and April 2012 in the Atlantic Antarctic Sector provided a very important opportunity to get adults of this key fish species in order to perform such analyses.

The general objective of my contribution to the *Polarstern* cruise is to fill a gap in present knowledge of the life-cycle of Antarctic silverfish (*Pleuragramma antarcticum*), by clarify the reproductive features of this key fish species of the Antarctic coastal ecosystem.

Specific objectives are:

- To investigate the timing of the spawning events in P. antarcticum in the coastal region of Antarctic Atlantic sector;
- To characterize sexual dimorphism and reproductive features in adult specimens of *P. antarcticum* in the Antarctic Atlantic sector.

Work at sea

Pleuragramma antarcticum was only sporadically found in the catches of trawl operations performed at the Elephant and South Shetland areas. A more consistent number of specimens of the species was caught at Joinville Island in the fishing activities deployed between 350 and 450 m of depth. 120 *Pleuragramma* specimens were selected from the trawl catches in order to collect morphological and biological data of each individual. At the wet lab of the ship most of the sampled fish were measured, weighed and dissected in order to obtain the following information: total and standard lengths (TL and SL); total and eviscerated weights (TW and EW); sex and macroscopic maturity stage (S and M); gonadic weight (GW); liver weight (LW); stomach weight, stomach content composition, weight, filling degree, degree of digestion (SW, SCC, SCW, SFD, SDD). Moreover from each individual, samples of the gonad, liver, brain and muscle were extracted and fixed in 4% formalin, 70% ethanol, RNA-Later and *sagittae* otoliths were taken. Finally each *Pleuragramma* specimen were labelled and frozen (each specimen wrapped in aluminium or plastic foils) at -20° C as soon as possible. On these specimens an accurate morpho-meristic analysis will be performed in the laboratories of National Antarctic Museum of Genoa University.

Preliminary (expected) results

P. antarcticum samples were comprised of sub-adults and adults with individual lengths ranging between 9.5 and 21.5 cm SL with a sex-ratio (males/females) of 1:0.70. Six individuals were sexually undetermined. From the point of view of reproductive state, fishes up to 17-cm SL were all immature with very small and thin gonads, not detectable to the naked eye.

Females more than 17-cm SL were composed by 70% of individuals in early phase of maturation with ovary extended in a large part of body cavity, small oocytes clearly visible to the naked eye and GSI (gonadosomatic index=GW/EW*100) ranging from 0.8 to 5.7. Males more than 17-cm SL appeared more advanced in term of reproductive conditions with almost 40% of specimens having fully developed testis, filling most of the visceral cavity with a GSI between 5.1 and 12.6.

The histological characterization of the gonads at different macroscopic developmental stages will be performed in the laboratories of the Genoa University.

Data management

All data will be made available by publication in scientific journals.

7. POPULATION GENETICS AND PHYLOGENETICS OF NOTOTHENIOID FISH IN THE AREA OF ELEPHANT ISLAND – SOUTH SHETLAND ISLANDS AND THE ANTARCTIC PENINSULA: LONG-TERM FOLLOW UP AND SAMPLING FOR GENE EXPRESSION PROFILING

Chiara Papetti, Lorenzo Zane (not on board)	University of Padova

Objectives

Ongoing projects on Antarctic fish at the University of Padua (Italy) include studies of the molecular phylogeny of notothenioids and population genetics of *Chionodraco rastrospinosus*, *Chaneocephalus aceratus* and *Pleuragramma antarcticum*. Previous samples of these three species were analysed in published and under revision studies and belong to the Elephant Island - South Shetland Islands – Antarctic Peninsula area (CCAMLR Subarea 48.1). These samples were collected both during two surveys conducted by *Polarstern* in 2001/2002 (ANT-XIX/3) and 2006/07 (ANT-XXIII/8) and also provided by other scientists in the framework of new collaborations.

A long-term genetic monitoring of these species in the West Antarctic Peninsula will allow verifying stability of differentiation pattern. Patterns of water circulation at small spatio-temporal scales may be modified by global warming leading to a strong impact of inter-annual variability in the recruitment and growth of both pelagic and benthic organisms. Moreover the application of new approaches in conservation genomics including functional genomics, transcriptomics and gene expression methodologies, may give a major boost to the understanding of the evolution and population genetic structuring of Antarctic marine organism, especially in response to global climate change.

The ANT-XXVIII/4 cruise has provided a unique opportunity to expand the population sample collection and will enable us to extend genetic analysis of populations of further Antarctic species.

Work at sea

The work at sea targeted the expansion of our temporal sampling series of frozen and ethanol preserved muscle/fin tissues of notothenioid fish for population genetics analyses.

Samples were obtained from opportunistic sampling of fish tissues, made available by means of fishing efforts operated by other researchers. The working plan targeted the collection of adult and juvenile specimens, together with their total length, wet weight, sex, gonad index/maturity state information, and otoliths. In particular, as during the ANT-XIX/3 and ANT-XXIII/8 cruises, a unique individual identifier was assigned to a sub-sample of the fish collected, thus allowing to record ancillary information such as sex, length, maturity stage, and age of each fish for further use in following genetic analyses. This information was recorded with the permission of scientific groups focused in collecting these data and in collaboration with Emilio Riginella (University of Padova and IRPEM-CNR, Ancona, Italy; see chapter 8, this volume) who will provide the data related to otolith collection and sex determination. Few single specimen of different sex and species were digitally recorded in collaboration with E. Riginella. Muscle tissue for DNA extraction was dissected from each individual and preserved in ethanol (99% v/v). Additional organs (spleen, blood, brain, liver and heart) for RNA extraction have been sampled from fresh individuals under clean conditions, and stored in 2 ml RNA later (RNAlater™ Ambion at -80°C).

Preliminary (expected) results

Tissue samples for DNA extraction were collected from more than 660 individual fish during ANT-XXVIII/4. For all of them, information on individual length, weight, sex and gonad size and maturity were recorded. One to ten grams of caudal muscle tissue were collected from each individual. Each muscle sampled was stored in 99% ethanol (at -20°C). Additional samples were collected thanks to the joint sampling effort of Malte Damerau (Institute of Fisheries Ecology, vTI, Hamburg, Germany), Tina Sandersfeld, Nils Koschnick and Magnus Lucassen (Alfred Wegener Institute, Bremerhaven, Germany). This combined effort allowed to increase the reciprocal sampling size to more than 1300 individuals.

Nine abundant species yielded particularly useful large sets of test specimen, namely: *C. aceratus* (177), *C. rastrospinosus* (94), *Cryodraco antarcticus* (61), *Champsocepalus gunnari* (66), *Notothenia rossii* (35), *Notothenia coriiceps* (20), *Lepidonotothen squamifrons* (50), *Gobionotothen gibberifrons* (46) and *Ophthalmolycus amberensis* (Zoarcidae, 41).

These species were collected in three areas covered by sampling activity (Elephant Island, King George Island and Joinville Island), This tissue collection will complement samples already stored at Padua University and collected in the same area in 1996 (*Polarstern* cruise ANT-XIV/2), 1997 (*James Clark Ross* cruise JCR26), 2002, 2006 and 2011 (*Polarstern* cruises ANT-XIX/3, ANT-XXIII/8 and ANT-XXVII/3). *C. aceratus, N. rossii, N. coriiceps* and *C. rastrospinosus* were collected in high numbers near Elephant Island, and in reasonable numbers near King George Island. The availability of different size classes, and the possibility of working on the same individuals aged by E. Riginella (University of Padova and ISMAR-CNR, Ancona, Italy; see Chapter 8; this volume) may enable genetic analysis of different cohorts and sex. A small sample was obtained for the pelagic species *P. antarcticum* (about 30 individuals from Joinville Island). However, this sample will prove useful for the ongoing study on this species.

Finally, few individuals of *Euphausia* spec. were collected as by-catch in collaboration with Nerida Wilson (Australian Museum, Sydney, Australia), and will be very useful for new studies at Padova University. All the remaining experimental protocols, such as DNA extraction and genetic analysis will be carried out once back in the home laboratory.

Data management

All data collected during this cruise will be provided upon request. All population samples will be stored at the Biology Department of Padova University and may also be available to scientists from other institutions. All data resulting from the analysis of the population samples collected during this cruise will become available through publications or reports in international scientific journals.

8. POPULATIONS STRUCTURE OF *CHAENOCEPHALUS ACERATUS* (CHANNICHTHYIDAE, TELEOSTEA) ACROSS THE SOUTHERN SCOTIA ARC BY MEANS OF LIFE HISTORY PARAMETERS LINKED TO GROWTH AND REPRODUCTION

Emilio Riginella[1,2]; Carlotta Mazzoldi[1] and Mario La Mesa[2] (not on board)

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[2]ISMAR-CNR

Objectives

The Southern Scotia Arc has been one of the most harvested areas until ’90, when commercial finfish exploitation was banned by CCAMLR. One of the most important target species was the Scotia Sea icefish, *Chaenocephalus aceratus*, which is distributed along the Southern Scotia Arc, including the tip of the Antarctic Peninsula. The present research aims to study the population structure of *C. aceratus* in its distribution areal by means of life history parameters linked to growth and reproduction, in order to provide useful advices to CCAMLR for a better management of finfish resources.

The management of Antarctic fish species harvesting by CCAMLR is generally based on presumed stock units, considering as discrete populations of the same species, when inhabiting the shelves of islands separated by deep waters, as in the case of *C. aceratus*. Deep waters separating the shelves of the Scotia Arc Islands, indeed, may act as spatial boundaries for this species, suggesting the existence of discrete populations possibly isolated. Consequently, this prompts to a specific management as separated stocks. In the present research we aim to study life history traits such as reproduction, spawning and maturity, as well as age and growth frequently used as a basis for the characterisation of fish stocks.

Teleost fishes show a large variability in reproductive apparatus and gametes. Variation in morphology of male reproductive apparatus and investment in sperm can be related to reproductive modalities. Besides, females display wide inter-specific variability in fecundity and egg size. For what is known about their reproductive strategies, Antarctic fishes, in particular notothenioids (Kock and Kellermann, 1991) have a high reproductive investment, documented by high gonadosomatic indices, large egg sizes and, in some cases, long lasting male parental care (Detrich et al. 2005). The present research aims to collect samples that enable the comparative study of male and female reproductive apparatus and investment in gametes. This will be particularly interesting from an evolutionary biology point of view, given the adaptations shown by Antarctic fishes to their peculiar environment, and for their conservation, since the knowledge of reproductive characteristics of exploited species is recognized to be crucial for their management.

During the *Polarstern* ANT-XXVII/3 expedition, gonad and otolith samples of four species were collected, such as *Notothenia rossii*, *Lepidonotothen squamifrons*, *Gobionotothen gibberifrons*, *Patagonotothen guntheri*. During this cruise, sampling was aimed to expand the sample collection to other available species, in order to perform a wider comparative analysis of reproductive traits of Antarctic fishes in terms of structure, function, gametogenesis and egg size, as well as of life history traits, such as age and size at sexual maturity.

Work at sea

For each specimen, a set of standard measurements and biological parameters (total length, total weight, gonad weight, sex and stage of maturity) were recorded and entered in a database. After dissection, both sagittal otoliths were collected and stored dry in vials. Gonad samples of males and females of different species were removed and fixed in Dietrich solution, for histological analyses, or Formaldehyde 7% (in sea water solution), for fecundity estimation.

Each sample was labelled with species name, date and site of collection, sex and size, and stored at room temperature. Individuals of different size were collected in order to allow the estimation of size/age at sexual maturity for a larger number of samples. This work was performed in collaboration with Chiara Papetti (University of Padova, see chapter 7, this volume) who will provide the data related to notothenioid fish population genetics of samples collected during this cruise. Further analyses will be carried out in the laboratories in Italy, at the University of Padova (reproductive biology) and at the Institute of Marine Science of Ancona (age and growth), respectively.

Preliminary results

Overall, 866 specimens were collected from 11 notothenioid species. Different species were selected for this study (sample size in brackets): *C. aceratus* (224), *Chionodraco rastrospinosus* (112), *N. rossii* (71), *N. coriiceps* (44), *Lepidonotothen larseni* (67), *Cryodraco antarcticus* (66), *Champsocephalus gunnari* (103), *G. gibberifrons* (59), *L. squamifrons* (60), *Ophthalmolycus amberensis* (42) and *L. nudifrons* (16). Few specimens of other species have been sampled for future exchange with international scientific institutions. For all species, otolith and gonad samples were obtained from the whole size range of fish collected. The size range of each species, measured as total length, was as follows: *C. aceratus* (14.5 - 68 cm), *C. rastrospinosus* (7 - 49 cm), *N. rossii* (6.5 - 68 cm), *N. coriiceps* (26.5 - 54 cm), *.L larseni* (11 - 22 cm), *C. antarcticus* (20 - 65 cm), *C. gunnari* (7 - 49 cm), *G. gibberifrons* (15 - 50 cm), *L. squamifrons* (12.5 - 50 cm), *O. amberensis* (19 - 35 cm) and *L. nudifrons* (7 - 18 cm).

Moreover, digitally recorded images of gonad and otolith samples together with the whole specimen, taken during the sampling activity, will be used for additional comparative analysis.

Finally, a portion of anal fin of few male and female specimens (mature and immature) of *C. aceratus*, *C. rastrospinosus*, *C. antarcticus* and *C. gunnari* were collected and stored in Dietrich solution for histological analyses.

Data management

All data collected during this cruise will be provided upon request. All samples will be stored at the Hydrobiological Station "Umberto D'Ancona" of Chioggia (Venice, Italy), belonging to the Biology Department of Padova University. All data resulting from samples analyses collected during this cruise will become available through publications or reports in scientific journals.

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9. GENETIC POPULATION STRUCTURES OF NOTOTHENIOIDS ALONG THE SCOTIA ARC

Malte Damerau[1], Marco Colombo[2]
Reinhold Hanel[1] (not on board),
Walter Salzburger[2] (not on board)

[1]vTI
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Objectives

Since the cooling of the Southern Ocean approximately 20 million years ago, a unique ichthyofauna evolved on the shelves of the Antarctic continent and adjacent islands showing low species diversity and high levels of endemism. The majority of fish are bottom dwelling and belong to the suborder Notothenioidei (Perciformes). Their larvae usually develop pelagically over an extended period of several months. During this time, larvae may be dispersed over large distances by strong current systems, including the Antarctic Circumpolar Current that surrounds Antarctica. Indeed, high genetic homogeneity and low differentiation among populations is often found even for species with circum-Antarctic distributions, highlighting the role of prolonged larval phases for gene flow. On the other hand, larvae are often found to be retained in neritic waters by local gyres. Also, oceanic fronts and strong currents may act as barriers hindering gene flow by larval dispersal or migration.

In our study, we want to compare the genetic population structures along the Scotia Arc region of selected notothenioid species with differing life-history strategies and larval durations to elucidate the role of prolonged larval phases and prevailing current systems in population structuring and, moreover, the influence of ecology and gene flow on the ongoing adaptive radiation of notothenioids in the Southern Ocean. The studies will be carried out based on nuclear microsatellite markers and mitochondrial DNA sequences.

In another project, we take a broader approach and want to use our collected data of notothenioids to identify the patterns and processes that underlie diversification. In this SYNERGIA project, a collaboration of Walter Salzburger with Marcelo Sanchez of the Palaeontological Institute of the University of Zurich and Heinz Furrer from the Department of Earth Sciences at ETH Zurich, we will take a novel approach to compare evolutionary radiations in fossil and living fishes using up-to-date technology. Concretely, we will compare radiations of the extinct Saurichthys group and of the extant African cichlids, sticklebacks from temperate waters as well as Antarctic notothenioids. We will use cladistic analyses based on morphological characters in Saurichthys and molecular data in the case of extant taxa to provide a phylogenetic framework. We will then conduct comparative analyses between the radiations of the respective fish groups using a set of methods such as stable isotope-, stomach content- and demographic analyses as well as morphometric and anatomical comparisons.

Work at sea

In the area of the Antarctic Peninsula and South Shetland Islands, demersal notothenioid fish was collected by bottom trawl. After each haul, species were identified based on the identification key of Gon & Heemstra (1990). For population genetic and phylogenetic analyses, muscle tissue was collected from every species and stored in ethanol. A special focus was on *Chaenocephalus aceratus* and *Champsocephalus gunnari*, that showed some degree of genetic differentiation in previous studies (Papetti et al. 2009, Damerau et al. 2012). Additionally, biological data, as e.g. total length and sex, was recorded. The combined data will allow us to thoroughly analyse the spatial and temporal demographic influence on genetic population structuring in these species. Furthermore, photos suitable for morphometrical analyses in the SYNERGIA project were taken from a range of species (see Table 9.1 under preliminary results).

Preliminary (expected) results

During ANT-XXVIII/4 we collected, in close collaboration with Chiara Papetti and Emilio Riginella from University of Padova (Italy) as well as Nils Koschnick and Tina Sandersfeld from Alfred-Wegener-Institute in Bremerhaven (Germany), 1503 DNA samples from 36 notothenioid species. The most speciose group were the nototheniids (15), followed by channichthyids (9), artedidraconids (6), bathydraconids (5) and harpagiferids (1). From 15 species, we were able to sample tissue from a sufficient number of individuals (≥40) for population genetic analyses belonging to the area of South Shetland Islands and Antarctic Peninsula. These samples can be used to compare the population(s) of this area to those from other islands along the Scotia Arc. By far the most samples were collected from *C. aceratus* (241) and *C. gunnari* (198), allowing us a detailed examination of the genetic population structure in the study area. For phylogenetic analyses, four new species can now be added to our existing data set (*Harpagifer antarcticus, Chionobathyscus dewitti, Gerlachea australis, Pogonophryne marmorata*).

Tab. 9.1: List of species and number of individuals photographed for the use of morphometrical analyses

Species name	Number of individuals
Akarotaxis nudiceps	1
Artedidraco skottsbergi	5
Chaenocephalus aceratus	34
Chaenodraco wilsoni	30
Champsocephalus gunnari	30
Chionodraco rastrospinosus	31
Cryodraco antarcticus	32
Dissostichus mawsoni	24
Gobionotothen gibberifrons	31
Harpagifer antarcticus	4
Lepidonotothen larseni	30
Lepidonotothen nudifrons	33

Species name	Number of individuals
Lepidonotothen squamifrons	31
Neopagetopsis ionah	10
Notothenia coriiceps	30
Notothenia rossii	30
Parachaenichthys charcoti	1
Pleuragramma antarcticum	30
Pogonophryne marmorata	1
Pogonophryne scotti	1
Pseudochaenichthys georgianus	25
Trematomus bernacchii	7
Trematomus eulepidotus	30
Trematomus hansoni	8
Trematomus newnesi	9
Trematomus tokarevi	1

Data management

All genetic data derived from the collected samples will be made publicly available through NCBI's Genbank. All results will be made available by publication in scientific journals

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10. BIODIVERSITY AND EVOLUTION OF PARASITIC LIFE IN THE SOUTHERN OCEAN: RESPONSE TO ECOSYSTEM CHANGE

Sven Klimpel, Thomas Kuhn, Markus Wilhelm Busch, Sebastian Emde BiK-F

Objectives

Antarctica offers a unique natural laboratory for undertaking fundamental research on the relationship between the climate, evolutionary processes and species adaptation to extreme environmental conditions. Krill, cephalopods and Antarctic fish species are considered the key species of the marine food web in the Southern Ocean. Being a species rich but often well hidden component of the Antarctic fauna, fish parasites have been studied with a focus on single parasite species or taxa. Parasites are a driving force in the process of evolution and are an integral part of every ecosystem. Parallel to the abiotic environment, and, among other biotic factors, they generate a pressure for selection and adaptation to their hosts. Molecular techniques have been applied to utilize parasites as ”biological tags” to characterize the trophic position in the food web (ecosystem) and population structure of their hosts.

The evaluation of their genetic variability might provide important information about the population biology and behavior of their intermediate and final hosts. Occurrence studies of anisakid nematodes of the genera *Anisakis* for example have been proven useful for fish stock separation and the assessment of distribution patterns of their respective final hosts (e.g. Klimpel et al. 2010, Kuhn et al. 2011). The results support preceding studies that propose anisakid nematodes as useful biological indicators for their final host distribution and abundance as they closely follow the trophic relationships among their successive hosts. Furthermore, Klimpel et al. (2011) identified for the first time *A. paggiae* in the Irminger Sea and indicated a more extended migration towards northern latitudes than could have been inferred from the distribution range of kogiid whales reported so far.

The combination of parasitological, genetical and feeding ecological studies reveals information on the life cycle biology and transmission strategies (trophic interactions) of fish, bird and mammal parasites along the Antarctic Peninsula and contributes to the assessment of relationship between their host populations. The development of the fish parasite diversity within the region might have happened either in close co-evolution with the notothenioid fish or is a consequence of regularly occurring parasite invasions of formerly more northern species into the Antarctic. The results can be directly compared with two earlier studies during the Antarctic summer 1996/97 (ANT-XIV/2) and 2006/07 (ANT-XXIII/8), especially considering the fact that the Antarctic Peninsula is one of the three areas of the globe that are currently experienced rapid regional climate change.

Work at sea

Full details of the field sampling are provided by other participants (i.e. Kock et al., chapter 3 this volume). Antarctic fish species were collected during the ANT-XXVIII/4 research cruise of *Polarstern* off Elephant Island, the South Shetland Islands and Joinville Island.

All specimens were taken as a subsample from the catch, identified to the lowest taxon possible, and measured (total length and total weight). Different fish species, 17 specimens from 5 families, were deep-frozen for later studies in our laboratories in Frankfurt/Main (table 10.1). Some fish species had been directly investigated on board for stomach content analyses and metazoan parasites.

The presence of metazoan parasites was studied using a stereomicroscope. Special attention was given to the occurrence of anisakid nematodes, such as *Contracaecum osculatum*, *C. radiatum* and *Pseudoterranova decipiens*. The isolated parasites were preserved in 70% and 100% ethanol (abs.).

A total of 464 anisakid nematodes from 13 fish species were preserved for subsequent molecular genetic studies. 851 tissue samples from 34 fish species were collected and preserved in absolute ethanol for population genetics. In addition fish, euphausiids or other crustaceans were deep-frozen for further examinations at our laboratories in Frankfurt/Main.

Tab. 10.1: Sampled fish species with fishing stations and numbers of collected specimens (n).

Fish Family	Fish species	Station-No.	n
Bathydraconidae	*Gerlachea australis*		5
	Gymnodraco acuticeps		9
	Parachaenichthys charcoti	188, 195, 202-204, 220, 222, 229, 230 234, 248, 253, 258-260, 282, 283, 286	47
	Parachaenichthys georgianus	204, 209, 227, 253, 257, 259, 265, 266	14
	Racovitzia glacialis	188, 275	6
Channichthyidae	*Chaenocephalus aceratus*		49
	Chaenodraco wilsoni		32
	Champsocephalus gunnari		41
	Neopagetopsis ionah	242, 265	3
	Pagetopsis macropterus	269	4
Nototheniidae	*Lepidonothen larseni*	188	40
	Lepidonothen nudifrons	190	40
	Lepidonotothen squamifrons	188, 206	49
	Trematomus eulepidotus	226, 228, 234, 236-238	39
	Trematomus hansoni	219, 264, 278, 285, 286, 288	7
	Trematomus newnesi	196, 247, 269	9
Macrouridae	*Macrourus whitsoni*	275	36
Myctophidae	*Gymnoscopelus nicholsi*	194, 206, 209, 235, 247	474

Preliminary (expected) results

The expedition ANT-XXVIII/4 continued our research activities on the Antarctic ichthyoparasite fauna and diversity at the top of the Antarctic Peninsula. In combination with previous research cruises (e.g. ANT-XIV/2, ANT-XXIII/8) the new results can be combined with data since 1992. The parasitological and stomach content examinations of the deep-frozen fish species will enable us to compare data from nearly three decades. As a preliminary result, most fishes are parasitized with hirudineans (leeches) on the skin and mouth cavity and monogeneans (trematodes) and copepods (crustaceans) on the gills. The organs of the body cavity of various fish species (e.g. *Chaenocephalus aceratus*, *Lepidonotothen larseni*, *L. squamifrons, Trematomus eulepidotus, Dissostichus mawsoni)* are also heavily infested with larval stages of different anisakid nematode species (Fig. 10.1).

Fig. 10.1: Dissected body cavity of Chaenocephalus aceratus *with larval anisakid nematodes parasitizing different inner organs.*

The identification of these larval stages of the genera *Anisakis, Contracaecum* and *Pseudoterranova* on morphology is neither easy nor possible. Molecular analyses have demonstrated that they hide complexes of "cryptic-/sibling species" with different ecology and host preferences that can only be distinguished using highly variable genetic markers. The nematodes specimens that were sampled on this cruise will be identified to (sibling-) species level by means of these modern methods and forwarded to several further examinations such as phylogenetics, population genetics, distribution modeling and morphological as well as histological comparison.

One preliminary result is the potential identification of two *Anisakis* species (*Anisakis pegreffii*, *A. simplex C*) in the myctophid fish species *Gymnoscopelus nicholsi,* which could extend the already known distribution of these two species.

The species range of *A. pegreffii* extends from Mediterranean waters through the East Atlantic Ocean down to the Antarctic Peninsula, with additional records in Japanese and Chinese waters. *A. simplex* C has a discontinuous range; along the Canadian/US east coast, at the southern tip of Africa, and between New Zealand and Australia. Occurrence has also been proven between South American and Antarctic waters (see Fig. 10.2). These two parasite species include oceanic delphinids as final hosts in their life cycle, which are known to form large populations in the

Atlantic Ocean and are missing in the Southern Ocean (Antarctica) (Klimpel et al. 2010, Kuhn et al. 2011).

The assessed presence data will be combined with those obtained in former studies and transferred on a grid with a resolution of 1° x 1° covering the globe, using a non-commercial geographical information system (QGIS). Based on the centroids of the quadrats, the α-hull will be calculated for 25 different values ranging from 2 to 50 in a two-step interval using the alpha-hull package (Pateiro-Lopez & Rodriguez-Casal, 2010). The final distribution of both *Anisakis* species will be visualized in a range map with a continuous colour gradient, in which the intensity of the red colour increases with the probability of species occurrence in a certain area (Fig. 10.2). We expect a southwards extended distribution of the two mentioned nematode parasite species.

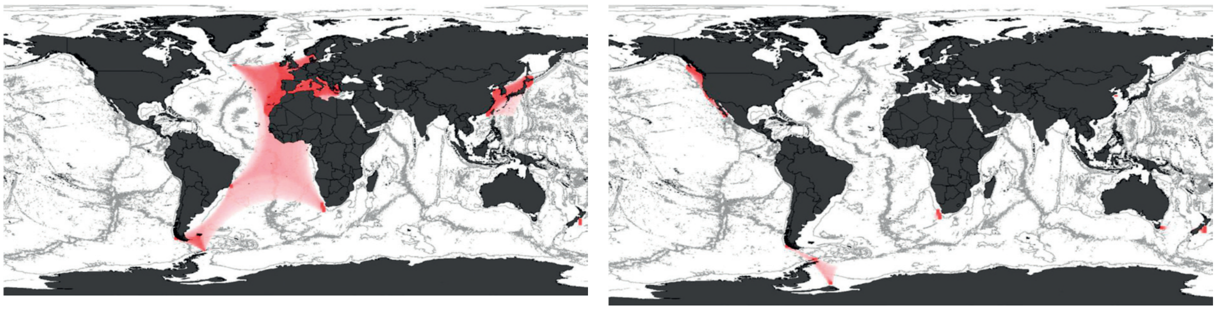

Fig. 10.2: Modeled species range of both Anisakis species. Colour intensity reflects probability of Anisakis occurrence. left: Anisakis pegreffii*, right:* A. simplex C*.*

Data management

The obtained gene sequences of the analysed anisakid nematode sibling species will be deposited in Genbank. All results will be made available by publication in scientific journals.

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11. DETECTION OF VULNERABLE MARINE ECOSYSTEMS (VMES) IN THE AREA OF ELEPHANT ISLAND – SOUTH SHETLAND ISLANDS

Susanne Lockhart[1], Nerida Wilson[2], Eric Lazo-Wasem[3]

[1]NOAA's US AMLR Program
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Objectives

Protection of Vulnerable Marine Ecosystems (VMEs) is an important component within the management framework of bottom fisheries in high seas areas of the world's oceans. The Commission for the Conservation of Marine Living Resources (CCAMLR) has adopted Conservation measures aimed at minimizing adverse impacts on VMEs in the Southern Ocean. These include measures which require a notification to be completed when evidence of VMEs are encountered during the course of fishery-independent research activities, such as a demersal finfish bottom trawl survey.

CCAMLR has interpreted a VME to be consistent with an area that includes the presence of benthic invertebrate taxa that significantly contribute to the creation of complex three-dimensional structure, cluster in high densities, change the structure of the substratum, provide substrata for other organisms, or populated by rare or unique benthic taxa. There are currently 27 taxonomic groups recognized by CCAMLR as VME indicator taxa. CCAMLR requires that the presence of these taxa be monitored on research cruises, and presence of a certain density of VME indicator taxa in an area can lead to the designation of a VME, and inclusion into the CCAMLR VME registry.

Information collected during previous expeditions along the Antarctic Peninsula and the South Orkney Islands in 2006 and 2009 respectively has led to the registrations of 30 VMEs in these areas. However, this analysis has not been completed for the South Shetland Islands region of Subarea 48.1.

The main purpose of the study was to examine the benthic invertebrate VME indicator taxa taken during the course of the demersal finfish survey of the South Shetlands Islands (Dr. Karl-Hermann Kock; Project Leader) as part of *Polarstern* ANT-XXVIII/4. The by-catch was analyzed to determine composition, density, and patterns of benthic communities around the South Shetland Islands. If there is sufficient evidence of the presence of a VME, this information will be used as justification toward submission of VME notifications to CCAMLR, which could potentially be included into the CCAMLR VME registry. This better allows CCAMLR the ability to manage and minimize risk to VMEs, in both present and potential future fisheries, in the Convention area.

Our project is part of the international effort of CCAMLR members to detect the presence of Vulnerable Marine Ecosystems in the Southern Ocean, and is embedded in CCAMLR's ecosystem approach to managing Antarctic resources.

Work at sea

There has been no need for additional gear-deployment requirements beyond that which will be used for the demersal finfish bottom trawl survey (Chapter 3, this volume).

Upon the arrival of a trawl's haul onboard, members of both the fish and invertebrate teams worked to sort the former from the latter. The latter was then subjected to further sorting for composition analyses. Large hauls of invertebrate catch required subsampling. This happened for 16 of the 66 successful hauls.

The composition of each sample was analysed by sorting invertebrates into approx. 68 feasible taxonomic groupings or operational taxonomic units (OTUs) that incorporate the VME indicator taxa adopted by CCAMLR. Masses of each OTU were recorded and individuals counted where appropriate. Any dead or unsortable organic matter was also weighed, and for the latter, characterized (e.g. 60% demosponge, 30% irregular echinoid fragments, 10% organic matter).

Live specimens of each OTU, and of common species or species of particular interest, were photographed for potential inclusion in general Antarctic, or specific VME, invertebrate field guides, or for use in institutional or international photographic databases.

In addition, samples of such specimens/species were collected and preserved (for the most part in 95% EtOH) for potential inclusion in molecular phylogenetic or phylogeographic studies, and also for deposition at a number of museums world-wide.

Preliminary (expected) results

Over the course of the expedition, 4.25 metric tons of benthic invertebrates were brought aboard (66 hauls). Of this, 1.68 metric tons (64 hauls, 16 subsampled) were subjected to a fine-scale analysis (sorted into 68 OTUs). Detailed analyses of the data are still required. Using the area swept by the trawl the biomass of VME indicator taxa at each station will be standardized to 1200 m^2 and any stations that are calculated to have ≥10 kg will trigger the conditions required for designation as a VME.

Initial indications suggest that a number of VMEs were likely encountered, particularly on the shelf region south of Elephant Island. An excellent example is station 190 where the benthic invertebrate catch weighed 1.89 metric tons, approximately 45% of the total benthic invertebrate catch for the whole expedition. However, although further analysis of the data are required, preliminary indications suggest that there is substantially less density and biomass of VME indicator taxa along the shelf areas of the South Shetland Islands relative to the northern Antarctic Peninsula and the South Orkney Islands as revealed by past expeditions.

Data management

A Notification of Encounter with a VME will be submitted under CCAMLR Conservation Measure 22-06 for each station that meets or exceeds the threshold of ≥10 kg (≥10 VME units). The notification will include general information, locations, supporting evidence, rationale, analyses and justification for each proposed VME. Notifications will be submitted for consideration by CCAMLR's Ecosystem Monitoring and Management working group (WG-EMM). All data will reside with NOAA's US AMLR Program and will be available upon request.

12. CEPHALOPOD ABUNDANCE AND TROPHIC ECOLOGY OFF THE ANTARCTIC PENINSULA

Christoph Noever[1], [1]University of Bergen
Uwe Piatkowski[2] (not on board) [2]IFM-GEOMAR

Objectives

Cephalopods play an important role in the Antarctic ecosystem. However, our understanding of basic biological parameters of this group is only fragmentary for Antarctic waters.

In the last years, twelve new octopod species have been described from the surrounding of the Antarctic Peninsula, and it was documented that the cephalopod community in this area is much more diverse and richer in numbers than was previously suspected. Those studies were largely based on cephalopod collections of former *Polarstern* cruises. Cephalopods sometimes occur in large numbers and together with teleosts, the mobile demersal and benthopelagic fauna. Undoubtedly, they form a major faunal group in the Southern Ocean ecosystem.

Work at sea

During the cruise all cephalopods were taken by bottom trawl. The overall goal was to expand our understanding of the diversity, life cycles, distribution and abundance of the various cephalopod species. Freshly caught specimens were photographed to document the subtle morphological characters, such as skin texture and coloration. All cephalopods were sorted from the catches, identified, measured, and sex and maturity stages were recorded. Another major focus was the investigation of stomach contents of cephalopods to identify their prey and to relate this to the various species of other faunal groups that were caught. For further diet analysis tissue samples were taken to analyse stable isotopes, which will provide information on the cephalopods long-term diet and an estimation of their trophic position. Further tissue samples were taken for molecular studies.

Specimens that could not be fully processed on board were frozen for further investigation at the IFM-GEOMAR in Kiel.

Preliminary results

Cephalopods occurred at all stations, partly with high abundances. Over 3000 octopod specimens and 3 squids were caught during the expedition, which by now is the largest collection of Antarctic cephalopods studied. Octopods were a quite diverse group in the catches, with 17 different species found during the cruise. This high diversity is mainly due to the genus *Pareledone,* which has undergone an endemic radiation in Antarctic waters. Other frequent species were *Adelieledone polymorpha*, *Megaleledone setebos* and *Benthoctopus* sp. Concentations of Cephalopods were highest around Elephant Island, with up to 337 specimens per trawl.

Investigation of the stomach contents showed high occurrences of crustaceans and brittle stars as prey items.

Data management

All data resulting from the analysis of the samples collected will become available through publications or reports in international scientific journals. Samples from the cruise stored at the IFM-GEOMAR may become available to other scientists on request.

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13. COMPOSITION AND ACTIVITY OF THE BACTERIOPLANKTON COMMUNITIES IN THE DRAKE PASSAGE AND ANTARCTIC PENINSULA REGION WITH A SPECIAL EMPHASIS ON THE *ROSEOBACTER* CLADE AND DISSOLVED ORGANIC MATTER

Meinhard Simon[1], Sara Billerbeck[1], Thorsten Brinkhoff[1], Marco Dogs[1], Swaantje Müllenmeister[1], Maren Seibt[1], Michael Seidel[1], Maike Smits[3], Irene Wagner-Döbler[2], Hui Wang[2], Bernd Wemheuer[3], Mascha Wurst1

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[3]University of Göttingen

Objectives

We aim at a comprehensive assessment of the bacterioplankton community in the Drake Passage and the Peninsula region of the Southern Ocean with a special emphasis on the *Roseobacter* clade and its major bacterioplankton subclusters. This project is part of a key work package of the Transregional Collaborative Research Center *Ecology, Physiology and Molecular Biology of the Roseobacter clade*: Towards a Systems Biology Understanding of a Globally Important Clade of Marine Bacteria (TRR 51). The work includes investigations of the biogeography, growth and population dynamics, the genomic potential (metagenomics) and actively expressed genes (metatranscriptomics) and the impact on the decomposition of dissolved organic matter (DOM) and cycling by the bacterioplankton communities. Our investigations can only be done in a concerted action in which also the other members of the bacterioplankton communities are considered, as well as bulk parameters of the entire bacterioplankton communities and relevant biogeochemical parameters such as chlorophyll and the composition and concentration of DOM. Previous studies dealing with some of these aspects have been carried out in this region before (Manganelli et al. 2009, Straza et al. 2010). However, one particular group of marine bacteria and in particular the *Roseobacter* clade have not been investigated before in such great detail.

A list of investigated parameters is given in table 13.1.

Tab. 13.1: List of parameters studied for assessing bacterioplankton communities during cruise ANT-XXVIII/4.

Parameter	Water depths (m)								
	20	40	60	100	200	500	1000	2000	>3000
POC	+	+	+	+		+	+	+	+
Chlorophyll	+	+	+	+	+				
Phytoplankton	+	+	+	+					
Inorganic nutrients	+	+	+	+	+	+	+	+	+
Bacterial abundance	+	+	+	+	+	+	+	+	+
Bacterial production	+	+	+	+	+	+	+		
Glucose turnover rate	+	+	+	+	+	+	+		
Amino acid turnover rate	+	+	+	+	+				
FISH	+		+	+					
Aerobic anoxygenic bacteria	+	+	+	+	+				
DGGE	+	+	+	+	+	+	+	+	+
16S rRNA gene Pyrosequencing	+	+	+	+	+	+	+	+	+
Metagenomics	+		+						+
Metatranscriptomics	+	+	+	+	+	+	+	+	+
DOC	+	+	+	+	+	+	+	+	+
DOM	+	+	+	+	+	+	+	+	+
Vitamins	+	+	+	+	+	+	+	+	+

Work at sea

Our main work on shipboard was the collection and processing of water samples from depths between 20 and 3500 m. Samples were collected with Niskin bottles mounted on a CTD rosette from the mixed layer, the mesopelagic and bathypelagic zones (for details on the CTD see Badewien et al., chapter 18, this volume). Our sampling scheme included fixed depths between 20 and 200 m and at deep stations also at 500 and 1000 m. Below, sampling depths were identified according to the temperature and salinity profile. In total 16 stations were visited, five deep stations on the continental slope and in the Drake Passage and 11 stations on the continental shelf. For exact locations and further details see table 13.2 and Fig. 13.1.

Tab. 13.2: List of stations and depths investigated for studies of the bacterioplankton and dissolved organic matter during cruise ANT-XXVIII/4.

Station	Date	Ship time	Depth (m)	Sampled Depths (m)	
PS79/178	16.03.12	1:30	3994	20-200	
PS79/179	16.03.12	15:19	4210	20-200	500, 1000
PS79/193	18.03.12	22:10	2095	20-200	500, 1000, 2000
PS79/205	20.03.12	20:30	3540	20-200	500, 1000, 2000, 3500
PS79/217	22.03.12	20:30	1845	20-200	
PS79/232	24.03.12	20:30	331	20-200	

Station	Date	Ship time	Depth (m)	Sampled Depths (m)	
PS79/235	25.03.12	13:00	316	20-200	
PS79/241	26.03.12	13:30	1845	20-200	500, 1000, 1800
PS79/244	27.03.12	12:30	394	20-200	
PS79/247	28.03.12	10:30	316	20-200	
PS79/251	29.03.12	08:30	436	20-200	
PS79/262	30.03.12	20:30	4420	20-200	500, 1000, 2000
PS79/267	01.04.12	04:00	2190	20-200	
PS79/277	02.04.12	21:00	1484	20-200	
PS79/281	03.04.12	23:00	740	20-200	350, 600
PS79/287	04.04.12	22:00	3644	20-200	500, 1000, 2500, 3600

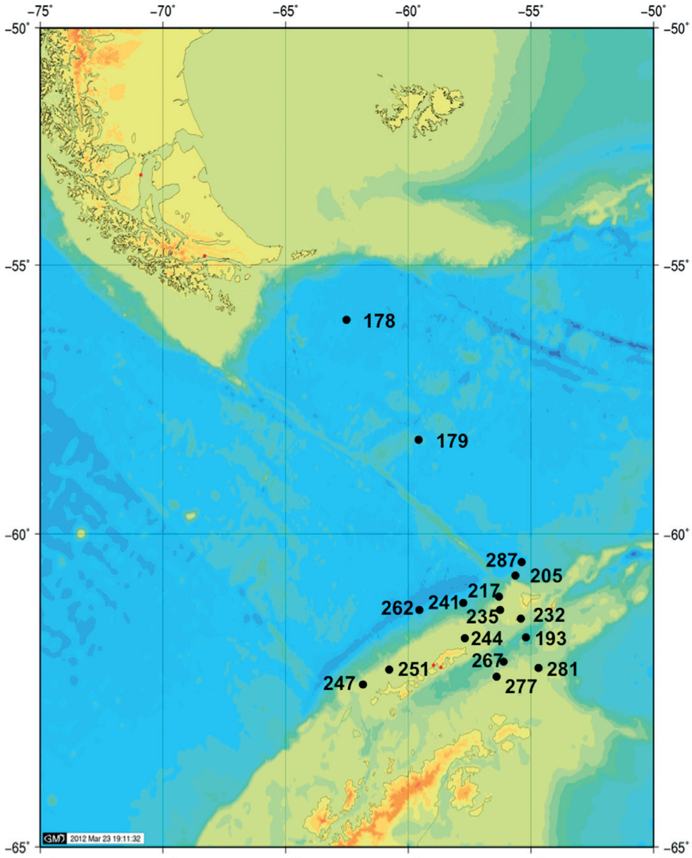

Fig. 13.1: Map with stations where samples for this study were collected during cruise ANT-XXVIII/4

In most cases, samples were filtered onto membrane filters of various type and size, frozen at -20 or -80 °C. Further processing will be done in the home laboratories. Samples for phytoplankton and nutrient analyses were fixed with Lugol's solution and HgCl, respectively, and will be analyzed further at home. Samples for the analyses of dissolved amino acids, carbohydrates, vitamins, DOC and DOM were prefiltered and frozen or acidified (DOC). Samples for bacterial abundance, production and turnover of dissolved free amino acids and glucose were analyzed on shipboard. Bacterial abundance was assessed by flow cytometry and bacterial production and substrate turnover by radiotracer techniques and applying 14C-leucine, 3H-leucine, -glucose and –amino acids. For details on the methods see Simon and Azam (1989) and Simon and Rosenstock (2007).

Preliminary results

The analysis of the water masses from the CTD and sigma-T data showed that we sampled quite different water masses (Badewien et al., chapter 18 this volume). The data on bacterial abundance, production and turnover rates of amino acids and glucose in most cases did not reflect these water masses, but rather differences between the stations on the continental shelf, the slope and Drake Passage. The more productive stations on the shelf exhibited consistently higher rates of bacterial biomass production and also shorter generation times of the bacterioplankton communities than those on the continental slope and the Drake Passage (Fig. 13.2 and 13.3). Whereas the values of bacterial biomass production on the continental slope and in the Drake Passage are similar to data from a previous study in this region (Manganelli et al. (2009) the values on the shelf are on average significantly higher than those of previous studies (Manganelli et al.2009, Straza et al. 2010). Bacterioplankton bulk generation times of as fast as 1 - 2 days in the mixed layer of this cold, but obviously very productive region were most remarkable. These findings are surprising, considering that the study was carried out in the late austral fall and at *in-situ* temperatures of 0 - 1 °C and including stations close to the ice edge. We might have encountered a particularly productive situation, reflected also by a surprisingly high abundance of fin wales and krill in this region (chapter 3, 16 this volume). Below 100 m, bacterial activity, as shown in the form of generation time, was much lower than above as a result of the much lower substrate supply below the mixed layer. The data on concentrations of chlorophyll, dissolved amino acids and carbohydrates and DOC will provide us with further details on the availability of substrates to the bacterioplankton.

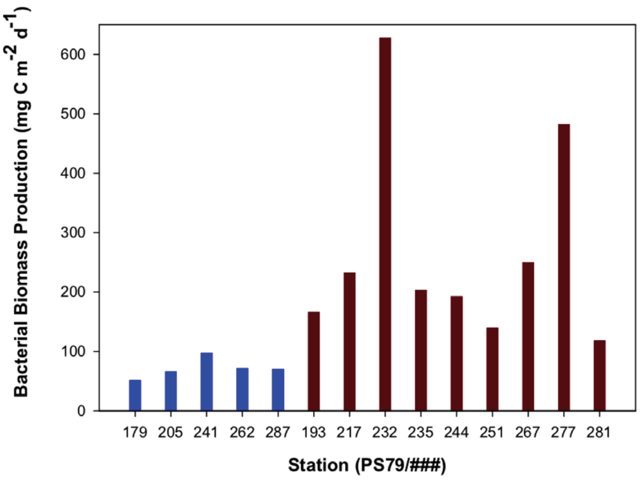

Fig. 13.2: Bacterial biomass production integrated from 0 to 200 m at all stations visited during cruise ANT-XXVIII/4. Stations on the continental slope and the Drake Passage (179-287) are shown on the left in blue and those on the continental shelf on the right in dark red (193-281).

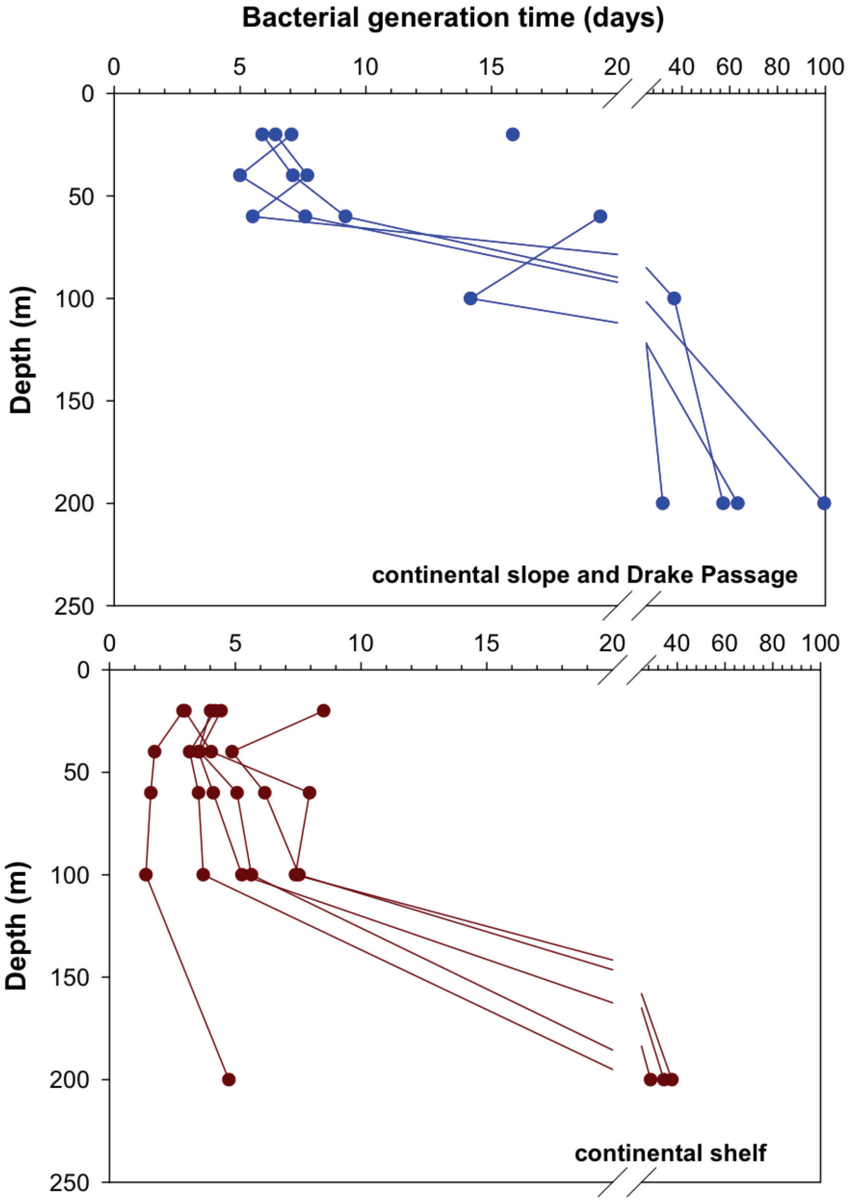

Fig. 13.3: Bacterioplankton bulk generation times of various profiles on the continental slope and the Drake Passage (upper panel) and on the continental shelf (lower panel) during cruise ANT-XXVIII/4.

The most interesting question is whether and how these differences will be reflected in the composition and metabolic activities of the bacterioplankton communities at these stations. Our analyses hopefully will shed light on this issue.

These results and those of all other parameters for which samples were collected, however, will become available only after processing of the samples in the home laboratories after several months to years.

Data management

All finally processed data will be stored on a server at ICBM and of TRR 51 and will be available on request if not otherwise mentioned. Data on the pyrosequencing and metagenomics and metatranscriptomics will be processed and stored on a server of the Göttingen Genomics lab at the University of Göttingen and at HZI. The final data of the metagenomics and metatranscriptomics and on sequenced genes will be made publicly available via GenBank and NCBI. Most of the data will be published in international peer-reviewed journals.

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14. THE METABOLIC POTENTIAL AND THE DISTRIBUTION OF THE *ROSEOBACTER* CLADE IN MARINE SEDIMENTS

Bert Engelen, Marco Dogs ICBM
not on board: Saranya Kanukollu, Heribert Cypionka

Objectives

The high abundance of *Roseobacter*-affiliated bacteria in the pelagial of high productive areas is often correlated to algal blooms and thus to elevated concentrations of dimethyl sulfonium propionate (DMSP). Sedimenting algal material, in turn, may lead to an enrichment of DMSP-consuming *Roseobacter* species at the sediment surface. Additionally, some of these *Roseobacter* species are probably involved in the oxidation of dimethyl sulfate (DMS) as inferred from previous investigations. A key gene for this process, the reverse dissimilatory sulfite reductase (r*dsr*), was found in a fosmid from marine sediments that also contained *Roseobacter* affiliated sequences. On the other hand, the detection of the DMSO-reductase gene in the genome of *Dinoroseobacter shibae* points towards the ability to grow under anoxic conditions by the respiration of dimethyl sulfonium oxide as electron acceptor.

These findings led to the following questions:

- Can sediment dwelling *Roseobacter* species switch between oxidative and reductive pathways of their sulfur metabolism?
- Are there regional distribution patterns and is there an overlap in diversity between sediments and the overlying waters?
- Which factors trigger the distribution, abundance and diversity of the *Roseobacter* clade in marine sediments?

Work at sea

To answer the above-mentioned questions, samples from surface-near sediment were taken by a multicorer (MUC) at different water depths on the shelf of the South Shetland Islands and especially around Elephant Island (Fig. 14.1). Corresponding water samples were taken directly from the bottom water of the coreliners and from the chlorophyll/turbidity maximum of nearby CTD stations (Fig. 14.1).

In total, 35 sediments layers (1 - 25 cm) and corresponding bottom waters from 7 stations (*PS79/192-1*, *211-2*, *212-1*, *224-3*, *255-1*, *256-1*, *271-1*) were subsampled for further analysis. The material derived from water depths of app. 250, 370, 500, 555, 1185, 1480 and 1600 meters below sea level (Table 1). The CTD samples were obtained from water depth of 20 – 180 mbsl at stations *PS79/193-1*, *211-1*, *226-2*, *254-2* and *270-1* (table 14.1). From all water and sediment samples, aliquots were processed for DNA-extraction, total cell counts and CARD-FISH analysis. Pore water was separately collected form the respective sediment layers for the analysis of DOC, amino acids and sulfate concentrations. Additionally, from each station, two sediment layers (1 and 10 cm) and two water samples (bottom water, chlorophyll/turbidity maximum) were incubated in serial dilutions using four different media for the specific enrichment of microorganisms that are involved in the sulfur cycle. The growth media were especially designed to cultivate abundant DMSP- and DMS-oxidising bacteria and to grow DMSO-reducing bacteria under anoxic conditions. The cultures were continuously incubated onboard *Polarstern* during ANT-XXVIII/5 for four weeks at +10°C.

Tab. 14.1: Position and depth of stations for sediment and water sampling

Station	Position Lat	Position Lon	Depth (m)	Gear	Water Sample Depths (m)
PS79/192	61° 33.93' S	55° 1.58' W	1598.7	MUC	1598.7
PS79/193	61° 43.77' S	55° 10.95' W	2103.4	CTD/RO	50
PS79/211	61° 4.41' S	56° 0.40' W	253.9	CTD/RO	20, 180
PS79/211	61° 4.49' S	56° 0.69' W	249.3	MUC	249.3
PS79/212	61° 3.45' S	56° 2.59' W	554.5	MUC	554.5
PS79/224	61° 6.83' S	56° 21.59' W	1184.5	MUC	1184.5
PS79/226	61° 0.76' S	55° 55.02' W	228.4	CTD/RO	60
PS79/254	62° 7.39' S	60° 36.37' W	276.5	CTD/RO	40, 90
PS79/255	62° 5.35' S	60° 11.99' W	370.5	MUC	370.5
PS79/256	62° 2.25' S	60° 11.32' W	499.8	MUC	499.8
PS79/270	62° 27.38' S	55° 57.24' W	313.5	CTD/RO	20
PS79/271	62° 15.90' S	56° 53.37' W	1479.1	MUC	1479.1

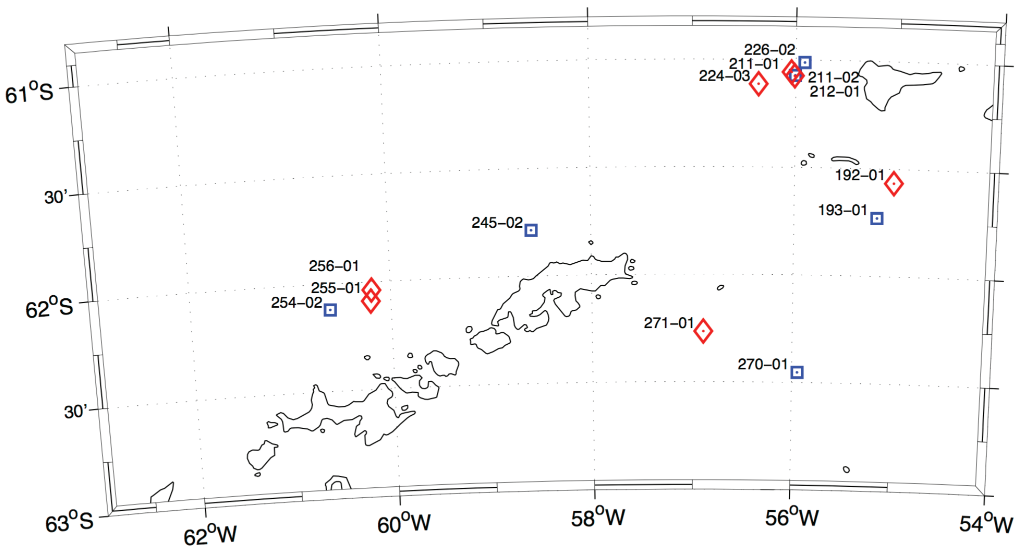

Fig. 14.1 Location of the sampling sites for sediments and corresponding water samples used in this study. Samples were recovered on the shelf of the South Shetland Islands and especially around Elephant Island. Stations for sediment sampling are indicated by a red diamond, corresponding CTD stations are marked by a blue square.

Preliminary (expected) results

It is expected, that the cultures that were inoculated and incubated on board *Polarstern* will show growth after arriving in Bremerhaven. The serial dilution cultures will be monitored at the ICBM in Oldenburg to quantify the amount of bacteria that are involved in the degradation of the provided sulfur compounds. The highest dilutions that show growth will serve as a source for bacterial isolates. All enrichment cultures will be screened molecular biologically for the presence and diversity of *Roseobacter* species. All shore based culture work will be performed in the frame of the PhD-thesis of Saranya Kanukollu. The quantitative and qualitative comparison with the original microbial community composition of the sediment and water samples will be performed in the frame of a master thesis. Finally, the results will be correlated to those of the other cruise participants that work in more detail on pelagic samples.

Data management

The results will be published in international peer-reviewed journals.

15. CULTURE EXPERIMENTS ON THE ENVIRONMENTAL CONTROLS OF TRACE METAL RATIOS (MG/CA, B/CA, U/CA) RECORDED IN CALCAREOUS TESTS OF ARCTIC DEEP-SEA BENTHIC FORAMINIFERA

Stefanie Kaboth, Erik Wurz AWI
Jutta Wollenburg (not on board)

Objectives

Newly developed high-pressure aquaria have recently facilitated the first efficient cultivation (producing offspring) of our most trusted palaeodeep-water recorders *Fontbotia wuellerstorfi* and *Uvigerina peregrina*. In different experimental set-ups the same facilities have been used during the ANT-XXVIII/4 and ANT-XXVIII/5 cruise to cultivate these foraminifera and associated species in waters with different carbonate chemistries to establish the first species-specific trace metal calibration curves for the Southern ocean. Therefore, short sediment cores from 1300 to 1500 m water depth must be collected and transferred into high-pressure aquaria as well as atmospheric-pressure aquaria.

Work at sea

Sediment sampling was carried out using a standard 8-tube multicorer (MUC) with an inner tube diameter of 10 centimetres. Three MUCs were successfully deployed at 3 stations (1540 to 1571 m water depth) south-westerly of Elephant Island. Immediately after recovery the MUC tubes were transferred into push corers and those into the aquaria. By this method, we have successfully filled 5 high-pressure aquaria that are now cultured at pressures of 145 to 150 bar, and 10 aquaria running at atmospheric pressure.

The aquaria were operated in a cold laboratory running at 0 °C. Each aquarium (high-pressure and atmospheric pressure) was connected to its own supportive seawater system. Hereby high-pressure pumps and a chain of in- and outlet valves maintain *in-situ* pressure and assisted by peristaltic pumps a constant seawater flow through the high-pressure aquaria. The seawater used in the system was sampled from 1200 to 1500 m water depths. Seawater sampling was accomplished using an SBE 32 carousel water sampler operated by T. Badewien from ICBM (see chapter 18 this volume).

The pH of the running systems was constantly noted and adjusted by a pH-control system and connected buffer pumps. Oxygen was measured every 4 hours. Once a week, a suspension of algae was added to the seawater inflow as a food supply.

Preliminary Results

The aquaria and seawater circuits will be maintained during the expedition ANT-XXVIII/5 until May 16th 2012. Afterwards the systems will be moved to the laboratories at the Alfred-Wegener-Institute in Bremerhaven. Preliminary results will be obtained approximately 6 months after the end of ANT-XXIII/5.

16. MAPS: MARINE MAMMAL PERIMETER SURVEILLANCE

Elke Burkhardt[1], Caterina Lanfredi[2], Sebastian Richter[1,3]
not on board: Olaf Boebel[1], Lars Kindermann[1], Daniel P.Zitterbart[1,3], Arianna Azzellino[2]

[1]AWI
[2]Politecnico di Milano
[3]University of Erlangen

Objectives

The reliable determination of cetacean abundances and habitat preferences depends on the acquisition of significant amounts of sighting data. Multiple approaches to gather such data quasi-continuously from ships of opportunity are currently being developed and tested, including passive and active hydroacoustics, dedicated and opportunistic sighting surveys, as well as video and infrared imaging. MAPS aims at a) the development of an automated detection system on the basis of continuous thermal imaging to support visual marine mammal observations and b) the collection of visual sighting data for habitat suitability modeling.

With regard to the IR system, this cruise's goal was to collect and save as much IR data as possible (i.e. throughout the entire cruise) with special focus on data collection during nighttime, as this was the first cruise with considerable periods of darkness. Both hard- and software components of the auto detection system should operate continuously to test their stability and performance under working conditions. Additional technical developments included data processing and storage, stabilization and control of camera features.

To collect species specific sighting data for comparison with the IR system and for habitat suitability modeling, dedicated marine mammal observations should conducted from the ship's bridge and flying bridge (observation bridge), partially by employing to-the-second logging of blowing whales. Information of such accuracy is indispensable to be able to manually search for a whale's blow in the thermal images during retrospective analysis and to unequivocally identify false negatives (i.e. missed events).

Work at sea

Operation of the FIRST Navy thermal imager

The FIRST Navy sensor was operated quasi-continuously throughout the entire cruise for approximately 585 h. The only downtimes occurred due to freezing of the system during unfavorable weather conditions on 2012/04/01 and 2012/04/03 (table 16.1).

Tab. 16.1: Timetable showing the operation periods of the FIRST-navy thermal sensor headw.

Start yyyymmdd-hhmm	End yyyymmdd-hhmm	Hours operational hh:mm	Unit number sensor head
20120314-160000	20120401-162000	432:20	1
20120401-174000	20120403-160000	46:20	1
20120403-170000	20120408-030000	106:00	1
Sum		584:40	

Infrared data recorded

A continuous IR-video data stream, covering almost the entire cruise was recorded, comprising approximately 574 hours and 93 TB of data on 31 3-TByte hard disk drives (table 16.2).

Tab. 16.2: Log of the recorded data sets

Type	Hard disk No.	Start yyyymmdd-hhmmss	End yyyymmdd-hhmmss	Duration hh:mm
First RAW	1	20120314-234608	20120315-184235	18:56:27
	2	20120315-184235	20120316-132239	18:40:04
	3	20120316-132239	20120317-080243	18:40:04
	4	20120317-080243	20120318-020203	17:59:20
	5	20120318-021204	20120318-205206	18:40:02
	6	20120318-205206	20120319-153210	18:40:04
	7	20120319-153210	20120320-095329	18:21:19
	8	20120320-100738	20120321-045316	18:45:38
	9	20120321-045316	20120321-233320	18:40:04
	10	20120321-233320	20120322-181325	18:40:05
	11	20120322-181325	20120323-124611	18:32:46
	12	20120323-125257	20120324-073259	18:40:02
	13	20120324-073335	20120325-021304	18:39:29
	14	20120325-021304	20120325-205308	18:40:04
	15	20120325-205308	20120326-153125	18:38:17
	16	20120326-153913	20120327-101915	18:40:02
	17	20120327-101915	20120328-045919	18:40:04
	18	20120328-045919	20120328-233523	18:36:04
	19	20120328-233523	20120329-181941	18:44:18

Type	Hard disk No.	Start yyyymmdd-hhmmss	End yyyymmdd-hhmmss	Duration hh:mm
	20	20120329-182720	20120330-130723	18:40:03
	21	20120330-130724	20120331-074728	18:40:04
	22	20120331-074728	20120401-022732	18:40:04
	23	20120401-022732	20120401-220018	19:32:46
	24	20120401-220840	20120402-164843	18:40:03
	25	20120402-164843	20120403-112848	18:40:05
	26	20120403-112848	20120404-065222	19:23:34
	27	20120404-065222	20120405-024059	19:48:37
	28	20120405-035355	20120405-223358	18:40:03
	29	20120405-223358	20120406-171402	18:40:04
	30	20120406-171402	20120407-115406	18:40:04
	31	20120407-115406	20120408-023343	14:39:37
	Sum	Total		576:39
		Corrected for gaps due to freezing		574:35

On 2012/04/01 between 16:20:00 and 17:40:00 UTC and on 2012/04/03 between 16:00:00 and 17:00:00 UTC the FIRST was shut down due to freezing. These two incidents are accounted for in the calculation of the corrected recorded hours. Data between 2012/04/05 02:40:59 and 03:53:55 UTC was lost, as the hard drives were exchanged somewhat late. In addition, time-lapse data, containing one image every 10 seconds were recorded for the entire cruise on a single additional hard drive.

Focus reset

The focus had to be reset five times, mostly due to significant changes in environmental conditions, presumably air temperature, which affect the focal distance of the thermal optics (table 16.3).

Tab. 16.3: Focus reset of the FIRST thermal imager

Date	Direction	Water temp	Reason
20120314-160000		10.70	usual adjustments necessary due to cooling process (12 h)
20120317-151700	-4.00	2.00	unsharp
20120321-121400	-3.00	1.3	unsharp
20120324-133000	2.00	1.1	unsharp

Date	Direction	Water temp	Reason
20120325-200300	-4.00	1.3	unsharp
20120104-174000			adjustment after restart of unit

Visual observations

During this cruise, visual sightings were recorded by two dedicated marine mammal observers (MMOs) from the bridge of *Polarstern*. The daily average effort was approximately 12 hours (from dusk till dawn). Marine mammal observers were scanning an area of approximately 270° either with naked eye or binoculars (Fujinon FMTRC-SX, 7x 50). Binoculars were equipped with a reticule scale, which was used for distance estimation. Sightings were logged electronically with the WALOG software (version 1.3), which allows logging sighting details together with the ships metadata, e.g. GPS position. On occasion, photos were taken by digital cameras to support the species identification. On several days single blows were logged using the BLOWLOG software on a touchscreen tablet computer, which allows logging individual blow events to the second along with the direction of the blow.

Preliminary results

Technical development of Tashtego and PiP software

During this expedition, Tashtego was updated to its latest development version Tashtego124. This version features for the first time a scale invariant feature detection algorithm, implemented to minimize false positives caused by birds and enhance detection of whale blows at all distances. The improved algorithm worked significantly better, only under certain weather conditions some parts of the ship's superstructure tended to cause massively clustered false positives, pending further analysis.

Automatic whale detection

During this expedition, the auto detection system was operated for the second time during darkness, and for the first time during darkness in combination with the latest Tashtego version. The automatic whale detection algorithm captured more than 400 whale blows during nighttimes. Two examples are provided below (Fig. 16.1 and 16.2), providing first direct evidence that an automatic detection system on the basis of thermal imaging is capable of detecting whales at night at distances up to 4 km, providing the unprecedented capability of nocturnal marine mammal mitigation.

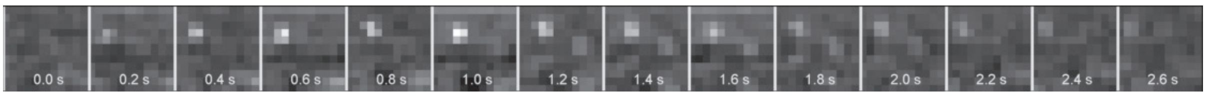

Fig 16.1: Sequence of video snippets (0.2s resolution) of a whale blow detected automatically at night. Date: 24.03.2012 00:07; Distance: 3582m; Latitude: 61.11°S Longitude: 56.36°W; Water temperature: 1.34°C; Air temperature: -1.7°C.

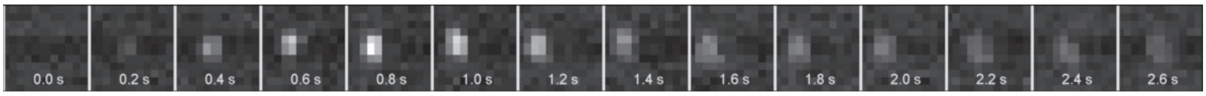

Fig 16.2: Sequence of video snippets (0.2s resolution) of a whale blow detected automatically at night. Date: 28.03.2012 03:27; Distance: ~3500m; Latitude: 61.88°S Longitude: 60.29 °W; Water temperature: 1.44 °C; Air temperature: 2.3°C.

Visual sightings

A total of 26 days were spent at sea with an effort of 295 h for marine mammals observations from the bridge of *Polarstern*, resulting in 282 sighting events, which are plotted in Figs. 16.3 and 16.4. A total of 8 (possibly 9, pending on final review of photos from possibly a sei whale) cetacean species were recorded. Table 16.4 lists all cetacean *sightings events* by species. Here we choose the term *sighting event* rather than *sighting* as on some occasions (e.g. during frequent animal encounters or while ship was on station) one could not clearly distinguish if consecutive sightings in a short period of time were two separate sightings or a possible re-sighting of the same animal. The most abundant species during the cruise was the fin whale (*Balaenoptera physalus*).

Tab. 16.4: MMO cetacean sightings by species from the bridge of *Polarstern* during ANT-XXVIII/4.

Species (Latin name)	Species (Common name)	No of sighting events	Percentage of total sightings
Balaenoptera physalus	Fin whale	155	55.0
undefined large whale	undefined large whale	78	27.7
Cephalorhynchus commersonii	Commerson's dolphin	24	8.5
Megaptera novaeangliae	Humpback whale	8	2.8
undefined whale	undefined whale	6	2.1
Lagenorhynchus australis	Peale's dolphin	2	1.1
Balaenoptera bonaerensis	Antarctic minke whale	2	0.7
Lagenorhynchus obscurus	Dusky dolphin	2	0.7
Lagenorhynchus cruciger	Hourglass dolphin	1	0.4
Orcinus orca	Antarctic Killer whale	1	0.4
undefined dolphins	undefined dolphins	1	0.4
undefined small whale	undefined small whale	1	0.4
Total		282	100.0

Cue counting

In order to further develop and test the performance of the infrared imager and the automatic detection algorithm, individual whale blows were on occasion logged to the second by dedicated observers. For this task the observer was equipped with a tablet computer and customized software (BLOWLOG), which by a single tap on the touch sensitive screen, logs recording time, direction and direction accuracy. To ensure correct time, the tablet computer was synchronized by the ships NTP time service at least once daily. In total 2025 blows were recorded in approx. 11 h of effort (table 16.5).

Tab. 16.5: Single blow counts

Date	effort time (hrs)	No blows logged
timestamp=2012-03-17	00:28:10	159
timestamp=2012-03-18	00:41:45	0
timestamp=2012-03-20	Discarded due to logging failure	
timestamp=2012-03-21	6:55:16	1118
timestamp=2012-03-23	1:34:13	423
timestamp=2012-03-24	1:37:39	219
timestamp=2012-03-29	0:14:48	106
Total	11:31:51	2025

Data management

Data description and metadata will be accessible through the PANGAEA database, however as IR and visual image data occupy more than 100 Terabytes, they will not be available online. PI: Olaf Boebel

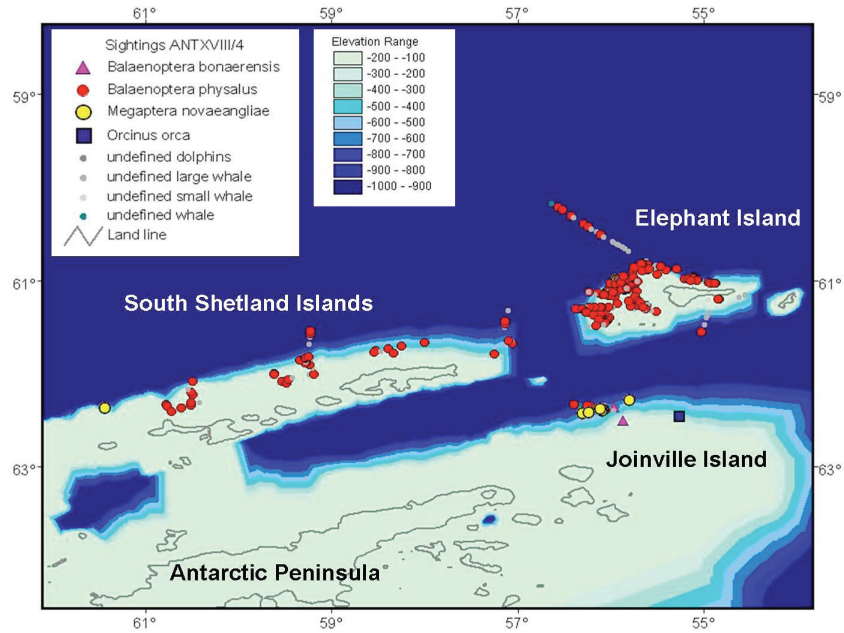

Fig. 16.3: Map of MMO sightings during ANT-XXVIII/4 south of 60°S.

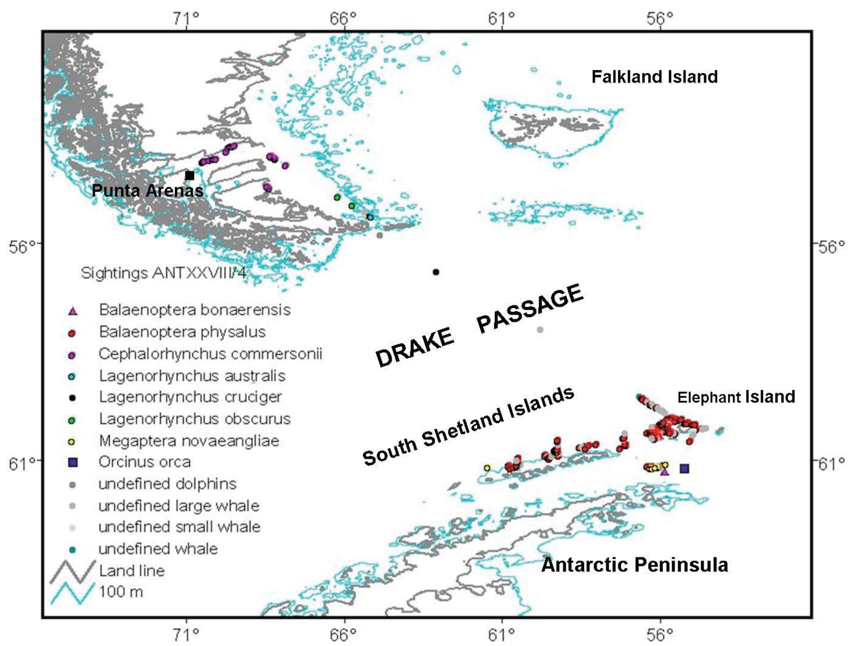

Fig. 16.4: Map of MMO cetacean sightings during ANT-XXXVIII/4

17. HIGHER TROPHIC LEVELS: DISTRIBUTION OF MARINE MAMMALS AND SEABIRDS AT SEA

Olivier Dochy, Christophe Gruwier, Claude Joiris[1] (not on board) PolE

Objectives

In the frame of our long-term study of the at-sea distribution of seabirds and marine mammals, special attention is to be paid to less studied Antarctic zones such as the eastern and western parts of the Weddell Sea, and the seas surrounding the South Shetland Islands (Joiris 1991 & 2000). Countings were made from the bridge of *Polarstern* during cruise leg ANT-XXVIII/4.

We are also interested in the mechanisms explaining this distribution: water masses and bottom structures such as slopes, which influence the localization of fronts (upwellings). Of special interest are the complementary studies of the main prey of seabirds and cetaceans: zooplankton and krill, nekton and small fish (Joiris & Falck 2010).

Work at sea

The distribution of marine mammals and seabirds was derived from continuous transect counts from the bridge. For the marine mammals we had the pleasure to cooperate with Elke Burkhardt (AWI) and Caterina Lanfredi (PolM) (see chapter 16, this volume).

Preliminary (expected) results

We conducted 250 transect counts of 30 minutes so far, with more than 100,000 birds of 46 species. The most numerous species were Southern Fulmar *Fulmarus glacialoides* (ca. 75,000; Fig. 17.1), Grey-headed Albatross *Thalassarche chrysostoma* (7,000), Antarctic Prion *Pachyptila desolata* (5,000). Some species were only recorded north of the Antarctic Convergence Zone, such as Northern and Southern Royal Albatross *Diomedea epomophora and D. sandfordi* and Great Shearwater *Puffinus gravis*. On the other hand, Snow Petrel *Pagodroma nivea* and Adélie Penguin *Pygoscelis adeliae* are restricted to the ice zone where they reached large densities (Fig. 17.2). Some other species encountered were at least 1,000 km out of their known range: Sooty Albatross *Phoebetria fusca*, Soft-plumaged Petrel *Pterodroma mollis* (both in Drake Passage) and Common Diving-Petrel *Pelecanoides urinatrix* (found alive on ship near South Shetland Islands). In this way our data contribute to increase the knowledge of the at-sea distribution of seabirds. There are only few data for this region in the austral autumn.

The area west of Elephant Island, at the edge of the continental shelf, had the largest densities of birds. West and north of the South Shetland Islands, densities were less, except for some transects north of Livingston Island. The numbers of Grey-headed Albatross staying here in autumn are assumed to be relatively large compared to the world population of about 600,000 birds (Shirihai, 2008).

Fig. 17.1: Rafts of Southern Fulmar Fulmarus glacialoides *on the Southern Ocean near Elephant Island. Photo: Olivier Dochy, PolE.*

Fig. 17.2: Adélie Penguins Pygoscelis adeliae *were the most numerous species in the ice zone. Photo: Olivier Dochy, PolE.*

Fin Whale *Balaenoptera physalus* proved to be common around the visited islands, with many individuals and groups of up to 80 or more seen (near 300 observations). Seals such as Antarctic Fur Seal *Arctocephalus gazella* are widespread but thinly distributed in the open sea, but common in the ice (here also Crabeater Seal *Lobodon carcinophaga*, Leopard Seal *Hydrurga leptonyx*). Commerson's Dolphins *Cephalorhynchus commersonii* were commonly seen in the Magellan Strait (200+), Humpback Whales were scarce and mostly along the ice edge while Killer Whale *Orcinus orca* (5) and Minke Whale *Balaenoptera bonaerensis* (3) were within the ice zone (5 ind.).

Further research will reveal if there are clear correlations with oceanographic and biological parameters, such as water quality parameters, seafloor topography, plankton blooms or krill or fish concentrations. This knowledge can then be used for the mapping of vulnerable areas.

Data management

All mammal data are available in the MAPS data set (AWI, Elke Burkhardt), seabird data in the PolE data set (joiriscr@gmail.com).

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Joiris CR, Falck E (2010) Summer at-sea distribution of Little Auks *Alle alle* and Harp Seals *Pagophilus (Phoca) groenlandica* in the Greenland Sea: impact of small-scale hydrological events. Polar Biology, 34, 541-548. DOI: 10.1007/s00300-010-0910-0. Online: 03 November 2010.

Shirihai H, 2008. Birds and Marine Mammals of the Antarctic Continent and the Southern Ocean. The complete guide to Antarctic Wildlife. Princeton University Press, Princeton & Oxford. 544 pp.

18. THE OCEANOGRAPHIC CONDITIONS IN THE DRAKE PASSAGE AND THE ANTARCTIC PENINSULA REGION

Thomas H. Badewien, Alexander Gavrilov, Meinhard Simon ICBM

Objectives

The oceanographic measurements are fundamental to all groups participating in the leg ANT-XXVIII/4 for analyzing the data obtained during the cruise. The investigations of this expedition focused mainly on the Roseobacter clade, one of the most important groups of marine bacteria, and the composition of dissolved organic matter (DOM) as well as studies on Antarctic fish, marine mammals and birds.

The oceanographic measurements were carried out by use of a CTD- (Conductivity, Temperature, Depth) probe attached to a rosette water sampler, and a shipboard thermosalinograph. The major goal was to identify the thermohaline structure of the water column. In addition, different water masses had to be identified.

Work at sea

The CTD system used during this cruise was a Sea-Bird Electronics Inc. SBE 911plus probe, SN 09P16392-0485 attached to a SBE 32 Carousel Water Sampler SN 3252063-0718 containing 24 12-liter Ocean Test Equipment Inc. bottles. The CTD system was equipped with double temperature and conductivity sensors, pressure sensor, altimeter, chlorophyll fluorometer and transmissiometer:

Temperature 1	Temperature 2
Sea-Bird Electr. Inc.	Sea-Bird Electr. Inc.
SN: 03P2423 Calb. 03. May 2011	SN: 03P2685 Calb. 03. May 2011
Conductivity 1	Conductivity 2
Sea-Bird Electr. Inc.	Sea-Bird Electr. Inc.
SN: 042078 Calb. 05 May 2011	SN: 042446 Calb. 05 May 2011
Pressure Transducer	Transmissiometer
Sea-Bird Electr. Inc.	Wet Labs C-Star
SN: 068997 Calb. 21 July 1997	SN: CST-814DR Calb. 24 Oct 2011
Recalibration on deck: 15 March 2012	Field recalibration: 15 March 2012

Chlorophyll Fluorometer	Altimeter
Wet Labs ECO – AFL/FL	Bentos
SN: FLRTD-1670 Calb. 11 Nov 2009	SN: 122
Sensitivity check on board 15 March 2012	

Before each measurement, the CTD was adapted to the cold water at 20 m water depth for 3 min. Thereafter, recording of the various parameters (temperature, salinity, fluorescence, transmission) was started at the surface down to 5 - 10 m above the sea floor. Temperature was measured in the ITS-90 temperature standard (potential T in °C), salinity in psu (pss 78 standard). For the upper 200 m the CTD was lowered at 0.5 m/s for a most accurate recording of the data and thereafter the speed was increased up to 1 m/s. Water samples were collected during the upcast of the CTD at given depths.
After data saving on the PC and detailed recording of all data with the software Seasave the data were processed by means of ManageCTD, loops deleted, and additional data were added such as CTD header, and ship position, exported from Dship data. Further, data were despiked and finally they were converted into ascii format. Water density (sigma-T) was calculated to identify water masses. Other data from the Dship data set (salinometer, Ferrybox, weather recordings, ADCP, GPS) were used for further processing and characterising the obtained CTD data.

The sensors used were pre-calibrated by the manufacturers (date see above). The transmissiometer was re-calibrated in the field according to the Sea-Bird instruction and a sensitivity check was performed for the chlorophyll fluorometer at the beginning of the cruise.

Each day, two water samples were taken as references for the salinity analyses. The measurements were conducted by means of an Optimare salinometer SN: 007.

Thermosalinograph

The shipboard thermosalinograph mounted at the bow of the ship used during this cruise was a Sea-Bird Electronics Inc. SBE 21, SN 3190. The salinity values were check daily by taking a water sample and analysing with a salinometer.

Preliminary results

Altogether, 51 CTD profiles were carried out during the cruise. 19 profiles were carried out in the framework of the Roseobacter project, eight of these profiles reached to water depths between 1000 m and 4240 m, eleven of these reached to water depths from 220 m to 700 m. In the frame of the Antarctic fish investigations, 27 (shallow) CTD-profiles with a water depth from 90 m to 500 m were conducted. The positions are marked in the station map, Fig. 18.1.

The evaluation of the primary and the secondary sensors revealed very good agreement throughout the cruise, no drift between the double sensors were observed. The differences between the double sensors within the 49 profiles were calculated as follows:

temperature dT =-0.0004 K;
conductivity dC = 0.0013 mS/cm.

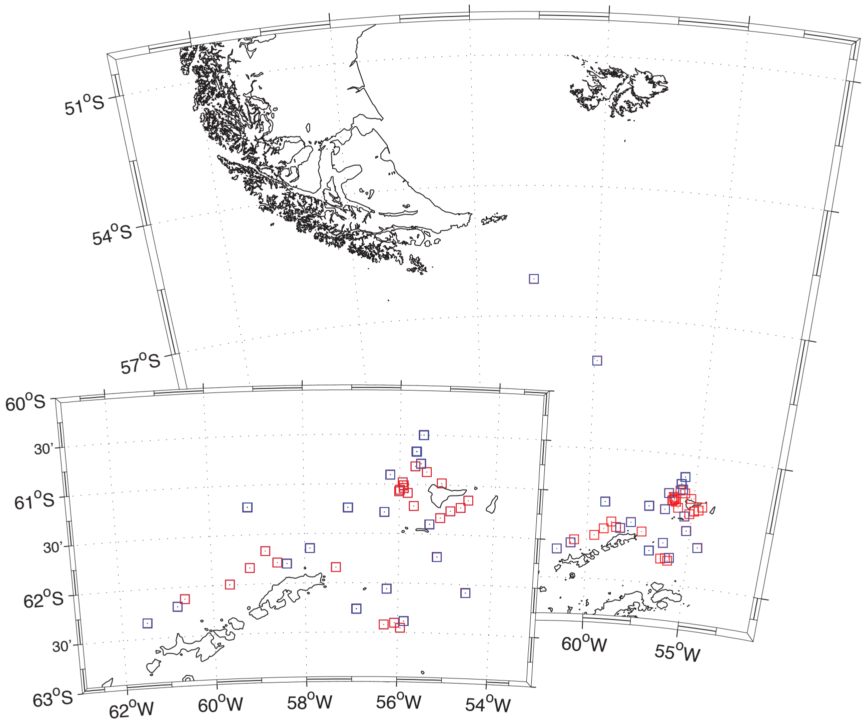

Fig. 18.1: All CTD positions during the cruise ANT-XXVIII/4, Punta Arenas – Punta Arenas, 14 March – 9 April 2012; blue squares: Roseobacter, red squares: Antarctic fish.

Transect Drake Passage

Five CTD stations (178-01, 179-01, 187-01, 205-02, 287-02) were carried out on a transect across the Drake Passage. Data taken from the shipboard themosalinograph were used to identify different water masses and fronts. Fig. 18.2 shows the ship track. The Subantarctic Front 55° S (SAF) can be identified between number two and three by analysing of the gradient in water temperature and salinity (Fig. 18.3 and Fig. 18.4). The Polar Front (PF), which separates the Subantarctic Surface Water from the Antarctic circumpolar water, was located at 58° S and the Antarctic Divergence at 60° 45' S.

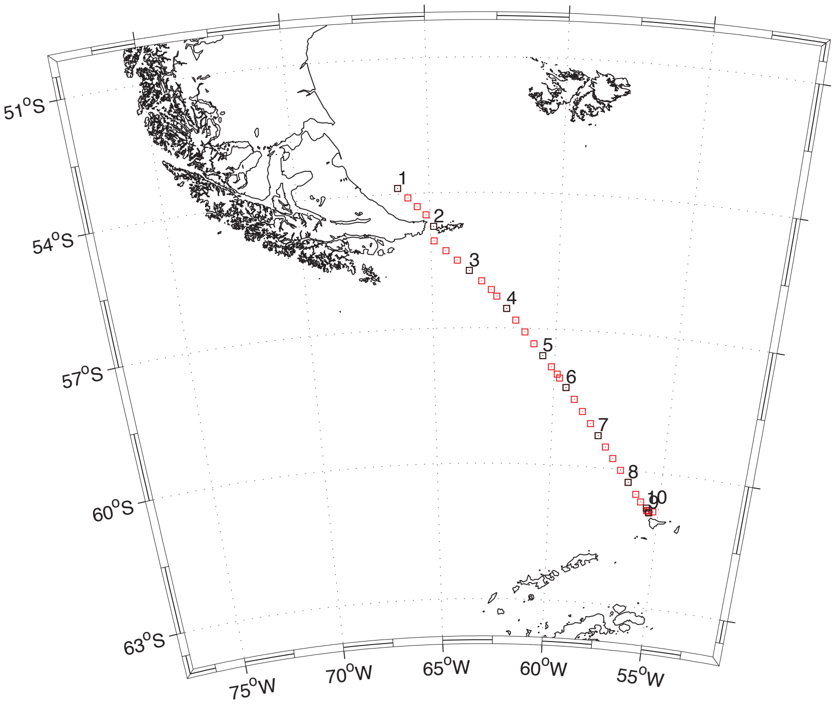

Fig. 18.2: Ship transect across the Drake Passage, the distance between the black squares corresponds to time intervals of 6.6 hours.

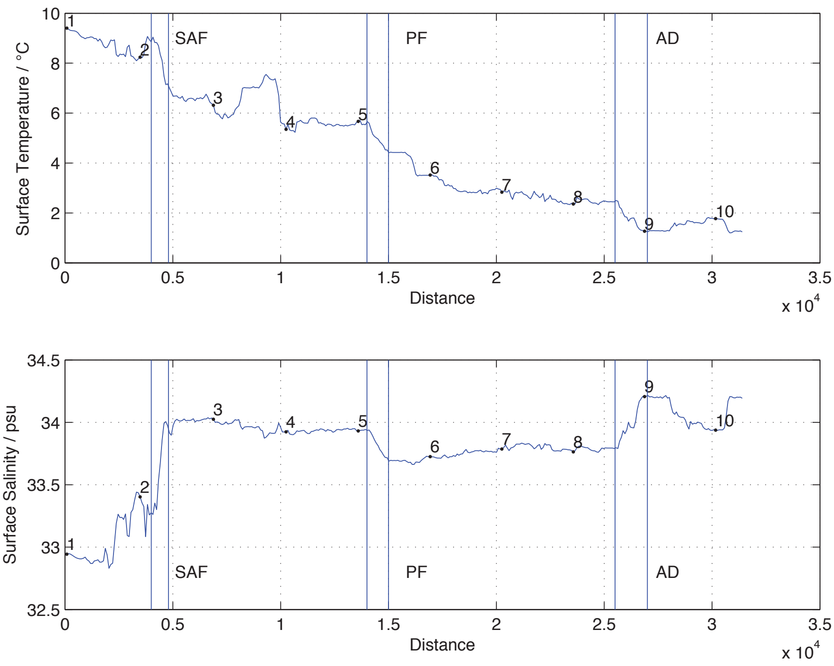

Fig. 18.3 Surface temperature and salinity determined by the shipboard thermosalinograph; SAF (Subantarctic Front), PF (Polar Front), AD (Antarctic Divergence.

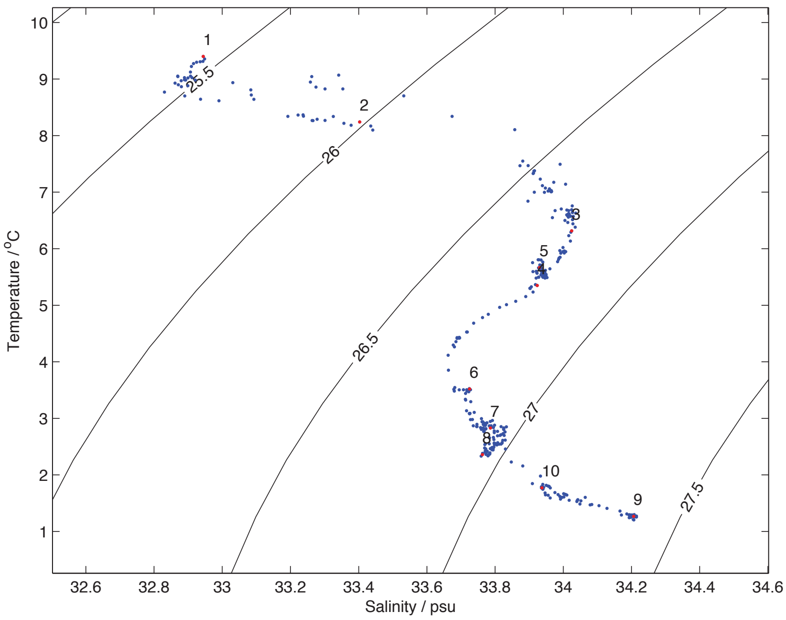

Fig. 18.4: T-S diagram of the profiles plotted by data of the shipboard thermosalinograph.

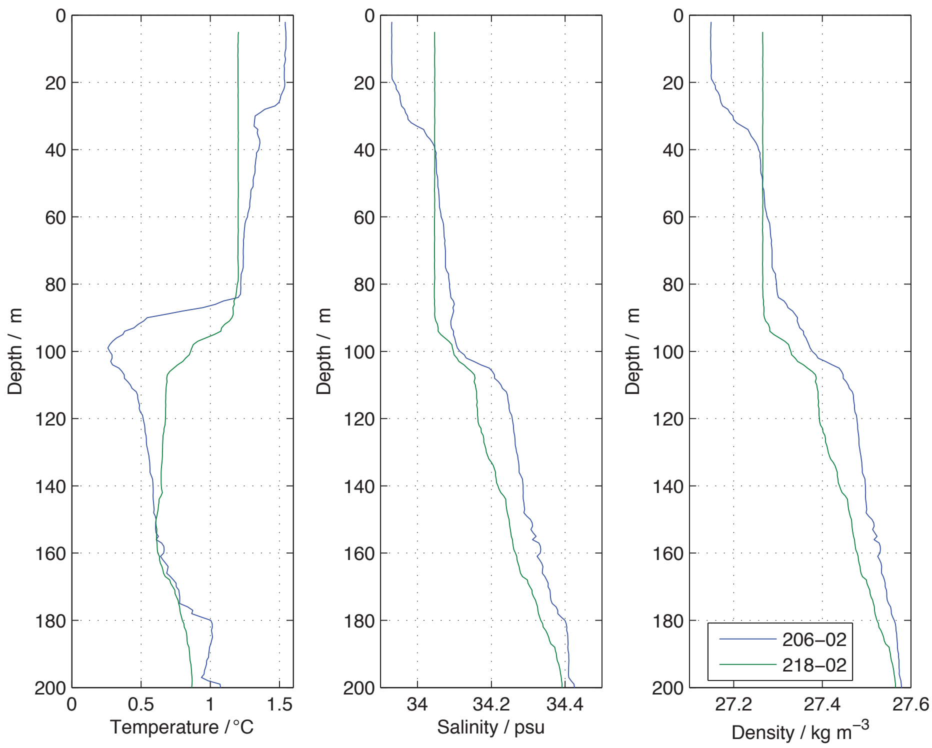

Fig. 18.5: Temperature, salinity and density profiles north of Elephant Island; profile PS79/206-2 blue line, profile PS79/218-2 green line.

Mixed Layer

At March 21, 2012, the mixed layer had a temperature of 1.5 °C and reached a depth of 30 m north of Elephant Island (profile PS79/206-2). During the next days, the air temperature decreased strongly. Consequently, the mixed layer deepened. Two days later, at almost the same position (23 March 2012, profile PS79/218-2), the mixed layer had a depth of 90 m.

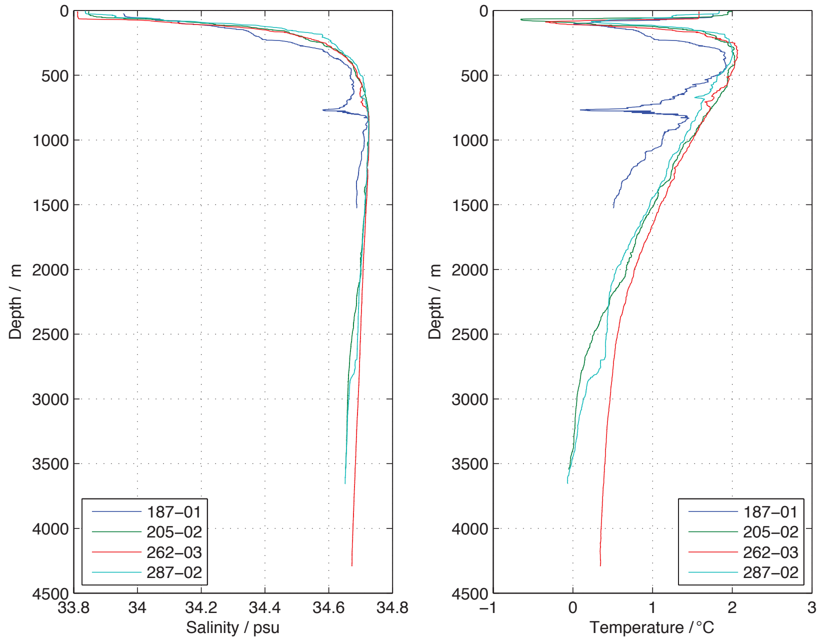

Fig. 18.6: Four deep temperature and salinity profiles north of Elephant Island and King George Island.

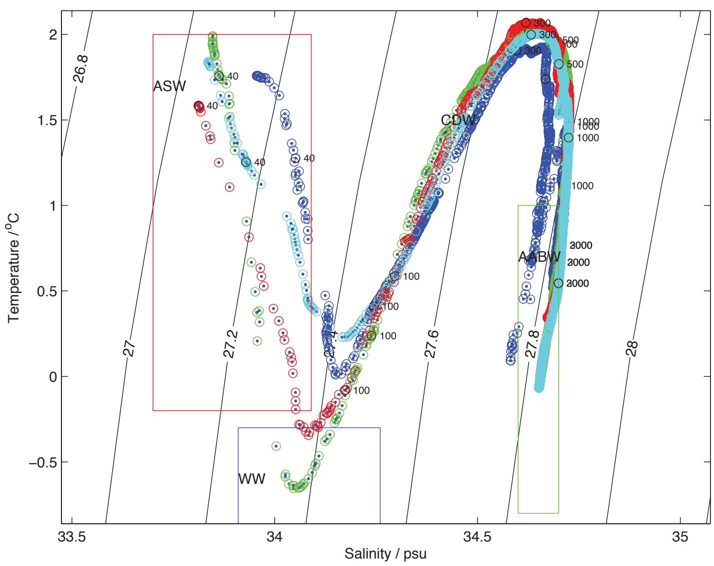

Fig. 18.7: T-S diagram of the profiles plotted in Fig. 18.6, blue line: profile 187-01, green line: profile 205-02, red line: profile 262-03, cyan line: profile 287-02, the black circles indicates the water depth.

Water Masses

Four deep profiles north of Elephant Island and King George Island were used to identify different water masses. The temperature and salinity profiles are shown in Fig. 18.6 and the T-S diagram in Fig. 18.7. Four water masses can be characterised: ASW (Antarctic Surface Water) with a temperature of 2 °C, low salinity (34.7 – 34.1 psu) and a depth down to 50 m. Below the ASW, the Winter Water (WW) is situated between 50 and 150 m depth with a temperature less than 0 °C. The Circumpolar Deep Water has a salinity of 34.5 psu and temperatures of up to 2 °C and the Antarctic Bottom Water as the deepest water mass exhibited a density of 27.8 kg m^{-3}.

Data management

After the cruise, the CTD data will be validated and published in the open access journal Earth System Science Data (ESSD). The validated data will also be available via the AWI Pangaea database.

References

ESSD: Earth System Science Data, Copernicus Pulications, www.earth-syst-sci-data.net

Tomczak M, Godfrey JS (1994) Regional Oceanography: An Introduction, Pergamon Rapid communications in mass spectrometry, 53-88.

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION LIST

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

	Adresse/Address
Australian Museum	Australian Museum 6 College Street Sydney NSW 2010 Australia
AWI	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven Germany
BIK-F	Biodiversität und Klima Forschungszentrum Medizinische Biodiversität und Parasitiologie Goethe-Universität Senckenberganlage 25 60325 Frankfurt Germany
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard Nocht Str. 76 20359 Hamburg Germany
EMPA	Eidgenössische Materialprüfungs- und Forschungsanstalt Überlandstrasse 129 8600 Dübendorf Switzerland
HZI	Helmholtzzentrum für Infektionsforschung Inhoffstraße 7 38124 Braunschweig Germany
ICBM	Institut für Chemie und Biologie des Meeres Carl von Ossietzky Universität Oldenburg 26111 Oldenburg Germany

	Adresse/Address
INIDEP	Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP) Paseo Victoria Ocampo 1 Mar del Plata B7602HSA Argentina
ISMAR-CNR	Instituto di scienze marine-Consiglio Nazionale delle Ricerche Sede di Ancona Largo Fiera della Pesca 60125 Ancona Italy
IFM-GEOMAR	IFM-GEOMAR Leibniz-Institut für Meereswissenschaften Düsternbrooker Weg 20 24105 Kiel Germany
IFOP	Instituto de Fomento Pesquero Av.Blanco No 839 Valparaiso Chile
NOAA	Antarctic Ecosystem Research Division Southwest Fisheries Science Center NOAA National Marine Fisheries Service 3333 North Torrey Pines Court La Jolla, CA 92037 USA
PolE	Laboratory for Polar Ecology Rue du Fodia 18 1367 Ramillies Belgium
Politecnico di Milano	Politecnico de Milano Leonardo da Vinci 32 20133 Milano Italy
University of Bergen	University of Bergen Department of Biology Marine Biodiversity Thormøhlensgt. 53 A/B 5020 Bergen Norway

	Adresse/Address
University of Basel	Universität Basel Programm Mensch-Gesellschaft-Umwelt Departement Umweltwissenschaften Vesalgasse 1 4051 Basel Switzerland
University of Bern	Universität Bern Zentrum für Fisch- und Wildtiermedizin Länggassstrasse 122 3001 Bern Switzerland
University of Erlangen	Friedrich-Alexander-Universität Erlangen-Nürnberg Schlossplatz 4 91054 Erlangen Germany
University of Genova	University of Genova Istituto Superiore per la Protezione e la Ricerca Ambientale c/o National Antarctic Museum Viale Benedetto XV 16132 Genova Italy
University of Göttingen	Georg-August-Universität Göttingen Institut für Mikrobiologie und Genetik 37077 Göttingen Germany
University of Padova	University of Padova Department of Biology Via Ugo Bassi 58B 35131 Padova Italy
vTI	Institut für Seefischerei, Johann Heinrich von Thünen Institut für ländliche Räume, Wald und Fischerei Palmaille 9 22767 Hamburg Germany
Yale Peabody Museum	Peabody Museum of Natural History Yale University 170 Whitney Avenue New Haven, CT 06520-8118 USA

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Badewien	Thomas	ICBM	Scientist, oceanography
Billerbeck	Sara	ICBM	PhD student, biology
Brinkhoff	Thorsten	ICBM	Scientist, microbiology
Burkhardt	Elke	AWI	Scientist, biology
Burkhardt-Holm	Patricia	UniBasel	Scientist, biology
Busch	Markus	BIK-F	Scientist, biology
Colombo	Marco	vTI	PhD student, biology
Damerau	Malte	vTI	PhD student, biology
Dochy	Olivier	PolE	Scientist, biology
Dogs	Marco	ICBM	PhD student, biology
Elsheimer	Annika	vTI	Technician
Emde	Sebastian	BIK-F	PhD student, biology
Engelen	Bert	ICBM	Scientist, microbiology
Gavrilov	Alexander	ICBM	Student, marine environ. science
Gruvier	Christophe	PolE	Scientist, biology
Heckmann	Hans	Heliservice	Pilot, helicopter
Jones	Christopher D.	NOAA	Scientist, biology
Kaboth	Stefanie	AWI	Student, geology
Klimpel	Sven	BIK-F	Scientist, biology
Kock	Karl-Hermann	vTI	Scientist, fish biology
Koschnick	Nils	AWI	Engineer
Kuhn	Thomas	BIK-F	PhD student, biology
Lanfredi	Caterina	PolMilano	PhD student, biology
Lazo-Wasem	Eric A.	Yale Peabody	Senior collections manager
Lockhart	Susanne	NOAA	Scientist, biology
Lucassen	Magnus	AWI	Scientist, biology
Möllendorf	Carsten	Heliservice	Mechanist, helicopter
Müllenmeister	Swaantje	ICBM	Student, marine environ. science
Noever	Christoph	UniBergen	PhD student, biology
Papetti	Chiara	UniPadova	Scientist, biology
Rentsch	Harald	DWD	Meteorologist
Richter	Sebastian	AWI	Engineer
Riginella	Emilio	UniPadova	PhD student, biology
Sandersfeld	Tina	AWI	PhD student, biology
Segner	Helmut	UniBern	Scientist, zoology
Seibt	Maren	ICBM	PhD student, biology
Seidel	Michael	ICBM	Scientist, geochemistry
Siegel	Volker	vTI	Scientist, biology
Simon	Meinhard	ICBM	Scientist, microbiology
Smits	Maike	UniGöttingen	Student, biology
Sonnabend	Hartmut	DWD	Technician, meteorology

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Toro Omar	Ivan	IFOP	Engineer, fishery
Vacchi	Marino	UniGenova	Scientist, biology
Vaupel	Lars	Heliservice	Pilot, helicopter
Wagner Döbler	Irene	HZI	Scientist, microbiology
Wang	Hui	HZI	PhD student, biology
Wemheuer	Bernd	UniGöttingen	PhD student, biology
Wilson	Nerida	AustMuseum	Scientific officer
Wolske	Julia	vTI	Technician
Wurst	Mascha	ICBM	PhD student, biology
Wurz	Erik	AWI	Student, marine biotechnology
Zavatteri	Anabela	INIDEP	Scientist, biology

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1	Wunderlich, Thomas	Master
2	Grundmann, Uwe	1. Offc.
3	Ziemann, Olaf	Ch. Eng.
4	Hering, Igor	2. Offc.
5	Lauber, Felix	2. Offc.
6	Peine, Lutz	2. Offc.
7	Winter, Hauke	Doctor
8	Koch, Georg	R. Offc.
9	Kotnik, Herbert	2. Eng.
10	Schnürch, Helmut	2. Eng.
11	Westphal, Henning	2. Eng.
12	Brehme, Andreas	Elec. Eng.
13	Fröb, Martin	ELO
14	Muhle, Helmut	ELO
15	Winter, Andreas	ELO
16	Feiertag, Thomas	ELO
17	Clasen, Burkhard	Boatsw.
18	Neisner,Winfried	Carpenter
20	Burzan, G.-Ekkehard	A.B.
27	Guse, Hartmut	A.B.
23	Hartwig-L., Andreas	A.B.
25	Kreis, Reinhard	A.B.
24	Kretzschmar, Uwe	A.B.
22	Moser, Siegfried	A.B.
28	Scheel, Sebastian	A.B.
21	Schröder, Norbert	A.B.
26	Schröter, Rene	A.B.
19	Schultz, Ottomar	A.B.
29	Beth, Detlef	Storek.
30	Becker, Holger	Mot-man
31	Fritz, Günter	Mot-man
32	Krösche, Eckard	Mot-man
33	Dinse, Horst	Mot-man
34	Watzel, Bernhard	Mot-man
35	Fischer, Matthias	Cook
36	Tupy, Mario	Cooksmate
37	Martens, Michael	Cooksmate
38	Dinse, Petra	1. Stwdess
39	Hennig, Christina	Stwdess/Nurse
40	Chen, Quan Lun	2. Steward
41	Hischke, Peggy	2. Stwdess
42	Hu, Guo Yong	2. Steward
43	Streit, Christina	2. Stwdess
44	Wartenberg, Irina	2. Stwdess
45	Ruan, Hui Guang	Laundrym.

A.4 STATIONSLISTE / STATION LIST PS 79

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/178-1	2012-03-16	04:58:00	CTD/RO	on ground/max depth	56° 9.71' S	62° 38.57' W	4013.4
PS79/179-1	2012-03-16	18:15:00	CTD/RO	on ground/max depth	57° 59.28' S	59° 52.32' W	4279.2
PS79/180-1	2012-03-16	22:50:59	LD	on ground/max depth	58° 30.29' S	59° 8.71' W	4226.1
PS79/181-1	2012-03-17	02:04:59	LD	on ground/max depth	59° 0.11' S	58° 24.61' W	3842.9
PS79/182-1	2012-03-17	05:32:59	LD	on ground/max depth	59° 30.90' S	57° 39.56' W	3487.4
PS79/183-1	2012-03-17	08:57:59	LD	on ground/max depth	60° 0.73' S	56° 53.44' W	3572.5
PS79/184-1	2012-03-17	12:14:59	LD	on ground/max depth	60° 30.02' S	56° 7.47' W	3983.0
PS79/185-1	2012-03-17	16:37:00	BT	profile start	60° 52.16' S	55° 30.15' W	251.3
PS79/185-1	2012-03-17	17:07:00	BT	profile end	60° 53.24' S	55° 26.84' W	247.8
PS79/185-2	2012-03-17	19:20:00	CTD/RO	on ground/max depth	60° 52.34' S	55° 26.10' W	303.3
PS79/186-1	2012-03-17	22:00:00	MUC	on ground/max depth	60° 50.43' S	55° 32.02' W	552.2
PS79/186-2	2012-03-17	22:45:01	LD	on ground/max depth	60° 49.67' S	55° 33.72' W	1001.8
PS79/187-1	2012-03-17	23:55:00	CTD/RO	on ground/max depth	60° 47.44' S	55° 33.58' W	2622.2
PS79/188-1	2012-03-18	10:01:00	BT	profile start	61° 11.22' S	54° 35.30' W	277.5
PS79/188-1	2012-03-18	10:31:00	BT	profile end	61° 9.86' S	54° 32.99' W	355.9
PS79/188-2	2012-03-18	11:41:00	CTD/RO	on ground/max depth	61° 9.00' S	54° 33.26' W	305.7
PS79/189-1	2012-03-18	12:39:00	BT	profile start	61° 12.02' S	54° 40.53' W	266.6
PS79/189-1	2012-03-18	13:09:00	BT	profile end	61° 13.24' S	54° 42.95' W	263.3
PS79/189-2	2012-03-18	14:20:00	CTD/RO	on ground/max depth	61° 13.52' S	54° 42.49' W	273.9
PS79/190-1	2012-03-18	15:22:00	BT	profile start	61° 12.00' S	54° 52.49' W	71.3
PS79/190-1	2012-03-18	15:52:00	BT	profile end	61° 12.48' S	54° 56.30' W	52.8
PS79/191-1	2012-03-18	18:03:00	BT	profile start	61° 15.66' S	54° 52.31' W	134.6
PS79/191-1	2012-03-18	18:33:00	BT	profile end	61° 16.09' S	54° 56.12' W	189.0
PS79/191-2	2012-03-18	19:32:01	CTD/RO	on ground/max depth	61° 15.77' S	54° 55.27' W	160.1
PS79/192-1	2012-03-18	22:41:00	MUC	on ground/max depth	61° 33.93' S	55° 1.58' W	1598.7
PS79/192-2	2012-03-18	23:25:59	LD	on ground/max depth	61° 34.07' S	55° 1.42' W	1640.0
PS79/193-1	2012-03-19	01:23:00	CTD/RO	on ground/max depth	61° 43.77' S	55° 10.95' W	2103.4
PS79/193-2	2012-03-19	02:55:00	CTD/RO	on ground/max depth	61° 43.76' S	55° 10.83' W	2114.6
PS79/194-1	2012-03-19	09:49:00	BT	profile start	61° 20.74' S	55° 11.00' W	280.9
PS79/194-1	2012-03-19	10:19:00	BT	profile end	61° 20.12' S	55° 7.38' W	383.7
PS79/194-2	2012-03-19	11:19:00	CTD/RO	on ground/max depth	61° 20.16' S	55° 7.63' W	354.2
PS79/195-1	2012-03-19	13:23:00	BT	profile start	61° 20.06' S	55° 31.64' W	148.9
PS79/195-1	2012-03-19	13:53:00	BT	profile end	61° 20.36' S	55° 27.96' W	160.2
PS79/196-1	2012-03-19	16:16:00	BT	profile start	61° 16.43' S	55° 37.38' W	109.2
PS79/196-1	2012-03-19	16:46:00	BT	profile end	61° 18.36' S	55° 37.86' W	130.0
PS79/197-1	2012-03-19	18:53:00	BT	profile start	61° 17.04' S	55° 42.73' W	139.0
PS79/197-1	2012-03-19	19:23:00	BT	profile end	61° 18.91' S	55° 42.84' W	212.2
PS79/198-1	2012-03-19	23:05:00	MUC	on ground/max depth	61° 18.48' S	56° 27.14' W	435.0

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/198-2	2012-03-19	23:40:00	MUC	on ground/max depth	61° 18.39' S	56° 28.10' W	417.6
PS79/198-3	2012-03-20	00:12:00	MUC	on ground/max depth	61° 18.42' S	56° 29.20' W	398.7
PS79/199-1	2012-03-20	09:33:00	BT	profile start	61° 4.78' S	56° 1.76' W	244.8
PS79/199-1	2012-03-20	09:53:00	BT	profile end	61° 4.10' S	55° 59.83' W	266.2
PS79/199-2	2012-03-20	11:08:00	CTD/RO	on ground/max depth	61° 3.35' S	55° 59.74' W	309.7
PS79/200-1	2012-03-20	13:15:00	BT	profile start	61° 9.52' S	56° 1.30' W	150.4
PS79/200-1	2012-03-20	13:45:00	BT	profile end	61° 9.00' S	56° 5.27' W	178.9
PS79/201-1	2012-03-22	12:04:00	TRAPF	on ground/max depth	61° 9.12' S	56° 6.36' W	199.4
PS79/201-2	2012-03-22	12:37:00	TRAPF	on ground/max depth	61° 9.28' S	56° 5.75' W	192.4
PS79/202-1	2012-03-20	15:54:00	BT	profile start	61° 10.50' S	55° 55.65' W	124.9
PS79/202-1	2012-03-20	16:24:00	BT	profile end	61° 11.29' S	55° 51.94' W	121.1
PS79/203-1	2012-03-20	17:24:00	BT	profile start	61° 12.98' S	55° 52.64' W	136.7
PS79/203-1	2012-03-20	17:54:00	BT	profile end	61° 14.65' S	55° 54.61' W	158.0
PS79/204-1	2012-03-20	18:46:00	BT	profile start	61° 14.35' S	55° 48.88' W	131.8
PS79/204-1	2012-03-20	19:16:00	BT	profile end	61° 16.06' S	55° 47.31' W	146.9
PS79/205-1	2012-03-20	23:40:00	CTD/RO	on ground/max depth	60° 40.02' S	55° 39.41' W	3539.4
PS79/205-2	2012-03-21	01:34:00	CTD/RO	on ground/max depth	60° 40.37' S	55° 37.94' W	3537.5
PS79/206-1	2012-03-21	09:53:00	BT	profile start	60° 49.77' S	55° 37.25' W	479.7
PS79/206-1	2012-03-21	10:06:00	BT	profile end	60° 49.52' S	55° 38.64' W	470.6
PS79/206-2	2012-03-21	11:23:00	CTD/RO	on ground/max depth	60° 49.12' S	55° 40.77' W	480.5
PS79/207-1	2012-03-21	12:20:00	BT	profile start	60° 53.15' S	55° 36.47' W	174.8
PS79/207-1	2012-03-21	12:50:00	BT	profile end	60° 53.75' S	55° 40.16' W	137.1
PS79/208-1	2012-03-21	14:38:00	BT	profile start	60° 52.67' S	55° 28.80' W	243.7
PS79/208-1	2012-03-21	15:08:00	BT	profile end	60° 53.60' S	55° 25.68' W	240.8
PS79/209-1	2012-03-21	16:33:00	BT	profile start	60° 51.53' S	55° 30.25' W	290.2
PS79/209-1	2012-03-21	17:03:00	BT	profile end	60° 52.31' S	55° 26.71' W	291.8
PS79/210-1	2012-03-21	18:13:00	BT	profile start	60° 55.69' S	55° 27.43' W	116.2
PS79/210-1	2012-03-21	18:42:00	BT	profile end	60° 55.12' S	55° 24.56' W	198.9
PS79/211-1	2012-03-22	01:12:00	CTD/RO	on ground/max depth	61° 4.41' S	56° 0.40' W	253.9
PS79/211-2	2012-03-22	01:35:00	MUC	on ground/max depth	61° 4.49' S	56° 0.69' W	249.3
PS79/212-1	2012-03-22	02:26:00	MUC	on ground/max depth	61° 3.45' S	56° 2.59' W	554.5
PS79/213-1	2012-03-22	03:17:00	MUC	on ground/max depth	61° 4.68' S	56° 0.43' W	236.7
PS79/214-1	2012-03-22	16:00:00	BT	profile start	61° 2.58' S	55° 45.51' W	111.8
PS79/214-1	2012-03-22	16:30:00	BT	profile end	61° 0.70' S	55° 45.00' W	147.8
PS79/215-1	2012-03-22	18:13:00	CTD/RO	on ground/max depth	61° 5.29' S	55° 49.52' W	107.7
PS79/216-1	2012-03-22	20:21:00	BT	profile start	61° 4.84' S	55° 49.08' W	109.1
PS79/216-1	2012-03-22	20:51:00	BT	profile end	61° 3.04' S	55° 48.29' W	118.8
PS79/217-1	2012-03-22	23:13:00	CTD/RO	on ground/max depth	60° 54.17' S	56° 11.48' W	1855.5
PS79/217-2	2012-03-22	23:27:59	LD	on ground/max depth	60° 54.10' S	56° 11.45' W	1852.2
PS79/217-3	2012-03-23	00:19:00	MUC	on ground/max depth	60° 54.11' S	56° 11.43' W	1851.4
PS79/217-4	2012-03-23	02:04:00	MUC	on ground/max depth	60° 54.09' S	56° 11.39' W	1849.7
PS79/218-1	2012-03-23	09:46:00	BT	profile start	61° 0.53' S	55° 58.39' W	299.2

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/218-1	2012-03-23	10:16:00	BT	profile end	60° 58.89' S	55° 56.67' W	299.6
PS79/218-2	2012-03-23	11:11:00	CTD/RO	on ground/max depth	60° 58.79' S	55° 56.38' W	265.4
PS79/219-1	2012-03-23	12:11:00	BT	profile start	61° 0.68' S	55° 58.03' W	304.6
PS79/219-1	2012-03-23	12:41:00	BT	profile end	60° 59.18' S	55° 55.90' W	256.3
PS79/220-1	2012-03-23	14:12:00	BT	profile start	61° 2.59' S	55° 57.03' W	273.0
PS79/220-1	2012-03-23	14:42:00	BT	profile end	61° 0.80' S	55° 56.10' W	267.0
PS79/221-1	2012-03-23	16:04:00	BT	profile start	61° 3.33' S	55° 51.93' W	152.1
PS79/221-1	2012-03-23	16:34:00	BT	profile end	61° 1.51' S	55° 51.20' W	139.8
PS79/222-1	2012-03-23	17:57:00	BT	profile start	61° 7.03' S	55° 54.43' W	126.7
PS79/222-1	2012-03-23	18:27:00	BT	profile end	61° 5.29' S	55° 52.84' W	127.9
PS79/223-1	2012-03-23	19:02:01	TRAPF	on ground/max depth	61° 5.46' S	55° 49.76' W	0.0
PS79/223-2	2012-03-23	19:12:01	TRAPF	on ground/max depth	61° 5.68' S	55° 49.40' W	0.0
PS79/224-1	2012-03-23	21:39:59	LD	on ground/max depth	61° 6.55' S	56° 20.89' W	1088.3
PS79/224-2	2012-03-23	22:11:00	MUC	on ground/max depth	61° 6.73' S	56° 21.31' W	1095.1
PS79/224-3	2012-03-23	23:06:00	MUC	on ground/max depth	61° 6.83' S	56° 21.59' W	1184.5
PS79/224-4	2012-03-24	00:11:00	MUC	on ground/max depth	61° 6.76' S	56° 21.78' W	1201.1
PS79/225-1	2012-03-24	01:25:00	MUC	on ground/max depth	61° 5.41' S	56° 21.41' W	1311.8
PS79/226-1	2012-03-24	09:33:00	BT	profile start	60° 58.30' S	55° 55.25' W	212.7
PS79/226-1	2012-03-24	10:03:00	BT	profile end	60° 59.95' S	55° 55.46' W	244.3
PS79/226-2	2012-03-24	10:41:00	CTD/RO	on ground/max depth	61° 0.76' S	55° 55.02' W	228.4
PS79/227-1	2012-03-24	11:32:00	BT	profile start	61° 1.09' S	55° 50.69' W	140.2
PS79/227-1	2012-03-24	12:02:00	BT	profile end	60° 59.48' S	55° 49.28' W	152.5
PS79/228-1	2012-03-24	12:47:00	BT	profile start	60° 58.37' S	55° 47.38' W	201.1
PS79/228-1	2012-03-24	13:17:00	BT	profile end	60° 57.61' S	55° 44.24' W	193.0
PS79/229-1	2012-03-24	14:04:00	BT	profile start	60° 57.82' S	55° 40.59' W	88.8
PS79/229-1	2012-03-24	14:34:00	BT	profile end	60° 59.33' S	55° 42.32' W	97.2
PS79/230-1	2012-03-24	16:30:00	BT	profile start	61° 7.59' S	55° 42.35' W	64.0
PS79/230-1	2012-03-24	17:00:00	BT	profile end	61° 9.02' S	55° 40.55' W	82.7
PS79/231-1	2012-03-24	19:11:00	BT	profile start	61° 4.53' S	55° 54.58' W	168.6
PS79/231-1	2012-03-24	19:21:00	BT	profile end	61° 5.11' S	55° 54.49' W	157.6
PS79/232-1	2012-03-24	23:44:00	CTD/RO	on ground/max depth	61° 24.08' S	55° 21.41' W	324.2
PS79/233-1	2012-03-25	02:10:00	MUC	on ground/max depth	61° 33.92' S	55° 1.58' W	1602.0
PS79/233-2	2012-03-25	03:36:00	MUC	on ground/max depth	61° 33.91' S	55° 1.51' W	1597.0
PS79/234-1	2012-03-25	11:38:00	BT	profile start	61° 17.42' S	56° 1.25' W	279.7
PS79/234-1	2012-03-25	12:08:00	BT	profile end	61° 17.33' S	56° 5.06' W	306.1
PS79/235-1	2012-03-25	13:08:00	BT	profile start	61° 17.40' S	56° 12.57' W	328.5
PS79/235-1	2012-03-25	13:38:00	BT	profile end	61° 17.03' S	56° 16.37' W	316.1
PS79/235-2	2012-03-25	14:11:00	CTD/RO	on ground/max depth	61° 16.90' S	56° 18.50' W	311.4
PS79/235-3	2012-03-25	14:48:00	CTD/RO	on ground/max depth	61° 17.06' S	56° 18.59' W	308.9
PS79/236-1	2012-03-25	16:06:00	BT	profile start	61° 22.28' S	56° 10.24' W	293.1
PS79/236-1	2012-03-25	16:36:00	BT	profile end	61° 21.43' S	56° 7.01' W	323.5
PS79/237-1	2012-03-25	17:32:00	BT	profile start	61° 19.92' S	56° 1.97' W	343.1

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/237-1	2012-03-25	18:02:00	BT	profile end	61° 19.43' S	55° 58.96' W	325.6
PS79/238-1	2012-03-25	20:15:00	BT	profile start	61° 25.79' S	56° 7.17' W	297.6
PS79/238-1	2012-03-25	20:45:00	BT	profile end	61° 27.24' S	56° 4.65' W	280.2
PS79/239-1	2012-03-26	09:37:00	BT	profile start	61° 49.50' S	57° 23.61' W	277.5
PS79/239-1	2012-03-26	10:07:00	BT	profile end	61° 50.38' S	57° 20.50' W	271.9
PS79/239-2	2012-03-26	10:56:00	CTD/RO	on ground/max depth	61° 50.62' S	57° 19.93' W	275.5
PS79/240-1	2012-03-26	12:47:00	BT	profile start	61° 38.75' S	57° 5.83' W	463.6
PS79/240-1	2012-03-26	13:10:00	BT	profile end	61° 38.43' S	57° 8.83' W	469.0
PS79/240-2	2012-03-26	16:12:59	LD	on ground/max depth	61° 24.55' S	57° 7.54' W	829.4
PS79/241-1	2012-03-26	17:40:00	CTD/RO	on ground/max depth	61° 14.42' S	57° 4.53' W	1846.1
PS79/241-2	2012-03-26	17:53:59	LD	on ground/max depth	61° 14.35' S	57° 4.44' W	1852.1
PS79/241-3	2012-03-26	18:50:00	CTD/RO	on ground/max depth	61° 14.37' S	57° 4.25' W	1850.6
PS79/241-4	2012-03-26	20:03:00	MUC	on ground/max depth	61° 14.63' S	57° 3.45' W	1834.4
PS79/242-1	2012-03-27	09:38:00	BT	profile start	61° 35.88' S	57° 16.68' W	423.0
PS79/242-1	2012-03-27	10:08:00	BT	profile end	61° 35.55' S	57° 19.73' W	426.6
PS79/243-1	2012-03-27	11:59:00	BT	profile start	61° 38.21' S	57° 32.72' W	425.4
PS79/243-1	2012-03-27	12:11:00	BT	profile end	61° 38.15' S	57° 34.09' W	431.6
PS79/244-1	2012-03-27	13:41:00	BT	profile start	61° 38.86' S	57° 47.52' W	322.2
PS79/244-1	2012-03-27	14:11:00	BT	profile end	61° 38.80' S	57° 51.31' W	334.0
PS79/244-2	2012-03-27	14:58:00	CTD/RO	on ground/max depth	61° 38.90' S	57° 53.35' W	336.0
PS79/244-3	2012-03-27	15:54:59	LD	on ground/max depth	61° 41.17' S	58° 7.57' W	307.0
PS79/245-1	2012-03-27	18:13:00	BT	profile start	61° 45.20' S	58° 31.49' W	282.8
PS79/245-1	2012-03-27	18:43:00	BT	profile end	61° 45.94' S	58° 34.57' W	278.5
PS79/245-2	2012-03-27	19:42:00	CTD/RO	on ground/max depth	61° 47.32' S	58° 35.34' W	259.3
PS79/246-1	2012-03-27	23:22:59	LD	on ground/max depth	61° 42.88' S	59° 22.36' W	1011.7
PS79/247-1	2012-03-28	13:17:00	CTD/RO	on ground/max depth	62° 20.62' S	61° 27.10' W	327.4
PS79/247-2	2012-03-28	14:24:00	BT	profile start	62° 22.19' S	61° 25.78' W	325.4
PS79/247-2	2012-03-28	14:54:00	BT	profile end	62° 23.72' S	61° 24.45' W	353.3
PS79/248-1	2012-03-28	16:03:59	LD	on ground/max depth	62° 28.03' S	61° 21.66' W	146.1
PS79/248-2	2012-03-28	16:51:00	BT	profile start	62° 29.18' S	61° 24.57' W	120.3
PS79/248-2	2012-03-28	17:16:00	BT	profile end	62° 28.15' S	61° 21.92' W	141.3
PS79/249-1	2012-03-28	19:47:00	BT	profile start	62° 36.42' S	61° 50.45' W	181.1
PS79/249-1	2012-03-28	19:56:00	BT	profile end	62° 35.97' S	61° 50.33' W	178.4
PS79/249-2	2012-03-28	20:31:59	LD	on ground/max depth	62° 34.77' S	61° 48.85' W	164.9
PS79/250-1	2012-03-28	23:09:00	FLS	profile start	62° 29.75' S	62° 31.07' W	1066.8
PS79/250-1	2012-03-29	02:01:59	FLS	profile end	62° 51.95' S	61° 46.89' W	138.7
PS79/250-2	2012-03-28	23:30:59	LD	on ground/max depth	62° 32.42' S	62° 25.69' W	449.8
PS79/251-1	2012-03-29	11:18:00	CTD/RO	on ground/max depth	62° 11.65' S	60° 46.38' W	440.9
PS79/251-2	2012-03-29	12:18:00	BT	profile start	62° 11.23' S	60° 47.24' W	420.1
PS79/251-2	2012-03-29	12:48:00	BT	profile end	62° 9.78' S	60° 49.44' W	434.4
PS79/252-1	2012-03-29	15:21:00	BT	profile start	62° 23.80' S	60° 48.81' W	87.7
PS79/252-1	2012-03-29	15:51:00	BT	profile end	62° 24.28' S	60° 44.91' W	90.7

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/253-1	2012-03-29	17:28:00	BT	profile start	62° 19.44' S	60° 27.39' W	110.9
PS79/253-1	2012-03-29	17:58:00	BT	profile end	62° 20.28' S	60° 31.31' W	127.8
PS79/254-1	2012-03-29	20:27:00	BT	profile start	62° 5.51' S	60° 31.93' W	285.8
PS79/254-1	2012-03-29	20:57:00	BT	profile end	62° 6.43' S	60° 35.27' W	363.6
PS79/254-2	2012-03-29	21:44:00	CTD/RO	on ground/max depth	62° 7.39' S	60° 36.37' W	276.5
PS79/255-1	2012-03-29	23:47:00	MUC	on ground/max depth	62° 5.35' S	60° 11.99' W	370.5
PS79/256-1	2012-03-30	00:43:00	MUC	on ground/max depth	62° 2.25' S	60° 11.32' W	499.8
PS79/257-1	2012-03-30	09:33:00	BT	profile start	62° 1.63' S	59° 36.15' W	172.9
PS79/257-1	2012-03-30	09:49:00	BT	profile end	62° 0.71' S	59° 37.13' W	175.3
PS79/257-2	2012-03-30	10:32:00	CTD/RO	on ground/max depth	61° 59.80' S	59° 37.42' W	181.9
PS79/258-1	2012-03-30	12:03:00	BT	profile start	62° 6.64' S	59° 28.60' W	95.0
PS79/258-1	2012-03-30	12:33:00	BT	profile end	62° 5.29' S	59° 31.12' W	105.1
PS79/259-1	2012-03-30	14:42:00	BT	profile start	61° 59.99' S	59° 14.73' W	129.1
PS79/259-1	2012-03-30	15:08:00	BT	profile end	61° 59.97' S	59° 11.29' W	142.8
PS79/260-1	2012-03-30	16:37:00	BT	profile start	61° 51.74' S	59° 15.47' W	259.5
PS79/260-1	2012-03-30	17:07:00	BT	profile end	61° 50.50' S	59° 12.16' W	269.1
PS79/260-2	2012-03-30	17:44:00	CTD/RO	on ground/max depth	61° 50.12' S	59° 10.67' W	268.0
PS79/261-1	2012-03-30	18:51:00	BT	profile start	61° 50.22' S	59° 17.62' W	319.3
PS79/261-1	2012-03-30	19:01:00	BT	profile end	61° 49.84' S	59° 16.48' W	319.3
PS79/262-1	2012-03-30	23:05:59	LD	on ground/max depth	61° 14.73' S	59° 11.23' W	4420.3
PS79/262-2	2012-03-30	23:32:00	CTD/RO	on ground/max depth	61° 13.31' S	59° 11.32' W	4239.1
PS79/262-3	2012-03-31	01:30:00	CTD/RO	on ground/max depth	61° 13.28' S	59° 11.45' W	4233.1
PS79/263-1	2012-03-31	09:36:01	BT	profile start	61° 40.43' S	58° 51.46' W	366.1
PS79/263-1	2012-03-31	09:36:02	BT	profile end	61° 40.43' S	58° 51.46' W	366.1
PS79/263-2	2012-03-31	10:45:00	CTD/RO	on ground/max depth	61° 40.29' S	58° 50.38' W	369.3
PS79/263-3	2012-03-31	11:45:00	BT	profile start	61° 40.55' S	58° 51.64' W	368.4
PS79/263-3	2012-03-31	12:15:00	BT	profile end	61° 39.28' S	58° 48.89' W	406.0
PS79/264-1	2012-03-31	14:25:00	BT	profile start	61° 50.00' S	58° 40.01' W	192.1
PS79/264-1	2012-03-31	14:55:00	BT	profile end	61° 50.01' S	58° 36.33' W	189.1
PS79/265-1	2012-03-31	17:37:00	BT	profile start	61° 45.83' S	58° 30.09' W	278.6
PS79/265-1	2012-03-31	18:07:00	BT	profile end	61° 45.50' S	58° 25.77' W	279.7
PS79/266-1	2012-03-31	19:38:00	BT	profile start	61° 48.03' S	58° 29.24' W	205.1
PS79/266-1	2012-03-31	20:08:00	BT	profile end	61° 47.71' S	58° 25.11' W	209.0
PS79/266-2	2012-03-31	21:00:00	CTD/RO	on ground/max depth	61° 48.10' S	58° 23.23' W	203.5
PS79/267-1	2012-04-01	06:24:00	CTD/RO	on ground/max depth	62° 3.82' S	56° 15.32' W	2179.1
PS79/268-1	2012-04-01	11:41:00	BT	profile start	62° 15.61' S	55° 18.44' W	366.1
PS79/268-1	2012-04-01	12:11:00	BT	profile end	62° 13.77' S	55° 17.68' W	351.9
PS79/269-1	2012-04-01	16:18:00	BT	profile start	62° 27.59' S	55° 15.62' W	227.3
PS79/269-1	2012-04-01	16:43:00	BT	profile end	62° 26.14' S	55° 16.16' W	254.8
PS79/270-1	2012-04-01	21:05:00	CTD/RO	on ground/max depth	62° 27.38' S	55° 57.24' W	313.5
PS79/271-1	2012-04-02	02:18:00	MUC	on ground/max depth	62° 15.90' S	56° 53.37' W	1479.1
PS79/271-2	2012-04-02	02:12:59	LD	on ground/max depth	62° 15.89' S	56° 53.32' W	1478.6

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/272-1	2012-04-02	10:23:00	CTD/RO	on ground/max depth	62° 22.96' S	55° 52.35' W	283.8
PS79/272-2	2012-04-02	10:53:00	EF	profile start	62° 23.61' S	55° 50.14' W	245.4
PS79/272-2	2012-04-02	11:00:00	EF	on ground/max depth	62° 23.66' S	55° 50.36' W	245.9
PS79/272-2	2012-04-02	11:01:59	EF	profile end	62° 23.66' S	55° 50.39' W	246.3
PS79/273-1	2012-04-02	13:03:00	BT	profile start	62° 22.04' S	55° 57.65' W	336.6
PS79/273-1	2012-04-02	13:33:00	BT	profile end	62° 23.90' S	55° 58.36' W	348.5
PS79/274-1	2012-04-02	15:36:00	BT	profile start	62° 23.64' S	56° 5.33' W	409.2
PS79/274-1	2012-04-02	15:36:01	BT	profile end	62° 23.64' S	56° 5.33' W	409.2
PS79/274-2	2012-04-02	16:17:00	CTD/RO	on ground/max depth	62° 24.35' S	56° 4.54' W	402.4
PS79/275-1	2012-04-02	17:41:00	BT	profile start	62° 25.36' S	56° 13.61' W	425.3
PS79/275-1	2012-04-02	18:11:00	BT	profile end	62° 23.83' S	56° 11.34' W	450.1
PS79/276-1	2012-04-02	19:26:00	BN	profile start	62° 22.76' S	56° 9.80' W	446.5
PS79/276-1	2012-04-02	19:36:00	BN	profile end	62° 22.32' S	56° 9.06' W	446.0
PS79/277-1	2012-04-02	23:02:00	CTD/RO	on ground/max depth	62° 15.93' S	56° 53.93' W	1486.2
PS79/277-2	2012-04-03	00:04:00	CTD/RO	on ground/max depth	62° 15.92' S	56° 53.96' W	1486.2
PS79/278-1	2012-04-03	09:45:00	BT	profile start	62° 25.80' S	56° 12.58' W	425.9
PS79/278-1	2012-04-03	10:15:00	BT	profile end	62° 26.34' S	56° 16.46' W	422.6
PS79/278-2	2012-04-03	11:29:00	CTD/RO	on ground/max depth	62° 25.31' S	56° 18.12' W	438.6
PS79/279-1	2012-04-03	15:37:00	BT	profile start	62° 16.69' S	55° 49.96' W	302.3
PS79/279-1	2012-04-03	16:02:00	BT	profile end	62° 17.23' S	55° 46.64' W	324.3
PS79/280-1	2012-04-03	17:36:00	BT	profile start	62° 16.56' S	55° 47.73' W	329.7
PS79/280-1	2012-04-03	17:46:00	BT	profile end	62° 16.85' S	55° 46.42' W	337.7
PS79/280-2	2012-04-03	18:37:59	LD	on ground/max depth	62° 17.40' S	55° 46.35' W	322.8
PS79/281-1	2012-04-04	01:07:00	CTD/RO	on ground/max depth	62° 5.11' S	54° 32.45' W	738.3
PS79/281-2	2012-04-04	01:49:00	CTD/RO	on ground/max depth	62° 5.13' S	54° 32.21' W	736.6
PS79/282-1	2012-04-04	11:12:00	BT	profile start	61° 10.54' S	55° 41.61' W	88.5
PS79/282-1	2012-04-04	11:42:00	BT	profile end	61° 12.24' S	55° 41.59' W	96.1
PS79/282-2	2012-04-04	12:13:00	CTD/RO	on ground/max depth	61° 13.14' S	55° 41.91' W	100.9
PS79/283-1	2012-04-04	13:58:00	BT	profile start	61° 1.75' S	55° 48.50' W	122.8
PS79/283-1	2012-04-04	14:28:00	BT	profile end	61° 2.64' S	55° 51.58' W	150.8
PS79/284-1	2012-04-04	15:47:00	BT	profile start	61° 0.31' S	55° 51.01' W	154.2
PS79/284-1	2012-04-04	16:17:00	BT	profile end	60° 59.14' S	55° 53.76' W	185.6
PS79/285-1	2012-04-04	17:41:00	BT	profile start	61° 1.12' S	55° 56.24' W	275.2
PS79/285-1	2012-04-04	18:11:00	BT	profile end	61° 2.97' S	55° 57.18' W	272.5
PS79/286-1	2012-04-04	19:23:00	BT	profile start	61° 0.16' S	55° 53.06' W	165.8
PS79/286-1	2012-04-04	19:53:00	BT	profile end	61° 1.65' S	55° 54.14' W	213.3
PS79/286-2	2012-04-04	20:30:00	CTD/RO	on ground/max depth	61° 2.24' S	55° 54.72' W	222.7
PS79/287-1	2012-04-05	00:48:00	CTD/RO	on ground/max depth	60° 30.00' S	55° 30.75' W	3644.2
PS79/287-2	2012-04-05	02:30:00	CTD/RO	on ground/max depth	60° 30.04' S	55° 30.89' W	3643.5
PS79/288-1	2012-04-05	09:55:00	BT	profile start	60° 56.92' S	55° 9.22' W	266.2
PS79/288-1	2012-04-05	10:19:00	BT	profile end	60° 57.91' S	55° 7.07' W	305.0
PS79/288-2	2012-04-05	11:08:00	CTD/RO	on ground/max depth	60° 59.08' S	55° 7.74' W	288.2

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS79/289-1	2012-04-05	12:20:00	BT	profile start	60° 58.76' S	55° 9.71' W	256.4
PS79/289-1	2012-04-05	12:50:00	BT	profile end	60° 58.26' S	55° 6.35' W	307.6
PS79/290-1	2012-04-05	15:49:00	BT	profile start	61° 2.15' S	54° 52.79' W	288.0
PS79/290-1	2012-04-05	16:19:00	BT	profile end	61° 1.96' S	54° 56.54' W	333.5
PS79/290-2	2012-04-05	19:59:00	CTD/RO	on ground/max depth	61° 0.92' S	55° 3.61' W	154.4
PS79/291-1	2012-04-06	01:06:59	LD	on ground/max depth	60° 24.21' S	56° 12.54' W	3905.9
PS79/292-1	2012-04-06	02:52:59	LD	on ground/max depth	60° 9.88' S	56° 37.45' W	3780.6
PS79/293-1	2012-04-06	07:15:59	LD	on ground/max depth	59° 34.45' S	57° 38.53' W	3533.0
PS79/294-1	2012-04-06	12:12:59	LD	on ground/max depth	58° 54.08' S	58° 47.09' W	4189.6
PS79/295-1	2012-04-06	16:02:59	LD	on ground/max depth	58° 22.11' S	59° 40.36' W	3641.1

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