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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2013 (ANT-XXIX/3)

Edited by
Julian Gutt
with contributions of the participants

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ANT-XXIX/3

22 January - 18 March 2013

Punta Arenas - Punta Arenas

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Coordinator
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1. ÜBERBLICK UND FAHRTVERLAUF

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Die Expedition ANT-XXIX/3 (PS81) begann am 22. Januar in Punta Arenas (Chile) mit knapp zweitägiger Verspätung wegen eines Kranschadens und damit verbundener Ladungsprobleme. Schon vor Antritt der Reise stand fest, dass wegen der schwierigen Eisbedingungen das Erreichen der drei geplanten Untersuchungsgebiete, Larsen A/B (marine Ökosystemforschung), Larsen C (physikalische Ozeanografie) und östlich der Spitze der Antarktischen Halbinsel im Weddellmeer (Krillforschung), schwer bis unmöglich werden würde. Dasselbe galt auch für die meisten direkt benachbarten Ausweichgebiete. An Bord fanden intensive Gespräche statt, um alternative Pläne zu konkretisieren. Dabei wurde deutlich, dass das Ineinandergreifen von physikalischer Ozeanografie, Bathymetrie und allgemeiner Meeresbiologie nicht mehr so zu realisieren war, wie es für die spezifischen wissenschaftlichen Fragestellungen im Larsen-Gebiet geplant war.

Die großen Arbeitsgruppen entschlossen sich zu den folgenden Ersatzprogrammen. Das Projekt zur Erforschung der Tiefenwasserbildung im westlichen Weddellmeer sollte ursprünglich, aufbauend auf Ergebnissen von ANT-XVIII in 2000 (Schröder et al., 2002) und ANT-XXII/2 (ISPOL, Absy et al., 2008; Hellmer et al., 2008; Huhn et al., 2008), insbesondere vor dem Larsen C Schelfeis nahe den Quellregionen des Tiefenwassers, aber auch in den Larsen A and B Buchten stattfinden. Die Untersuchungen sollten nun in ein Gebiet zwischen 60° und 65°S so verlegt werden, dass die Ausbreitung der neu gebildeten Wassermasse nach Norden, entlang des Schelfhanges in das Powell-Becken hinein, verfolgt werden konnte. Dazu wurden Stationen auf fünf quasi zonalen Transekten bis 50°W geplant, an Hand derer stromab auch der Verbleib des kalten Tiefenwassers aus dem südlichen Weddellmeer zu rekonstruieren ist. Ein weiterer meridionaler Transekt auf 55°W und zwei Schnitte über die Bransfieldstraße bei ca. 58°W sowie nördlich von Livingston Island ergänzt das physikalisch ozeanografische Programm, um den Einfluss von Weddellmeer-Wasser auf die östliche Bransfieldstrasse und den tiefen Gegenstrom am Fuß des Kontinentalsockels in der Drake Passage abschätzen zu können.

Die ursprüngliche Planung des Krill- und Planktonprogramms hatte zum Ziel, zwischen 63°S und 66°S nach Süden in das Weddellmeer vorzustoßen und dort erstmals standardisierte Untersuchungen an potentiellen Krillbeständen und Planktongemeinschaften durchzuführen. Eine offene Frage war, ob im Weddellmeer eine unabhängige Krillpopulation existiert, die entweder Krilllarven in das Scotiameer entlässt oder sogar einen Teil der hohen Krillkonzentrationen im Südwest-Atlantik ausmacht. Die schwierige Eissituation machte eine Modifizierung des ursprünglichen Plans notwendig, wodurch ein gemeinsames Stationsnetz mit dem Programm der physikalischen Ozeanografie entwickelt wurde. Das alternative Untersuchungsgebiet deckte nun das Gebiet zwischen 60°S und 65°S ab, wobei die Stationen teilweise in eisfreiem Wasser der östlichen Bransfield Straße auf einem Nord-Süd-Schnitt bei 55°W lagen. Diese Verlagerung nach Norden sollte auch weiterhin Untersuchungen in einem Gebiet mit Weddellmeer-Ausstrom unter weniger schwierigen Eisbedingungen erlauben. Außerdem können Proben von diesen Stationen Auskunft darüber geben, wie sich die Krillpopulation und die Planktongemeinschaft im Vergleich zu dem Gebiet westlich der Antarktischen Halbinsel zusammensetzen. Das ursprüngliche Ziel blieb somit weitgehend erhalten, auch wenn im südlichen Bereich ein Teil der Probennahme ausgefallen ist.

Bei dem ursprünglichen benthologisch-dominierten allgemeinbiologischen Vorhaben wäre es um die Reaktion des marinen Ökosystems auf das Wegbrechen der Larsen A und B Schelfeisgebiete gegangen. Dabei wären Arbeiten fortgeführt worden, die erstmalig während ANT-XXIII/3 im Rahmen des Census of Antarctic Marine Life (CAML, Gutt et al., 2011) und ANT-XXVII/3 erfolgten. Insbesondere der angenommene Wechsel von einem deutlich oligotrophen zu einem „normalen" Antarktischen System hätte dabei im Mittelpunkt gestanden.

Das Ersatzprogramm griff diesen ökologischen Gedanken auf und stellt, ebenso wie das ursprüngliche Projekt, einen wesentlichen Beitrag zum neuen SCAR-Biologie-Programm „Antarctic Thresholds - Ecosystem Resilience and Adaptation" (AnT-ERA) dar. Es wurde ein Ansatz gewählt, innerhalb dessen benthische Strukturen sowie Prozesse untersucht wurden und der sowohl eine großräumige als auch eine mittelskalige Komponente hatte. Diesem Konzept lag die Annahme zu Grunde, dass es Unterschiede in Qualität und Quantität der Nahrungsverfügbarkeit für unterschiedliche Benthoskomponenten (mobile und sessile Fauna, Epi- und Infauna, Mega-, Makro-, Meiofauna), zwischen den Gebieten westliches Weddellmeer (WS), Bransfieldstrasse (BS) und Drake Passage westlich der South Shetland Inseln (DP) gibt. Als Basis dafür dienten langjährige Ergebnisse zur sommerlichen Primärproduktion in der euphotischen Zone (Bracher et al., pers. comm.), die mittlere sommerliche Meereisbdedeckung, die Bodenwassertemperatur (Clarke et al., 2009) sowie zwei Bestandsaufnahmen des Makrobenthos, vor der eine auf fischereibiologische Beifänge (Lockhart and Jones, 2008), die andere auf eine benthosökologische Studie (Piepenburg et al., 2002) zurückgeht. Zusätzlich wurde davon ausgegangen, dass es, bedingt durch Bodentopografie und Strömung, auch innerhalb der Untersuchungsgebiete solche Unterschiede, insbesondere mit Folgen für die Nahrungsverfügbarkeit gibt. Daraus ergab sich ein Stationsdesign, das großräumige Untersuchungen (zwischen Untersuchungsgebieten) mit mittelskaligen (innerhalb der Gebiete, zwischen mehreren Kernstationen) verschachtelt, so dass für die einzelnen Gebiete repräsentative Ergebnisse zu erwarten sind. Gleichzeitig sind so auch Vergleiche auf verschiedenen räumlichen Skalen entlang von ökologischen Gradienten möglich. Insbesondere der auf den repräsentativen mittelskaligen Ergebnissen aufbauende großräumige Vergleich stellt die Basis für die Entwicklung von Zukunftsszenarien für benthische Lebensgemeinschaften bei anhaltenden klimabedingten Umweltveränderungen, z.B. in Nahrungsverfügbarkeit, Temperatur und Eisbedeckung, dar.

Als Proxi für die mittelskalige Nahrungsverfügbarkeit diente die heterogene Meeresbodentopografie, weil sie maßgeblich die bodennahe Strömung beeinflusst. Hierfür wurden innerhalb einer Kernstation vier verschiedene Habitate ausgewählt: flache Bank (ca. 200 m), oberer exponierter Hang (ca. 270 m), tieferer Hang (ca. 450 m) und Canyon (ca. 500 m). Dieses Konzept beinhaltete, dass alle

Beprobungsgeräte, einschließlich RMT-Netz für Krillfänge, CTD-Messungen und Wasserproben, auf allen Stationen eingesetzt werden sollten. Begleitende regionale Meeresbodenvermessungen in den einzelnen Untersuchungsgebieten würden außer ihrem Selbstzweck wertvolle Informationen zur Detailplanung des biologischen Stationsdesigns und für die spätere Interpretation entsprechender Ergebnisse erbringen. Obwohl zu erwarten war, dass auf Grund der Sedimenteigenschaften nicht alle Geräte überall eingesetzt werden können, erlaubt dieses Konzept trotzdem, für alle Kernstationen eine, wenn auch nicht komplette, Aussage über jede Fraktion des Benthos treffen zu können. In der Drake Passage und im Weddellmeer wurde das Stationsdesign dem Fehlen einzelner Habitate durch Reduzieren der einzelnen Stationen pro Kernstation oder Modifikation der Habitat-Definitionen angepasst.

Nach dem Auslaufen aus Punta Arenas in westliche Richtung durchquerte *Polarstern* die Drake-Passage und erreichte am 26. Januar ein teilweise eisbedecktes Gebietes an der Spitze der Antarktischen Halbinsel nördlich von Joinville Island. Dort wurden in einem später der Bransfield Straße zugerechneten Habitat für ca. zwei Tage erste Benthosbeprobungen (Multicorer, Dredgen, bildgebende Methode OFOS, Kastengreifer) durchgeführt und, je nach Eislage, lokal durch bathymetrische Vermessungen unterstützt (Abb. 1.1). Anschließend begab sich *Polarstern* auf eine Serie von Transekten (F, G, D, E, C, B), die der Krillforschung im Rahmen von CCAMLR und der Ozeanografie zur Erforschung der Bildung des Tiefenwassers, bzw. dessen Fluss nach Norden gleichermaßen dienten. Die CTD-Stationen wurden trotz hoher Eisbedeckung mit wenigen Lücken bis zum 7. Februar erfolgreich und -wie geplant- quasi synoptisch abgearbeitet. Das RMT-Netz kam an insgesamt 70 % der alternativ geplanten Stationen erfolgreich zum Einsatz. Die Benthosarbeiten wurden küstennah im Weddellmeer am östlichen Ausgang des Antarktischen Sunds im Erebus und Terror Golf fortgesetzt. Anschließend gab es vom 11. bis 18. Februar zwei Krill-/Ozeanografie-Schnitte weiter im Süden (A, O), die am nördlichen Rand des ursprünglichen Krill-Untersuchungsgebietes lagen.

Am 18. Februar fiel die endgültige Entscheidung, den Plan, das Larsengebiet doch noch zu erreichen, aufzugeben. Nach Satellitenbildern schien es unmöglich, in den inneren Buchten zu arbeiten. Ein nur schmaler Streifen offenen Wassers vor Larsen A, dessen ungewisse Zukunft, umgeben von solidem Meereis, und der Weg dorthin durchs Eis (und zurück) ließen ein Erreichen und dortiges Arbeiten gänzlich ineffizient bis unmöglich erscheinen.

Während der oben erwähnten Krill-/Ozeanografie-Schnitte im Weddellmeer auf der Höhe des Antarktischen Sundes hatte *Polarstern* eine auffällig flache Stelle überfahren, auf die sich nun für 2,5 Tage alle Beprobungs-Anstrengungen richteten. Diese flache Bank stellte ein interessantes Objekt für die Erforschung der pelago-benthischen Kopplung, der sie treibenden ökologischen Kräfte und für die evolutive sowie ökologische Ausbreitung von Meerestieren dar. Möglicherweise handelt es sich um einen an der Spitze abgetragenen Vulkan. Während starker Winde hielt eine Kette gestrandeter Eisberge das Meereis von dieser Stelle fern.

Am 22. Februar durchfuhr *Polarstern* den Antarktischen Sund und die Biologen setzten die benthologisch-dominierten Arbeiten gemäß dem oben geschilderten Konzept auf dem Schelf der Halbinsel in der Bransfieldstrasse fort, unterbrochen von einem kurzen ozeanografischen Schnitt incl. Krillfängen. Hier wurden die vier verschiedene Habitaten (flache Bank, oberer exponierter Hang, tieferer Hang und Canyon) konsequent von allen Geräten - mit einigen Ausnahmen, z.B. keine Multicorer auf steinigem Grund - beprobt. Dieses Konzept wurde auf alle drei Kernstationen angewendet. So wird es für jedes dieser ca. 15 x 10 km großen Areale (=Kernstation) ein umfangreiches Bild der benthischen Artenzusammensetzungen von der Meio- bis zur Megafauna vor dem Hintergrund der sie prägenden ökologischen Prozesses und Umweltparameter geben. Nach Abschluss dieser Arbeiten auf dem Schelf der Halbinsel wurde auf einer Station der Krater von Deception Island ozeanografisch insbesondere in Hinblick auf Spurenstoffe beprobt. Am 7. März erreichte *Polarstern* das Gebiet nördlich der South Shetland Inseln, wo das oben geschilderte ökologische Konzept zur allgemeinen Meeresbiologie auf drei Kernstationen mit reduziertem Aufwand umgesetzt wurde. Das meeresbiologische Alternativprogramm mit benthologischem Schwerpunkt in den drei Gebieten Weddellmeer, Bransfielstraße und Drake Passage, das einem verschachtelten Konzept auf verschiedenen räumlichen Skalen folgten und Beprobungen auf gesamte neun Kernstationen mit je bis zu vier Einzelstationen umfasste, wurden einschließlich der bathymetrischen Vermessungen am 12. März erfolgreich und vollständig abgeschlossen. Die ozeanografischen Arbeiten wurden mit einem kurzen Schnitt nördlich von Livingston Island am 13. März beendet. Die wissenschaftlichen Walzählungen aus dem Helicopter wurden während der gesamten Reise durchgeführt, sofern die Wetterbedingungen es erlaubten. Besonders östlich der Antarktischen Halbinsel verhinderten tief hängende Wolken und Nebel oftmals über mehrere Tage Zählflüge. In den eisbedeckten Gewässern östlich der Antarktischen Halbinsel lag der Fokus auf der Erfassungen der Verteilung von Antarktischen Zwergwalen in Beziehung zur Meereisbedeckung. Das zeitweilig unerwartet gute Wetter in der Drake Passage erlaubte dann weitere intensive Walzählflüge nördlich der South Shetland Inseln, die eine höhere Artenvielfalt und höhere Individuendichte als östliche der Halbinsel zeigten. Auf insgesamt 40 Flügen erfolgten 267 Sichtungen mit insgesamt 669 Individuen von 7 Walarten.

Je ein Beobachter/Beobachterin aus Argentinien und Chile waren wegen beantragter Forschungsgenehmigungen in den Hoheitsgewässern für die gesamte Expedition an Bord.

Ein zweiköpfiges ZDF-Team berichtete in Nachrichtensendungen, Magazinen und einem Blog über die Expedition und bereitet mehrere Fernsehdokumentationen vor. Ein weiterer Blog im Rahmen der Association of Polar Early Career Scientists (APECS) wurde von den Jungwissenschaftlern an Bord gestaltet.

Die Reise endete am 18. März wegen der oben genannten logistischen Probleme einen Tag verfrüht in Punta Arenas.

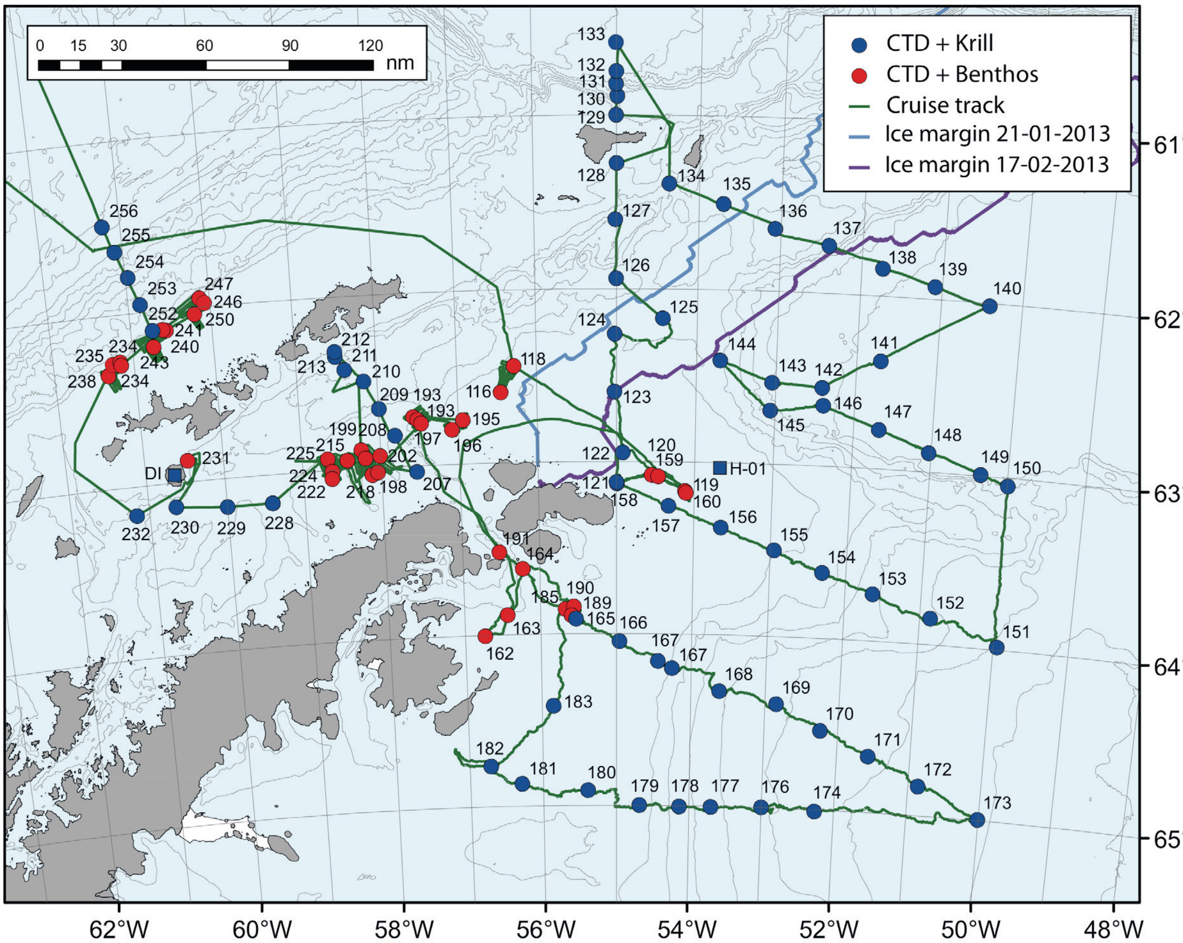

Abb. 1.1: Kursplot der Polarstern-Expedition ANT-XXIX/3 mit CTD+Krill- sowie CTD+Benthos-Stationen; Bathymetrie: AWI Bathymetrische Arbeitsgruppe/IBCSO

Fig. 1.1: Course plot of the expedition ANT-XXIX/3 of Polarstern with CTD+krill and CTD+benthos stations; bathymetry: AWI bathymetric working group/IBCSO

SUMMARY AND ITINERARY

Expedition ANT-XXIX/3 (PS81) started in Punta Arenas, Chile, on 22 January after a delay of almost two days due to crane damage and consequential loading problems. Due to the difficult ice conditions it was already known from the beginning that it would be difficult to reach the three planned study areas, Larsen A/B (marine ecosystem research), Larsen C (physical oceanography) and east of the tip of the Antarctic Peninsula in the Weddell Sea (krill research), as well as adjacent areas. It became obvious that the integration of physical oceanography, bathymetry and general marine biology could not be realized anymore, as it had been planned for the Larsen-specific scientific questions. Therefore, once on board the larger working groups substantiated the alternative plans as described below.

The project to investigate the formation of deep water in the western Weddell Sea should have been carried out off the Larsen C ice shelf close to its source area, based on results from ANT-XVIII, 2000 (Schröder et al., 2002) and ANT-XXII/2 (ISPOL, Absy et al., 2008, Hellmer et al., 2008, Huhn et al., 2008) and also within the Larsen A and B embayments. The region of investigation was shifted to an area between 60°S and 65°S where the northward expansion of the newly formed water mass along the continental slope into the Powell Basin could be followed. Stations were planned along five quasi-zonal transects until 50°W, of which the results can also provide a basis to reconstruct the fate of the cold deep water originating in the southern Weddell Sea. Other meridional transects at 55°W and approximately 58°W in the Bransfield Strait and north of Livingston Island complemented the physical oceanography program, which aims to estimate the proportion of Weddell Sea water in the eastern Bransfield Strait and in the deep counter current of the Drake Passage.

The original planning of the krill and plankton program had the aim to reach an area in the Weddell Sea between 63°S and 66°S to carry out the first standardised survey on potential krill stocks and plankton communities. It was an open question of whether an independent krill population exists in the Weddell Sea, which either releases krill larvae into the Scotia Sea or contributes to the high density of krill in the Southwest Atlantic. The difficult ice situation demanded a modification of the original plan, leading to a joint station design with the physical oceanographers. The study area was shifted northward between 60°S and 65°S with stations in partly ice-free areas in the eastern Bransfield Strait on a north-south transect at 55°W. This shift of the study area to the north should allow, nevertheless, a survey in an area of the outflow from the Weddell Sea in less difficult ice conditions. These stations can also provide information about the composition of krill populations and plankton communities in the area west of the Antarctic Peninsula. Based on this concept the original aim could be maintained, even though stations were cancelled in the southern margin of the study area.

The original approach of general biology, which mainly focused on the benthos, was centred around the response of the marine system to the disintegration of the Larsen A and B ice shelves. This would have continued surveys initiated during

ANT-XXIII/3 in the framework of the Census of Antarctic Marine Life (CAML; Gutt et al., 2011) and also conducted during ANT-XXVII/3. The assumed turn-over from an oligotrophic to a "normal" Antarctic system had been the focus.

The alternative program was consistent with this general ecological idea and also contributes to SCAR's new biology program "Antarctic Thresholds - Ecosystem Resilience and Adaptation" (AnT-ERA). An approach had been decided that considered benthic patterns and processes both at large and intermediate spatial scales. It was assumed that differences in the quality and quantity of food supply for different ecological guilds exist (mobile and sessile fauna, epi- and infauna, mega-, macro- and meiofauna) between an area east of the tip of the Antarctic Peninsula in the Weddell Sea (WS), in the Bransfield Strait (BS) and west of the South Shetland Islands in the Drake Passage (DP). This assumption is derived from long-term results on the seasonal summer primary production in the euphotic zone (Bracher et al., pers. comm.), averaged summer sea-ice cover, bottom water temperature (Clarke et al., 2009), and two macrobenthic community studies, one based on by-catches from scientific fishery surveys (Lockhart and Jones, 2008) and the other on a scientific benthos survey (Piepenburg et al., 2002). In addition, it was assumed that differences in food availability to the benthos within these areas are influenced by bottom topography and currents. These ideas resulted in a nested approach that covered large-scale investigations (between study areas) and intermediate-scales (within study areas, between core stations). This may provide representative results for single areas and will allow comparisons at larger spatial scales along ecological gradients. The large-scale comparison will contribute to the development of future scenarios for benthic communities in case of ongoing climate-induced environmental changes, e.g., in terms of in food availability, temperature and ice cover.

The heterogeneous bottom topography served as a proxi for food availability because topography considerably affects the near bottom current. Four different habitats were selected within each core station, a location for a suite of benthic work: shallow bank (approximately 200 m), upper exposed slope (approximately 270 m), deeper slope (approximately 450 m), and canyon (approximately 500 m). This concept comprised the deployment of all general sampling equipment including the RMT-net for krill catches, CTD-measurements and water samples at all stations. Additionally, regional bathymetric surveys in the study areas should provide valuable information for general bathymetric studies, for the detailed planning of the sampling design and later for the interpretation of the biological results. Although it could be expected that some gear could not be used at all stations mainly due to sediment characteristics, this concept provides results for major benthic components at these core stations. This concept and sampling design was adjusted for the area east of the Antarctic Peninsula and north of the South Shetland Islands in the Drake Passage by reducing the number of sampling sites per core station or modified definitions of the habitats since not all ecological scenarios were present at each station.

After leaving Punta Arenas to the west *Polarstern* crossed the Drake Passage and arrived at an ice-covered area north of Joinville Island and near the tip of the Antarctic Peninsula on 26 January. A first benthos station was sampled for two days using the multi-corer, imaging gear OFOS, box-corer, and dredges attributed later to the Bransfield Strait area. Depending on the ice conditions these activities were complimented by a local bathymetric survey. After that *Polarstern* carried out a number of transects (F, G, D, E, C, B), which formed a major part of the krill research (in the context of CCAMLR) and the physical oceanography study of the fate of newly formed deep bottom water (Fig. 1.1). The CTD-stations were successfully completed, as planned, quasi-synoptically until 7 February despite high ice cover. The RMT-net was deployed successfully at 70 % of these alternatively planned stations. The benthos work resumed in the Weddell Sea at the south-eastern entrance of the Antarctic Sound in the Erebus and Terror Gulf. Two more krill/CTD transects were conducted in the south (A, O) from 11 to 18 February. These were situated at the northern margin of the originally planned krill research box.

It was finally decided on 18 February to give up reaching the Larsen areas. Based on satellite and radar images it appeared impossible to work in the inner embayments. There was a narrow strip of open water in front of Larsen A, but it was surrounded by solid sea-ice. There was no clear way through the ice to reach this open water and no guarantee for *Polarstern*'s return. Because of the unpredictable trajectories of the ice, there was no argument to reach and work in this small area of open water. During one of the krill/CTD transects *Polarstern* crossed a very shallow area, which became the focus of the ecological sampling for the next 2.5 days. This shallow bank was an interesting object for research on pelagic-benthic coupling of the ecological drivers, and of evolutionary as well as ecological dispersal of marine organisms. This shallow bank is probably a capped volcano. During a phase of strong winds a chain of grounded icebergs kept the sea-ice from this site.

Polarstern passed through the Antarctic Sound on 22 February and the general marine biologists continued their benthos work on the shelf of the Antarctic Peninsula in the Bransfield Strait as described above. A short oceanographic transect with krill catches was also completed on this side of the Sound. At the four different habitats (bank, upper slope, slope, canyon) all sampling equipment was deployed with minor exceptions, e.g., no multicorer on gravely sediments. The strategy was applied to all three core stations, each comprising four habitats. Consequently, for each of these core stations a comprehensive image of their benthic composition can be achieved, ranging from meio- and macro- to megafauna with some benthic-pelagic coupling processes, which shape this structure. After station work on the shelf of the Antarctic Peninsula was finished, a station in the crater of Deception Island was sampled oceanographically, especially for trace elements. *Polarstern* reached the area north of the South Shetland Islands in the Drake Passage 7 March where general marine biological research was conducted at three core stations with reduced effort. The alternative benthologically-dominated sampling targeting three areas in the Weddell Sea, Bransfield Straight, and Drake Passage at different spatial scales and applying a nested approach ended 12 March after completing a total of nine core stations with up to four single stations each, including the bathymetric surveys. Finally, the oceanographic work finished with a short transect north of Livingston Island on 13 March.

The scientific observations and counting of whales were mainly carried out throughout the cruise depending on weather conditions. Especially east of the Antarctic Peninsula fog and low clouds often prevented survey flights. East of the peninsula the major scientific focus was the distribution of Antarctic minke whales in relation to sea-ice conditions. Unexpectedly, good weather conditions in the Drake Passage allowed several successful whale survey flights north of the South Shetland Islands, which showed higher numbers of species and an overall higher whale density than in the area east of the peninsula. During 40 surveys a total of 267 sightings of 669 individuals belonging to 7 species were recorded.

An observer from Argentina and one from Chile were on board in accordance with their respective country's research permits of the *Polarstern* in territorial waters.

A two person broadcast team from the ZDF (Zweites Deutsches Fernsehen) reported about the expedition to the news station, news magazines, a blog, and prepared documentaries throughout the cruise. Younger scientists on board designed another blog for the Association of Polar Early Career Scientists (APECS).

The expedition ended in Punta Arenas, Chile, on 18 March, one day earlier than scheduled due to the logistic problems described above.

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2. WEATHER CONDITIONS

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Polarstern sailed out on 22 January. The ship aimed at the north western part of the Weddell Sea, in direction of the shelf ice area edge of Larsen A/B. The ship steamed in direction of the western entrance of the Magellan Strait, then further on to the north eastern end of the Antarctic Peninsula. The weather was good with fine visibility without precipitation, a rare occurrence in this area, that is frequently influenced by weather fronts or troughs and westerly winds.

Finally the South Pacific was reached and a southern course was set. At this time strong westerly winds blew at the southern edge of a high in front of the Chilean coast. Behind a low near South Georgia the wind direction shifted to southwest and the ship moved heavily. On 25 January the ship reached the north eastern part of the Bransfield Strait. At the southern edge of the frontal zone weather fronts and troughs passed the ship accompanied by quickly changing weather conditions and sometimes stormy westerly winds. Inside the ice fields the ship was protected against wind force 8 to 9, which caused wave heights up to 8 m in the free water north of the pack ice. After appropriate weather prediction and decrease of the wave height the ship entered free water.

Until end of January and beginning of February the weather was changeable with occasionally poor visibility and deep clouds, unfortunately also passing the Antarctic Sound. The north western part of the Weddell Sea was entered. Now several cyclones moved from the Drake Passage eastward and developed in lee of the Antarctic Peninsula as secondary lows. They intensified and moved eastward across the northern part of the Weddell Sea. Thus there was a change of northerly, later south westerly winds, frequently accompanied by snow and rain, deep clouds and quite often poor visibility. There were only short time windows with sufficient flight conditions for whale watching by helicopter, ice detection flights or other scientific work based on helicopter transport.

During mid-February a new lee cyclone nearby east of the Peninsula developed heavily. It moved at the northern edge of Weddell Sea eastward and intensified further on. In the post cold-frontal weather there blew a stormy south westerly wind for more than 48 hours, by which the dense ice fields surrounding Larsen A and B drifted northward (Figs 2.1 & 2.2). The ship had to break through dense ice fields when returning towards the Bransfield Strait. This time the passage through the Antarctic Sound occurred during beautiful and cold weather with magnificent view.

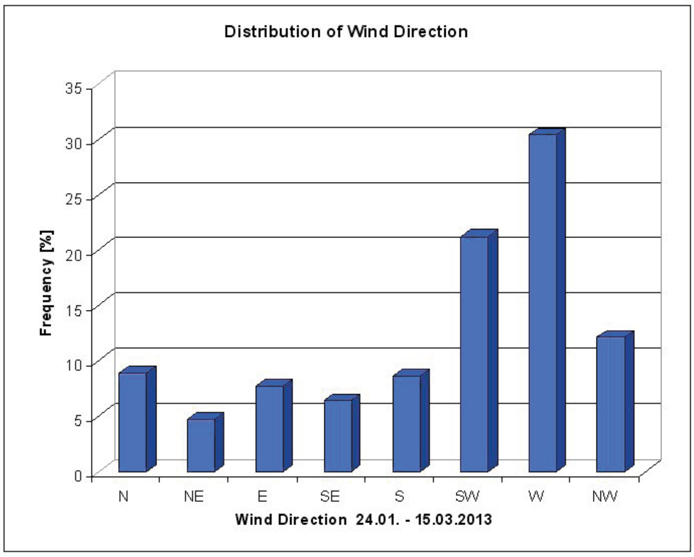

Fig. 2.1: Distribution of wind direction

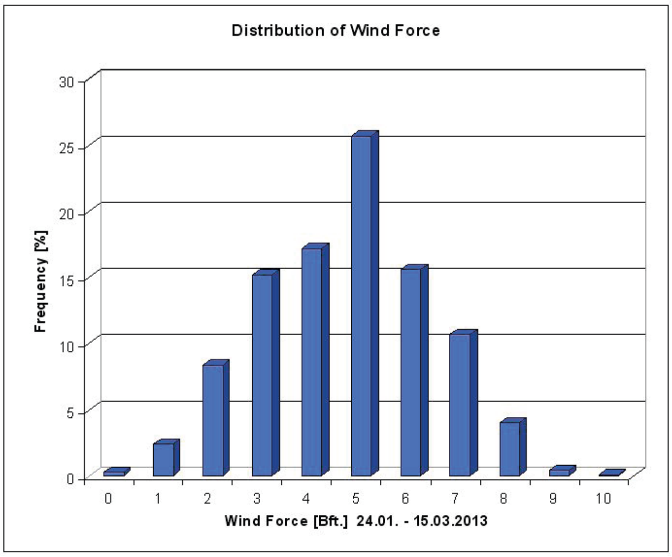

Fig. 2.2: Distribution of wind force

During the next two weeks Bransfield Strait was intended as research area. The weather was imprinted by a an extensive low over South Pacific and Amundsen Sea, high pressure influence southwest and southeast of Tierra del Fuego and secondary lows over eastern Weddell Sea. During moderate pressure differences weather troughs and fronts crossed the ship during again bad flight conditions, i.e. poor visibility and deep ceiling / clouds (Figs 2.3 & 2.4). At the end of February the pressure differences increased and intensive cyclones approached from Drake Passage. The westerly wind blew sometimes stormy. Further intensive low systems followed during the end of February and the beginning March. A preliminary end of this situation was done by a stormy low that aimed from an area 600 km west of Cape Horn to the region south of the South Shetland Islands. It caused an interruption of scientific outside work.

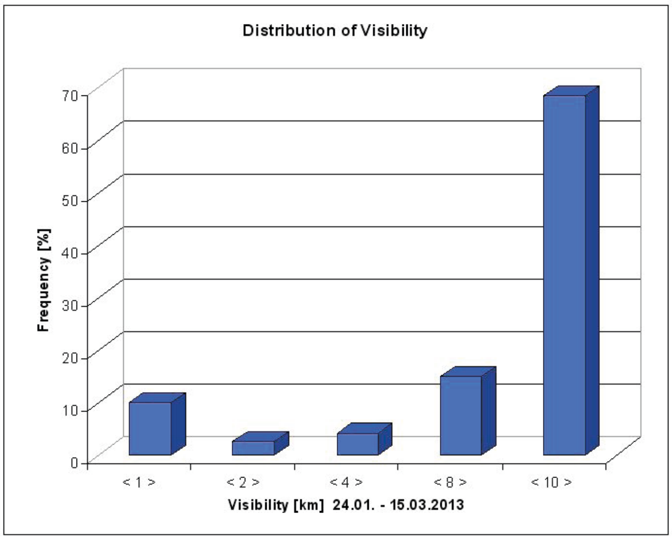

Fig. 2.3: Distribution of visibility

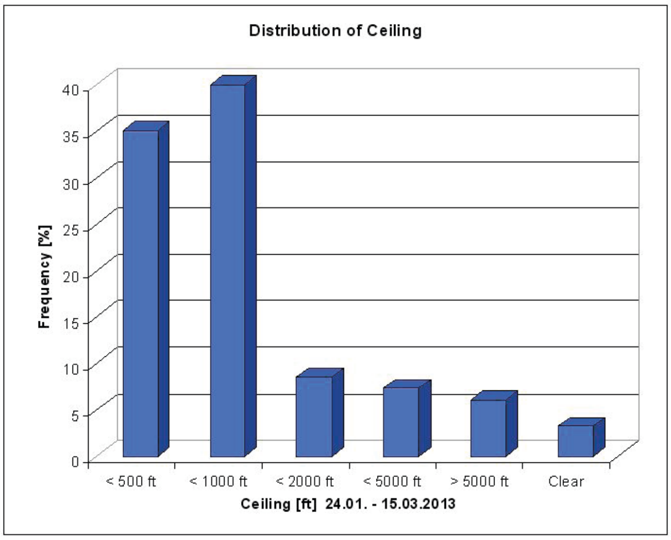

Fig. 2.4: Distribution of ceiling

Later cyclones passed on northerly tracks through Drake Passage. They did not influence the research area along the Antarctic Peninsula. Here high pressure influence spread under an upper atmosphere ridge from Tierra del Fuego to the northern edge of the Peninsula for a few days. Work on ship and whale watching by helicopter was possible, when the wind was rather weak with sometimes sunny intervals. There only existed a swell up to 2 m that is typical for the Drake Passage. Only a short break was caused by a small but intensive low that passed the ship north eastward. During a short time it brought strong to stormy north easterly winds. After this intermezzo the work could be done without disturbance.

From 11 March the high withdraw from the Drake Passage and new low pressure influence and increasing westerly wind dominated the weather. Finally research work was done and the ship returned across the Drake Passage, accompanied by wind force 5 to 7 and wave heights up to 3 m. Punta Arenas was reached on 18 March.

3. MARINE ECOLOGY

3.1 Macrobenthic community analysis and biodiversity study

Maria Chiara Alvaro[1], Andrea Barco[2], Astrid Böhmer[3,4], Bruno David[5], Chantal de Ridder[6], Philippe Dubois[6], Cedric d'Udekem d'Acoz[7], Marc Eléaume[8], Julian Gutt[3], Dorte Janussen[9], Daniel Kersken[9], Pablo López González[10], Irene Martinez Baraldés[10], Marie Verheye[7], Núria Teixidò Ullod[11]

[1] MNA
[2]UROMA
[3]AWI
[4]UOLD
[5]UBOU
[6]ULB
[7]RBINS
[8]MNHM
[9]FS
[10]USEV
[11]ICM-CSIC

Objectives

A range of scientific information on Antarctic macrobenthic communites has existed since the 1950's. Nowadays zoogeographic approaches became common again due to the availability of data, but these databases are often species-specific and include only presences, but not absences, abundances or biomass. As a consequence, a standardised mapping of macrobenthic communities is available only at a very coarse level within single surveys and not between projects preventing coverage of a much larger spatial and temporal scale. Such information on the community level, however, is essential to develop protection strategies and novel advanced process studies.

Consequently, the first aim of this approach was to quantify Antarctic macrobenthic communities. This case study could provide a basis for a circum-Antarctic classification and standardised overview of Antarctic macrobenthos. The overarching goal is to achieve general conclusions on the structure and functioning of the macrobenthos in a changing environment. The constraints of the project are: (1) The high diversity and difficult identification of Antarctic organisms must be considered. (2) The concept must provide universally comparable information based on standardised data acquisition and analyses. Obligatory parameters of faunistic structure will include systematic affiliations with a resolution to be defined, which must also be applicable to non-experts and biomass. If direct measurement of biomass is impossible, proxies providing data in mass classes can be used. Obligatory parameters for ecosystem functioning could be life-modes (vagile, sessile, sedentary, epibiotic, fast growing, slow growing) and feeding-types (predator, suspension feeder, deposit feeder, grazer, scavenger). Additionally, optional parameters can include ecological key species, which are easily and clearly identifiable. (3) The concept should be applicable anywhere and anytime under realistic constraints. (4) Parameters must allow comparability across different sampling methods, e.g. after finalisation of the concept the selection of even optional parameters can no longer be changed. (5) The concept should consider that methodological filters always mask true conditions. Environmental parameters can be (a) obligatory, incl. metadata or (b) optional.

Work at sea

Macro- and megabenthic fauna were collected with an Agassiz-trawl (AGT). Following the general concept of a nested approach, the trawl was deployed at different ecological scenarios in the Weddell Sea (depressions, deep shelves and banks), the Bransfield Strait (banks, upper slopes, slopes and canyons) and the Drake Passage (upper slopes, slopes) (Table 3.1.1, Fig. 3.1.1).

Tab. 3.1.1: Agassiz-trawl hauls with trawl distance according to area (Weddell Sea, Bransfield Strait, Drake Passage), site and ecological scenario. For abbreviations see appendix, A.5.

Station (PS81)	AGT #	Depth (m)	Trawl distance (m)	Area, site, scenario
116-4	1	233	634	W_DI_B
116-9	2	248	644	W_DI_B
118-4	3	434	969	B_JN_U
159-3	4	488	955	W_JE_D
160-3	5	238	755	W_JE_B
162-7	6	216	470	W_ET_B
163-8	7	217	945	W_ET_B
163-9	8	551	939	W_ET_D
164-4	9	102	605	W_DI_B
185-3	10	296	739	W_VO_U
188-4	11	425	849	W_VO_D
193-8	12	431	1035	B_E_S
193-9	13	420	1054	B_E_S
195-2	14	177	733	B_E_B
196-8	15	580	915	B_E_C
197-4	16	285	709	B_E_U
197-5	17	273	530	B_E_U
198-5	18	179	630	B_C_B
199-4	19	325	651	B_C_U
204-2	20	781	880	B_C_C
217-6	21	483	777	B_C_S
220-2	22	782	790	B_W_C
224-3	23	261	515	B_W_U
227-2	24	564	687	B_W_S
234-5	25	251	549	D_W_S
237-3	26	522	460	D_W_S
240-3	27	277	525	D_C_U
244-2	28	464	584	D_C_S
246-3	29	266	627	D_E_S
249-2	30	421	895	D_E_U

The AGT weighs 500 kg, measures 3.5 m across, and uses a standard AGT-net with a mesh size of 10 mm in the cod end. Whenever possible, prior to the AGT-deployments, video transects of the sea floor were reviewed with the OFOS-team to find the most suitable coordinates for the AGT-transect. This also allowed us to compare AGT catches with the OFOS photographic transects. Trawling was performed according to a standard protocol by U. Grundmann (1st officer on *Polarstern*, pers. comm.): The AGT is deployed with a wire speed of 0.7m/sec. The length of wire should be approximately 2 x the water depth with a ship speed of 2.5 knots. This is to ensure that the wire is stretched out while the AGT is being deployed but is not yet trawling. The time at which the AGT reaches the sea floor can be determined by a decrease in wire tension. When the desired length of wire has been put out, the AGT trawls for 10 min at 1 knot. Then the ship is stopped and the AGT is retrieved with a wire speed of 0.5 m/sec. The approximate trawling distance can be estimated by subtracting the length of wire at the moment the AGT leaves the sea floor (as determined by an obvious increase in wire tension) from the total length of the wire out, and add to this the distance trawled (10 min by 1 nm/h, which is = 309 m). All together we conducted 30 AGT-deployments, of which 25 were successful. In one case the ground chain was missing (AGT #1), and twice the net was overturned (AGTs #12 and #16), however in all these cases the net still contained small catches. The net was found open upon retrieval of AGT #7 and torn on retrieval of AGT #14. In both cases the entire catch was lost.

As soon as the catch came on deck it was photographed to get an impression of the total volume. Before collecting any material, a 50 l subsample of the catch was taken and sieved with a minimum mesh size of 1 mm for further quantification purposes.

After sorting the macro- and megabenthic fauna from the AGT, the organisms were identified to the species level whenever possible. The identification was done by different specialists on board: Porifera by D. Janussen (FS); Anthozoa, Pygnogonida and Ophiuroidea by P. López (USEV); Mollusca by M.C. Alvaro (MNA) and A. Barco (UROMA); Mysidacea, Decapoda, Amphipoda by C. d'Udekem d'Acoz (RBINS); Echinoidea by B. David (UBOU) and C. De Ridder (ULB); Crinoidea and Asteroidea by M. Eléaume (MNHN); Holothuroidea by J. Gutt (AWI); and Pisces by K.H. Kock (VTI-SF). Samples of Bryozoa and Polychaeta were dried or fixed with ethanol, respectively, for later identification by taxonomic experts. All the invertebrate fauna collected from each station was classified to species or morpho-species level (species that could not be named to species level but were individually recognized) and photographed. All individuals identified to the species level were counted and weighed. For those species that appeared fragmented (e.g., bryozoans) we applied the natural logarithm of fragment numbers to obtain an estimate of individuals. The data obtained from all stations were the basis for both the biodiversity and taxonomic-functional approaches.

Expected results

Raw data can be analysed in two ways: (1) in a coarse classification of macrobenthic communities based on systematic or functional groups, e.g. as provided by Lockhart and Jones (2008) but with a higher systematic resolution or based on a standardised data acquirement as proposed by Gutt et al. (2013a); (2) as a detailed biodiversity study that comprises all information with the highest possible systematic resolution.

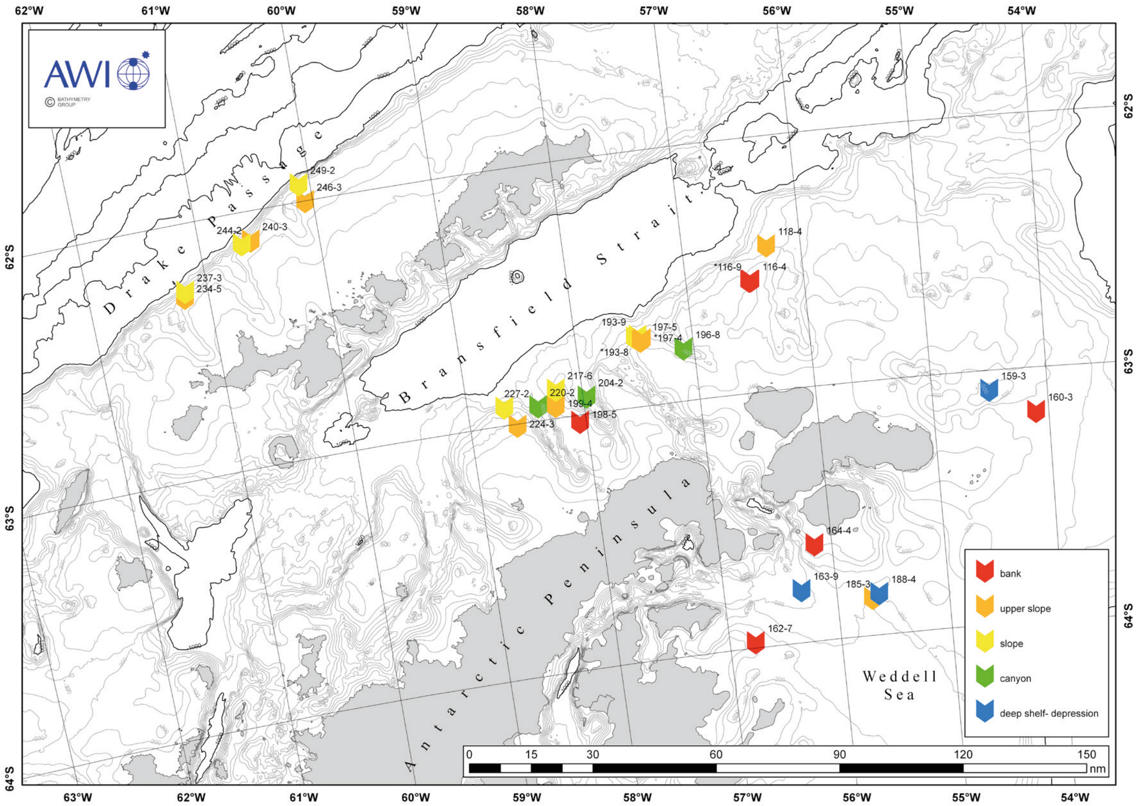

Fig. 3.1.1: Station map of AGT deployments within the different sampling areas (Weddell Sea, Bransfield Strait and Drake Passage). Trawling took place at banks (red ≤200 m), upper slopes (orange ~ ≤350 m), slopes (yellow ≤550 m), canyons (green ≤800 m), deep-shelf-depressions (dark blue ≤550 m), volcano upper slopes (purple ≤300 m) and volcano deep shelves (light blue ≤400 m). Station numbers marked (*) indicates that no subsample was taken because catches were too small; station 195 is not depicted because no subsample was taken (haul failed totally). Bathymetry: AWI bathymetric working group/IBCSO.

Data management

Results on the coarse classification are to be uploaded to ANTABIF as done already for a comprehensive historical data set (Gutt et al., 2013b). In charge of biodiversity data for specific systematic groups are the specialists presenting their specialised studies with data management information below. In case of no further specific analyses raw data will also be uploaded to ANTABIF.

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3.2 Dynamics of benthic ecosystem functioning in response to predicted environmental shifts

Heike Link[1], Dieter Piepenburg[2]

[1]McGill
[2]IPÖ

Objectives

The concept of 'ecosystem functioning' is receiving increasing attention in the efforts of maintaining long-term sustainable marine systems (Naeem et al., 2012). The term has been coined to describe the entirety of ecosystem properties, including its functional compartments and the rates of the processes that link the compartments together, as well as ecosystem goods and services (Garcia et al., 2011). Due to the complexity of ecosystems as a whole, researchers usually look at only selected sub-sets of functioning components in experimental or field studies. In the marine environment, benthic ecosystem functioning (BEF) refers to the processes carried out by the organisms inhabiting the seafloor. Among these processes, benthic boundary fluxes are of great ecological importance (Fig. 3.2.1). They include the turnover of oxygen and organic carbon (respiration), as well as the remineralization of inorganic nutrients (nitrate, phosphate, and silicate) caused by organic matter degradation.

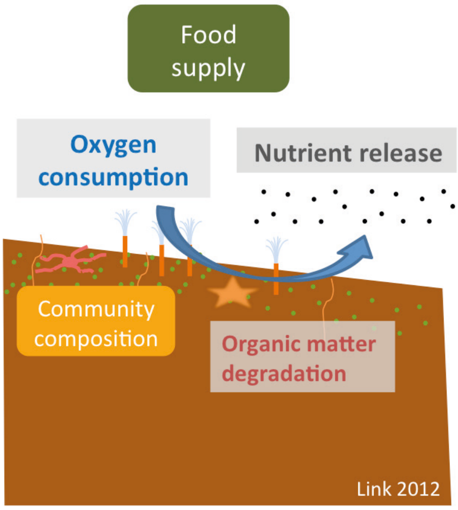

Fig. 3.2.1: Schematic illustration of benthic ecosystem functioning (BEF) as used in this project. The process of organic matter degradation and nutrient release is assumed to be influenced by food supply and community composition.

The quantity of carbon and nutrients remineralized at the seafloor depends on several factors, the most important of which are the quantity and quality of organic matter reaching the seafloor (Grebmeier and Barry, 1991; Link, 2012) and the composition of the seafloor communities (Sun et al., 2009; Link et al., 2013). In polar environments, organic matter export from pelagic primary production to the benthos (pelagic-benthic coupling) is either very small under ice cover or strongly seasonally pulsed (Smith et al., 2006). During the short polar spring and summer periods when the sea ice is melting, the intensive primary and secondary production in the upper water column and the sea ice provides high-quality lipid-rich food to the benthos (Isla et al., 2011). Carbon cycling in sediments and by benthic communities has been reported from a number of studies on the continental shelf and slope, including Arctic (Piepenburg et al., 1995; Renaud et al., 2007; Link et al., 2011) and Antarctic environments (Hartnett et al., 2008, Sachs et al., 2009). But studies combining the functions of oxygen consumption, secondary production and nutrient release are extremely scarce.

Climate-related predicted changes in benthic community composition and benthic food supply in the three Antarctic regions targeted by the integrated comparative PS81 study (see chapter 1. Summary and Itinerary, this volume) raise the question whether such changes will influence BEF. Moreover, it raises the questions whether such influences vary among three regions that presently underly different ice, primary productivity and current regimes. Little is known about benthic boundary fluxes in polar regions (Link, 2012), and even less how these benthic processes have changed and will change in response to the continuing climate shift off the Antarctic Peninsula.

The main question of our study was how benthic ecosystem functioning will develop on the shelves off the Antarctic Peninsula under the continuous reduction of sea ice and ice shelves, given the presumed alteration in community composition and organic matter sedimentation presently happening in this area. Within this framework, we have addressed three specific research objectives:

1. Quantify benthic boundary fluxes (oxygen, silicic acid, phosphate, nitrogen species) at the core stations in the three study regions.
2. Determine the influence of food quantity and quality and benthic community composition on benthic boundary fluxes.
3. Evaluate future changes of benthic ecosystem functioning using an experimental approach that simulates the effects ofcontinuing warming and sea ice and shelf-ice decline, off the Antarctic Peninsula.

Work at sea

General sampling design

To address objectives 1 and 2, we took sediment core samples at 13 core sites, distributed in the three study areas (Table 3.2.1). Three to five replicate sediment cores of 10 cm diameter and 20-25 cm length were obtained using a multicorer (MUC), or by subsampling a giant box corer (GKG). Incubations of sediment cores with inhabiting communities (bacteria, meiofauna, macrofauna) and boundary water (either from the multi-corer or sub-sampled from box cores or taken from bottom-water CTD samples) were used to assess benthic respiration, silicic acid, nitrate, ammonium and phosphate remineralization rates (Fig. 3.2.2). After incubation, the same sediment cores were passed through a 0.5 mm mesh sieve under slow running seawater. The sieve residues were preserved in a 4 % seawater-formaldehyde solution for later analyses of species diversity and abundance under a dissection microscope.

Tab. 3.2.1: List of stations sampled for the 3 objectives addressed by the benthic ecosystem functioning project. BS = Bransfield Strait, WS = Weddell Sea, DP = Drake Passage. For full label abbreviation list, see A.4 and A.6.

Date	Station	Gear	Latitude	Longitude	Depth [m]	Repli-cates	Objective	Area
27.01.13	118-5	MUC	62° 26.93‘ S	56° 17.05‘ W	425.2	5	1 & 2	B_JN_U
	118-7	GKG	62° 27.00‘ S	56° 16.96‘ W	422.4			
28.01.13	119-3	GKG	63° 10.07‘ S	54° 7.20‘ W	227.6	3	1 & 2	W_JE_B
28.01.13	120-4	MUC	63° 4.78‘ S	54° 31.45‘ W	493.8	3	1 & 2	W_JE_D
10.02.13	162-2	GKG	64° 0.11‘ S	56° 44.43‘ W	222.9	5	1 & 2	W_ET_B
	162-6	MUC	64° 0.12‘ S	56° 44.12‘ W	223.8			
11.02.13	163-3	MUC	63° 50.97‘ S	56° 25.24‘ W	517	3	1 & 2	W_ET_D
19.02.13	185-2	GKG	63° 52.20‘ S	55° 36.67‘ W	232	3	1 & 2	W_VO_U
21.02.13	190-6	MUC	63° 50.58‘ S	55° 31.66‘ W	389	10	1, 2, 3	W_VO_D
	190-7	MUC	63° 50.75‘ S	55° 32.14‘ W	390			
	190-9	MUC	63° 50.74‘ S	55° 32.57‘ W	393			
27.02.13	202-2	MUC	62° 56.00‘ S	58° 0.55‘ W	757	3	1 & 2	B_C_C
02.03.13	217-5	MUC	62° 53.25‘ S	58° 14.13‘ W	532	3	1 & 2	B_C_S
02.03.13	218-2	MUC	62° 56.94‘ S	58° 25.73‘ W	688	3	1 & 2	B_W_C
04.03.13	225-2	MUC	62° 56.08‘ S	58° 40.76‘ W	543	3	1 & 2	B_W_S
07.03.13	235-2	MUC	62° 16.35‘ S	61° 10.23‘ W	355	3	1 & 2	D_W_S
09.03.13	241-2	GKG	62° 6.59‘ S	60° 36.47‘ W	400	16	1, 2, 3	D_C_S
	241-3	GKG	62° 6.60‘ S	60° 36.51‘ W	403			
	241-4	GKG	62° 6.59‘ S	60° 36.50‘ W	403			
	241-5	GKG	62° 6.60‘ S	60° 36.50‘ W	403			

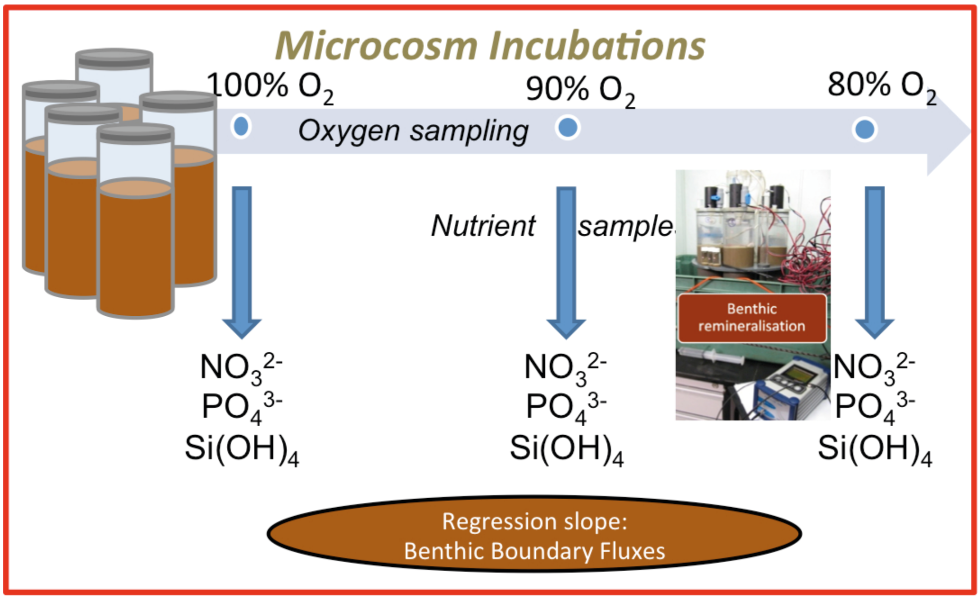

Fig. 3.2.2: Illustration of the general sampling processing of microcosm incubations

At two sites, one (stn. 190) in the high-Antarctic ice-covered Weddell Sea and the other (stn. 241) in the oceanic ice-free Drake Passage north of the South Shetland Island, we conducted pulse-chase experiments, simulating presumed future environmental shifts by crossed food and fauna treatment (objective 3). For these experiments, 10 and 16 replicate sediments cores, respectively, were sampled at each station (Table 3.2.1).

Sediment core incubations and benthic boundary flux measurements

Shipboard incubations of sediment microcosms were run in a dark, temperature-controlled room (0.8 to 2° C) for 24 to 72 h. Total sediment oxygen flux was determined as the decrease in oxygen concentrations in the water phase and was measured periodically (2 to 8 h intervals) with a non-invasive optical probe (Fibox 3 LCD, PreSens, Regensburg, Germany). To determine changes in nutrient concentrations, samples of the overlying water phase were taken at three times during the incubation, including the onset and end. Oxygen and nutrient fluxes are determined as the slope of the linear regression of the oxygen and nutrient concentration on incubation time and corrected for solute concentration in the replacement water. A more detailed description of this method can be found in Link et al. (2011) and Link et al. (2012).

Pulse-chase experiments

We performed two tracer experiments with food addition and macrofauna addition to the sediment cores to quantify their impact on benthic boundary fluxes and secondary production.

At stn 241, we first added macrofauna (1 amphiurid brittle star, 1 holothurian (*Molpadia* sp.), 1 pycnogonid, and 1 maldanid polychaete) to 8 of 16 sediment cores taken from four GKG casts. Macrobenthic organisms for fauna addition were collected from box cores and/or Agassiz trawl catches or Rauschert dredge catches taken at the same or a nearby station and acclimatized in air-saturated seawater for 2 days before addition to sediment cores. In a fully crossed design, four of the *in-situ* and four macrofauna-treated cores were spiked with 11 mg of ^{13}C-labelled diatoms *Thalassiosira rotula* (Ursula Witte, Oceanlab, Aberdeen, UK; Witte et al., 2003). Thus, a total of 16 sediment cores (4 non-treated, 4 fauna-treated, 4 algae-treated, 4 fauna+algae-treated) were incubated following the general protocol described above.

Nutrient and dissolved inorganic carbon (DIC) samples were taken at the start of the incubation and after 1, 2 and 3 days. After 1 day (1 replicate per treatment) and 3 days (3 replicates per treatment) all cores were sliced into 0-2 cm and 2-5 cm sections for macro- and meiofauna analyses, and the 5 cm-bottom section was sieved for macrofauna analysis. Sediment sections and sieve residues were conserved using buffered 4 % seawater-formaldehyde solution and will be analysed for diversity and stable isotope composition at the home institute. A subsample of 2.5 cm diameter was obtained from each core and sliced into 0-1 cm, 1-2 cm and 2-5 cm sections for bacteria and biogeochemical analyses. Sediment subsamples were frozen immediately at -80° C for later analyses in the home institute. At stn 190 we performed a similar tracer experiment but without applying a fully crossed design, as only 10 sediment cores from three MUC casts were available.

Preliminary (expected) results

In general, we did not produce publishable results during the cruise, as the vast majority of the samples taken have yet to be analysed in the lab (nutrient fluxes, DIC fluxes, isotope data, abundance, biomass, composition and diversity of meiofauna and macrofauna assemblages in sediment cores).

As an example for one type of data to be achieved during future analyses, we show here first oxygen flux results from three stations off Joinville Island and two stations in the Erebus and Terror Gulf (Fig. 3.2.3). The sediment-community respirations rates ranged from 2.2 to 3.8 mmol O_2 m^{-2} d^{-1} off Joinville Island. In the Erebus and Terror Gulf rates were clearly higher, ranging between 6.1 and 6.7 mmol O_2 m^{-2} d^{-1}. The reason for this difference has still to be investigated by the later comparative spatial analyses including other ecological parameters obtained from this cruise (e.g., macrofauna abundance, food supply).

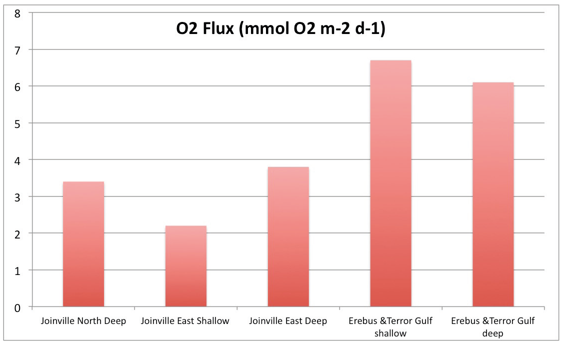

Fig. 3.2.3: Oxygen fluxes (mmol O_2 m^{-2} d^{-1}) at five stations on the shelf off the northern Antarctic Peninsula

Data management

Most data (see Preliminary results) will be obtained through laboratory analyses after the cruise. As soon as they are available, processed data will be uploaded to the open-access databases PANGAEA and/or SCAR-MarBIN.

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3.3 Megabenthic distribution patterns

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Objectives

Megabenthic fauna, i.e., those seafloor organisms that are large enough to be visible in seabed images and/or to be caught by towed sampling gear, have been shown to be of very high ecological significance for the Antarctic shelf ecosystems (Gutt, 2006). They strongly affect the small-scale topography of seafloor habitats and do thus exert prime influence on the structure of the entire benthic community (Gili et al., 2006). Some species are especially sensitive to environmental change due to their slow growth, specific reproduction mode, high degree of environmental adaptation and narrow physiological tolerances. Therefore, they can serve as early indicators of ecosystem shifts in response to climate change (Barnes et al., 2009).

Based on findings of previous investigations (see chapter 1. Itinerary and summary, this report), we carried out a comparative field study in the three study areas off the Antarctic Peninsula to investigate the abundance, distribution, composition and diversity of epibenthic megafauna. We used the Ocean Floor Observation System (OFOS), a camera sonde equipped with a digital still-photo camera providing high-resolution images (21 Megapixel) of the seabed.

The main objectives of our study were:

- Carry out a survey of megabenthic assemblages on the shelves off the northern Antarctic Peninsula.
- Identify spatial distribution patterns at local (within-station) and regional (among-station) scales, using a nested analysis approach.
- Standardise the classification of megabenthic communities, by comparative analysis of photographic transects and Agassiz trawl catches.

Work at sea

During the cruise, the OFOS was deployed at a total of 31 stations, delivering a total of more than 15,000 photos. At each station a series of 500 to 530 pictures were taken, each depicting approx. 3.5 m² of the seafloor. The transects were placed in such a way that different benthic ecological scenarios were considered (bank, upper slope, slope, depression, canyon; Table 3.3.1, Fig. 3.3.1). Along the photographic transects, each of which was approx. 3,700 m (2 nautical miles) long, photos were taken at intervals of 30 seconds. Three laser scale markers appear in the images, marking a distance of 50 cm on the organisms on the focal plane and thus providing an absolute scale in each photo. The OFOS was lowered during standstill of the ship. As soon as it was above ground the *Polarstern* drifted with 0.5 kn (approx. 0.25 m s^{-1}). Our net wire time (with the OFOS at the bottom) was four hours for each transect. The deployment of the OFOS and its operational procedures were controlled from the winch control room. There, we could see the synchronous transmission on the screen; therefore it was possible to take additional photos when desired or for notable discoveries. The height above ground of the OFOS was controlled by the winch driver who oriented himself at the altimeter that showed the optimal distance of 1.5 m above the seafloor.

At one station (stn 225), the OFOS was deployed for only one hour, due to high wave heights and strong wind. If the waves were too high in other stations we took the photos by hand, whenever the OFOS was in the right altitude (1.5 m) above the ground.

Tab. 3.3.1: List of stations where the Ocean Floor Observation System (OFOS) was deployed.

Date (yy-dd)	Stat. No.	Stat. Name	Start (Lat °S)	Start (Long °W)	End (Lat °S)	End (Long °W)	Aver. Depth (m)	Dura-tion (min)
01-26	116	B_JN_B	62 33.88846	56 23.54047	62 33.77724	56 27.23258	215	238
01-27	118	B_JN_U	62 27.21296	56 15.88939	62 25.54464	56 17.21200	426	250
02-08	159	W_JE_D	63 4.87023	54 32.71884	63 5.28929	54 28.95352	489	232
02-08	160	W_JE_B	63 10.18160	54 7.01506	63 10.97898	54 5.84667	233	218
02-09	161	W_ET_B	64 0.46051	56 43.85487	64 0.17069	56 40.03329	238	271
02-10	163	W_ET_D	63 53.09911	56 26.33014	63 51.17350	56 25.43633	481	216
02-11	164	W_DI_B	63 37.17158	56 13.55894	63 36.89483	56 9.11971	148	227
02-19	185	W_VO_B	63 53.22734	55 37.61190	63 51.20534	55 36.32512	191	241

Date (yy-dd)	Stat. No.	Stat. Name	Start (Lat °S)	Start (Long °W)	End (Lat °S)	End (Long °W)	Aver. Depth (m)	Duration (min)
02-19	186	W_VO_U	63 54.13320	55 34.53080	63 51.90430	55 33.77545	214	244
02-20	188	W_VO_D	63 52,24563	55 34,01042	63 50,41847	55 33,67264	380	240
02-20	189	W_VO_B	63 53.57372	55 35.51688	63 53.15766	55 34.70198	78	60
02-22	192	B_E_C	62 44.03795	57 30.97398	62 43.36775	57 26.93258	434	241
02-23	194	B_E_B	62 44.83983	56 56.55342	62 43.81675	56 53.39118	177	239
02-24	196	B_E_S	62 48.20766	57 6.08067	62 48.05814	57 1.70616	479	240
02-25	197	B_E_U	62 45.39565	57 28.15632	62 44.19235	57 25.24211	194	236
02-26	198	B_CB	63 2.31317	58 7.10720	63 1.69328	58 2.96777	175	241
02-26	199	B_C_U	62 57.50145	58 16.02833	62 56.66211	58 11.83289	302	180
02-27	200	B_C_B	63 0.05927	58 7.36271	63 0.02188	58 5.57044	215	109
02-28	204	B_W_C	62 56.13385	57 59.63105	62 55.99081	57 55.56216	765	289
03-02	215	B_C_S	62 53.57811	58 14.76205	62 53.48399	58 10.53389	449	241
03-02	218	B_W_C	62 56.99251	58 26.61432	62 56.54480	58 22.23068	746	244
03-03	222	B_W_B	63 2.98617	58 37.98601	63 3.04611	58 36.00606	160	120
03-03	223	B_W_U	63 0.47046	58 37.58964	63 0.47866	58 33.15579	268	230
03-04	225	B_W_S	62 55.73349	58 41.60434	62 56.24464	58 39.92816	553	96
03-05	231	B_DE_S	62 52.61208	60 29.39819	62 52.69115	60 27.33816	194	232
03-06	234	D_W_S	62 17.28139	61 13.94834	62 17.57826	61 9.66123	239	224
03-08	237	D_W_U	62 15.71101	61 12.44901	62 16.79212	61 9.09319	385	222
03-10	244	D_C_S	62 6.59610	60 36.35834	62 7.92081	60 39.68043	419	234
03-11	246	D_E_U	62 0.66477	60 3.65346	61 58.65092	60 3.97988	281	240
03-12	249	D_E_S	61 57.03291	60 7.80429	61 55.67425	60 4.69596	414.	234
03-12	251	D_C_U	62 7.74196	60 37.80090	62 6.36773	60 34.65803	274	240

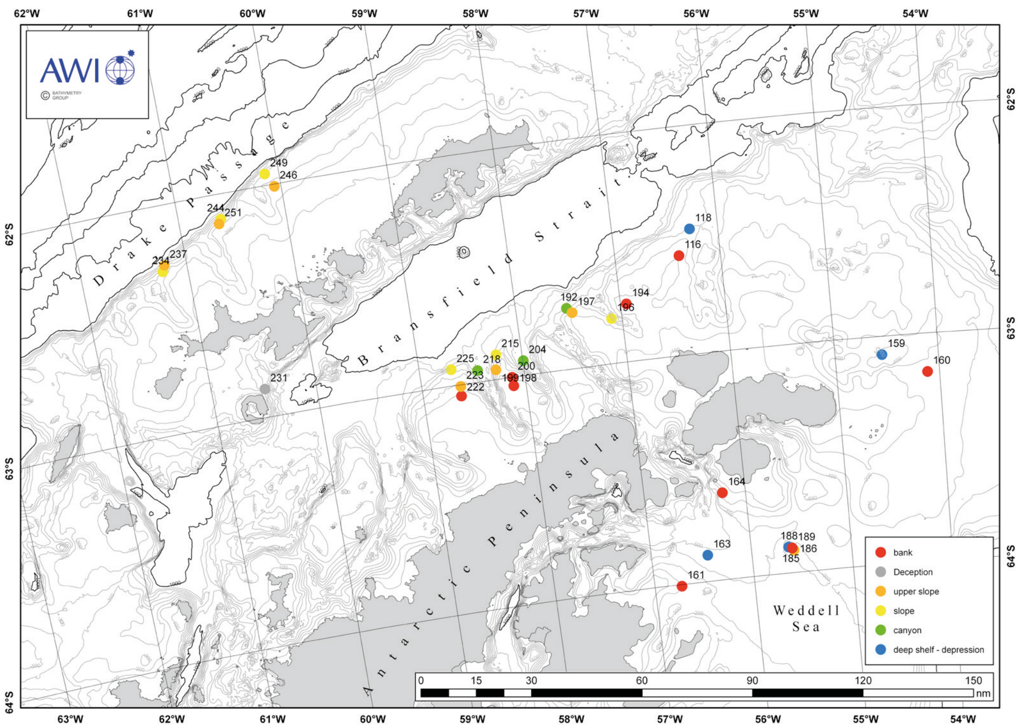

Fig. 3.3.1: Map of stations where the Ocean Floor Observation System (OFOS) was deployed; bathymetry: AWI bathymetric working group/IBCSO.

Preliminary results

Preliminary onboard analyses of our extensive photographic material suggest that there is a clear difference between the three study areas around the Antarctic Peninsula in the composition of the epibenthic megafauna. While the stations in the Bransfield Strait and the Weddell Sea were relatively rich (Fig.s 3.3.2 & 3.3.3), there were generally less epibenthic organisms in the Drake Passage (Fig. 3.3.4). Also the sediment differs between the regions: In the Bransfield Strait more gravel and big stones were present whereas the sediment in the Drake Passage appeared to be finer and softer. Conspicuous 'lebensspuren' at the sediment surface indicate the bottom was colonized by many infaunal polychaetes and brittle stars (Fig. 3.3.4). The observations showed that big glass sponges or bedrock were regularly colonized by various organisms like crinoids (Fig. 3.3.2)

Fig. 3.3.2: Glass sponge with crinoids on top, at stn 223 (Bransfield Strait)

Icebergs scouring marks were only recorded at four stations (# 164, 185, 188 and 196). Numerous compound ascidians were found especially at stations 163, 185 and 196, characterized by heights of up to 70 cm (Fig. 3.3.3). In general, in the Weddell Sea ascidians dominated the sea floor, whereas in the Bransfield Strait also bryozoans appear to be one of the most abundant animal groups.

Fig. 3.3.3: Synascidians at stn 185 (Volcano)

In the Drake Passage ophiuroids (brittle stars) and holothurians (sea cucumbers) were found in high densities. At station 231 at Deception Island another image occurred: there the sediment was relatively dark and consisted of volcanic material because of the origin of the island.

Surprising sightings were the large amounts of krill photographed at some stations (# 161, 186, 198, 237, 246, 249). Krill were not only detected in the upper part of the water column but also on the ground. In the Drake Passage we recorded mesopelagic myctophid fish that occurred both in the water column and closely above the sea bottom.

Fig. 3.3.4: Numerous ophiuroids burried in the sediment, at stn 246 (Drake Passage)

Data management

All sea-bed photographs combined with metadata on georeferenced OFOS transects will be uploaded to the Data Publisher for Earth & Environmental Science PANGAEA (www.pangaea.de).

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3.4. Biodiversity and pelagic-benthic coupling

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Objectives

The marked environmental differences at the sea surface and close to the seabed inspire interesting questions about how the pelagic and benthic ecosystems work and connect between each other, especially in polar conditions where seasonality is intense in the upper layers of the water column and more constant in the benthic realm. These coupling processes have been studied at the high-latitude southeastern Weddell Sea, where complex epiphytic benthic communities with high biomass and diversity have evolved for thousands of years in a rather constant environment. In contrast, at the northern most region of the Weddell Sea, the Antarctic Peninsula, the actual climate regime makes it undergo an above global average warming. In a relatively small region which encompasses the northeastern Weddell Sea (polar), the Bransfield Strait (transition) and the northern boundary of the South Shetland Archipelago in the Drake Passage (oceanic) there are three different environmental regimes mainly driven by seasonal sea ice extent and permanent water masses circulation. These environmental differences are apparently represented in the different benthic assemblages found in the region. Thus, they also determine biodiversity distribution patterns. Under the frame of pelagic-benthic coupling, the idea of the present initiative is to study the environmental setting and relate it to the benthic community assemblages. Given the accelerating pace of climate change and the still lack of knowledge on the functioning of these Antarctic ecosystems, studies on benthic-pelagic coupling are becoming urgent to understand how the Antarctic shelf ecosystems will cope with ongoing environmental changes.

The aim of the present studies was to characterize a series of biological, (e.g., abundance, biomass and distribution of benthic organisms), chemical (e.g., organic matter content in the sediments), geological (e.g., grain size) and physical (e.g., water masses, temperature and salinity) variables to assembly a comprehensive picture of the environmental frame that may determine differences in the benthic community assemblages. The strategy to accomplish with our main aim consisted in developing stations along a depth and environmental where a complete set of measurements could be carried out. The idea is to provide basis for a multidisciplinary holistic approach that may explain the present state and potential fate of the benthic communities in the three above mentioned regions in the Antarctic Peninsula vicinities.

Physical-chemical characteristics of sea floor sediments

Analyze grain size, organic matter contents and radionuclides in sediment cores to estimate the availability and potential nutritive quality of sediment for benthic consumers and their accumulation rates to integrate the results into a comprehensive picture, which includes the benthic community characteristics.

Genetic studies of Hexactinellid sponges

Hexactinellids are one of the most dominant groups constituting the Antarctic benthic communities and greatly contribute to the total abundance and biomass. However, little is known on their reproduction patterns (larval development, release, settlement, and recruitment), particularly on the extent of the sexual and asexual processes. The main focus of this study was to investigate the genotypic diversity of hexactinnelid populations in order to assess their dispersal potential and the degree of connection among populations.

Biodiversity of anthozoans and pycnogonids

Among anthozoans it is possible to find some of the major components in benthic sessile communities in terms of both abundance and diversity, offering a good substratum (e.g., refuge, feeding) to many other benthic groups. The Antarctic cnidarian fauna is still poorly known, and our present knowledge has been estimated to encompass no more than 50 % of all species (Winston, 1992). Most of the genera and species were described in the 1990's, and several undescribed genera and species are being described continuously (e.g., López-González and Gili, 2001; 2005; López-González et al., 2009; Rodríguez and López-González, 2003; 2008; Zapata-Guardiola and López-González, 2010; 2012). Morphological variability is not always known, and molecular studies are considered another potentially interesting source of characters (McFadden et al., 2011).

Pycnogonids from the Southern Ocean have been extensively studied (e.g., Fry and Hedgpeth, 1965; Child, 1994a; 1994b; 1995a; 1995b; 1995c). More than 250 species are currently recognized (the 15 % of the world fauna), with and 70 % of endemic species in the Southern Ocean (Munilla, 2001; Munilla and Soler, 2009). However, for many species, there is not relevant information about the morphological variability; and for some of them is only known a few specimens. The lack of information about the utility of some morphological characters and the addition of molecular information are the next steps in the research on this particular group. Despite of this, the description of new species is continuous (Munilla, 2000; 2002; 2005; Cano and López-González, 2007b; 2012), and some authors are exploring additional characters. The larval and postlarval stages of development seem to be a potential source of information (Arango et al., 2011), although the number of species examined is still relatively scarce.

Specific objectives:

- Detect the presence of boundaries and pattern of distribution at different taxa levels (family, genus, and species) in a gradient from the Weddell Sea to Drake Passage across the Bransfield Strait.
- Detect the possible faunal originality of geographically near canyons in relation to near deep and shallower bottoms.
- Detect undescribed or poorly known species that could help to the understanding of the relationship between Antarctica and other deep-sea bottoms and continental shelf in the past and in the present.
- Evaluate intra- and interspecific variability initially after morphological characters, but also keeping material for molecular population comparisons.
- Sustain the study of the reproductive patterns.
- Continue with the development of a bank of tissues usable for molecular studies in order to compare phylogenetic hypotheses bases on molecular data with those proposed based on morphological characters.

Work at sea

Sediment cores

A total of 17 multicorer (10 cm diameter) stations were developed. Five of them off Joinville Island representing the polar setting, six within the Bransfield Strait as the set of transition environment and six off Livingston Island, where the oceanic conditions are found.

Hexactinellid sponges

Specimens of hexactinellids were collected in 14 AGT stations: Weddell Sea area (3 stations), Bransfield Strait (9 stations) and Drake Passage (2 stations). Around 150 samples (1 cm*1cm) were taken for each specimen, slightly dried and fixed with ethanol 100 % for further genetic analyses.

Anthozans and pycnogonids

Anthozans and pycnogonids were mainly collected by Agassiz trawls (AGT), and Rauschert Dredge (RD). Colonies or individuals were sorted, photographed, and labelled. Living Hexacorals were photographed to obtain information about colour patterns of the different species. Specimens were mainly fixed in absolute ethanol for further molecular characterization (barcode and population dynamic). From Scleractinians a representative part of the polyp was fixed for molecular studies, while the remaining part was fixed in folmaldehyde 10 % (in sea water) for morphological and cytological examination (cnidae measurements), a third fraction was frozen. In order to further identify specific cnidae in sea anemones (e.g., *Stomphya*, *Hormosoma*), fragment of the tentacular crown was dissected, placed in distilled water for some minutes and then fixed in ethanol 70 % and formol 4 %. Octocorals were mainly fixed in absolute ethanol for smaller colonies, while for the larger, a fragment was fixed in absolute ethanol for molecular analyses. The rest of the colony was fixed in ethanol 70 % for morphological studies. Other colonies were also frozen. Pycnogonids specimens were also fixed for molecular and morphological description and comparisons. In the case of larger specimens, a leg was removed form the specimens and separately preserved in absolute ethanol, while the rest of the specimen was keep in ethanol 70 %. Special care was dedicated to those males carrying larvae and postlarval stages.

Preliminary (expected) results

Sediment cores

Based on the sediment core stations the samples can be separated into two different environments, one denominated, only for the purposes of this expedition, as slope and the other, canyon. These settings really represent the locations at the edge of the continental shelf and the axis of glacial troughs, where we found fine sediment that enabled the successful recovery of samples multicorers. Preliminary observations showed that the sediment was mainly constituted by sandy and even gravely mud in the vicinities of Joinville Island, sandy mud in the Bransfield Strait and fine sediment (silt and clay) off Livingston Island. The following preliminary results are from those sampling activities carried out in Western Weddell Sea (WWE), Bransfield Strait (BS), and Drake Passage (DP). The sampling effort in these areas was unequal. To compare these areas and subtransects, presence/absence data were selected to provide preliminary comparative analyses. The general abbreviations list described in the general information of this cruise has been considered in order to detect possible boundaries or differential distribution. Each area is characterized by 6 to 16 AGTs and additional RD.

Anthozoa

In the whole study area, about 1,000 colonies or individuals belonging to at least 75 species were collected in the 24 core stations (26 AGT and 10 RD). The numbers of samples providing anthozoans in these three areas were: 8 AGT and 6 RD from Western Weddell Sea (WWS), 16 AGT and 3 RD from the Bransfield Strait, and 6 AGT and 1 RD from Drake Passage. The general comparative sampling plan considered shallow (~100-350 m) and deeper stations (~400-600 m). The following comments will try to answer the same items exposed in the above listed scientific objectives:

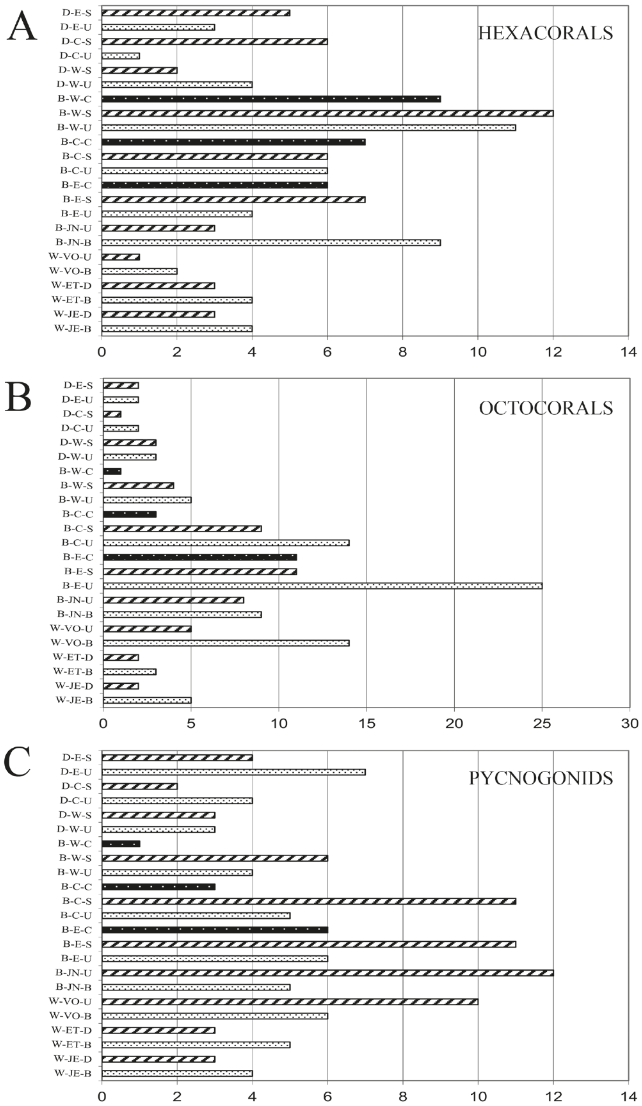

Fig. 3.4.1. Number of species at the different core stations:
A, Hexacorals. B, Octocorals. C, Pycnogonids.
Note: for stations codes see annex A.5.

1. According to the sampling effort carried out, 46 octocorals and 30 hexacorals species were identified in the collected material. The Bransfield Strait was the species richest area (35 octocorals and 24 hexacorals spp.) followed by WWS and Drake (8 /14, and 20/13 spp. respectively). In general, shallow stations showed a higher number of octocoral species (WWS and BS) while in their respective deep stations of both areas decrease being more accentuated in the WWS. In the Drake Passage, in general, the number of octocoral species in both sampled depths (shallow and deep) is low in comparison with the others areas. The hexacorals showed a similar pattern in WWS and BS, except for Drake Passage, where the number of species in the deep station almost doubled the species found in the shallow station (see Figs 3.4.1A, 3.4.1B and 3.4.2). Some species were practically present along the entire transect, in both shallow and deeper samples stations (e.g., *Epiactis georgiana*, *Stomphia selaginella*), others have been only collected in shallow and deeper stations of WWS and BS, but absent in the samples of the Drake Passage (e.g., *Primnoisis* spp., *Fannyella aurora*). A set of species has been only found in the Bransfield Strait (e.g., *Paraconotrocus antarcticus*, *Trichogorgia* sp., and *Flabellum curvatum*). It is interesting to see that the three *Isosicyonis* spp. forms have a different distribution: *Isosicyonis striata* was only present in the shallow sampled bottoms of WWS, *Isosicyonis alba* was found in shallow and deep localities of the

whole study area, and *Isosicyonis* sp. ("brown" form) has been only found in the Drake Passage, and it is also known to present around Elephant Island (López-González, unpubl. data). Of special interest is the collection of three specimens of Ceriantharia, often named tube sea anemones, other sporadic collections were also done in ANT-XVII/3 and ANT-XXIII/8 *Polarstern* cruises (López-González, pers. observ.). Currently it is known the presence of tube anemones in Antarctic waters after *Polarstern* cruises, but this species is apparently not formally described yet. The number of species in the three general sampled areas according to shallow and deep stations is shown in Figure 3.4.2. The comparative number of species of hexacorals and octocoral in the different areas and subsectors in shallow and deep stations as well as those shared species is shown in Figures 3.4.3A and 3.4.3B.

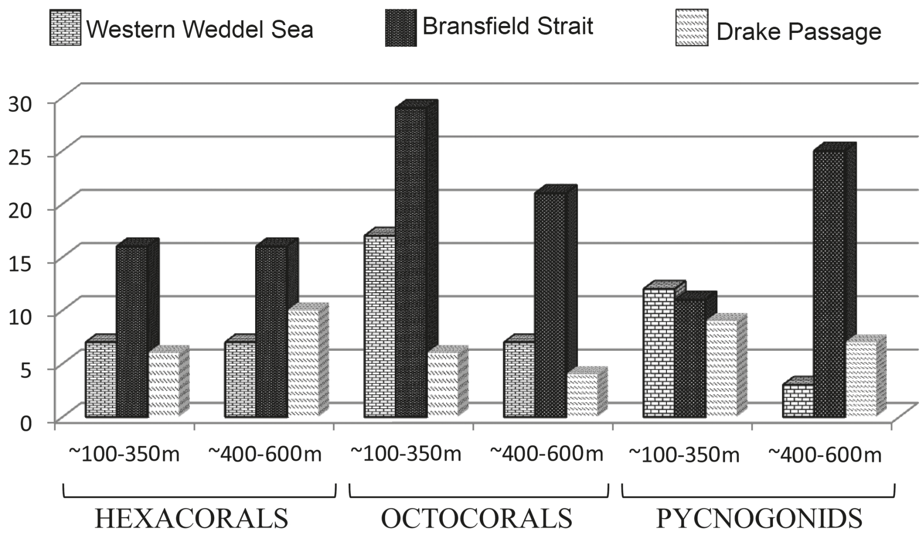

Fig. 3.4.2 Number of Hexacoral, Octocoral and Pycnogonid species at the different sampled areas: Western Weddell Sea, Bransfield Strait, and Drake Passage, at the two main sampled depth ranges.

2. The species richness of hexacorals spp. in the three sampled canyons at Bransfield Strait (West, Central, East) progressively decreases from West to East stations (9, 7, and 6 species, respectively) (Fig. 3.4.1A). Central canyon showed one species more than shallow and deep stations (7, 6, and 6 spp. respectively). Western canyon had less species than its near shallow and deep stations, while east canyon showed less species than the deep but more species than the shallow. The scleractinian species *Fungiacyathus marenzelleri* was exclusively found in the central and west canyons of the Bransfield Strait. This coral species has been found between 391 and 4,975 m depth (Cairns, 1982), however, in this expedition, has been only collected in these two canyons but not in any similar or deeper sampled station in the whole study area (including WWS and DP). It is possible that these canyons have environmental characteristics of deeper bottoms. In reference to the number of species of actiniarians and scleractinians in the different canyons, in the eastern one, more sea anemones species were present (4 and 2, respectively), while in the central canyon a single

scleractinian was found (*Fungiacyathus marenzelleri*), but up to six sea anemones were present. In this canyon (767-781 m depth) exclusively the sea anemone *Eltaninactis infundibulum* was found, a sea anemone species known from two widely separated areas: off the Antarctic Peninsula (stn 769-1, 230 m depth) (Rodríguez and López-González, 2013) and from the northwest of the Chatham Islands (east of New Zealand), between 2,610-2,668 m depth (Dunn, 1983). Finally, in the western canyon a total of 9 species, 6 of then were sea anemones and 3 scleractinians were found. Some of the species were present in most of the deeper and shallow stations along the complete sampling program in Bransfield Strait (e.g., *Stomphia selaginella, Flabellum curvatum*), while other species were only present in the deeper station on all sampled areas (e.g., *Aulactinia* sp.). Octocorals showed a species richness pattern opposite to those of the hexacorals (Figure 3.4.1B), the number of species increase from west to east canyon stations. The numbers of species in the canyons, in comparison with the depth stations, was in general lower, except for the east canyon where the number of species found was similar the same (11 spp.). Some of the species were found in most of the different bathymetric levels sampled in the Bransfield Strait, including canyons (e.g., *Thouarella crenelata*), while others, showed a more restricted distribution along the sampled area (e.g., *Trichogorgia* sp. and *Umbellula antarctica*, present in most of the shallower stations in the Bransfield Strait).

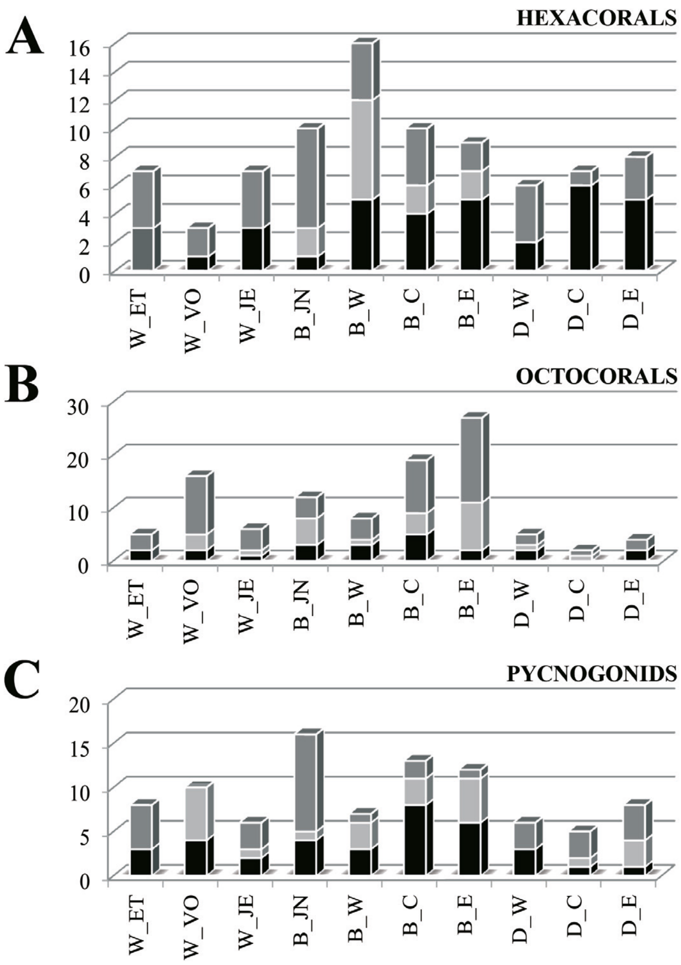

Fig. 3.4.3 Number of species present only in the deepest bathymetric range (black) compared with those only present in the shallowest bathymetric range (gray), and shared species (light gray) along the core sampled stations. A, Hexacorals; B, Octocorals; C, Pycnogonids.

3. In the present cruise, and after the complete study of the specimens, two soft coral species (collected in the AGT stn 197-4 and stn 197-5, both in Bransfield East Upper Slope) will be proposed a new species. Other potential new taxa include a sea anemone of the genus *Isosicyonis*, but a complete morphological and molecular study on our laboratories should be carried out before these taxa could be proposed as new. Other species, in this case gorgonians, will be analysed with special interest on those flagelliform primnoid similar to those of the genus *Primnoella*. The recent revision of the gorgonian genus *Thouarella* (see Taylor et al., 2013) will permit the identification of the species of one of the most specious and difficult to identify gorgonian genera in the Southern Ocean. Different *Thouarella* morphospecies collected during this cruise are apparently not described and will be the subject of further taxonomic studies.

4. In the study of the interspecific variation of morphological characters, special interest will be paid to the diversity and distribution of cnidocysts the in scleractinian genera *Flabellum* and *Paraconotrochus*. For the former genus the efforts will be focus on *Flabellum impensum*, *F. thouarsii*, *F. curvatum*, and *F. flexuosum*. This kind of studies has been carried out in European scleractinian of the family Dendrophylliidae (Martínez-Baraldés et al., submitted) and it shows to be stable at species level, with quantitative and quantitative differences between species of the same genus. The use of these characters on Antarctic scleractinians could solve to define species limits among morphological series of changes in skeleton shape often attributed to environmental changes. In addition, as a complementary study, nuclear (ITS, 28S) and mitochondrial (COI, 16S) DNA markers will be developed and discussed with the results obtained on cnidocyst information. For the intraspecific variability, enough material of two scleractinian species have been collected, *Paraconotrochus antarcticus* and *Fungiacyathus marenzelleri*. The former based on cnidocyst information on both sides of the Weddell Sea (Eastern Weddell Sea material provided by ANT-XXIII/8), while the *F. marenzelleri* comparison will be based on molecular markers in different canyons and other deep-sea samples provided after different previous *Polartern* cruises.

5. Comparative studies on reproductive pattern of Antarctic benthic anthozoans are still scarce. The obtained samples of *Anthomastus bathyproctus*, *Fungiacyathus marenzelleri*, and *Epiactis georgiana* will help to clarify some aspect of the reproductive cycle and will contribute in the case of *E. georgiana* to know the sexual or asexual origin of the young individuals that brood externally (Rodríguez et al., 2012).

6. In total, more than 500 anthozoan samples have been fixed in absolute ethanol for further molecular analyses. Barcode characterization or molecular population diversity are some of the aspect that could be investigated with this material. In this moment the morphological description of new of poorly known taxa is complemented with barcode comparisons. In addition to the new species above mentioned, there are other target taxa to be worked in the near future in this sense, the gorgonian genera *Trichogorgia*, *Thouarella, Ophidiogorgia*, *Primnoella*, and *Convexella*.

Pycnogonida

In the whole study area, about 400 individuals belonging to at least 34 species were collected in the 24 core stations (26 AGT and 15 RD). The number of samples providing sea spiders species in these three areas were: 8 AGT and 5 RD from Western Weddell Sea, 16 AGT and 7 RD from Bransfield Strait, and 6 AGT and 3 RD from Drake Passage. The following comments will try to answer the same items exposed in the above listed scientific objectives:

1. According to the sampling effort carried out, the Bransfield Strait was the species richest area (25 spp.) followed by Western Weddell Sea and Drake Passage (15, and 10 spp. respectively). It is difficult at this moment to support comments on the distribution of pycnogonid species along the WWS-BS-DP transect because most of the material need additional examinations to be done on land SEM and biometric analysis. Moreover, some of the morphospecies are known to probably be species complexes. There are not clear distributional pattern letting us the impression that, despite the apparent limited distribution capacities, the species of this group have a wider geographic and bathymetric distribution (at least within the SO limits) than the current known published data show. The depth station in Bransfield Strait showed the highest number of species not only respect to shallow stations, but also in comparison to all the sampled depths and stations in the whole study (WWS, BS, DP) (Fig. 3.4.1C). The number of species in the three general sampled areas according to shallow and deep stations is shown in Fig. 3.4.2. The comparative number of species of hexacorals and octocoral in the different areas and subsectors in shallow and deep stations as well as those shared species is shown in Fig. 3.4.3C. Perhaps the collection of four polymerous species (with more than four pair of walking legs) (*Decolopoda autralis*, *Dodecolopoda mawsoni*, *Pentanymphon charcoti* and *Pentapycnon charcoti*) is one of the most interesting finding, for some of these species no more than twenty or thirty specimens are now recorder in the literature. The genera *Nymphon*, *Ammothea*, *Pallenopsis* and *Colossendeis* are the most specious in the collected material.

2. The numbers of pycnogonid species in the sampled canyons progressively incremented from western to eastern localities, being canyon catches less abundant than in shallow and deep stations. Deep stations of the Bransfield Strait showed the highest number of species of the whole sampling program in this cruise (WWS, BS, DP). Some species were present in the different depths and environmental conditions (e.g., *Ammothea* sp.1, and *Nymphon* spp.), while other species were restricted to determined areas (e.g., *Dodecalopoda mawsoni* in western stations, or *Pallenopsis* spp. only present in the eastern and central stations).

3. It s difficult at this moment to detect potential new species among the collected material because of the reasons above commented. The species of the genus *Ammothea* has been subject of study in the last decade, with the description of several new species (see Munilla, 2000; 2002; 2005; Cano & López-González, 2007b; 2012), giving us the idea that we are still far from an approximate number of species identifiable by morphology in the Southern Ocean. Thus, special attention will be paid to the species of this genus with the present collected material. On the other hand, recent

studies carried out on *Nymphon* and *Colossendeis* show the presence of cryptic species, and the necessity to evaluate other morphological and molecular characters (Cano and López-González, 2007a; Arango et al., 2011).

4. The material collected in this cruise will be of special interest in the study of the inter- and intraspecific variability of *Colossendeis* and *Nymphon* species. A previous paper (Cano and López-González, 2007a) evaluated the structure diversity on the last ovigerous segment in a group of Antarctic *Colossendeis* species by SEM. This paper provided an additional number of characters useful to discriminate between species and species groups. Species of the *Nymphon australe* group are in need or revision, being often the species of this genus the most recorded pycnogonids in Antarctic cruises (Child, 1995a).

5. For most of pycnogonid species (except for the Colossendeidae), males retain egg masses on a specialized pair of appendages, the ovigers. In these masses larvae hatch as protonymphon (larva), and in some species that stage is retained on the ovigers and successively moult in other postlarval stages. Our current knowledge on the larval development of Pycnogonida is based on no more than 40 of the more than 1200 described species (Bain, 2003; Cano and López-González, 2009; 2010). During this cruise we have paid special attention on the presence of ovigerous males. For some genera, our knowledge is increasing (*Ammothea*) while for other (*Colossendeis, Pentapycnon, Pallenopsis*) nothing is known. The type of larval development and parental care in this group seems to be adaptative, and this kind of information is of special interest in Antarctic waters as is being studied in other benthic groups in relation to its dispersal capabilities. Several ovigerous male specimens of the genera *Ammothea*, *Pallenopsis*, *Austropallene*, and *Nymphon* have been collected, and the comparative description of the different larval and postlarval stages will give us a better overview of the developmental ontogenetic pattern that could be observer in each of these genera.

6. In total, more than 300 pycnogonid samples have been fixed in absolute ethanol for further molecular analyses. This material will be used for the study of species complex of the genus *Colossendeis* and *Nymphon*, as well as barcode (COI and 16S, see Arango et al., 2011) characterization in the description of new or poorly known species, mainly those of the genera *Ammothea* and *Nymphon*.

Data management

All the data generated with the samples obtained in this expedition will be stored in the Spanish Polar database HIELO with public access in the following address http://gcmd.gsfc.nasa.gov/KeywordSearch/Home.do?Portal=ipy&MetadataType=0

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3.5 Prosperity and limitation of the sponge shelf fauna

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Objectives

Major parts of the benthic communities on the Antarctic shelf are dominated by siliceous sponges, which, both *in-vivo* and *post-mortem*, structure the sea floor and provide habitats for other organisms including microbes; furthermore they play an important role in the pelagic-benthic coupling processes (Mintenbeck et al., 2007; Thurber, 2007). Investigations so far have shown that the common and abundant Antarctic sponge taxa are comprised of about 50 species from 30 genera (e.g., Janussen and Tendal, 2007). Some of these species, e.g., of the dominant Antarctic hexactinellid genus, *Rossella*, show considerable morphological variation and transitional traits that may indicate species complexes, ongoing speciation, or both (Göcke and Janussen, in press). Evaluations of macro-, meio-fauna assemblages from selected sponge species (e.g., from the genera *Rossella* and *Mycale*) revealed distinctly different endobiontic communities within different sponge taxa (unpubl. result).

This research project, as part of the ANT-XXIX/3 LASSO expedition, was designed to analyze the impact of climate change on the diversity of Porifera within the Antarctic shelf communities East of the Antarctic Peninsula. Due to heavy ice-conditions we chose to focus on the influence of temperature and food supply within different water masses to compare the Antarctic shelf fauna communities at stations in the northern Weddell Sea, the Bransfield Strait and the Drake Passage.

Work at sea

A representative selection of sponges from each Agassiz Trawl (AGT) catch was collected both by qualitative selection including a variety of specimens from all morphotypes and by quantitative sorting of all sponges from a subsample of approximately 50 liters. All sponges from the subsample were taxonomically sorted according to morpho-species, photographed and the specimens of each morpho-species were counted and weighed. The other sponges collected from the AGT catch were also sorted, photo-documented and subsamples were taken from each morpho-type and fixed for taxonomy and histology (formaldehyde), as well as genetics (96 % ethanol). Relatively clean sponge samples were rinsed in sterile filtered seawater and fixed in ethanol for bacterial screening. Samples from the same sponge specimens were frozen at -80° C and -20° C for lipids and stable isotopes analysis. Large samples or entire specimens of large and/or common sponges were fixed in formalin solution (4 %) for the removal of endobiotic animals post-cruise.

When possible, prior to the AGT-deployments, video transects of the sea floor were reviewed with the OFOS-team. This was done to find the most suitable bottom conditions for the AGT-transect, and also to compare AGT catches with the OFOS photographic transects (for further data on the AGT deployments, see chapter 3.1 Macrobenthic community analysis and biodiversity study, this volume). Bottom water samples were taken from the CTD from each main benthic station in order to compare microbes obtained from the sea water with those found within the sponge samples. A microfiltration system (Millipore filters, 38 µm) was used to filter 1 liter of bottom water in order to isolate microbes and each filter was subsequently frozen for post-cruise analysis. When available, sponge samples were also taken from the Rauschert dredge and the giant box corer (see chapter 3.2 Dynamics of benthic ecosystem functioning in response to predicted environmental shifts and chapter 3.8 Taxocoenoses of amphipod crustaceans, both this volume).

Preliminary results

During this expedition, we sampled approximately 600 sponges individuals from approximately 60 species (conservative estimate) from the 30 AGT-deployments, plus 6 additional samples from the Rauschert dredge and the giant box corer. The 32 benthic stations, all together, were grouped within three oceanographic and zoogeographic areas: The Weddell Sea East of Antarctic Peninsula, the Bransfield Strait and the Drake Passage West of Antarctic Peninsula. Stations were chosen according to different bathymetric features found within each area: bank, upper slope, slope, deep shelf/canyon. A comparison of the numbers of sponge species counted from each subsample and those opportunistically collected from the entire catch, including the subsample, shows that while the species numbers of entire catches are higher than those of the subsamples, the subsamples are representative in terms of relative species abundances when comparing the stations (Fig. 3.5.1).

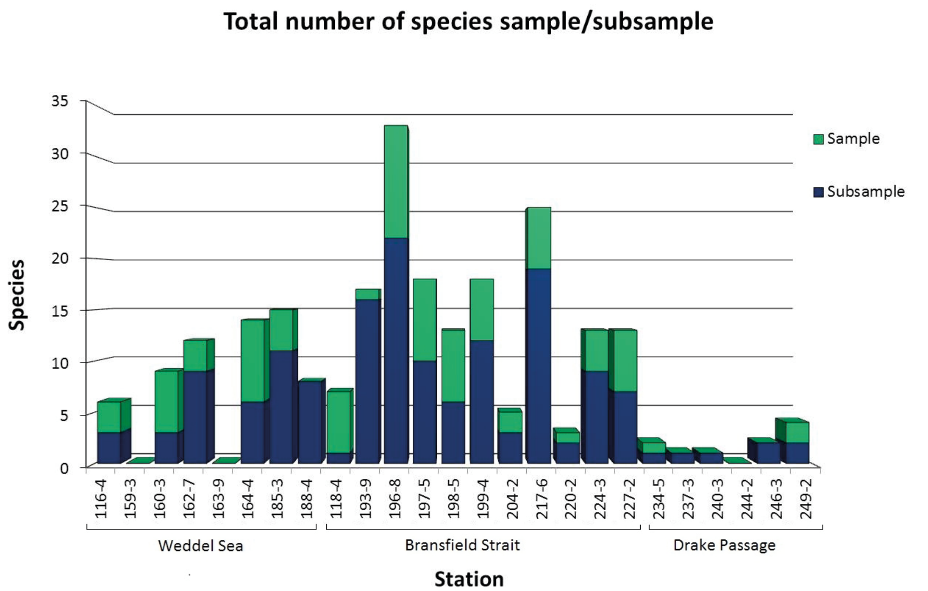

Fig. 3.5.1: Numbers of sponge species recorded within the subsamples compared with those collected from the entire catches

The sponge communities recorded from different geographic regions and depths show obvious differences in terms of species richness and diversity on generic and higher taxonomic levels. In general (with the exception of stn 196-8, as mentioned below), the shallow stations on a bank or the upper slope were found to be richer in species than those of the deep shelf or the canyon (Fig. 3.5.2). However, species richness does not correlate with the sponge biomass in terms of wet weight of all sponges as measured in the subsamples (Fig. 3.5.3). A gradient in species richness between shallow and deeper stations was found at the Weddell Sea stations, whereas in the Bransfield Strait, both shallow and deeper stations proved to be rich, both in species and higher taxa. The volcano seamount, which was discovered and investigated for the first time during this expedition, proved to harbor a diverse assemblage of megafauna, including sponges. This was especially true on the slope when compared with the adjacent deep shelf (stns 185 and 188, respectively).

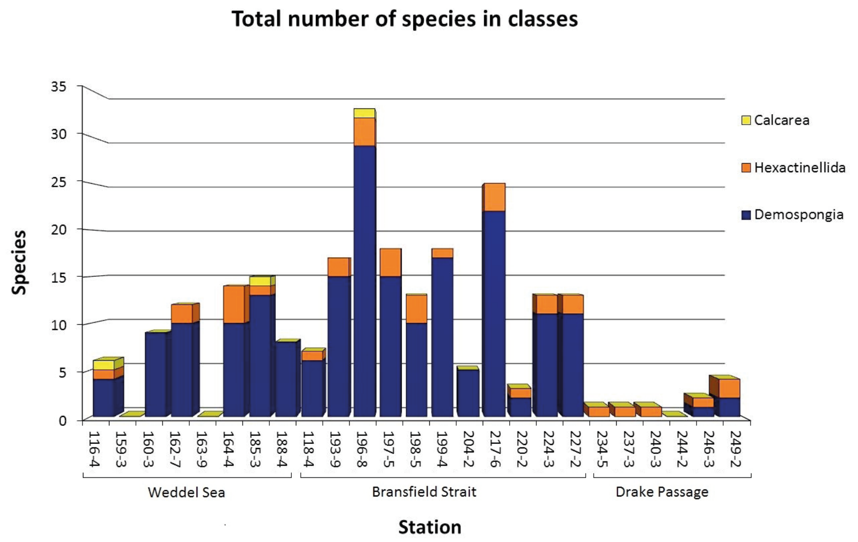

Fig. 3.5.2: Species numbers of the sponge classes, Hexactinellida, Demospongiae and Calcarea, and their distribution on stations

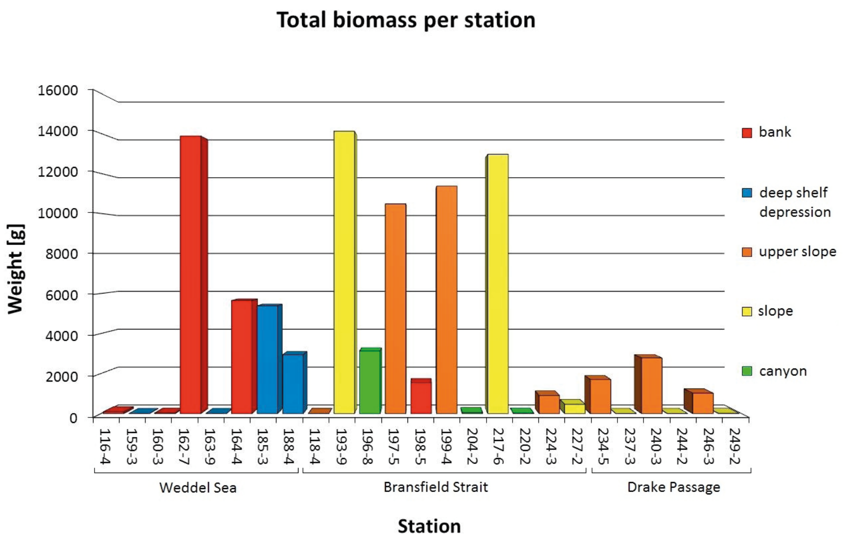

Fig. 3.5.3: Total sponge wet weights from the subsamples of the different AGT-stations

At stn 196-8 (Bransfield Strait, East, canyon, 560-590 m depth), we collected 29 sponge species, the highest number during this cruise, including representatives of the 3 main Porifera classes, Calcarea, Demospongiae and Hexactinellida. In general, with only one exception so far, the Calcarea are neither abundant nor common anywhere in the Antarctic (Janussen and Rapp, 2011; Rapp et al., 2011). During this expedition, we collected only 3 calcarean specimens from 3 stations, 2 in the Weddell Sea and 1 in Bransfield Strait. We collected only a single specimen of the Cladorhizidae Demospongiae, carnivorous sponges, at Bransfield Strait, east, slope (stn 193-8). The family Cladorhizidae is widely distributed and highly diverse within the deep Weddell Sea (Janussen and Tendal, 2007), but they are rare on the Antarctic shelf. An exception is the occurrences of carnivorous sponges recorded from the low productivity shelf areas of the former Larsen AB ice-shelves and Larsen C ice-shelf (Gutt et al., 2011).

The Drake Passage stations yielded an impoverished Antarctic sponge assemblage, with either no sponges at all or only 1-2 species of *Rossella* and hardly any demosponges. Those Drake Passage locations that did provide a considerable amount of sponges were all dominated by rather small specimens of the same species, *Rossella* cf. *racovitzae* (Fig. 3.5.4). This faunal composition is very similar to what we previously found at stations in the Larsen Shelf area (Gutt et al., 2011) and may indicate a starved shelf community. Detailed comparisons with results from the Larsen shelf and with the diverse sponge communities of the Eastern Weddell Sea will be performed in the near future.

Fig. 3.5.4: Numerous small specimens of Rossella *cf.* racovitzae *from station no. #240-3, Drake Passage, central, upper slope*

Data management

After their final taxonomic identification and before their publication, the sponges collected will be catalogued in the SESAM Database (SEnckenberg SAMmlungsmanagement), including samples for the Senckenberg DNA bank collection. SESAM regularly provides all data into GBIF and EurOBIS. Furthermore, all our published Antarctic Porifera species are regularly reported to RAMS. Genetic sequences will be standardly submitted to the gene bank database prior to publication.

Acknowledgements

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3.6 Relation between benthic communities structure and functioning in response to food supply regime and water masses: echinoids 'response'

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Objectives

Regional climate change is observed in the Antarctic Peninsula since the late 1950's. The collapses of ice shelves like those of Larsen A (1998) and B (2002) East of the Peninsula are among the most visible climate-induced events. These highly disturbed sites together with areas undergoing 'natural' fluctuations in ice condition offer the opportunity to characterize colonizing processes expected to occur in a close future as a consequence of global change. About 10 % of known echinoid species occur south of the Polar Front, making the Southern Ocean an enriched 'spot' for echinoids as compared to the mean richness value of the world ocean. Antarctic echinoids belong to numerous ecological guilds, are recurrent members of benthic communities and are widely distributed throughout the Southern Ocean. They are therefore susceptible to participate to initial colonization and to ecological successions in disturbed areas.

The ANT-XXIX/3 expedition explored the shelf from the Northern part of the Antarctic Peninsula to the outer side of the South Shetland Islands (SE to NW transect running from the Weddell Sea to the Drake Passage), offering the opportunity to get integrated environmental data together with benthos samples. ANT-XXIX/3 focused on the structure and functioning of benthic communities in response to food supply modulated by environmental gradients: sea ice impact, water masses influence, and different other parameters (bottom temperature, chlorophyll-a, organic matter in the sediment, etc.).

Our main aim was to determine the feeding and physiological flexibilities of shelf echinoids in response to environmental changes, particularly those related to sea ice conditions and thus to food availability. This was investigated in three areas differing in their potential food supply (Glover et al., 2008; Lockhart and Jones, 2008): (1) a 'permanent' food bank area, north of South Shetland Islands in the Drake Passage; (2) an area with a 'regular' seasonal food input, the Bransfield Strait; (3) an area with an 'unpredictable' seasonal food input, east of Antarctic Peninsula in the Weddell Sea. This particular ecological frame provides a unique opportunity to study how feeding behaviors interfer with changes in biodiversity, abundances and community structures. It could also provide an insight on how marine ecosystems could change with future modifications of sea ice distribution and thickness.

Two additional topics (side researches) are also examined, (1) the echinoid biodiversity and its contribution to local communities, and (2) the population structure of brooding holothurians living as ectosymbionts on cidaroid spines.

Work at sea (see also Table 3.3.1)

Echinoids were mainly sampled using the Agassiz trawl. All collected echinoids were identified at the species level. Individuals of Cidaridae (*Ctenocidaris, Aporocidaris, Notocidaris*), Echinidae (*Sterechinus*) and Schizasteridae (*Abatus, Brachysternaster, Amphipneustes*) were dissected and selected tissues or organs prepared on board. Samples were kept in 70 % or 95% ethanol, frozen or dried. These will be used to determine (1) food sources of echinoids (gut contents analyzed in optical microscopy and tissues analyzed for stable isotopes of carbon and nitrogen), (2) impact of food regime on sea urchin growth (allometry relations between lantern size and test diameter) (see e.g., Ebert et al., 1999), (3) associated digestive transient microflora (identification of bacteria by pyrosequencing and inference of their enzymatic activities). Surface sediments (subsamples of box corer) were also sampled and frozen at -20° C; their bacterial communities and their stable isotope composition will be further analyzed. Bottom seawater temperature, salinity, pH and alkalinity were measured to interpret physiological data. Metabolic activities (O_2 consumption, excretion) were measured on *Sterechinus ssp*. The acid-base status (pH and alkalinity of the coelomic fluid –CF-) of representative species was characterized on the same specimens used for gut content and stable isotope analysis. Samples for DIC analysis of the CF were stored (Fig. 3.6.1).

In order to complete the ongoing phylogeny of brooding schizasterids, tissues of different species were sampled for further genetic analyses. This has been also done for several cidaroid species whose phylogenetic relationships are unclear.

The symbiotic holothurian, *Echinopsolus acanthocola*, was sampled on several species of cidaroids. They were preserved for molecular analyses and for anatomical observations in order to complete previous results on the brooding process and life history of this species.

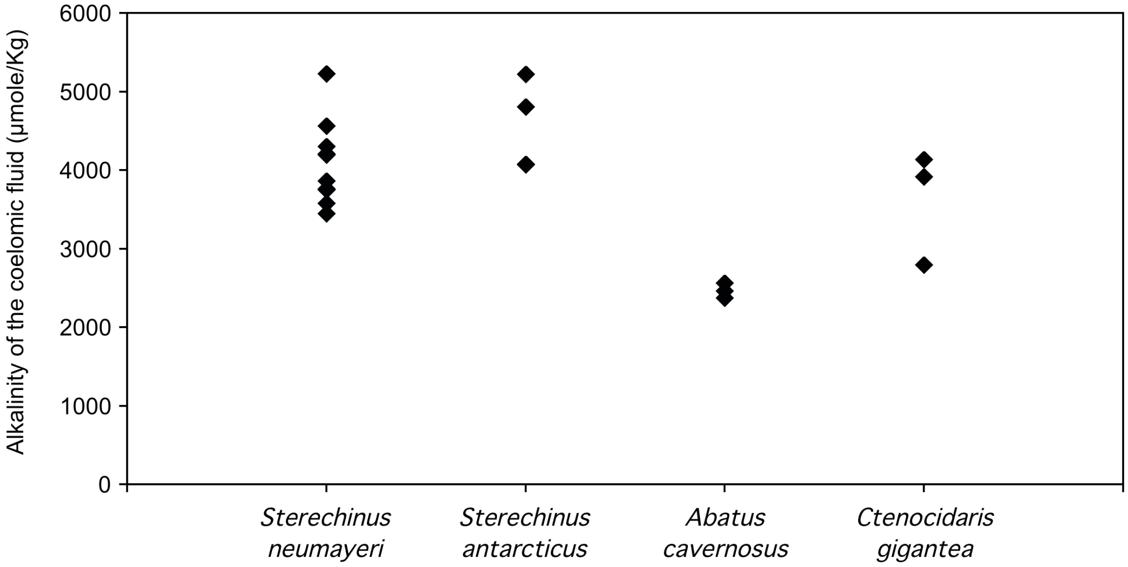

Fig. 3.6.1: Alkalinity of the coelomic fluid of sea urchins collected in the Weddell Sea during campaign ANT-XXIX/3; 1: Sterechinus neumayeri*, 2:* Sterechinus antarcticus*, 3:* Abatus cavernosus*, 4:* Ctenocidaris gigantea

Preliminary observations and expected results

Food, feeding processes, and metabolism survey (main research)

In Larsen A/B areas, three "pioneer" echinoid species were recorded in 2007: *Sterechinus antarcticus, S. neumayeri* and *Notocidaris mortenseni*. The three species were mostly feeding on sediments i.e. an 'unusual' food source as these species are rather opportunistic carnivores. Interestingly, these species were also shown to display local shift to carnivorous regime in areas north and west of the Peninsula, i.e., in stations undergoing more seasonal than permanent sea ice (Ingels et al., 2011). A similar shift was also observed for *Sterechinus* in the Ross Sea (Norkko et al., 2007). We are going to test if feeding categories fluctuate within taxon along the gradient of sea ice conditions. In more permanent sea ice, all echinoid whatever their 'usual' trophic guild are deposit-feeders. In more seasonal ice conditions, cidaroids and *Sterechinus* shift from deposit – feeding to carnivores / omnivores, reflecting food availability. Because food quantity and probably quality modifies the metabolism and ability to resist ocean acidification, we will correlate the energy expenses and acid-base status of the studied echinoids with their food regime. This will allow to infer their putative resilience in front of ocean acidification and to possibly determine the consequences for the ecosystem functioning (in the case of *Sterechinus* spp).

Echinoid biodiversity (side researches)

The detailed survey of the three explored main regions (Northern Weddell Sea, Bransfield Strait and Drake Passage) allowed to propose a first appraisal of the echinoid biodiversity pattern (Fig. 3.6.2). Regarding the richness of the collected faunas, there is a strong and significant ($p<0.0001$) contrast between the relatively poor northern Weddell Sea (from 1 to 4 species/station) and the Bransfield Strait, in which the specific richness ranges from 5 to 12 species/station (average 8.6). The richness peaks recorded in Bransfield overpass what is generally observed for echinoids, and single catches reach up to 15 % of the total echinoid biodiversity of the Southern Ocean. In the prospected depth range (from 100 to 700 m), there is no significant relationship between richness and depth. The echinoid richness in the prospected areas of the Drake Passage appears also low. However, contrary to Weddell Sea, the densities observed with the OFOS are extremely low. Therefore, the samples collected by AGT are likely to be not fully representative of the actual specific richness, and it will be necessary to complete them with observations from the OFOS. These preliminary results will be merged with those obtained during former cruises, including *Polarstern* PS61 and PS69.

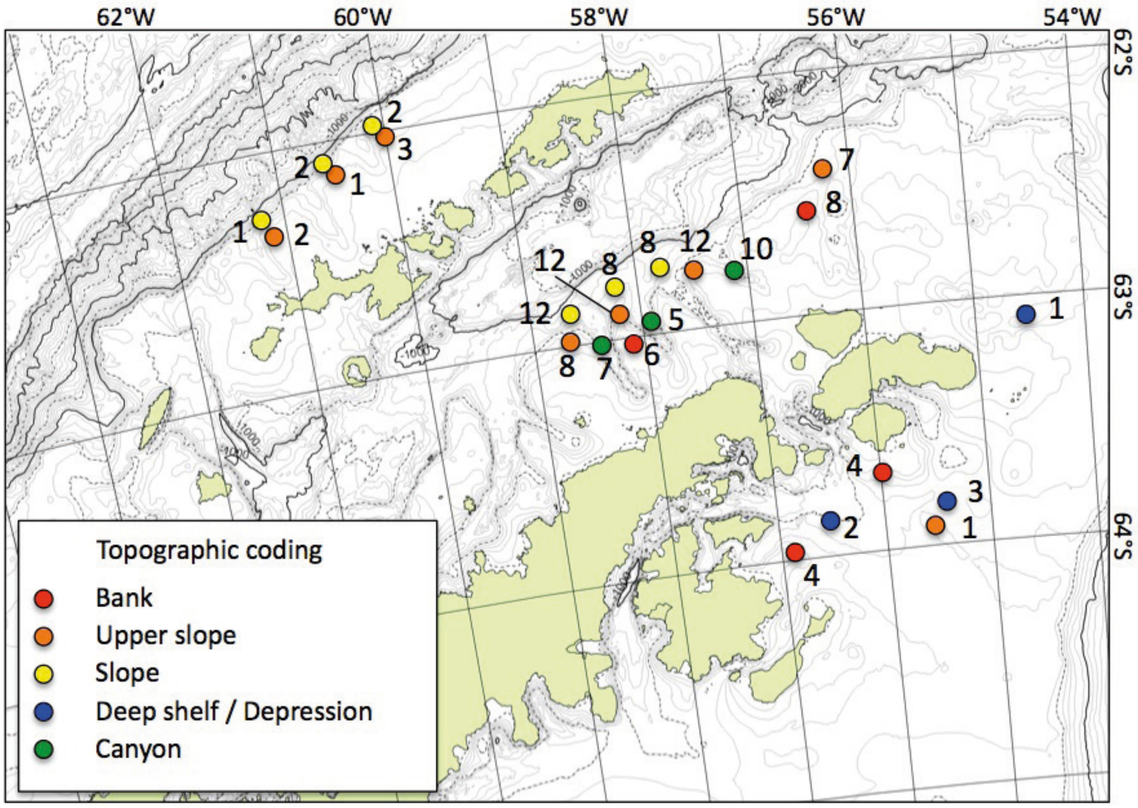

Fig. 3.6.2: Echinoid species richness in the investigated stations (bathymetry provided by the AWI bathymetric service)

A sampling in the Erebus and Terror Gulf (PS81/163-9) led to collect a large number of *Abatus bidens*, a poorly described species. The present discovery not only will make possible the first full description of *A. bidens*, but also will lead to explore the ecological association with *A. cavernosus*, a closely related species.

Population structure in symbiotic holothurians

The main objective is to examine the effect of brooding on dispersal through comparisons of the genetic structures (microsatellites) of hierarchized infrapopulations of *Echinopsolus acanthocola* (a symbiotic holothuroid specific of cidaroids). Our samples were collected in the Bransfield Strait, in the deep stations. Infra-population (burden) of *E. acanthocola* reaches up to 12 individuals per echinoid host (Fig. 3.6.3). Molecular analyses and interpretations will be performed in collaboration (Santiago, Dijon, and Brussels Laboratories).

Fig. 3.6.3: Seven Echinopsolus acanthocola *individuals on the spines of* Aporocidaris eltaniana

Data management

Data on biodiversity (inventories and patterns) will be integrated into the SCAR-Marine Biodiversity Information Network (SCAR-MarBIN) and accessible to the international scientific community. The results on the genetic sequences will be added to GEN-BANK.

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Tab. 3.6.1: Echinoid species, stations and explored fields (systematics and genetics prevail for all and are not indicated). Metab. (A): acid base balance; Metab (R): respirometry; Food sources: gut contents (ethanol 100) and stable isotopes samples; Microflora: bacterial communities (DNA, RNA, DAPI). AGT: large Agassiz Trawl, GKG Giant Box Corer, RMT Rectangular Midwater Trawl (Plankton), RD Rauschert Dredge. Reg: region; BS: Bransfield Strait, WS: Weddell Sea, DP: Drake Passage.

Family	Species	Reg	Stn	Depth (m)	Metab (A)	Metab (R)	Food sources	Micro-flora
Cidaridae	*Aporocidaris eltaniana*	BS	196-8	580				
		BS	204-2	781			X	X
		BS	220-2	782	X		X	
		BS	227-2	564				
	Ctenocidaris gigantea	BS	116-9	248	X			
		WS	162-7	216	X		X	
		WS	164-4	102			X	
		BS	197-5	273				
		DP	234-5	251			X	X
	Ctenocidaris longispina	BS	199-4	325				
		BS	217-6	408				
		BS	227-2	564				
	Ctenocidaris rugosa	BS	116-4	233				
		BS	116-9	248				
	Miracidaris sp	BS	193-9	420				
		BS	196-8	580				
		BS	197-5	273				
		BS	199-4	325				
		BS	217-6	408				
		BS	217-7	395				
	Notocidaris gaussensis	BS	197-5	273	X		X	X
		BS	199-4	325				
		BS	217-6	408				
	Notocidaris mortenseni	BS	193-8	428				
		BS	193-9	420				

Family	Species	Reg	Stn	Depth (m)	Metab (A)	Metab (R)	Food sources	Micro-flora
		BS	196-8	580				
		BS	197-5	273	X		X	X
		BS	199-4	325			X	
		BS	217-6	408				
		BS	217-7	395				
		BS	227-2	564				
	Rhynchocidaris triplopora	BS	116-9	248				
		BS	193-8	428				
		BS	193-9	420				
		BS	196-8	580				
		BS	197-5	273				
		BS	199-4	325				
		BS	217-6	408				
		BS	217-7	395				
		BS	224-3	261				
		BS	227-2	564				
Echinidae	*Sterechinus antarcticus*	BS	116-9	248	X			
		BS	118-4	434			X	X
		BS	193-8	428				
		BS	193-9	420	X		X	X
		BS	196-8	580			X	
		BS	197-5	273	X		X	X
		BS	199-4	325	X	X	X	X
		BS	217-6	408			X	X
		BS	217-7	395			X	X
		BS	227-2	564			X	
	Sterechinus neumayeri	WS	160-3	238	X		X	X
		WS	162-7	216			X	X
		WS	164-4	102	X	X	X	X
		WS	185-3	296	X	X	X	X
		WS	188-4	425			X	
		BS	196-8	580			X	
		BS	197-5	273			X	
		BS	198-5	179				
		BS	199-4	325	X		X	X
Urechinidae	*Antrechinus mortenseni*	BS	118-4	434				
		BS	193-8	428				
		BS	193-9	420				
		BS	196-8	580				
		BS	197-5	273				
		BS	199-4	325				
		BS	204-2	781				
		BS	205-1	200				

Family	Species	Reg	Stn	Depth (m)	Metab (A)	Metab (R)	Food sources	Micro-flora
		BS	220-2	782				
		BS	224-3	261				
		BS	227-2	564				
		DP	244-2	464				
Plexechinidae	*Plexechinus planus*	BS	220-2	782				
Pourtalesiidae	*Pourtalesia hispida*	BS	220-2	782				
Schizasteridae	*Abatus bidens*	WS	164-4	102				
		WS	188-4	425				
		WS	190-2	339				
		BS	196-8	580				
		BS	197-5	273				
		BS	198-5	179				
		BS	199-4	325				
		BS	204-2	781				
		BS	205-1	200				
		BS	220-2	782				
		BS	224-3	261				
		BS	227-2	564				
		DP	249-2	421				
	Abatus cavernosus	BS	116-9	248				
		WS	162-7	216				
		WS	164-4	102				
		BS	198-5	179				
		BS	220-2	782				
		BS	224-3	261				
		DP	234-5	251				
		DP	237-3	522				
		DP	240-3	277			X	
		DP	245-1	313				
		DP	246-3	266				
	Abatus philippi	BS	118-4	434				
	Amphipneustes lorioli	BS	116-9	248				
		BS	118-4	434				
		BS	193-8	428				
		BS	193-9	420	X		X	
		BS	198-5	179				
		BS	217-6	408				X
	Amphipneustes aff. *lorioli*	BS	197-5	273				
	Amphipneustes rostratus	WS	188-4	425				
		BS	193-9	420	X		X	
		BS	197-5	273				
		BS	199-4	325				
		BS	217-6	408				X

Family	Species	Reg	Stn	Depth (m)	Metab (A)	Metab (R)	Food sources	Micro-flora
		BS	224-3	261				
		BS	227-2	564	X			
		DP	249-2	421	X		X	
	Amphipneutes similis	BS	116-9	248				
		BS	118-4	434				
		WS	162-7	216			X	
		BS	193-8	428				
		BS	196-8	580				
		BS	197-5	273			X	
		BS	198-5	179				
		BS	199-4	325	X		X	
		BS	204-2	781	X		X	
		BS	205-1	200				
		BS	224-3	261				
		BS	227-2	564	X			
		DP	244-2	464			X	
		DP	246-3	266	X		X	
	Amphipneustes aff. *similis*	BS	193-8	428				
		BS	204-2	781	X		X	
		BS	205-1	200				
		BS	224-3	261				
		BS	227-2	564				
		DP	246-3	266			X	
	Brachysternaster chesheri	BS	116-9	248				
		BS	118-4	434				
		BS	193-9	420			X	
		BS	198-5	179				
		BS	199-4	325				
		BS	205-1	200				
		BS	220-2	782				
		BS	224-3	261				
		BS	227-2	564				
	Genicopatagus affinis	BS	118-4	434				
		BS	227-2	564				

3.7 Crinoid and asteroid diversity over ecologically contrasted areas

Marc Eléaume[1] [1]MNHN

Objectives

In a context of rapid global change, it is reasonable to think that the physical environment of benthic species will drastically change in a reduced time period. Temperature, salinity, primary production and ice cover will probably undergo substantial changes within the next decades. In turn, the composition and distribution of shelf benthic fauna will also be impacted. Cycles of glaciation/deglaciation events in the past are known to have already heavily impacted on the shelf benthic biodiversity and shaped the structure and composition of existing communities.

Crinoids and starfish constitute a conspicuous component of the Antarctic shelf mega-epibenthos. A few species, like the emblematic *Promachocrinus kerguelensis*, are locally very abundant. About 40 species of crinoids and 250 starfish occur in the Southern Ocean. In the last few years, several new species of crinoids have been or are being described (Eléaume et al., 2011; 2012), increasing considerably the number of species known from the Southern Ocean. Genetic studies also have contributed to our knowledge of the diversity of crinoids in the Southern Ocean and suggest that cryptic species are still unrecognized within *P. kerguelensis*, *Notocrinus virilis*, *Notocrinus mortenseni*, *Isometra graminea*, and *Isometra vivipara* (Hemery et al., 2012). Our preliminary results on 18 species of common Southern Ocean starfish yielded the same results, revealing unexpected genetic diversity. Moreover, we found that populations of brooding species, because brooders don't disperse much, are geographically structured and may be used as signatures of past glacial refugia. Both crinoids and starfish have brooding and broadcasting representatives in the Southern Ocean and may be used to test the existence all around the shelf of such refugia.

Our results suggest that the crinoid, and starfish biodiversity is only partially known and need to be further explored. The western Weddell Sea as well as the Bransfield Strait and the western coast of the Shetland Islands have never been properly investigated in terms of crinoid and asteroid diversity. One aim of the present project is to fill in these important biogeographic gaps.

In addition, because many taxa previously thought to be one species are now believed to be composed of complexes of cryptic species, the paradigm of their circumpolar distribution has to be revised. More generally, the study of genetic variation helps understand with some precision the geographic distribution and past history of benthic organisms.

Our goal is to better understand: (1) the circumpolar patterns of the benthic shelf fauna; (2) the genetic and geographic structure within species between population of target organisms; (3) the past history of crinoid and starfish in the Southern Ocean at different levels of integration, from gene to population and species.

Work at sea

Crinoid and starfish specimens were collected using the Agassiz trawl and a Rauschert dredge. Specimens or lots of specimens were given a unique field number and a picture was taken. Specimens were then preserved in 96 % pur ethanol. Not all the specimens were kept and preserved, due to the reduced storage space. Tube feet were collected from specimens in 2.5 ml eppendorf tubes with 96 % pur ethanol.

Preliminary results

A total of 32 trawling operations yielded asteroid or crinoid specimens (Tables 3.7.1 and 3.7.2), and 575 lots were collected and preserved. In addition 250 tissue samples were collected for DNA extraction.

Thirty five species of starfish were identified from the samples dredged (Table 3.7.1); some species were not recognised and will be further investigated. Among the identified material, 32 species were dredged from the Bransfield Strait, 23 from the Weddell Sea and 14 from the Drake Passage. In the Bransfield Strait, 30 species were dredged from the deeper stations, and 25 from the shallower stations. In the Weddell Sea, only 4 species were collected from the deeper stations, and 23 from the shallow stations. In the Drake Passage, four species were dredged from the deeper and 13 species from the shallower stations.

Tab. 3.7.1: List of starfish species present and absent from the samples dredged from the three target areas and two depth ranges. 1 = presence ; 0 = absence.

	BS		WS		DP	
	deep	**shallow**	**deep**	**shallow**	**deep**	**shallow**
Acodontaster capitatus	1	1	0	1	0	0
Acodontaster elongatus	1	0	0	0	0	0
Acodontaster hodgsoni	1	1	0	1	0	1
Acodontaster sp.	0	1	0	1	0	0
Bathybiaster loripes	1	1	0	1	0	1
Cheiraster hirsutus	1	1	0	0	0	1
Cheiratser hirsutus	0	0	0	0	1	0
Cuenotaster involutus	1	1	0	1	0	0
Diplasterias brucei	1	1	1	1	0	1
Henricia sp.	1	1	0	1	0	0
Hippasteria sp.	1	1	0	0	1	1
Labidiaster annulatus	1	1	0	0	0	1
Leptychaster flexuosus	0	1	1	1	0	0
Lophaster gaini	1	0	0	0	0	0
Lysasterias armata	1	0	0	0	0	0
Lysasterias heteractis	1	1	0	1	0	0
Lysasterias perrieri	1	0	0	1	0	0
Lysasterias sp.	1	1	0	0	0	1
Morph 1	1	1	0	1	0	0
Morph 2	1	1	1	1	1	1
Morph 3	0	0	0	0	0	1
Notasterias armata	1	1	0	1	1	1
Odinella nutrix	1	0	0	0	0	0
Odontaster sp.	1	1	0	1	0	0
Paralophaster antarcticus	1	1	0	1	0	0
Paralophaster sp.	1	1	0	1	0	0
Pergamaster sp.	1	1	0	0	0	0
Perknaster sp.	1	0	0	1	0	0
Perknaster sp1	0	0	0	1	0	0
Perknaster sp2	1	1	0	1	0	0
Porania antarctica	1	1	0	1	0	1
Psilaster charcoti	1	0	1	1	0	1
Pteraster sp.	1	1	0	1	0	0

	BS		WS		DP	
	deep	shallow	deep	shallow	deep	shallow
Rhopiella hirsuta	1	1	0	1	0	1
Solaster regularis	1	1	0	0	0	0

Ten species of crinoid were identified from the samples dredged (Table 3.7.2); it may be that the categories Eumorphometra sp., *Isometra* sp1, *Notocrinus virilis* and *Notocrinus mortenseni* represent several species each. This possibility will be further investigated. Among the identified material, 10 species were dredged from the Bransfield Strait, 6 from the Weddell Sea and 2 from the Drake Passage. In the Bransfield Strait, 9 species were dredged from the deeper stations, and 8 from the shallower stations. *Anisomatra frigida* and *Kempometra grisea* are thought to be rare species. Both occured in the deep canyon areas and *K. grisea* was regularly dredged from these environments. In the Weddell Sea, none was collected from the deeper stations, and six from the shallow stations. In the Drake Passage, one species were dredged from the deeper and one species from the shallower stations.

Tab. 3.7.2: List of crinoid species present and absent from the samples dredged from the three target areas and two depth ranges. 1 = presence ; 0 = absence.

	BS		WS		DP	
	deep	shallow	deep	shallow	deep	shallow
Anisometra frigida	1	0	0	0	0	0
Anthometrina adriani	1	1	0	1	0	0
Eumorphometra sp.	1	1	0	1	0	0
Florometra mawsoni	1	1	0	1	0	0
Isometra challengeri	0	1	0	0	0	0
Isometra sp1	1	1	0	1	0	0
Kempometra grisea	1	0	0	0	0	0
Notocrinus mortenseni	1	1	0	0	0	0
Notocrinus virilis	1	1	0	1	0	1
Promachocrinus kerguelensis	1	1	0	1	1	1

The preliminary results show that the species richness in the Bransfield Strait is higher as compared to the Drake Passage and Western Wedell Sea. There seem to be no difference in the Bransfield Strait between the deep and shallow stations. However, the deep Western Weddell Sea shows a reduced diversity compared to the shallower shelf. The same trend seems to occur in the Drake Passage but with even lower levels of diversity.

Data managment

All species occurrences will be entered in the MNHN Marine Invertebrates database INVMAR and in the SCAR-MarBIN. DNA sequence data will be added in the barcode of life database BOLD and in GENBANK.

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3.8 Taxocoenoses of amphipod crustaceans

Cédric d'Udekem d'Acoz[1], Marie Verheye[1]   [1]RBINS

Objectives

This project had four main objectives:

- to document and compare the traits of amphipod taxocoenoses from the North of the Antarctic Peninsula,
- to contribute to the description of morphological and molecular biodiversity of Antarctic amphipods, particularly those of the superfamilies Eusiroidea and Lysianassoidea,
- to contribute to the description of morphological and molecular biodiversity of Antarctic isopod and mysid crustaceans, polynoid polychaetes and bryozoans,
- to provide a new dataset of distributional, ecological and photographic information on Antarctic amphipods.

Work at sea

Material has been collected by Rauschert dredge (RD), Agassiz trawl (AGT), rectangular midwater trawl (RMT) and baited traps (ATC). Amphipods, isopods, mysids, bryozoans and polynoid polychaetes were sorted and preserved. Other organisms collected by the authors were dispatched to various colleagues on board. Whenever possible, specimens were identified and photographed and then fixed in 96 % or 100 % ethanol. DNA extractions were carried out for 48 specimens. The scientific experience and the life on board of the authors was presented to the public on a blog: www.2monthsinantarcticseas.blogspot.com.

Preliminary results

Crustaceans

Records of crustaceans identified on board during ANT-XXIX/3 (euphausiids excluded) are presented in Table 3.8.1.

Tab. 3.8.1: List of crustacean taxa per station recorded during ANT-XXIX/3. Entries in the table presumably or possibly covering more than one species are preceded by (c). Pelagic species are preceded by (p). Possible and putative undescribed species are followed by (!). Photographed species are indicated by #. The records are presented by areas, W (Weddell Sea), B (Bransfield Strait) and D (Drake Passage) and by station number. Records from the RMT are indicated by * (they include a few benthic species because the net sometimes came close to the bottom or even touched it). Records from the ATC stations are indicated by **.

AMPHIPODA
AMPELISCIDAE
Ampelisca bouvieri #: W; B; *160-3; 162-7; 162-8; 164-4; 164-5; 185-4; 224-3*
Ampelisca aff. *bouvieri* (!) #: W; *160-3; 162-7*
Ampelisca bransfieldi #: W; B; D; *118-8; 196-8; 204-2; 217-7; 220-2; 227-1; 227-2; 237-1; 237-3; 240-2; 240-3; 244-2; 244-3; 245-1; 246-3; 247-8; 249-2*
Ampelisca dallenei #: W; B; D; *160-3; 162-7; 224-2; 224-3; 217-7; 227-1; 227-2; 234-5; 234-6; 237-1; 244-3; 245-1*
Ampelisca richardsoni #: W; B; D; *116-9; 118-4; 160-3; 160-4; 162-7; 164-4; 185-3; 185-4; 188-5; 198-5; 234-5; 234-6; 240-2; 240-3; 244-3; 246-3*
(c) *Ampelisca* spp.: W; B; *162-8; 164-5; 188-4; 193-10; 196-8; 197-6; 199-4; 224-2*
Byblis securiger #: W; B; D; *116-9; 118-4; 188-2; 188-4; 199-4; 217-6; 217-7; 227-2; 237-3; 246-3; 249-2*
COROPHIOIDEA (INCLUDING CAPRELLIDS)
Aeginoides gaussi #: D; *244-3*
Anonychocheirus richardsoni: W; *164-4*
Caprellinoides singularis: W; *116-6*
(c) Corophioidea spp. n. det. #: W; B; D; *118-8; 164-5; 193-9; 193-10; 196-8; 197-5; 198-5; 198-6; 204-2; 217-7; 220-1; 227-2; 234-6; 237-1* (2 spp)*; 244-3; 245-1; 247-8*
Gammaropsis serricra #: B; *227-1*
(c) *Gammaropsis* spp. #: W; B; *164-5; 185-4; 193-10*
(c) *Haplocheira* spp. #: W; *160-4; 164-4; 164-5*
Jassa goniamera #: W; B; *159-4; 185-4; 188-4; 193-9; 196-8*
Jassa thurstoni: W; *118-8*
Megamphopus sp. (red eye) #: B; D; *227-1; 240-2; 245-1*
Paragammaropsis prenes #: W; B; D; *116-9; 199-4; 247-8*
Podoceridae sp. (!) #: D; *227-1*
Podocerus septemcarinatus #: W; B; D; *116-6, 118-4; 196-8; 197-6; 198-6; 217-7; 220-1; 224-2; 227-1; 244-3*
(c) *Pseudericthonius* spp. #: W; D; *116-6; 164-5; 237-3*
DEXAMINIDAE
(c) *Polycheria* spp.: W; B; *191-1*; 196-8; 217-7*
EUSIROIDEA
Acanthonotozomoides oatesi #: B; *197-6*
Acanthonotozomopsis pushkini #: W; B; *164-5; 197-6*
Alexandrella sp. (!) #: B; *227-2*
Anchiphimedia dorsalis #: D; *249-2*
Atyloella cf. *quadridens* #: B; *197-6*
Atylopsis aff. *fragilis* (!) #: B; D; *227-1; 244-3*
Bathypanoplea schellenbergi #: B; *217-6; 227-2*
Echiniphimedia echinata #: W; B; D; *116-9; 197-5; 217-6; 246-3*
Echiniphimedia gabrielae #: B; *193-8; 193-9*
Echiniphimedia cplx *hodgsoni* species with slender spine-like projections #: B; *199-4*
Echiniphimedia cplx *hodgsoni* species with stocky spine-like projections (!) #: W; B; *162-7; 164-4; 197-5; 217-6; 224-3*
Echiniphimedia scotti #: W; *185-4*
Echiniphimedia waegelei #: B; *199-4; 217-6*
Epimeria georgiana #: W; B; D; *116-9; 160-3; 164-4; 185-3; 185-4; 197-5; 204-2; 205-1*; 224-3; 234-5*
Epimeria grandirostris #: B; *197-6*
Epimeria inermis #: B; *224-2; 224-3; 227-2*
Epimeria macrodonta #: W; B; *185-3; 193-8*
Epimeria aff. *macrodonta*, blade-shaped dorsal teeth (!) #: W; B; *116-9; 162-7; 164-4; 185-3; 185-4; 193-8*
Epimeria pulchra red colour morph #: W; *185-3*
Epimeria aff. *puncticulata* (!) #: W; B; *164-5; 197-6*
Epimeria robustoides #: B; *196-8; 217-6; 227-2*
Epimeria aff. *schiaparelli* (!) #: W; B; *118-8; 193-8; 193-9; 196-8*
Epimeria similis #: B; *193-8; 193-9; 217-6*
(p) *Epimeriella macronyx* #: W; D; *182-1*; 238-1**
Epimeriella walkeri #: W; B; D; *185-4; 188-5; 197-5; 217-7; 234-5*
(c) Eusiroidea spp. n. det. #: B; D; *193-10; 196-8; 197-6*
Eusiroides georgiana: W; D; *164-4; 197-6*
Eusirus antarcticus ocelot 'form' #: W; B; *116-9; 162-7; 185-3; 185-4; 188-5; 196-8; 197-6; 198-6; 220-1; 224-2; 227-1; 227-2*

(c) *Eusirus* group *antarcticus/bouvieri* n. det.: B; *199-4*
Eusirus cplx *bouvieri* brown 'form' #: W; B; *185-4; 185-4; 188-4; 193-8; 197-5; 217-7*
Eusirus cplx *bouvieri* all white 'form' (!) #: W; *185-4*
Eusirus cplx *giganteus* non-spotted (all red) (!) #: B*; 227-2*
Eusirus cplx *giganteus* non-spotted (pale gray back / crimson legs) #: B; *204-2; 220-2*
Eusirus cplx *giganteus* spotted (P3-P4 white with red dactylus) (!) #: W; B; *118-4; 196-8; 227-2*
Eusirus cplx *giganteus* spotted (P3-P4 striped) (!) #: W; B; *188-4; 196-8; 217-6; 227-2*
(p) *Eusirus laticarpus* pale coloured with golden marks #: W; *147-1*, 148-1*; 152-2*; 154-1*; 171-2**
Eusirus cf. *laticarpus* colourless #: D; *234-5*
(p) *Eusirus microps* #: W; B; *148-1*; 153-1*; 158-1*; 164-6*; 167-1*; 168-1*; 171-2*; 173-2*; 175-1*; 176-2*; 182-1*; 188-4; 191-1**
Eusirus cplx *perdentatus* marbled #: W; B; *116-9; 162-7; 185-3; 185-4; 188-4; 193-8; 193-9; 197-5; 199-4; 204-2; 217-6; 224-3*
Eusirus cplx *perdentatus* spotted (!) #: W; B; *118-4; 185-3; 185-4; 188-4; 193-8; 193-9; 196-8; 197-5; 197-6; 199-4; 217-6; 217-7; 227-2*
(p) *Eusirus propeperdentatus* #: W; *135-1*, 146-1*; 154-1*; 167-1**
Gnathiphimedia sexdentata #: W; B; *116-6; 164-4; 185-4; 198-6; 224-2; 227-2*
Gnathiphimedia sp. (close to *G. barnardi*) (!) #: W; *185-4*
Iphimediella acuticoxa #: B; *197-6*
Iphimediella cyclogena #: W; B; *116-9; 185-3; 197-5*
Iphimidiella dominici #: B; *197-6*
Iphimediella margueritei #: B; *197-6*
Iphimidiella rigida #: W; B; *116-4, 116-9, 118-4; 164-4; 185-3; 193-8; 197-5; 199-4; 217-6; 224-3*
Iphimediella ruffoi #: W; *116-9*
Liouvillea n. sp. [no dorsal teeth] (!) #: W; B; *116-6; 164-4; 164-5; 197-5; 197-6; 224-2*
Maxilliphimedia longipes #: B; *197-5*
Oradarea tricarinata: W; *116-6*
Oradarea tridentata #: W; *185-4*
Oradarea sp. [3 teeth on back but neither *O. tricarinata* nor *O. tridentata*] (!) #: W; *159-3*
(c) *Oradarea* spp: B: *193-10; 197-6; 198-5; 198-6; 198-4*** (one specimen)*; 227-1; 217-7*
Oradarea walkeri: W; *185-4*
Parepimeria crenulata #: W; B; D; *116-6; 164-4; 185-4; 197-5; 197-6; 198-6; 244-3*
Parepimeria major #: W; B; D; *118-8; 162-8; 196-8; 204-2; 217-7; 227-2; 237-1*
Parepimeria minor #: B; D; *198-6; 224-2; 234-6; 240-2; 245-1; 247-8*
Prolaphystius isopodops #: B; *196-8*
Prostebbingia gracilis #: W; B; D; *164-4; 220-1; 220-2; 244-3; 245-1; 249-2*
Prostebbingia longicornis: W; *164-5*
Rhachotropis antarctica #: W; B; D; *116-9; 118-4, 118-8; 160-4; 164-4; 188-5; 197-6; 198-6; 217-7; 234-6; 240-2: 244-3; 247-8*
Rhachotropis schellenbergi #: B; *197-5; 197-6*
Rhachotropis sp., body colourless, huge irregular-shaped white eyes (!) #: D; *244-3*
Schradeira gracilis #: W; B; *116-6; 164-4; 198-6*
Stegopanoplea joubini #: W; B; *116-6; 164-4; 185-4*
HADZIOIDEA
Melitidae sp. (!) #: B; *217-7*
Paraceradocus cplx *gibber* brown and white; back with two white stripes #: W; B; *116-4, 116-9, 118-4; 160-3; 162-7; 164-4; 185-3; 198-5; 224-3*
Paraceradocus cplx *gibber* all brown (!) #: B; *204-2; 220-2*
HYPERIOIDEA
(p) *Cyllopus lucasi* #: *147-1*, 148-1*, 152-2*; 168-1*; 171-2*; 175-1*; 176-2*; 238-1**
(p) *Cyllopus magellanicus* #: *234-2*; 238-1**
(p) *Hyperia macrocephala*: *148-1*; 168-1**
(p) *Hyperiella macronyx* #: 148-1*; 168-1*; 175-1*; 207-2*; 238-1*
(p) *Hyperoche capucinus* #: *147-1*, 148-1*; 152-2*; 168-1*; 171-2*; 175-1*; 234-2**
(p) *Primno macropa* #: *148-1*; 168-1*; 171-2**
(p) *Scina* sp: *147-1**
(p) *Themisto gaudichaudii* #: *131-1*; 148-1*; 208-2*; 212-1*; 234-2*; 238-1**
(p) *Vibilia antarctica* #: *148-1*; 234-2*; 238-1**
LEUCOTHOIDAE
Leucothoe sp. yellow/orange marks (!) #: W; B; D; *162-7; 162-8; 185-4; 197-5; 217-7; 224-2; 234-5*
Leucothoe sp. white (no yellow marks) (!) #: B; *193-1*
(c) *Leucothoe* sp. (colour unrecorded): W; *118-8*
LILJEBORGIOIDEA

Liljeborgia georgiana #: W; B; *116-9; 198-5; 199-4*
Liljeborgia nesiotica #: W; B; *116-6; 185-4; 197-5; 197-6*
Liljeborgia polydeuces #: W; D; *118-8; 234-6; 237-1; 244-3; 245-1*
LYSIANASSOIDEA
Abyssorchomene charcoti #: B; D; *198-4**; 221-1**; 247-1***
Abyssorchomene group *scotianensis* (L-shaped eye) (!) #: B; D; *220-1; 247-1***
Aristias antarcticus #: W; B; *116-9; 185-3; 224-2*
(c) *Aristias* spp.: B; *199-4*
Cheirimedon crenipalmatus #: W; B; *162-8; 198-5*
(p*) Cyphocaris* cf *richardi* (!) #: W; *146-1*
(c) *Hippomedon* spp. #: W; B; *164-4; 198-4**; 221-1***
Lepidepecreella andeep: W; *118-4*
Lepidepecreella ovalis #: B; *185-4; 193-10*
(c) *Lepidepecreella* spp.: W; B; *118-8; 196-8; 217-7; 220-1; 220-2*
Lepidepecreoides sp. (!) #: D; *249-2*
Lepidepedreoides xenopus, typical form with basis of P5 posteriorly bluntly angular #: B; *193-10*
Lepidepecreoides xenopus, form with a long sharp posterior point on basis of P5 (!) #: B; *197-6*
Lysianassoidea n. det. with large reddish saddle on back #: W; B; *116-6; 164-4; 197-6; 198-5; 217-7*
Lysianassoidea n. det., pink body, eye forming a vertical white stripe #: B; *220-1*
Lysianassoidea n. det., no eye, spur on Ep3 #: D; 237-1
(c) Lysianassoidea spp. #: W; B; D; *118-4, 118-8; 160-4; 162-7; 164-4; 164-5; 167-1; 188-4; 196-8; 197-5; 220-1; 227-1* (6 spp.); *237-1* (3 spp.); *244-3* (3 spp.)
Orchomenella acanthurus #: W; B; *116-9; 162-7; 185-4; 197-6; 198-6*
Orchomenella pinguides #: W; B; D; *118-4; 118-8; 160-3; 164-6*; 198-5; 198-6; 198-4**; 237-1; 220-1*; *220-2; 244-3; 245-1*
Orchomenella sp.: B; *164-5*
Orchomenid n. det.: B; *160-4*
Orchomenid n. det. sigmoid and posteriorly angulose carina on urosomite 1: B; *247-1***
Orchomenyx macronyx #: W; *116-9* (inside tunicate)
Parschisturella carinata #: B; *198-4**; 220-1; 227-2*
Pseudorchomene coatsi #: B; D; *221-1**; 247-1***
Pseudorchomene plebs #: W; B; D; *164-6*; 182-1*; 198-4**; 221-1**; 247-1***
Pseudorchomene rossi #: W; B; D; *164-6*; 182-1*; 198-4**; 221-1**; 247-1***
Shackletonia sp. (!) #: D; *234-5; 249-2*
Tryphosella analogica #: B; *227-1*
Tryphosella group *macropareia* (red and white L-shaped eye) #: B; *198-4**; 217-7; 221-1***
Tryphosella group *macropareia* (pale L-shaped eye) #: B; D; *220-1; 224-2; 227-1; 227-2; 237-1*
Tryphosella murrayi #: W; B; *116-9; 118-8; 198-4**; 221-1***
Tryphosella sp., medially constricted white eye: D; *244-3*
Tryphosella sp., eye not L-shaped, urosomite 3 carinate and posteriorly concave #: B; *227-1*
(c) *Tryphosella/Uristes* spp: W; B; *118-8; 197-6*
Uristes gigas #: B; *196-8; 197-5; 197-6*
Waldeckia obesa #: W; *160-3; 162-7; 164-4*
MELPHIDIPPIDAE
Melphidippa antarctica #: W; B; D; *116-6; 118-8; 160-3; 185-4; 188-5; 193-10; 198-6; 217-7; 220-1; 224-2; 237-1; 244-3*
Melphidippa sp. (small sp. with shorter legs) (!) #: B; *217-7*
Melphisubchela prehenda #: D; *244-3*
OEDICEROTIDAE
Monoculodes antarcticus: W; D; *118-8; 240-2*
Oediceroides calmani (mottled with brown) #: W; B; D; *116-4; 116-6; 116-9; 118-8; 162-7; 164-5; 198-5; 198-6; 205-1*; 205-1*; 224-2; 224-3; 227-2; 234-6; 240-2; 240-3*
Oediceroides cf *calmani* (whitish) #: B; *164-4*
Oediceroides lahillei #: W; B; *164-4; 185-4*

(c) Oedicerotidae n. det. #: W; B; D; *118-8; 159-4; 160-4; 164-5; 185-4; 188-4; 188-5; 197-6; 217-7; 234-6; 245-1; 247-8*
PAGETINIDAE
Pagetina antarctica: W; *116-6*
PARDALISCIDAE
Halice sp: W; *118-8*
Nicippe unidentata #: D; *234-6; 240-2; 244-3; 245-1; 247-8*
PHOXOCEPHALOIDEA

Heterophoxus videns #: W; B; *164-4; 197-6*
Paraphoxus latipes #: W; B; *116-9; 196-8*
Pseudharpinia antarctica #: W; B; D; *159-3; 160-4; 162-8; 197-6; 220-1; 234-5; 237-1; 240-3; 244-3; 245-1; 247-8*
(c) Phoxocephalidae n. det.: B; D; *217-7; 234-6*
STEGOCEPHALIDAE
Andaniotes linearis: W; *118-8*
Stegocephalidae sp., fairly large gray stegocephalid from atrium of *Rosella* sponge #: W; *162-7*
(c) Stegocephalidae spp.: B; *193-10; 196-8; 198-5; 199-4; 206-1*; 224-2*
STENOTHOIDAE
Scaphodactylus aff. *foliodactylus* [the two proximal protrusions of the palm of Gn2 are proximally coalescent] (!): B; *193-10*
(c) Stenothoidae spp. #: W; B; D; *185-4; 193-10; 198-5; 217-7; 220-1; 234-6; 245-1; 247-8*
Torometopa elephantis: W; 162-8
Torometopa sp.: W; *118-4*
SYNOPIIDAE
Synopiidae sp. (!) #: D; *244-3*
Syrrhoe nodulosa #: W; B; *116-6; 118-8; 164-5; 188-5; 193-10; 197-5; 197-6; 198-6; 217-7; 224-2; 227-2*
Syrrhoe psychrophila #: D; *240-2*
Syrrhoites anaticauda #: B; *197-6*
Tiron antarcticus #: B; *193-10; 198-6; 217-7; 224-2*

CIRRIPEDIA
Bathylasma corolliforme #: B; *185-4; 188-4; 188-5*
(c) Scalpellidae n. det. #: W; B; D; *160-4* (on stalk of pedunculate tunicate); *188-5* (on large pycnogonid); *217-7; 247-8* (on polychaete tubes)

CUMACEA (identifications by Ute Mühlenhardt-Siegel)
Campylaspis maculata: W; *116-6; 164-5; 185-4*
Cyclaspis gigas: W; *116-6; 118-8; 164-5*
Diastylis cf. *anderssoni*: W; *185-4; 188-5*
Diastylis cf. *corniculata*: W; *164-5; 185-4*
Diastylopsis cf. *goekei*: W; *160-4; 185-4; 188-5*
Eudorella cf. *gracilior*: W; *160-4; 164-5*
Holostylis helleri Type A: B; *193-10*
Holostylis helleri Type C: W; *162-8; 164-5*
Leptostylis cf. *antipa*: B; *193-10*
Leucon sp.: D; *240-2*
Paralamprops cf. *asper*: W; *118-8*
Vaunthompsonia inermis: W; *185-4*
Vaunthompsonia meridionalis: W; *160-4*

DECAPODA
Chorismus antarcticus #: W; B; *116-4; 118-4; 160-3; 164-4; 185-3; 188-4; 193-8; 196-8; 197-4; 199-4; 217-6; 217-7; 227-2*
Notocrangon antarcticus #: W; B; *118-4; 159-3; 162-7; 188-4; 193-8; 196-8; 204-2; 217-6; 227-2*

ISOPODA
Aega cf *koltuni* #: W; B; *116-4; 164-4; 197-5; 198-5; 199-4*
Anthuridae sp.: B; *217-6*
(c) Arcturidae/Antarcturidae spp. #: W; B; D; *116-4; 160-3; 164-4; 185-3; 185-4; 188-4; 188-5; 193-10; 196-8; 197-5; 197-6; 198-5; 199-4; 217-6; 217-7; 237*-3 (on *Gersenia* sp.)
Arcturides scutata: D; *237-3*
(c) Aselotta spp.: B; *188-4; 196-8; 198-6; 217-7; 227-2*
Ceratoserolis meridionalis #: D; *244-2*

(c) *Ceratoserolis* cplx *trilobitoides* #: W; B; D; *118-4; 159-3; 162-7; 188-4; 188-5; 193-8; 193-9; 196-8;* 234-5; 237-3; 240-3; 244-2; 244-3; 246-3; 249-2
(c) *Glyptonotus* spp. #: W; B; *162-7; 164-4; 185-3; 199-4; 217-6; 227-2*
Idoteidae n. det. (small sp. with a lot of nodular projections) #: W; *164-4*
(c) *Natatolana* spp. #: W; B; D; *118-4; 164-4; 198-4**; 204-2; 217-6; 217-7; 220-2; 221-1**; 224-3; 227-2; 234-5; 240-3; 244-2; 244-3; 245-1; 246-3; 247-1**; 247-8*
Serolis bouvieri #: W; B; *118-4; 160-3; 162-7; 164-4; 185-4; 197-6*
Serolidae sp. 1 #: W; *164-5*

Serolidae sp. 2: B; *205-1**
Serolidae sp. 3 #: D; *240-2*
Storthyngura sp. #: B; *218-8*

LEPTOSTRACA
(c) Nebaliacea spp. #: B; *160-4; 162-8; 198-6; 217-7*

MYSIDACEA
(c) Antarctomysis spp. (!) #: W; B; D; *116-4; 118-4; 159-3; 160-3; 162-7; 188-4; 193-8; 193-9; 197-5; 198-5; 199-4; 217-6; 224-3; 240-3*
(c) Mysidacea spp. #: W; D; *159-4; 160-4; 198-6; 217-7; 227-1*

OSTRACODA
Ostracoda sp., large discoid species with bright red eggs #: B; *217-7*

Taxonomical observations

More than 150 species of amphipods were collected, of which 26 are considered as putative or possible undescribed species. The total number of species (and undescribed species) is however certainly higher, as identification on board was not always possible. Colour photographs are presented herein for some of those potential undescribed species (Figs 3.8.1 - 3.8.3): a very unusual Podoceridae with huge first antennae (Fig. 3.8.1A), a snow-white *Alexandrella* species (Fig. 3.8.1B), a common *Liouvillea* species without dorsal teeth (Fig. 3.8.1C), a large *Lepedepecreoides* species with an especially strong dorsal crest and a distinctive shape of the coxa of pereiopod 5 (Fig. 3.8.1F), a *Shackletonia* species with a tooth on the basis of pereiopod 5 (Fig. 3.8.1G), a Melitidae with long uropods 3 of unclear generic position (Fig. 3.8.1H), a colourless *Rhachotropis* species with huge white eyes and very slender legs (Fig. 3.8.1I), and a similarly coloured Synopiidae of unclear generic affinities (Fig. 3.8.1J).

Examination of living animals shows that the colour picture of a '*Gnathiphimedia sexdentata*' specimen given by Coleman (2007: plate 4 Figure c) was actually based on *Iphimediella ruffoi*. Photographs of correctly identified specimens of both species are presented herein: Fig. 3.8.1D for *G. sexdentata* and Fig. 3.8.1E for *I. ruffoi*.

The *Cyphocaris* specimen collected during ANT-XXIX/3 belongs to the form from the Southern Ocean usually identified as *C. richardi*. However, in this form, the tip of the basis of its pereiopod 5 is acutely and narrowly triangular with only two small teeth, both on the posterior margin, whilst in the holotype of *C. richardi* as illustrated by Chevreux (1905), it is apically rounded and deeply serrate. The real identity of Antarctic '*Cyphocaris richardi*' has yet to be established.

Examination of the material of *Echiniphimedia hodgsoni* collected during the cruise confirms previous observations of the authors, suggesting that two species are actually confused under that name: a form with robust spiniform projections and a form with slender projections. These two forms are illustrated side by side for the first time (Figs 3.8.2A-B and 3.8.2C-D).

Specimens agreeing perfectly with the original illustrations of *Epimeria macrodonta* given by Walker (1907, pl. 8, Figure 14) were recorded (Fig. 3.8.2E). Aside from them, a form similar but with broader teeth was also observed (Fig. 3.8.2F). The morphological characters are completely constant and the two forms also exhibit conspicuous differences in their colour patterns. The broad-toothed form, which is here referred as *Epimeria* aff. *macrodonta*, is considered to be an undescribed species.

Specimens agreeing perfectly with the descriptions of *Epimeria similis* given by Chevreux (1913) and Lörz et al. (2007) (Fig. 3.8.2G) were recorded. Aside from them, a similar but distinct form was also observed (Fig. 3.8.2H) It has no posterior bump on the second segment of pereion and it has longer teeth on article 3 of the antennular peduncle. This form is actually closer to *E. schiaparelli*, which is endemic to the Ross Sea (Lörz et al., 2007). It differs from the latter by the dorsal tooth of its pleonite 3, which is broader. The present form is referred as *E*. aff. *schiaparelli*.

COI sequences segregates *Eusirus perdentatus* in two separate clades (Verheye, 2011). Scarce photographic data suggested that these two clades correspond to two colour morphs: the so-called marbled and spotted forms. Extensive material of the two-colour morphs of *E. perdentatus* were collected during ANT-XXIX/3 (Fig. 3.8.3A-B), confirming the absence of intermediates between them. Furthermore, it appears that the spotted form was more abundant at greater depths and that it reaches a slightly larger size than the marbled form. These data support the idea that the two colour morphs are actually different species.

Analysis of COI sequences also indicates the occurence of separate clades within the related species *Eusirus giganteus* (see Verheye, 2011). Relationships between genetic lineages and colour morphs of *E. giganteus* s.l. are still imperfectly understood and will require more in depth study. All specimens collected during ANT-XXIX/3 could be separated in two major chromatic groups: a non-spotted group with crimson legs (Fig. 3.8.3C) and a spotted group with less pigmented legs, of which at least some are striped (Fig. 3.8.3D), suggesting the existence of at least two separate species within *E. giganteus* s.l. Small variations within these two groups were also observed but their significance is still unclear. It was observed that the maximum of abundance of *E. giganteus* s.l. is deeper than that of *E. perdentatus* s.l., and that amongst *E. giganteus* s.l., the non-spotted forms were usually found the deepest.

If the key of Andres (1984) is followed, all the *Paraceradocus* collected during ANT-XXIX/3 are keyed out as *P. gibber*. However two distinct colour morphs were observed: a brown and white form found at the shallower stations (Figs 3.8.3E-F) and an all brown form (Figs 3.8.3G-H) found at the two deepest stations (204-2 and 220-2). No intermediate colour patterns were observed in the extensive material examined on board (at stn 224-3 more than 40 specimens were observed). It is not ruled out that these two colour morphs belong to separate species, of which one would be undescribed. Further morphological and genetic studies are necessary to settle the issue.

Comparison between the Weddell Sea, Bransfield Strait and Drake Passage

Three areas near the tip of the Antarctic Peninsula were sampled with a standardized approach and an equivalent sampling effort: the Weddell Sea, the Bransfield Strait and the Drake Passage. While diverse substrates and biocenoses were observed in the Weddell Sea and Bransfield Strait stations (especially in the latter), Drake Passage stations only consisted of monotonous mud bottoms with very little epifauna, without decapods and without the isopod *Glyptonotus*, but with a lot of ophiurids and locally with a lot of tubicolous polychaetes. These biocenotic differences probably explain the significant differences observed in the composition of the amphipod fauna of the three areas. Of the 137 benthic amphipod species recorded, 79 were found in the Weddell area (24 found nowhere else), 99 in the Bransfield Strait area (39 found nowhere else) and 41 in the Drake Passage area (12 found nowhere else). Only 18 species were found in the three areas, suggesting a scarcity of opportunistic species around the Antarctic Peninsula and reflecting the predominance of rare species in the area. While the Drake Passage area exhibits a comparatively low amphipod diversity (for example with almost no *Eusirus*), this fauna has its own unique composition. Five of the eleven species found only in the Drake Passage area are potentially undescribed: *Lepedepecreoides* sp., Podoceridae sp., *Rhachotropis* sp., *Shackletonia* sp. and Synopiidae sp. Furthermore, *Nicippe unidentata*, which was known by only two previous records was found in no less than five of the Drake Passage stations.

Data management

Amphipods will be studied by C. d'Udekem d'Acoz, C. Havermans, M. Verheye (RBINS) and deposited at RBINS; isopods and mysids by C. Held (AWI) and deposited at Zoological Museum of Hamburg; bryozoans by H. De Blauwe (external collaborator at RBINS) and deposited at RBINS; polychaetes by R. Barnich (FS, Frankfurt a.M.) and deposited in the same institute. Data repository of biogeographic data to be processed by A. Van de Putte (RBINS): ANTABIF database (www.biodiversity.aq).

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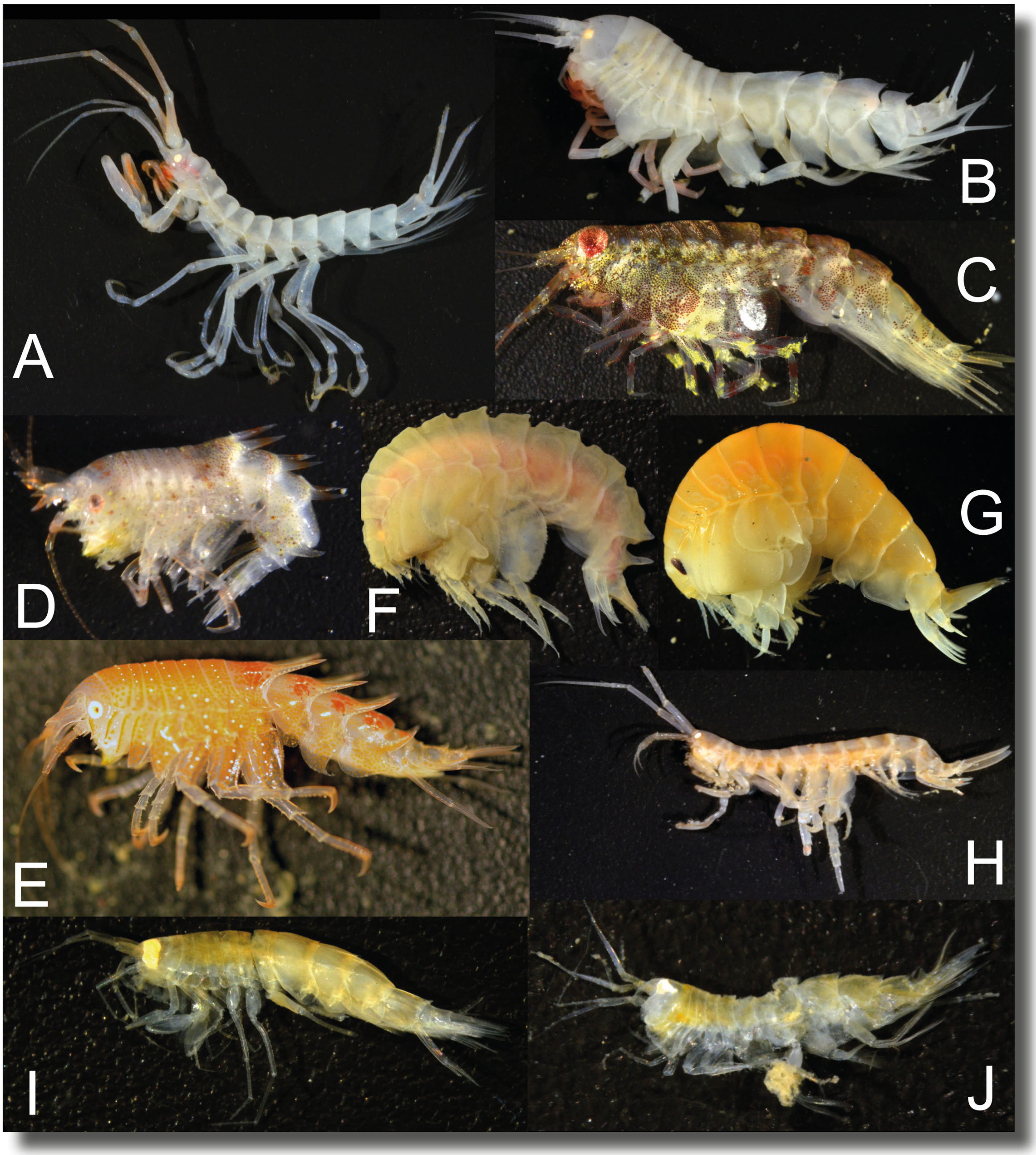

Fig. 3.8.1: A, Podoceridae sp., (227-1); B, Alexandrella *sp. (227-2); C,* Liouvillea *sp. (224-2); D,* Gnathiphimedia sexdentata *(198-6); E,* Ipimediella ruffoi *(116-9); F,* Lepedepecreoides *sp. (249-2); G,* Shackletonia *sp. (249-2); H, Melitidae sp. (217-7); I,* Rhachotropis *sp. (244-3); J, Synopiidae sp. (244-3)*

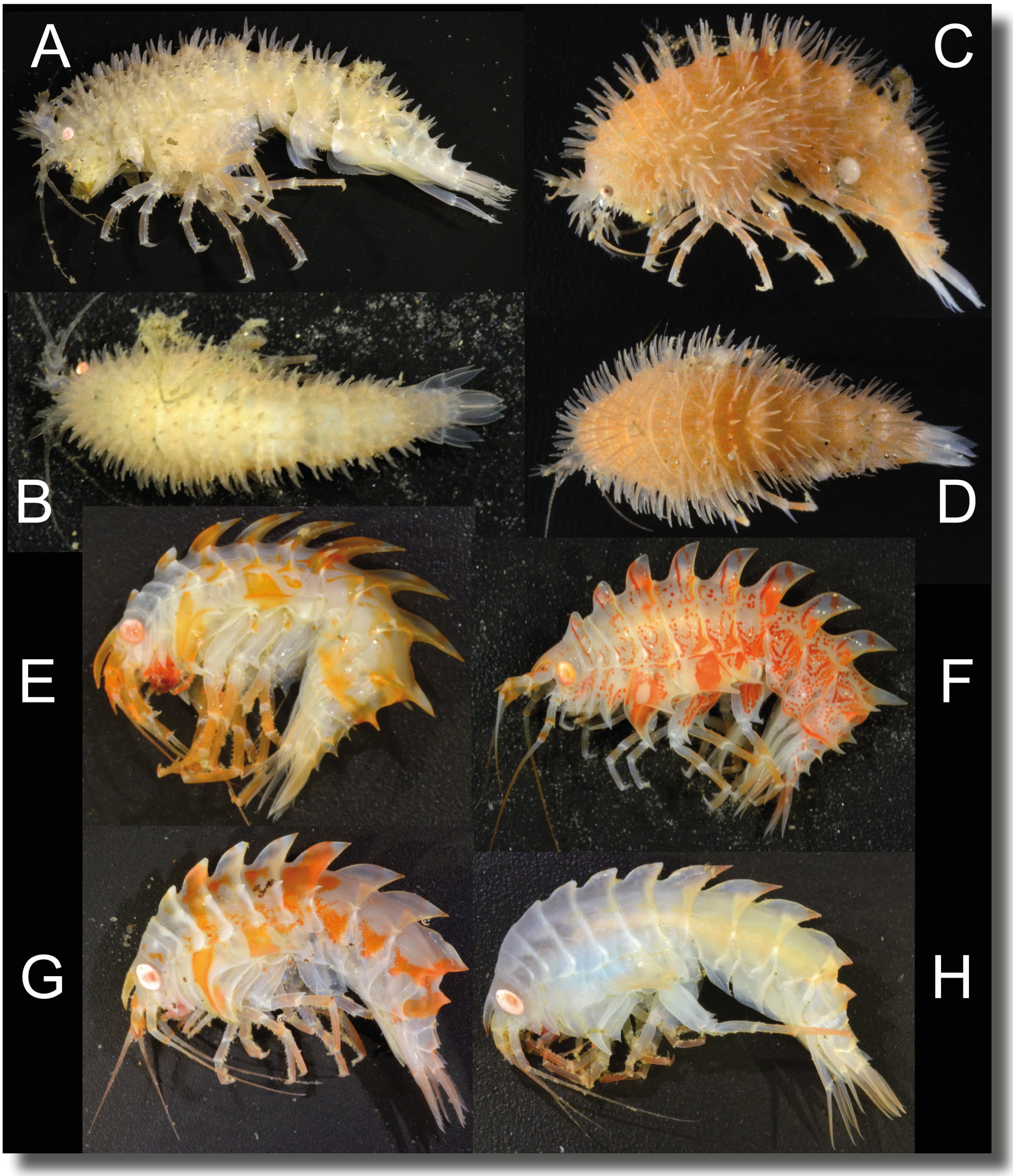

Fig. 3.8.2: A, Echiniphimedia *cplx* hodgsoni, *form with robust projections (197-5); B, idem (162-7); C-D,* Echiniphimedia *cplx* hodgsoni, *form with slender projections (199-4); E,* Epimeria macrodonta *(193-8); F,* Epimeria *aff.* macrodonta *(162-7); G,* Epimeria similis *(217-6);* Epimeria *aff.* schiaparelli *(193-8)*

Fig. 3.8.3: A, Eusirus *cplx* perdentatus *marbled (188-4); B,* Eusirus *cplx* perdentatus *spotted (196-8);* Eusirus *cplx* giganteus *non spotted (gray back / crimson legs) (204-2);* Eusirus *cplx* giganteus *spotted (P3-P4 striped) (217-6); E-F,* Paraceradocus *cplx* gibber *brown and white (224-3); G-H* Paraceradocus *cplx* gibber *all brown (220-2)*

3.9 Symbiotic interactions

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Objectives

Symbiosis is the living together, in close association, of organisms of different species. In literature several definitions have been proposed, but the original one by De Bary (1878) also included parasitism besides the balanced and, at least for one of the two partners, not harmful relationships. The ecological role of symbiotic interactions has only been recently re-evaluated, and found to affect the structure of food webs at a magnitude comparable to that of predation or physical disturbance (Hay et al., 2004). In Antarctica there are now several studied cases both for the Weddell Sea (e.g., Hartmann-Schröder, 1989; Jarms and Mühlenhardt-Siegel, 1997; López-González and Bresciani, 2001; Micaletto et al., 2002; Zelaya and Ituarte, 2002; Berge et al., 2004; Lehmann, 2007) and the Ross Sea (Schiaparelli et al., 2000; 2003; 2007; 2008; 2010; 2011; Alvaro et al., 2011).

Within the framework of the original LASSO project, the initial questions of our research were to understand: (1) if differences, in terms of typology/abundance of the symbiotic associations between macro-invertebrates, do exist between oligotrophic areas formerly ice-covered and the surrounding ones, and (2) if there is any on-going 'recolonization' process also for these kind of interactions, i.e. if symbiotic species are recolonizing new areas 'following' their hosts.

After the revision of the cruise program due to heavy ice conditions, the aims of this project have been modified and rescheduled by taking into account the new working hypotheses (specified in chapter 1. Itinerary and summary, this volume). The new targets were to evaluate the possible existence of differences, in terms of typology/abundance of symbiotic associations, (1) among the three different sampling areas Eastern Antarctic Peninsula (=Weddell Sea), Bransfield Strait and Drake Passage, (2) across all depths, and (3) between the Weddell and the Ross Sea, thanks to the availability of inedited as well as already published data about this topic for the latter basin. The goals of our research will be achieved by describing and characterizing in detail from an ecological point of view the encountered associations and by placing the symbionts into a broader phylogeographic context through the comparison of the COI sequences obtained from each guest with those already available from previous research projects, e.g. the sequences obtained within the CAML (Census of Antarctic Marine Life) project and the Italian PNRA project "BAMBi" (Barcoding of Antarctic Marine Biodiversity).

Work at sea

The sampling of benthic invertebrates was undertaken by means of the Agassiz trawl (AGT); only in one case, a specimen (i.e. an irregular sea urchin with associated bivalves) was obtained from the giant box corer (GKG, stn 190_2). After a preliminary sorting activity done on deck, the partners of the association were immediately placed in seawater. Once in lab, they were carefully observed and photographed with a Nikon D80 digital camera, equipped with a 105mm macro-lens and two adjustable flashes, in order to: i) document the exact position of the symbiont on the host, ii) capture colour patterns, and iii) highlight the main peculiarities of the partnership. Whenever possible, a tissue fragment of the symbiont was taken and fixed in 100 % ethanol for genetic analyses, otherwise the entire specimen was preserved in ethanol or stored frozen. The hosts, instead, were given to taxonomists present on board, after having properly labelled each specimen to keep track of the existence of a symbiotic relationship and cross check the data after the voyage.

Preliminary (expected) results

On the whole, in 22 out of 29 performed stations (76 % of the total) we were able to document the presence of at least a symbiotic interaction ascribed to 11 different categories, as specified in Table 3.9.1.

Most of these records corresponded to partnerships already described from the Ross Sea sector (see Schiaparelli et al., 2007; 2010; 2011), but never reported before for the Weddell Sea: i) specimens of *Notocrinus virilis* were observed to carry parasitic gastropods of the family Eulimidae (Fig. 3.9.1); ii) holothuroids belonging to the species *Bathyplotes bongraini* were interested by the presence of the parasitic polynoid polychaete *Eunoe opalina*, living on the ventral side of its host (Fig. 3.9.2); iii) the polynoid *Gorekia crassicirris* was found on different irregular sea urchins of the genera *Amphipneustes* and *Brachysternaster.*

On the other hand, two of these symbiotic interactions were documented for the first time and will be described in specific papers. The first one regarded the presence of an unidentified gastropod adhering to the calyx of two different species of crinoids, *Anthomethrina adriani* and *Isomethra* cf *vivipara*. The second remarkable finding was the presence of an unidentified large polynoid polichaete living in the gut of the irregular sea urchin *Brachysternaster chescheri,* similarly to the above reported case of *G. crassicirris.* It is also worth to note that the gastropod species *Capulus subcompressus*, known to parasitize the serpulid *Serpula narconensis* at Terra Nova Bay (Ross Sea, see Schiaparelli et al., 2000) and rarely observed in the area of the Antarctic Peninsula with few free living specimens (Engl, 2012), was found on the tubes of some serpulid polychaetes in the western sector of the Bransfield Strait (stn 227).

Since the material was frozen or ethanol fixed, molecular analyses will be performed in order to clarify the phylogenetic and phylogeographic affinities of the species involved in these associations within the areas investigated and, at the broader spatial scale, their relationship with the Ross Sea counterparts.

Preliminary multivariate analysis (MDS for factor SITE shown in Fig. 3.9.3), where factors SITE (with levels: Drake Passage, DP; Bransfield Strait, BS; Weddell Sea, WS) and DEPTH (with levels: 100-250; 250-400; >400) were tested on presence absence data of the above described 11 'symbiotic categories', did not allow to appreciate any difference in terms of distances between the sampled areas (i.e. factor SITE) or bathimetric zonation (i.e. factor DEPTH). However, molecular data will enable a much greater detail in the characterization of phylogeographic affinities of the species involved in the associations, which, in some cases (e.g. Bivalvia associated to irregular sea urchins), have been documented in tens of specimens in a single station.

Data management

All voucher species of all the relevant material (i.e. the specimens from which molecular sequences will be obtained) will be deposited at the Italian National Antarctic Museum (MNA), Section of Genoa. Sequences will be deposited in BOLD upon standard laboratory protocols.

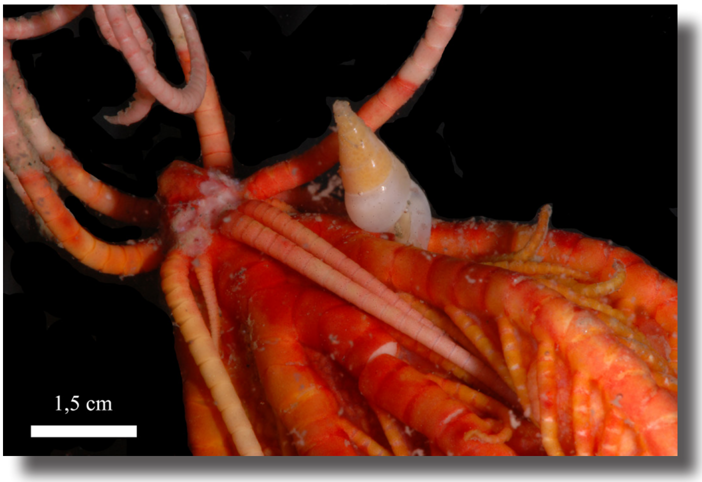

Fig. 3.9.1: Notocrinus virilis *with a parasitic gastropod of the family Eulimidae.*
Scale bar: 1.5 cm

Fig. 3.9.2: Bathyplotes bongraini *carrying two specimens of* Eunoe opalina.
Scale bar: 3 cm

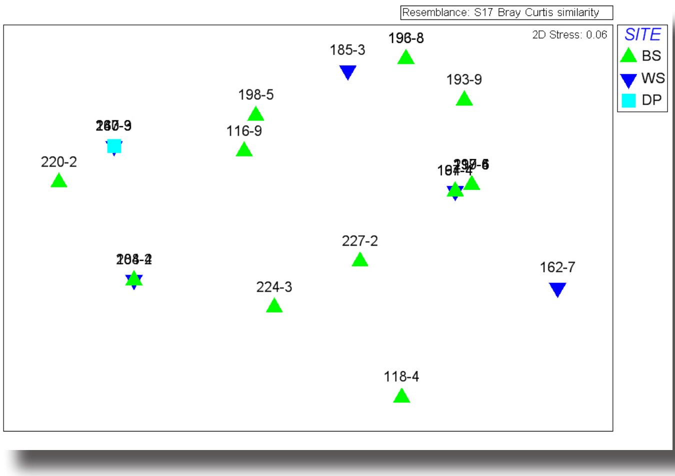

Fig. 3.9.3: MDS for factor SITE

Tab. 3.9.1: List of symbiotic associations per sampling site. I - Polynoidae (*Eunoe opalina*) on Holothuroidea (*Bathyplotes bongraini*); II - Eulimid gastropod on Crinoidea (*Notocrinus virilis*/*N. mortenseni*); III – Gastropoda on Crinoidea (*Anthomethrina adriani*/*Isomethra* cf *vivipara*); IV - Amphipoda (*Lepidepecreella* sp.) on Echinoidea Regularia (*Sterechinus antarcticus*); V – Bivalvia on Echinoidea Irregularia (*Abatus* spp.); VI - Polynoidae (*Gorekia crassicirris*) on Echinoidea Irregularia; VII - Polychaeta (Polynoidae) on Echinoidea Irregularia; VIII - Gastropoda (*Dickdellia labioflecta*) on Pycnogonida; IX - Gastropoda (*Capulus subcompressus*) on Polychaeta (Serpulidae); X - Polynoidae (*Polyeunoa laevis*) on Gorgonacea; XI - Porifera (*Iophon radiatum*) on Ophiuroidea. *=new symbioses.

Station number	Area	Symbiotic associations										
		I	II	III*	IV	V	VI	VII*	VIII	IX	X	XI
116_4	B_JN_B	-	-	-	-	-	-	-	-	-	-	-
116_9	B_JN_B	-	-	-	-	x	-	-	-	-	x	x
118_4	B_JN_U	x	-	-	x	-	-	-	-	-	-	x
159_3	B_JE_D	-	-	-	-	-	-	-	-	-	-	-
160_3	W_JE_B	-	-	-	-	-	-	-	-	-	-	-
162_7	W_ET_B	-	x	-	-	-	-	-	-	-	-	-
163_9	W_ET_D	-		-	-	x	-	-	-	-	-	-
164_4	W_DI_B	-	x	-	-	-	-	-	-	-	x	-
185_3	W_VO_U	-	-	x	-	-	-	-	-	-	x	-
188_4	W_VO_D	-	-	-	-	x	x	-	-	-	-	-
193_8	B_E_S	-	-	-	-	-	-	-	-	-	x	-
193_9	B_E_S	-	-	-	x	-	-	-	-	-	x	-
196_8	B_E_C	-	-	-	-	-	-	-	-	-	x	-
197_4	B_E_U	-	x	-	-	-	-	-	-	-	x	-
197_5	B_E_U	-	x	-	x	-	-	-	-	-	x	-
198_5	B_C_B	-	-	-	-	x	-	-	-	-	x	-
199_4	B_C_U	-	x	-	x	-	-	-	-	-	x	-
204_2	B_C_C	-	-	-	-	x	x	-	-	-	-	-
217_6	B_C_S	-	x	-	x	-	-	-	-	-	x	-
220_2	B_W_C	-	-	-	-	x	-	x	-	-	-	-
224_3	B_W_U	x	x	x	-	x	x	-	-	-	-	x
227_2	B_W_S	-	x	x	-	-	x	-	-	x	-	x
234_5	D_W_U	-	-	-	-	-	-	-	-	-	-	-
237_3	D_W_S	-	-	-	-	x	-	-	-	-	-	-
240_3	D_C_U	-	-	-	-	x	-	-	-	-	-	-
244_2	D_C_S	-	-	-	-	-	-	-	-	-	-	-
246_3	D_E_U	-	-	-	-	-	-	-	-	-	-	-
249_2	D_E_S	-	-	-	-	-	-	-	-	-	-	-

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3.10 Meiofauna and water masses: looking for the link

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Objectives

In line with the general benthic concept, our main focus during ANT-XXIX/3 was to find out whether there are differences in meiofauna shelf communities among three Antarctic regions with differing water masses, ice conditions, topography, and surface productivity. Meiofauna mainly consists of free-living nematodes (70-90 % of total abundance) and harpacticoid copepods. Organisms of the meiofauna size class measure between 32 µm and 1 mm. They play a significant role in the benthic food web and the remineralisation of nutrients.

By combining the community approach with stable isotope analysis of organic matter from the water column, the sediment, and the meiofauna organisms we want to shed light on the link between surface water productivity and the benthic response. The three investigated oceanic regimes differed in chlorophyll concentration. The Weddell Sea area had a lower surface chlorophyll content at the time of sampling than both Bransfield Strait and Drake Passage.

In our study we address the following questions:

- Do diversity and abundance of meiofauna shelf communities increase along the observed productivity gradient from the Weddell Sea water masses to the Bransfield Strait and the Drake Passage?
- How do water mass and productivity regime influence carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope signatures of meiofauna organisms in the sediment?

Work at sea

The sampling for our study during ANT-XXIX/3 was carried out at all stations where successful MUC6 deployments could be expected. Beforehand information on sediment composition and bottom topography was provided by the OFOS (Ocean Floor Observing System) and the bathymetry teams, see chapters 3.3 Megabenthic distribution patterns and 3.12 Regional bathymetry, both this volume. The MUC6 was mainly deployed at the deeper stations of the selected core sites in the Weddell Sea. Following the expedition's general concept for the benthos work, we deployed the MUC6 (and collected the additional CTD water samples) at all slope and canyon stations in the Bransfield Strait and the Drake Passage.

Quantitative samples for meiofauna analyses were collected at 18 stations in the 3 different areas (Weddell Sea, Bransfield Strait and Drake Passage, see Table 3.10.1). In most cases, the multicorer (MUC6) was used to recover undisturbed sediment cores. The MUC6 can mount up to 12 plexiglass cores, each with an inner diameter of 57 mm (surface 25.5 cm²). When conditions did not allow for the successful deployment of the MUC6, subsamples (25.5 cm² and 10 cm² cores) from the giant boxcorer (GKG) were taken. This was the case at the Volcano stations since these sediments contained many stones that would have damaged the MUC cores. At all stations, the MUC sampling was accompanied by CTD water column sampling with niskin bottles. At two locations (stns 190-1 and 230-1), we collected only CTD water samples to complement our dataset or that of other experts onboard.

At each location, three MUC6 deployments were carried out in order to collect true replicates. From each successful MUC6 deployment, different samples were collected for a variety of analyses. A first set of samples will be used for meiofauna community analysis. For that purpose, two cores from each deployment were sliced in 1 cm-layers down to 5cm depth and stored in a 4 % formaldehyde-seawater solution (borax-buffered). Later on, all meiofauna will be extracted, counted and identified to major taxon level in the home institutes. Harpacticoid copepods will be identified to genus/species level at FS-DZMB and nematodes to genus level at UGent.

Next to that, 3 or 4 cores of each deployment were stored for stable isotope analysis of copepods and nematodes. The first 3 centimetres of each core were sliced per cm and stored in petridishes at −20° C. In the FS-DZMB and UGent labs, copepods and nematodes will be picked out from these sediment slices and analysed for carbon and nitrogen isotopes.

Finally, remaining cores of each deployment were subsampled for environmental parameters with cut-off 10 mL syringes that were pushed into the core. One of those syringes will be used to analyse the pigment content of the sediment, another one for grain size determination and a third one for sediment stable isotope measurements (to relate isotopic signals of sediments with those of animals and the water column). Syringes for grain size and stable isotope analyses were stored at −20° C, whereas the subsamples for pigments were stored at −80° C.

In order to compare pigment content and stable isotope signals of the benthic components with the water column, chlorophyll-maximum and bottom water was sampled with a CTD rosette mounted with Niskin bottles (see chapter 4. Oceanography and tracer measurements, this volume). For both depths, water was filtered over one GF/C (for pigment samples) and one GF/F filter (for stable isotope samples). In case of the bottom water, 3–5L were collected per filter. Lower amounts of water were filtered when resuspended material lead to low filtering performance. For the chlorophyll maximum 3–5L were filtered depending on the colouring of the filters. Filtering was performed at approximately 200 mbar to avoid rupture of cells. The GF/C filters were stored at −80° C and will be used for pigment analysis in the UGent lab using HPLC. The GF/F filters are kept at −20° C and will be analysed for $\delta^{13}C$ and $\delta^{15}N$ stable isotope signatures.

Additionally, with the help of the CCAMLR krill team (see chapter 5. Antarctic krill population dynamics in the north-western Weddell Sea (CCAMLR), this volume), we obtained 17 krill samples (*Euphausia superba* and *E. crystallorophias*) from 12 stations in the three different regions for stable isotope analyses. With these samples we add another important component to our overview on links between the pelagic and the benthic compartments of the food web.

Tab. 3.10.1: List with CTD, GKG and MUC stations sampled for meiofauna communities as well as sediment and water column characteristics.

Station name	Stn no.	Date (2013)	Latitude	Longitude	depth (m)	gear	samples collected
B_JN_B (BS_Joinville_ North_bank)	116-1	26.01.	62°35.50´S	56°27.34´W	201.5	CTD	no
	116-7	26.01.	62°33.85´S	56°23.68´W	192.2	MUC	
	116-8	26.01.	62°33.89´S	56°23.62´W	190.6	MUC	
B_JN_U (BS_Joinville_ North_upper slope)	118-1	27.01.	62°26.47´S	56°17.26´W	439.5	CTD	yes
	118-9	27.01.	62°26.95´S	56°17.14´W	423.3	MUC	
	118-10	27.01.	62°26.90´S	56°17.19´W	427	MUC	
	118-11	27.01.	62°26.89´S	56°17.22´W	427	MUC	
W_JE_B (WS_Joinville_ East_bank)	119-1	28.01.	63°10.08‘S	54°7.17‘W	224.3	CTD	no
W_JE_D (WS_Joinville_ East_depression)	120-1	28.01.	63°4.62´S	54°33.11´W	530.4	CTD	yes
	120-5	28.01.	63°4.58´S	54°31.00´W	503.6	MUC	
	120-6	28.01.	63°4.10´S	54°30.86´W	484.8	MUC	
	120-7	28.01.	63°3.72´S	54°30.87´W	436.8	MUC	
W_ET_B (WS_Erebus_ Terror_bank)	162-1	10.02.	64°0.27´S	56°44.28´W	219.6	CTD	yes
	162-3	10.02.	64°0.11´S	56°44.28´W	222.1	MUC	
	162-4	10.02.	64°0.07´S	56°44.20´W	223.4	MUC	
	162-5	10.02.	64°0.14´S	56°44.33´W	221.9	MUC	
W_ET_D (WS_Erebus_ Terror_deep)	163-1	10.02.	63°53.07´S	56°26.19´W	468	CTD	yes
	163-4	11.02.	63°50.95´S	56°24.43´W	517.6	MUC	
	163-5	11.02.	63°51.01´S	56°23.97´W	516.6	MUC	
	163-6	11.02.	63°51.03´S	56°23.68´W	517.1	MUC	
W_DI_B (WS_Dundee_ Island_bank)	164-1	11.02.	63°37.07´S	56°13.53´W	196.7	CTD	no
W_VO_U (WS_Volcano_ upper slope)	185-2	19.02.	63°52.20´S	55°36.67´W	232	GKG	yes
W_VO_D (WS_Volcano_deep)	188-2	19.02.	63°51.86´S	55°34.39´W	339	GKG	no
	188-3	19.02.	63°52.01´S	55°35.15´W	310	GKG	yes
(W_VO_D) (H.Link)	190-1	20.02.	63°50.49´S	55°33.64´W	400	CTD	yes
B_E_S (BS_East_slope)	193-1	23.02.	62°43.01´S	57°34.16´W	577	CTD	yes
	193-4	23.02.	62°43.03´S	57°34.23´W	577	MUC	
	193-5	23.02.	62°43.03´S	57°34.24´W	579	MUC	
	193-6	23.02.	62°43.03´S	57°34.25´W	578	MUC	

Station name	Stn no.	Date (2013)	Latitude	Longitude	depth (m)	gear	samples collected
B_E_C (BS_East_canyon)	196-1	24.02.	62°48.01´S	57°4.97´W	567	CTD	yes
	196-4	24.02.	62°48.00´S	57°4.98´W	561	MUC	
	196-5	24.02.	62°48.03´S	57°4.97´W	567	MUC	
	196-6	24.02.	62°48.04´S	57°5.00´W	574	MUC	
	196-7	24.02.	62°48.00´S	57°4.99´W	559	MUC	
B_C_C (BS_Central_canyon)	202-1	27.02.	62°56.00´S	58°0.47´W	758	CTD	yes
	202-3	27.02.	62°56.00´S	58°0.49´W	756	MUC	
	202-4	27.02.	62°56.01´S	58°0.52´W	756	MUC	
	202-5	27.02.	62°55.99´S	58°0.61´W	757	MUC	
B_C_S (BS_Central_slope)	215-1	01.03.	62°53.57´S	58°14.66´W	530	CTD	yes
	217-1	02.03.	62°53.31´S	58°14.14´W	527	MUC	
	217-2	02.03.	62°53.31´S	58°14.17´W	529	MUC	
	217-3	02.03.	62°53.31´S	58°14.12´W	527	MUC	
	217-4	02.03.	62°53.29´S	58°14.09´W	527	MUC	
B_W_C (BS_West_canyon)	218-1	02.03.	62°56.93´S	58°25.66´W	691	CTD	yes
	218-4	02.03.	62°56.95´S	58°25.81´W	689	MUC	
	218-5	02.03.	62°56.95´S	58°25.84´W	689	MUC	
	218-6	02.03.	62°56.93´S	58°25.81´W	689	MUC	
B_W_S (BS_West_slope)	225-1	04.03.	62°56.07´S	58°40.62´W	539	CTD	yes
	225-3	04.03.	62°56.04´S	58°40.73´W	545	MUC	
	225-4	04.03.	62°56.06´S	58°40.76´W	544	MUC	
	225-6	04.03.	62°56.05´S	58°40.77´W	546	MUC	
B_DE_S (BS_Deception_slope)	230-1	05.03.	63°8.37´S	60°39.30´W	677	CTD	yes
D_W_S (DP_West_slope)	235-1	07.03.	62°16.30´S	61°10.27´W	369	CTD	yes
	235-4	07.03.	62°16.29´S	61°10.24´W	373	MUC	
	235-5	07.03.	62°16.31´S	61°10.24´W	363	MUC	
	235-6	07.03.	62°16.35´S	61°10.25´W	350	MUC	
D_W_C (DP_West_canyon)	238-2	08.03.	62°20.73´S	61°20.15´W	465	CTD	yes
	238-4	08.03.	62°20.82´S	61°20.01´W	460	MUC	
	238-5	08.03.	62°20.78´S	61°20.10´W	464	MUC	
	238-6	08.03.	62°20.80´S	61°20.06´W	466.5	MUC	
D_C_S (DP_Central_slope)	241-1	09.03.	62°6.63´S	60°36.52´W	395	CTD	yes
	244-5	10.03.	62°6.64´S	60°36.53´W	398	MUC	
	244-6	10.03.	62°6.62´S	60°36.50´W	400	MUC	
	244-7	10.03.	62°6.65´S	60°36.54´W	396	MUC	
D_C_C (DP_Central_canyon)	243-1	10.03.	62°12.27´S	60°44.42´W	497.4	CTD	yes
	243-3	10.03.	62°12.32´S	60°44.47´W	497.8	MUC	
	243-4	10.03.	62°12.31´S	60°44.48´W	497.7	MUC	
	243-5	10.03.	62°12.31´S	60°44.54´W	495.2	MUC	

Station name	Stn no.	Date (2013)	Latitude	Longitude	depth (m)	gear	samples collected
D_E_S (DP_East_slope)	247-2	11.03.	61°56.90´S	60°7.49´W	401	CTD	yes
	247-4	11.03.	61°56.93´S	60°7.48´W	396	MUC	
	247-5	11.03.	61°56.94´S	60°7.51´W	397	MUC	
	247-6	11.03.	61°56.93´S	60°7.44´W	396	MUC	
	247-7	11.03.	61°56.91´S	60°7.47´W	400	MUC	
D_E_C (DP_East_canyon)	250-1	12.03.	62°2.28´S	60°12.11´W	487	CTD	yes
	250-3	12.03.	62°2.22´S	60°12.01´W	489	MUC	
	250-4	12.03.	62°2.24´S	60°12.06´W	488	MUC	
	250-5	12.03.	62°2.24´S	60°12.03´W	488	MUC	

Preliminary results

Since extraction of animals and the analyses of environmental parameters and stable isotopes have to be done in a standardised way in the lab, all samples were shipped to the home institutes. Therefore, no preliminary results are available for the meiobenthos at this stage.

Data management

Data will be stored in the SCAR-MarBIN, PANGAEA, and VLIZ MDA data bases and will be made available after publication.

3.11 Marine mammal survey

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Objectives

Knowledge on the distribution, density and abundance of cetaceans in the Southern Ocean is still limited. Even less research has been conducted in the pack-ice region, as only few vessels are ice-strengthened enough to be able to penetrate into the ice. Macro-scale investigations on the distribution and abundance of Antarctic minke whales *(Balaenoptera bonaerensis)* have been conducted during three circum-Antarctic surveys by the International Whaling Commission's IDCR Programme from 1978/79 to the second half of the 1990s. Estimated Minke whale abundance declined from the second to the third circum-Antarctic survey by approximately 30 % (IWC, 2012). However, if their number has really declined, or to what extent minke whales have reacted to changing sea ice conditions in some areas, by changes in distribution and abundance on various scales, is unknown. The distribution and density of whales in the pack-ice could not be estimated by the IWC surveys, because survey vessels were not ice-strengthened. Therefore it remains debatable, to what extent minke whales inhabit the pack ice, and if they have moved into the pack-ice in larger numbers than hitherto thought (e.g. Kelly et al., 2012). *Polarstern* as one of the few ice-breaking vessels in the Southern Ocean offers the opportunity to study the distribution and abundance of minke whales in the pack-ice (Scheidat et al., 2007a; 2007b; 2011; Kock et al., 2009).

Aerial surveys conducted in the pack-ice provide a chance to test the hypotheses to what extent Minke whales utilize the pack-ice as habitat. In continuation of the work conducted during cruises ANT-XXIII/8, ANT-XXV/2, ANT-XXVII/2, and ANT-XXVIII/2, we collected systematic sighting data on cetaceans in and out of the pack-ice following standard line transect methodology. These data will be linked to ecologically relevant biotic and abiotic parameters, such as sea ice cover, collected simultaneously, in order to obtain information on habitat use. Results will allow for habitat modelling and density estimates of whales in and out of the pack-ice.

Work at sea

We conducted aerial surveys following standard line-transect distance sampling methodology (Buckland et al., 2001) with the two helicopters (BO 105) of *Polarstern* between January 25, and March 11. A total of 47 flights were accomplished, resulting in 74 hours of flying time. Seven of the flights, however, could not be used for data acquisition, as due to unfeasible weather conditions they had to be terminated within 20 minutes after take-off. The remaining 40 flights had an average duration of 1 hour and 48 minutes, ranging from 54 minutes to 2 hours and 21 minutes. All surveys were planned in an *ad hoc* manner. Track lines were designed in a way that they could be surveyed depending on the current position and track of *Polarstern* as well as on weather conditions, aiming to achieve a good coverage of the survey area and applying basic principles of good survey design following Buckland et al. (2001).

All survey flights were conducted at an altitude of 600 feet and a speed of 80-90 knots. Two observers were positioned in the back of the helicopter and observed the area to the right and to the left side of the helicopter, respectively, concentrating on the area below the helicopter. The third observer was seated in the port front seat of the helicopter observing the area to the front, focusing on the transect line. The observer in the front seat of the helicopter used the VOR software (Hiby and Lovell, 1998), running on a laptop computer, to continuously store GPS data, data on environmental conditions (sea state, cloud cover, glare, ice coverage, sighting conditions) and data on all sightings of marine mammals.

For each sighting of a marine mammal in the water, the following data were collected: species, distance to transect (via declination angle), group size, group composition, behavior, cue, swimming direction and potential reaction to the helicopter. Inclinometers were used to measure the declination angle to each sighting when abeam the helicopter, in order to later calculate the distance of the sighting to the transect line. This information is crucial for later estimation of the effectively covered strip width. If a sighting occurred and species could not be identified or group size not be determined immediately, the survey was halted in order to approach the sighting for closer inspection (closing mode). After identification, the helicopter returned to the transect line and the survey was continued. Digital photography was used to aid in species identification and for Photo-ID purposes.

Preliminary results

A total of 40 successful surveys were conducted, covering 7,648.5 km *on-effort* (i.e. in observing mode). During these surveys, a total of 267 cetacean sightings of 669 individuals were recorded. Seven species were identified. Table 3.11.1 provides an overview of the number of sightings and individuals by species encountered. Fig. 3.11.1 presents all tracklines covered and positions and species of all sightings recorded.

Data management

Publication in scientific journals in the fields of marine biology and zoology and presentation on scientific conferences will make the data obtained available for science and public. Survey results will be presented to the Scientific Committee of the International Whaling Commission. Data will be stored in the Antarctic Marine Mammal Survey Database of the Institute for Terrestrial and Aquatic Wildlife Research, Büsum, Germany.

Acknowledgement

We would like to thank Captain Pahl and the entire crew of *Polarstern* for their never-ending support throughout the whole survey. Our survey would not have been possible without the excellent work and support of the helicopter crew, Klaus Hammrich, Lars Vaupel, Carsten Möllendorf and Thomas Müller. We are grateful to the meteorological office onboard, Manfred Gebauer and Hartmut Sonnabend. Their weather forecasts made it possible to conduct this survey in very variable weather conditions. This project was funded by the German Federal Ministry of Food, Agriculture and Consumer Protection within the project: „Modellierungen zu Populationsgrößen und räumlicher Verteilung von Zwergwalen im antarktischen Packeis auf der Grundlage von See- und luftgestützten Tiersichtungen (Förderkennzeichen 2811HS002)".

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Tab. 3.11.1: Cetacean sightings by species from the aerial surveys

Species	Number of groups	Number of individuals
Antarctic minke whale (*Balaenoptera bonaerensis*)	18	32
Humpback whale (*Megaptera novaeangliae*)	68	130
Fin whale (*Balaenoptera physalus*)	123	354
Southern bottlenose whale (*Hyperoodon planifrons*)	1	2
Killer whale (*Orcinus orca*)	7	73
Blue whale *(Balaenoptera musculus)*	1	1
Hourglass dolphin *(Lagenorhynchus cruciger)*	2	9
Unidentified beaked whale	1	3
Unidentified baleen whale	44	65
Total	265	669

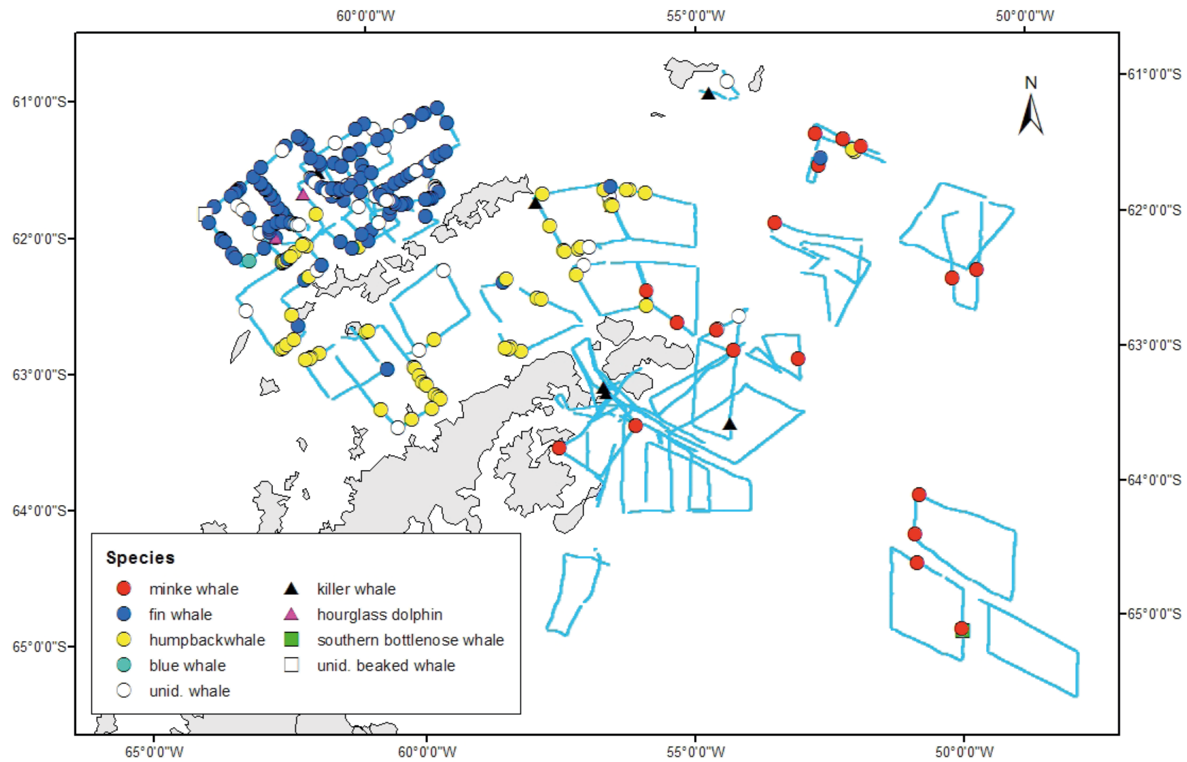

Fig. 3.11.1: Cetacean sightings and tracklines covered on-effort *during the aerial cetacean survey*

3.12 Regional bathymetry

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Objectives

If you are going somewhere and you do not want to get lost – you need a map.

Accurate knowledge of the seafloor topography, hence high resolution bathymetry data, is the key, the basic information necessary to understand many marine processes in a spatial context. Especially around Antarctica, older bathymetric data often suffer from low navigation accuracy and low depth sounding quality due to bad weather and ice conditions. Bathymetric models of this area are often derived from satellite altimetry with only limited direct sounding measurements. Consequently, the main task of the bathymetry group during ANT-XXIX/3 was to collect high resolution seabed data from unmapped areas. Furthermore, sampling site selection and station planning were supported with detailed bathymetric information and high resolution maps of areas of potential interest. On the basis of detailed seabed maps, it was e.g. possible to assess if a sampling site represented the general topographic setting of an area or if it was influenced by the local topography.

For the ecosystem approach followed during ANT-XXIX/3, detailed information of small scale topography were provided for key sampling sites around Elephant, Joinville and Dundee Island and for bank, trough a canyon settings in the Bransfield Strait and the Drake Passage. Even though the Bransfield Strait and the Drake Passage were relatively well mapped, it was still possible to chart areas with only little or no existing bathymetric information. In addition to the bathymetric data, information on the sedimentary architecture of sites of interest were recorded with the Atlas PARASOUND sub-bottom echosounder and provided for detailed sampling site selection.

In addition to the scientific work during the ANT-XXIX/3, the Hydrosweep DS3 multibeam echosounder was tested in water depths from 100 to 4,500 m after a brief software reconfiguration by Atlas Hydrographic® in Punta Arenas. Furthermore, possible interferences between the Hydrosweep DS3 multibeam chosounder and the EK60 fish echosounder were tested.

Work at sea

Techincal set-up

During ANT-XXIX/3, multibeam data were recorded with the Atlas Hydrographic® Hydrosweep DS3 multibeam echosounder permanently installed on *Polarstern*. The Hydrosweep DS3 was operated with the following relevant parameter settings: Swath width portside 300 %, swath width starboard 300 %, beam pattern ‚equal footprint‛, desired number of beams 345, C-Keel source ‚System C-keel‛, transmission sequence ‚equidistant transmission‛. More detailed information on set-up and settings can be extracted from the sensor parameter set ‚ANT29-3_JE-approved‛ which was applied during ANT-XXIX/3, renamed to ‚ANT29-3_ used_13-01-21‛ and only adjusted for changes in water depths. The Hydrosweep DS3 operation software was ‘Atlas Hydromap Control’ version 2.3.1.0. Multibeam data were recorded with the Atlas Parastore software version 3.3.13.0 in *.asd format and with the Hypack® software package version 12 12.0.0.1 in *.hsx/

raw format. In Hypack®, the data sets were stored in 30 min blocks. For further data processing, the *.hsx/raw files were imported in CARIS HIPS and SIPS®. In CARIS HIPS and SIPS®, water column sound velocity profiles were applied to the multibeam data. The sound velocities were calculated after Chen and Millero (1977). The necessary data sets were recorded with a Seabird 911+ CTD and kindly provided by the AWI Oceanography Group. In total 73 sound velocity profiles were used for sound velocity corrections. For data access, station planning and further use, the multibeam data were included in an ArcINFO® based GIS Project. Water column data were not recorded with the Hydrosweep DS3 during ANT-XXIX/3.

Operation

On transit, after leaving the 200 nm zone of Chile, the Hydrosweep DS3 multibeam echosounder was operated in a partly supervised mode. The transit was furthermore used to test the performance of the Hydrosweep DS3 multibeam echosoudner in water depth between 1,000 m and 4,500 m. This depth interval was present during most of the transit. In the study area, small scale high resolution bathymetric surveys were conducted for all biological core stations (Fig. 3.12.1). In sea-ice, surveys lines were designed according to the ice conditions and adapted during the survey whenever necessary. The difficult ice situation this year, however, prevented full coverage bathymetric surveys in the Weddell Sea. During krill surveys in the northwest Weddell Sea, no multibeam data were recorded due to interferences of the Hydrosweep DS3 multibeam system with the EK60 fish ecosounder.

In the survey areas, the Hydrosweep DS3 multibeam echosounder was operated from the bridge using the Ultra VNC® win32 remote desktop software to access the acquisition computers in the bathymetry lab. This allowed for interactive survey planning when required and an immediate sounding-stop during whale encounters. At the core stations, multibeam surveys were usually performed during the night prior to the station work. At the end of the nightshift, the results of each survey were gridded and immediately provided as hard copy and in an ArcINFO® GIS for station planning and site selection. During station work and whale encounters, the sounding was stopped in accordance with the UBA regulations. The surveys were planned on the basis of existing maps and bathymetric information. An overlap of parallel multibeam tracks of at least 20 % was envisaged. Due to inaccuracy of the existing data, track lines often had to be revised and adjusted during the survey. The cooperation between the ship and the scientists was excellent and resulted in good multibeam coverage and high quality multibeam data sets.

Preliminary results

In total, an area of almost 14,000 km² (7,700 nm² respectively) was surveyed during ANT-XXIX/3. The total coverage can be separated in partly unsupervised transit sections and fully supervised multibeam surveys. Of the total coverage, 10,211 km² (5,595 nm²) were partly supervised transit and 3,767 km² (2,064 nm²) were dedicated surveys. 10 box surveys were performed at the core sampling stations.

The box surveys comprised sites on banks and slopes as well as in adjacent canyons. In addition, an extensive survey was performed at a newly discovered sub-marine volcano.

An initial result of the high resolution survey was that especially in the Bransfield Strait and the Drake Passage the small scale, local topography differed from the large scale Antarctic digital terrain models. For the interpretation of the data generated during this cruise, the bathymetry data can therefore provide valuable information on the seabed in the vicinity of the sampling sites and potentially support the interpretation of data sets from other disciplines.

Data management

All multibeam data recorded during *Polarstern* expedition will be stored by the AWI bathymetry group for post-processing. The processed data will be included in the Data Publisher for Earth & Environmental Science PANGAEA and made publically available after a moratorium period. During the moratorium period, data requests should be sent to the AWI bathymetry group. All bathymetry data recorded during ANT-XXIX/3 will be provided to IBCSO (International Bathymetric Chart of the Southern Ocean) and GEBCO (General Bathymetric Chart of the Ocean).

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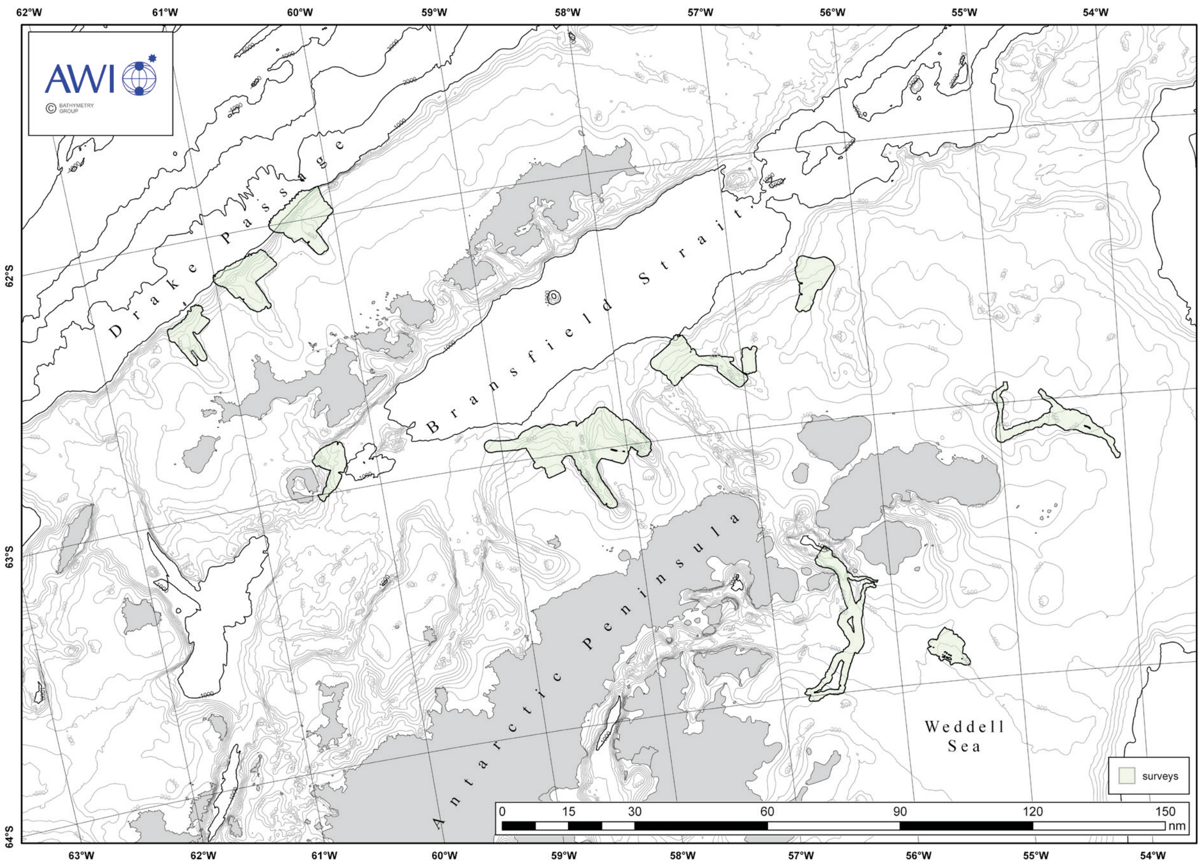

Fig. 3.12.1 Overview map of regional bathymetric surveys

3.13 Marine microbiology

Sara Thomas[1]

[1]UHAWAII

Objectives

The dark ocean (below 200 m) comprises ≥70 % of the global ocean's volume, and contains ≥98 % of the global dissolved inorganic carbon (DIC; Gruber et al., 2004). While geochemical measurements have provided major advancements to understanding the general ocean carbon cycle, our knowledge of the dark ocean's carbon cycle and microbial community is rudimentary (Herndl et al., 2005; Reinthaler et al., 2010). Active and metabolically diverse microbial assemblages have recently been identified in the dark ocean (Herndl et al., 2005; Reinthaler et al., 2010; Swan et al., 2011) contradicting the historical view of dark ocean microbes as extremely slow growing or dormant. Investigating this active community may provide insights to the widely recognized uncoupling of primary production and respiration where microbial carbon demands exceed the particulate organic carbon flux below the euphotic zone. Over the past decade, major groups of Archaea, have been identified as a metabolically active fraction of the ocean's mesopelagic and bathypelagic regions, and these nitrifying microorganisms appear to account for a significant fraction of inorganic carbon fixation in the ocean's interior (Pearson et al., 2001; Herndl et al., 2005; Ingall et al., 2006). However, archeal nitrification appears insufficient to support measured inorganic carbon fixation rates (Agogué et al., 2008; Reinthaler et al., 2010; Varela et al., 2011) and so unidentified microbial lineages and energy sources are believed to contribute to a significant portion of dark carbon fixation (Swan et al., 2011). Genetic studies have identified novel genes contained in the dark microbial assemblage, including adenosine 5-phophosulfate reductase (*aprA*) (Meyer and Kuever, 2007; Swan et al., 2011), reverse-type dissimilatory sulfite reductase (*rdsrA*), and ribulose-1 5-phophosphate carboxylase-oxygenase (*RuBisCO*) (Swan et al., 2011). *RuBisCO* is found in two forms, with Form I the primary type observed in oceanic phytoplankton (Paul et al., 2000). However, in a study examining expression of the gene encoding the large subunit of *RuBisCO*,

Picard et al. (1997) unexpectedly found Form I *rbcL* genes actively expressed in the dimly lit regions of the euphotic zone and concluded chemoautotrophs, which utilize inorganic carbon, may also contribute to the diversity of carbon fixing organisms in the ocean. Furthermore, Swan et al. (2011) discovered consistent co-occurrence of *aprA*, *rdsrA*, and *RuBisCO* genes in multiple dark bacterial lineages, indicating the potential use of dissimilatory sulfur oxidation for energetic support of autotrophic carbon fixation in ubiquitous *Deltaproteobacteria* and *Gammaproteobacteria* (Swan et al., 2011). Given the abundance of these microbes in the dark ocean, this active community may fix inorganic carbon, coupled to the oxidation of reduced sulfur compounds, at globally significant rates providing new insights on carbon cycling in the global ocean.

The *Polarstern* ANT-XXIX/3 expedition provided the opportunity to explore the following questions:

1. How abundant are specific groups of chemoautotrophic bacteria in this region?
2. How do the relative distributions of these organisms vary along productivity gradients (onshore/offshore) and with changes in hydrographic forcing throughout the region?

Work at sea

Sampling stations

Samples for marine microbiological investigations were collected from select stations during oceanographic/krill transects as seen in Figure 3.13.1.

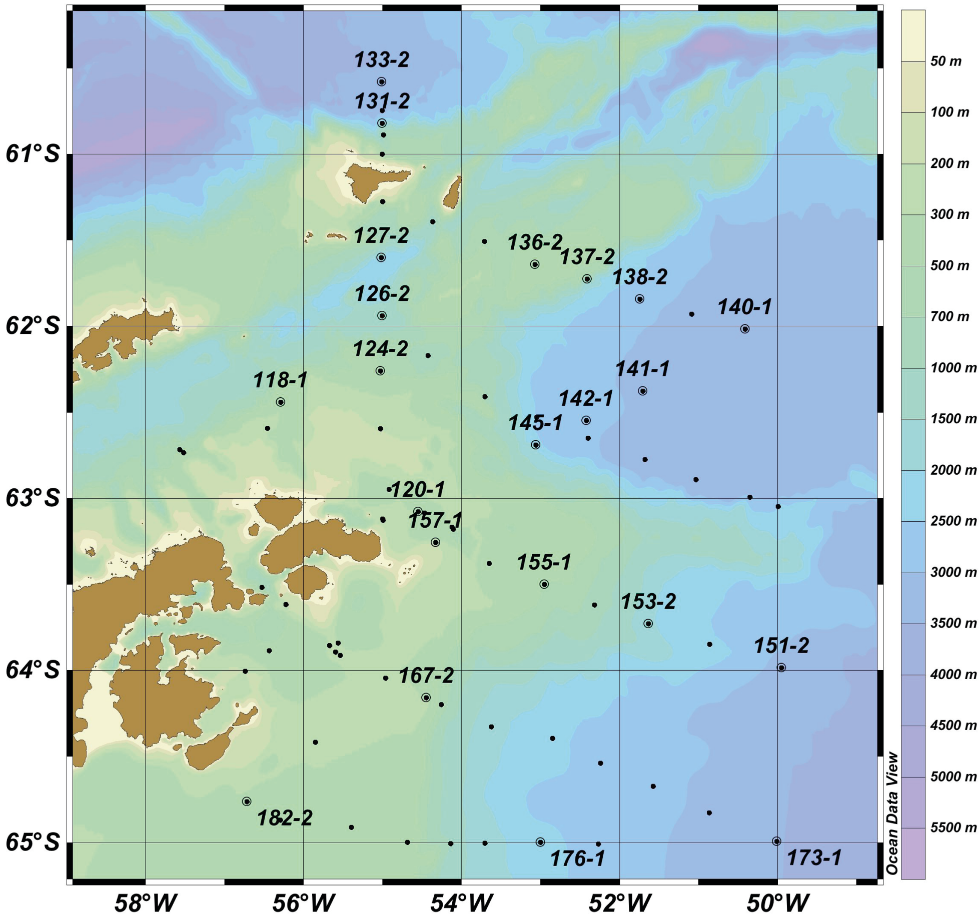

Fig. 3.13.1: Stations sampled for marine microbiology

Nucleic acid collection and extraction

Seawater from discrete depths was collected from a Conductivity Temperature Depth (CTD) rosette into acid washed polycarbonate bottles. Two liters were pumped through 25 mm diameter 0.2µm pore size Supor ® filters and placed into 2 mL microcentrifuge tubes. Filters for RNA extraction were immersed in 500 µL RNlater buffer and flash frozen in liquid nitrogen when available on *Polarstern*. All vials were stored at -80° C until processed in the shore-based laboratory in Honolulu, HI.

In the laboratory, plankton caught on filters will be mechanically and chemically disrupted to harvest nucleic acids. Briefly, DNA will be extracted from filters following a modified version of the Qiagen Plant kit. RNA will be extracted following a modified version of the Qiagen RNeasy procedure. DNA and RNA concentrations will be quantified flourometrically using fluorometric dyes (Invitrogen, Carlsbad, CA, USA) and a plate reading spectrofluorometer.

Fluorescence in-situ hybridization (FISH)

Forty milliliters of seawater was also collected from discrete depths, placed into 50 mL centrifuge tubes, and fixed with formalin (2 % v/v final concentration). Fixed samples were held at 4° C for 24 hrs before being gently vacuum filtered (<5 mm Hg) onto a 25mm diameter 0.22 μm pore size polycarbonate filter supported by a glass-fiber filt er (GF/F). A small volume (5-10 mL) of Millipore water followed the seawater to wash the filters. Polycarbonate filters were attached to pre-labeled 75x25 mm microscope slides with tough-spot stickers or placed into shallow Gelman petri dishes with the appropriate GF/F. Processing in the home laboratory will follow the protocol described by DeLong et al. (1989) and Amann et al. (1990) to allow for quantification of specific groups of chemoautotrophic bacteria by fluorescence in situ hybridization (FISH).

Chlorophyll-a

To determine between station gradients in phytoplankton biomass, 125 mL of seawater from selected discrete depths was collected in an amber polycarbonate bottle and vacuum filtered onto a GF/F. Filters were folded in half, placed into a foil pocket and stored at -80° C. Upon processing in Honolulu, filters will be put into 5 mL acetone and allowed to extract for seven days in the dark. Chlorophyll concentrations will be quantified flourometrically using a Turner 10AU Fluorometer.

Data management

The relevant samples collected on expedition ANT-XXIX/3 are intended for use within a Master's degree research project at the University of Hawai'i at Manoa. The study aims to publish in a peer-reviewed scientific journal to be determined at a later date.

Data will be provided upon request by the author.

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4. OCEANOGRAPHY AND TRACER MEASUREMENTS

4.1. Observation of dense shelf, deep, and bottom waters downstream of their source regions at the Larsen A, B, and C ice shelves

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Objectives

Although the plans have to be changed for good reason (see also chapter 1. Itinerary and summary, this volume) some of the objectives of the oceanography still remained. Parts of these are especially the following scientific questions:

- Investigate and identify pathways of recently formed dense shelf water masses.
- Investigate and identify routes of Modified Warm Deep Water on the continental shelf.
- Understand the mechanisms and the time frame, which triggers the intermittent flushing of the dense reservoirs on the shelf.
- What are the pathways of shelf waters, which form the deep waters of the Bransfield Strait central basin?

We therefore focus on a quasi-synoptic observation grid detecting the descending plume of newly formed fresh and cold water downstream of its formation regions near the Larsen C ice shelf or in the troughs of the former ice shelves Larsen A and B.

To detect this plume we did 5 long transects (150 nm each) from the shallow shelf north of 65°S into the deep Weddell basin crossing the shelf break nearly perpendicular called O, A, B, C, and D (see Figs 4.1.1, 4.1.1a-c). These transects were supplemented by a south-north section along 55°W (F) to measure the inflow of Weddell water into the Bransfield Strait from the east around the tip of the Antarctic Peninsula (AAP). In addition a short section (E) was done to from the deep Powell basin in the direction of the tip of the Peninsula. Most of these stations were accompanied by measurements of the krill group.

A number of CTD casts were done to support the different biological groups on their core stations in the three different regimes, the western Weddell shelf (9 casts), the southern Bransfield Strait (15), and the shelf on the Drake Passage side of Livingston Island, South Shetland Islands (10). Within the Bransfield Strait two cross sections were done south of King George Island (He) and in the west between the southern shelf and Deception Island (Hw) to detect the in- and outflowing water masses of the Bransfield Strait.

The oceanographic work was completed by 5 stations on a transect running from the shallow shelf in front of Livingston Island into the deep Drake Passage to measure the deep counter current at the base of the continental slope which has its origin in Antarctic Bottom Water of the Weddell Sea. In addition a new light version of helicopter CTD (SBE19V2, selfcontained) was tested on a single station from an ice flow, the data of which can be used to fill a gap on transect E. The same CTD was used for a cast in the crater of the Deception volcano.

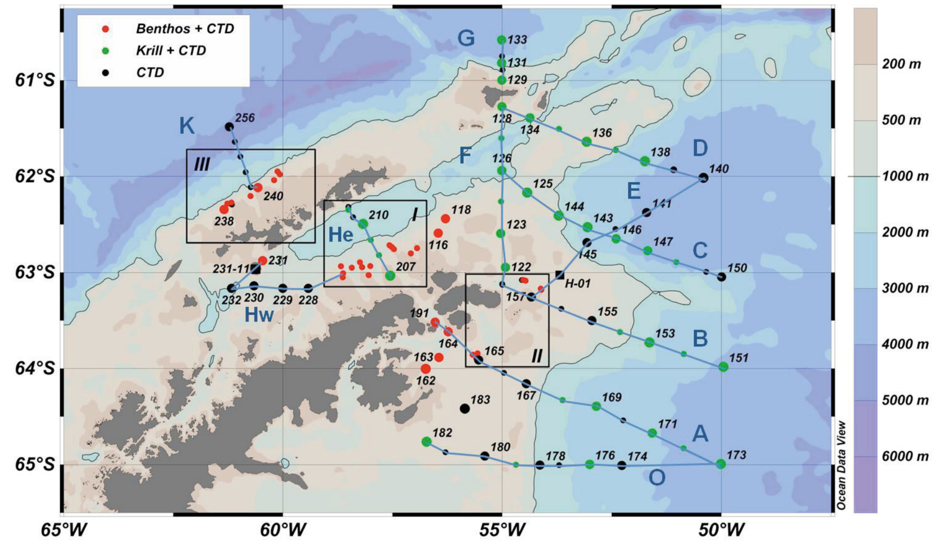

Fig. 4.1.1: CTD stations with station number and oceanographic transects with their annotations used in the text. The inserts I, II, III show the specific areas in more detail. The insert describes the biological groups who are mainly interested in the CTD station.

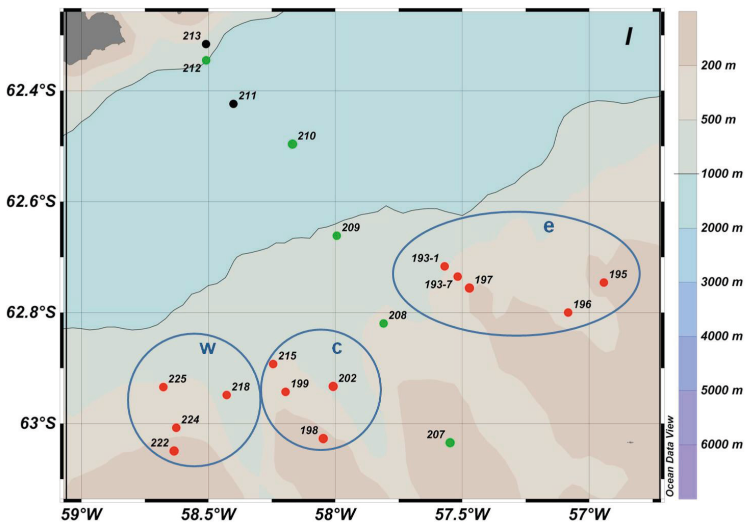

Fig. 4.1.1a: CTD stations of insert III. (w - western, c - central, e – eastern benthic core stations)

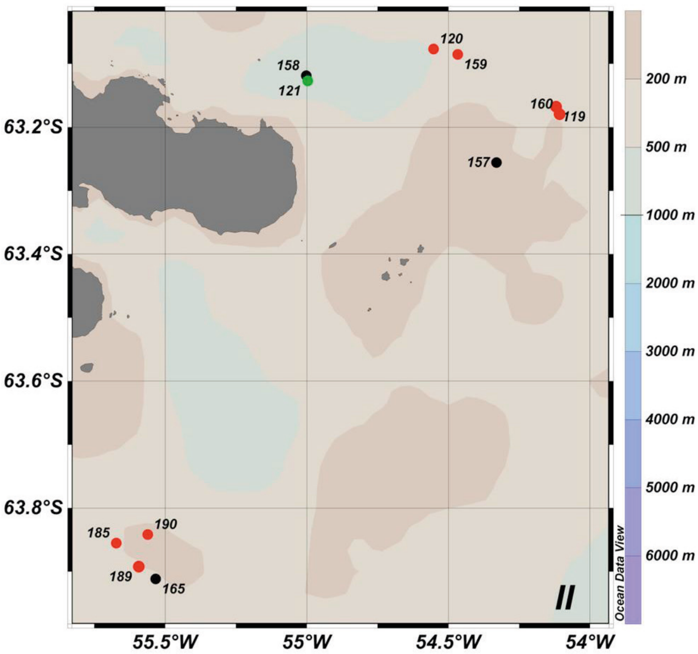

Fig. 4.1.1b: CTD stations of inserts II

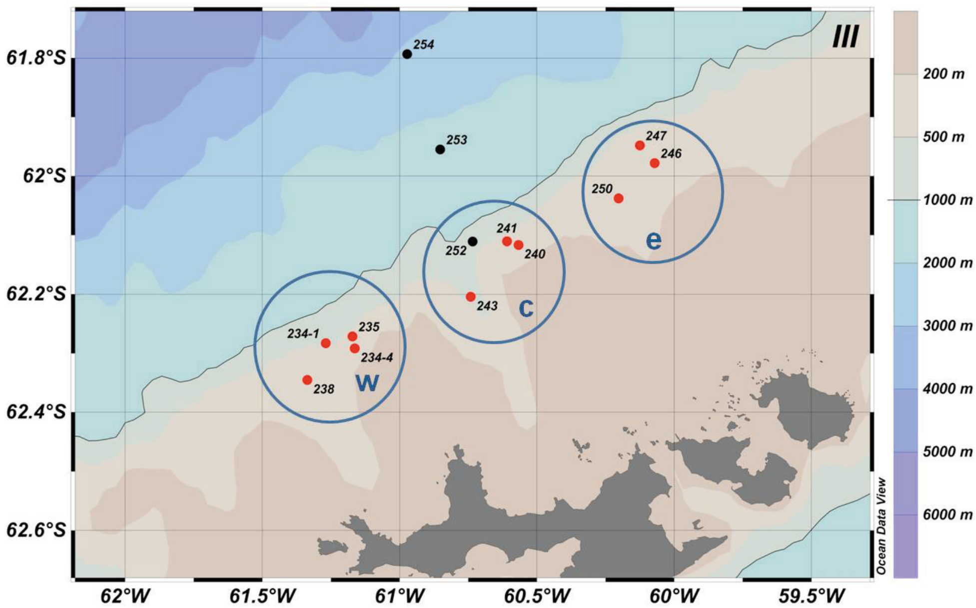

Fig. 4.1.1c: CTD stations of insert III. (w - western, c - central, e – eastern benthic core stations)

Work at sea

The programme consisted of measurements from the ship using a Seabird 911+ CTD (SN 321) connected to a caroussel (SBE 32, SN 718) with 24-(12-l) water bottles. This instrument system contains two sensor pairs of conductivity (SBE 4, SN 2470, SN 3585) and temperature (SBE 3, SN 2929, SN 5027), a high precision pressure sensor Digiquartz 410K-105 (SN 53962), one oxygen sensor (SBE 43, SN

1605), a transmissiometer (Wetlab Cstar, SN 1220), a fluorometer (Wetlab ECO-FLRTD, SN 1670) and an altimeter (Benthos Model PSA 916 ,SN 47768).

The conductivity and temperature sensor calibration were performed before and after the cruise at Seabird Electronics. The accuracy of the temperature sensors can be given to 2 mK. The readings for the pressure sensors are better than 1 dbar. The conductivity was corrected using salinity measurements from water samples. IAPSO Standard Seawater from the P-series P154 (K15= 0.99990, practical salinity 34.996) was used. A total of 98 water samples were measured using an Optimare Precision Salinometer OPS 006. On the basis of the water sample correction, salinity is measured to an accuracy of 0.002 (see also Fig. 4.1.2) with a difference in the range of 0.004. The salinity still has to be corrected at home after recalibration of the sensors at the factory.

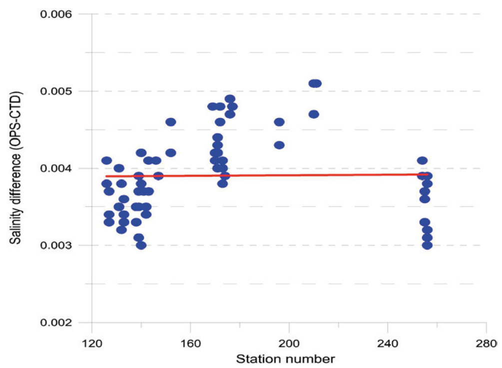

Fig. 4.1.2: Salinity difference of water samples measured with OPS minus CTD salinity over station number equivalent to time

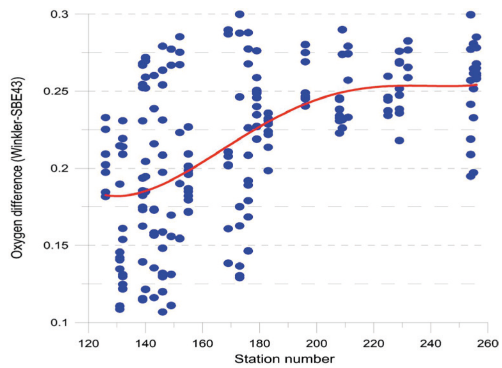

Fig. 4.1.3: Oxygen difference between water samples measured by Winkler method minus CTD oxygen sensor values over station number (time)

The oxygen was corrected from water samples by using the Winkler method with a Dissolved Oxygen Analyser (DOA, SIS type). 217 water samples were measured from 25 stations, which had a small trend with time (Fig. 4.1.3) and still have to be corrected for the hysteresis under increasing pressure.

In total 110 CTD profiles were measured on this cruise. From these casts 37 were measured direct at the benthos stations, 38 in the combined krill and oceanographic survey and 35 only for additional oceanographic reasons. The distribution over depth is as follows:

14 in water depths of more than 3,000 m, 25 between 1,000 m and 3,000 m, 24 in the range of 500 m to 1,000 m, and 47 in water depths of less than 500 m. The deepest cast was at 4,237 m, the shallowest cast at 17 m.

Two casts were done with a Seabird SBE19V2 (SN 6666), which has an accuracy of 3 mK in temperature, 0.005 in salinity, and 1.0 dbar in pressure.

The whole system will be calibrated using the pre and post calibration values from Seabird. The accuracy for temperature is better than 2 mK, for salinity it is better than 0.002, and the pressure sensor measured with an accuracy better than 1 dbar.

To supply the ship with surface temperature and salinity values the two ships SBE 21/SBE 38 thermosalinographs were used, one in 6 m depth in the bow thruster tunnel and one in 11 m depth in the keel. Both instruments were controlled by taking water samples which are measured on board.

Preliminary (expected) results

The experiment represents a synoptic oceanographic data set of the western Weddell Sea including the continental shelf north of Larsen A. Newly formed water masses built in front of the Larsen ice shelf dominate the whole area and with these transects it will be possible to follow these cold, dense plumes descending at the shelf break along the continental slope on their way north. It is also be possible to analyse the influence of Weddell water masses on the benthic communities of the southern Bransfield Strait, when surrounding the Antarctic Peninsula or flowing through the Antarctic Sound.

Measurements on the shallow shelf north of Livingston Island were done to give an actual background of water mass composition and the influence of circumpolar water for the interpretation of the different biological groups. Two sections north of Elephant Island and north of Livingston Island into the deep Drake Passage complete the oceanographic program. They were done to measure the counter current at the foot of the shelf break with its signature from the Weddell Sea.

Surface measurements with the ships thermosalinograph

By using the information of the ships thermosalinograph the changes in temperature and salinity near the surface are visible. The interpretation of the data could be of greater importance for the marine mammal and bird observing group in analysing fluctuations in the abundance of species and comparing it to the frontal zones of the ACC (Fig. 4.1.4).

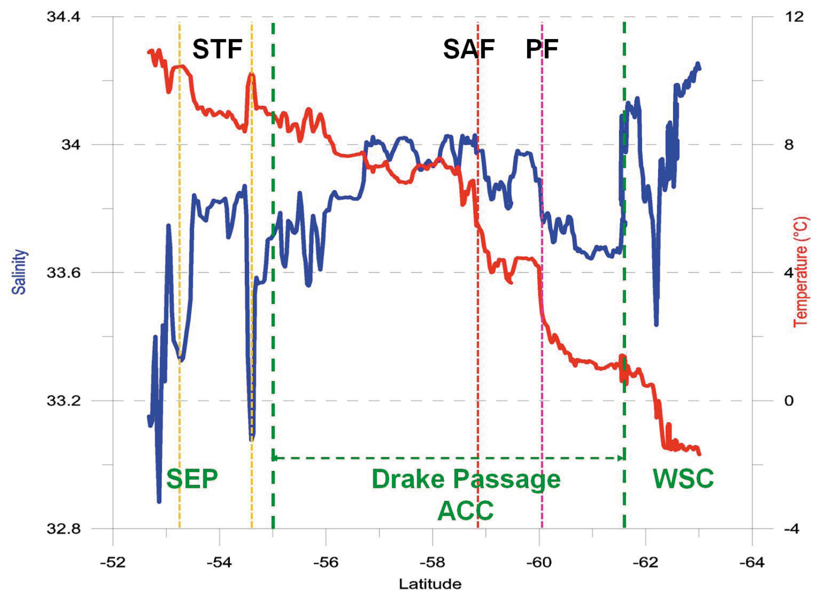

Fig. 4.1.4: Surface (11m) temperature and salinity when crossing the Drake Passage over latitude. The position of fronts in the Antarctic Circumpolar Current (ACC) are shown. STF – Subtropical front, SAF – Subantarctic front, PF – Polar front. SEP - South east pacific, WSC – Weddell-Scotia-Confluence Zone.

Physical properties of deep stations north of Elephant Island compared to stations in the Powell Basin and the Weddell Sea

The oceanographic collection shown in Fig. 4.1.5 illustrates the differences of physical parameter as temperature, salinity, and oxygen over depth for the background region, the Scotia Sea north of Elephant Island, the Weddell Sea, and the Powell Basin.

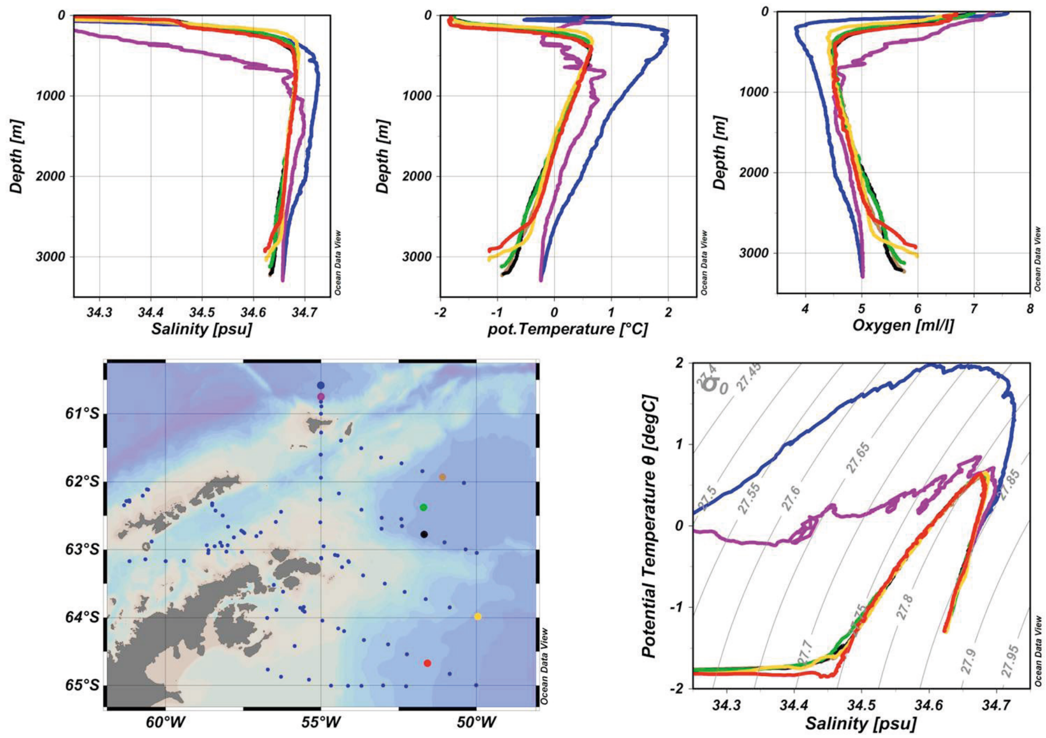

Fig. 4.1.5: 7 deep CTD stations north of Elephant Island, in the Powell Basin, and in the Weddell Sea

Here it is obvious that the profiles in the Weddell Sea are less saline, cooler, and with higher values of soluble oxygen in depth's below the temperature maximum at approx. 500 m. The stations with the lowest temperature and the highest oxygen content at the bottom (~3,000 m) are represented by the yellow (stn 151) and red (stn 171) profiles. This indicates the influence of cold and fresh water of Larsen origin descending along the slope of the continental shelf break into the abyss. Because this water is found well up on the slope and not at the depth of the basin (~4,500 m) it is obvious that the source of this newly formed water is not the Filchner outflow far south but the Larsen ice shelf nearby.

The origin of water at the tip of the Antarctic Peninsula

When comparing profiles of stations north of Joinville Island with Weddell influenced profiles from the eastern shelf areas off the Antarctic Peninsula, the structure of the curves looks quite similar. For depth's of more than 150 m, lower than the seasonal thermocline, all three stations show the same origin of Weddell shelf waters in temperature and salinity. This is an indication of the strong influence of the Weddell Sea to waters of the Bransfield Strait north of Joinville Island (Fig. 4.1.6).

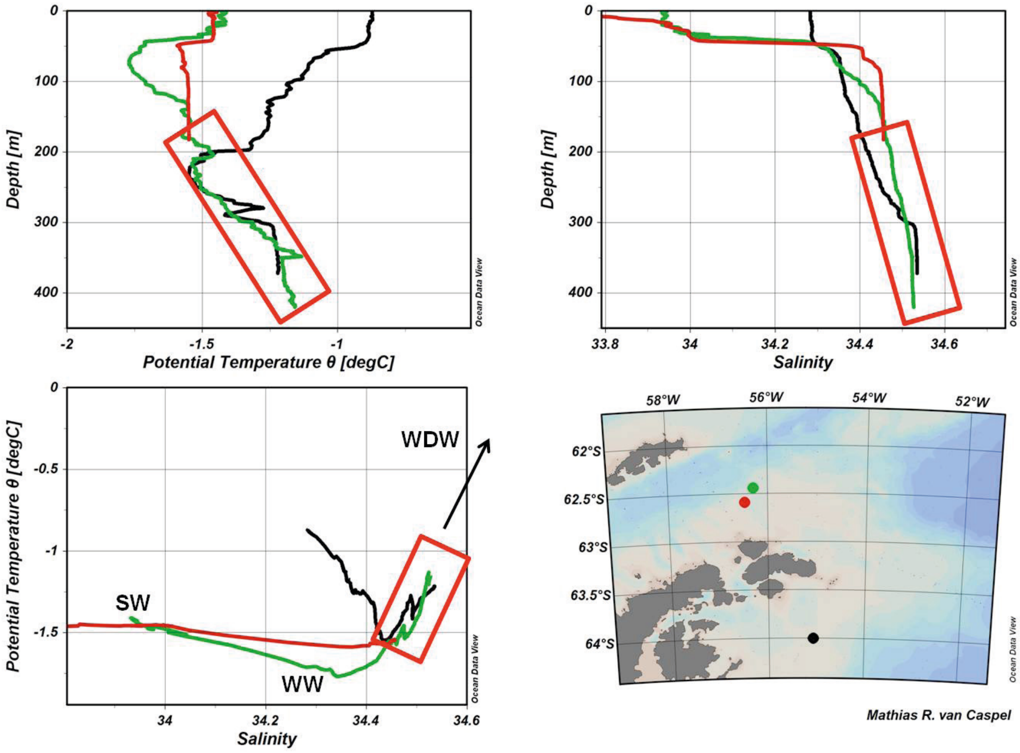

Fig. 4.1.6: Example of 3 CTD stations on the shelf) of Joinville Island, north (green: 118, red: 116) and south (black: 182)

There is also evidence that cold and oxygen rich waters from the Weddell shelf east of the Peninsula enter the southern banks of the Bransfield Strait through the Antarctic Sound (Fig. 4.1.7). This is shown by almost the same characteristics of temperature, salinity, and oxygen profile of stn 193 (green) compared to stn 190 (yellow) on the Weddell shelf. In contrast, the profile of stn 243 (red) on the Drake Passage side of the Livingston shelf shows clearly higher temperatures and less oxygen content over the whole water column, which is controlled by Circumpolar Deep Water (CDW) spilling onto the vast shelf areas north of the South Shetland Islands.

Physical properties on a transect along 55°W.

The combination of section F and G along 55°W represents the eastern end of the Bransfield Strait regime, which is also one source for the Weddell Scotia Confluence Zone extending from here to east of the South Orkney plateau. Between Joinville and Elephant Island the typical structure of the deep Bransfield Strait is shown (Figs 4.1.8. and 4.1.8a-c), with cold and saline deep waters with a higher oxygen content from the Weddell Sea as the waters entering the Bransfield Strait from the west having their origin in the Antarctic Circumpolar Current (ACC).

North of Elephant Island the typical structure of the ACC is seen with its warm (2.5° C) and saline (>34.65) core of Circumpolar Deep Water (CDW) which has very low values in oxygen (<5 ml/l). Direct north of Elephant the seasonal thermocline is depressed down to 700 m depth due to dynamical reasons of the eastward flowing circumpolar waters.

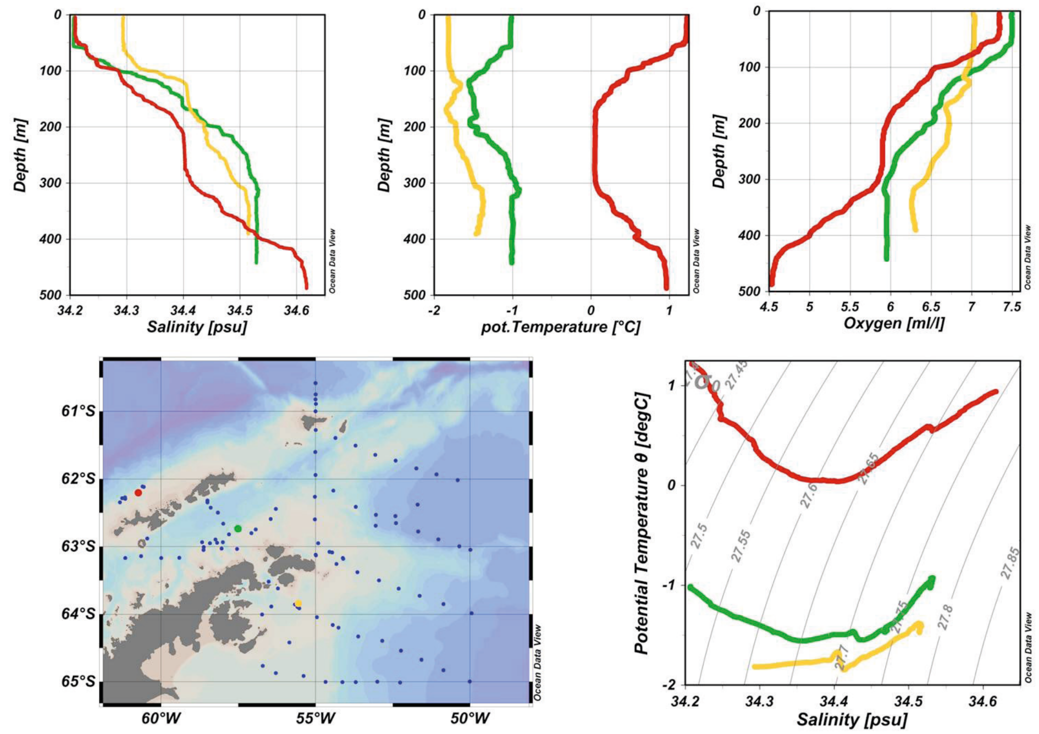

Fig. 4.1.7: Example of 3 CTD stations on the northern Livingston shelf (red: 243), the southern bank of the Bransfield Strait (green: 193), and east of the Antarctic Sound on the Weddell shelf (yellow: 190)

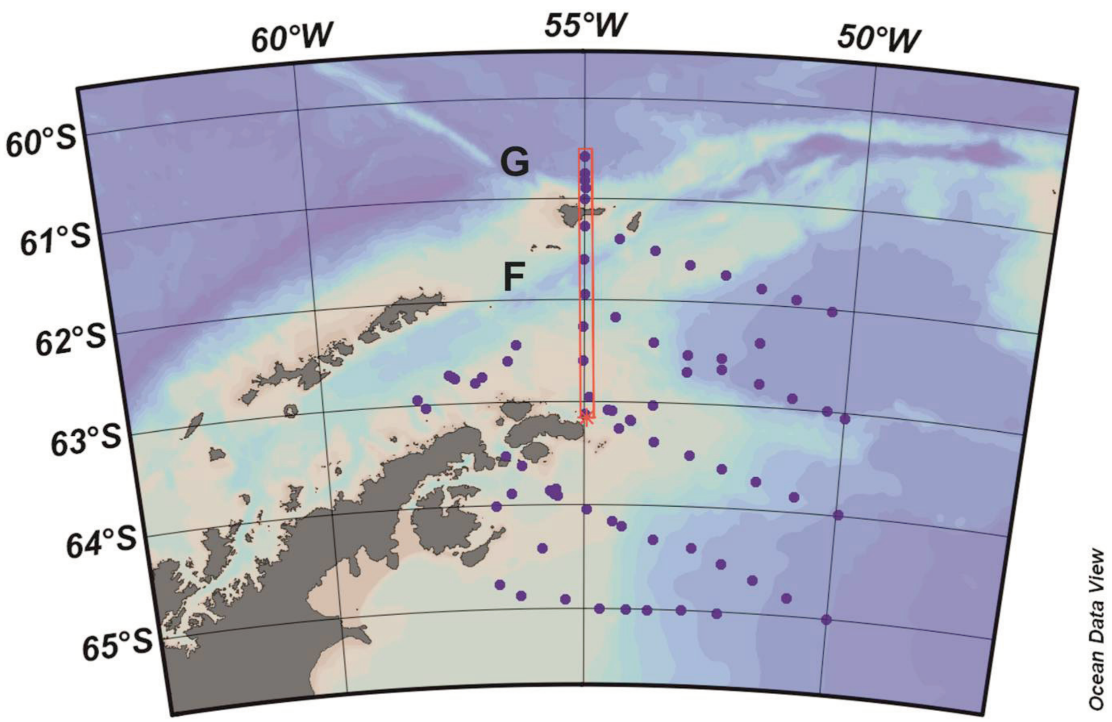

Fig. 4.1.8: Position of transect F-G

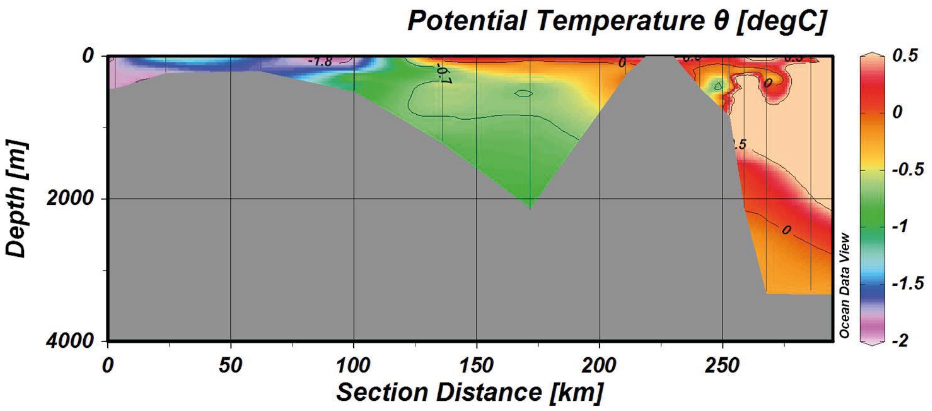

Fig. 4.1.8a: Potential temperature on a hydrographic section F-G between Joinville Island and Elephant Island along 55°W

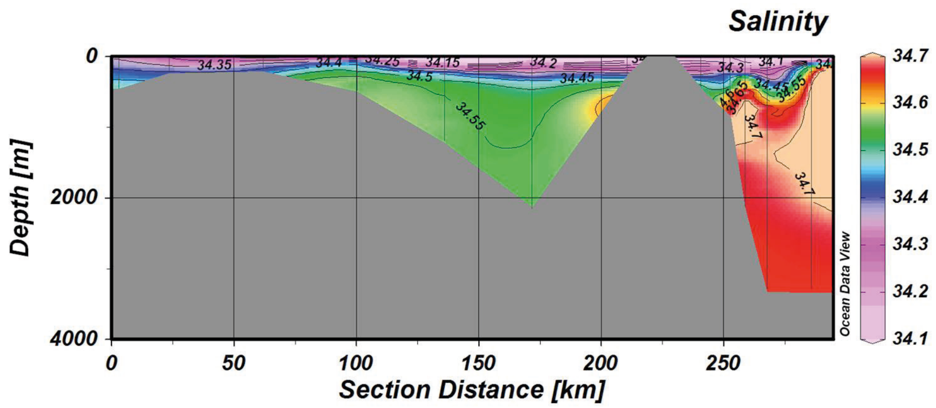

Fig. 4.1.8b: Salinity on a hydrographic section F-G between Joinville Island to Elephant Island along 55°W

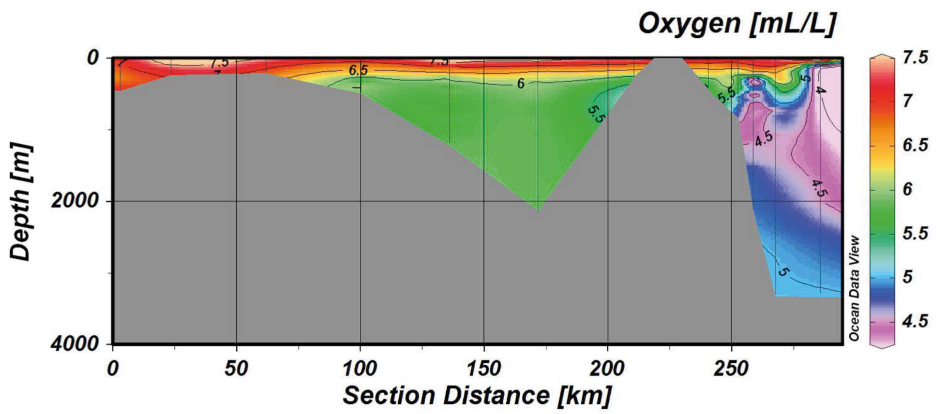

Fig. 4.1.8c: Dissolved oxygen in ml/l on a hydrographic section F-G between Joinville Island to Elephant Island along 55°W

Hydrography and physical properties of the Bransfield Strait

The water mass characteristics on a transect across the Bransfield Strait at its western entrance show the warm, saline and oxygen depleted tongue of circumpolar waters in the northern part (km 100 to 200) of the strait compared to colder, fresher and oxygen rich waters of Weddell origin in the southern areas (km 0 to 100). Due to its higher density, this water is able to fill the deep Bransfield Strait troughs (Fig. 4.1.9).

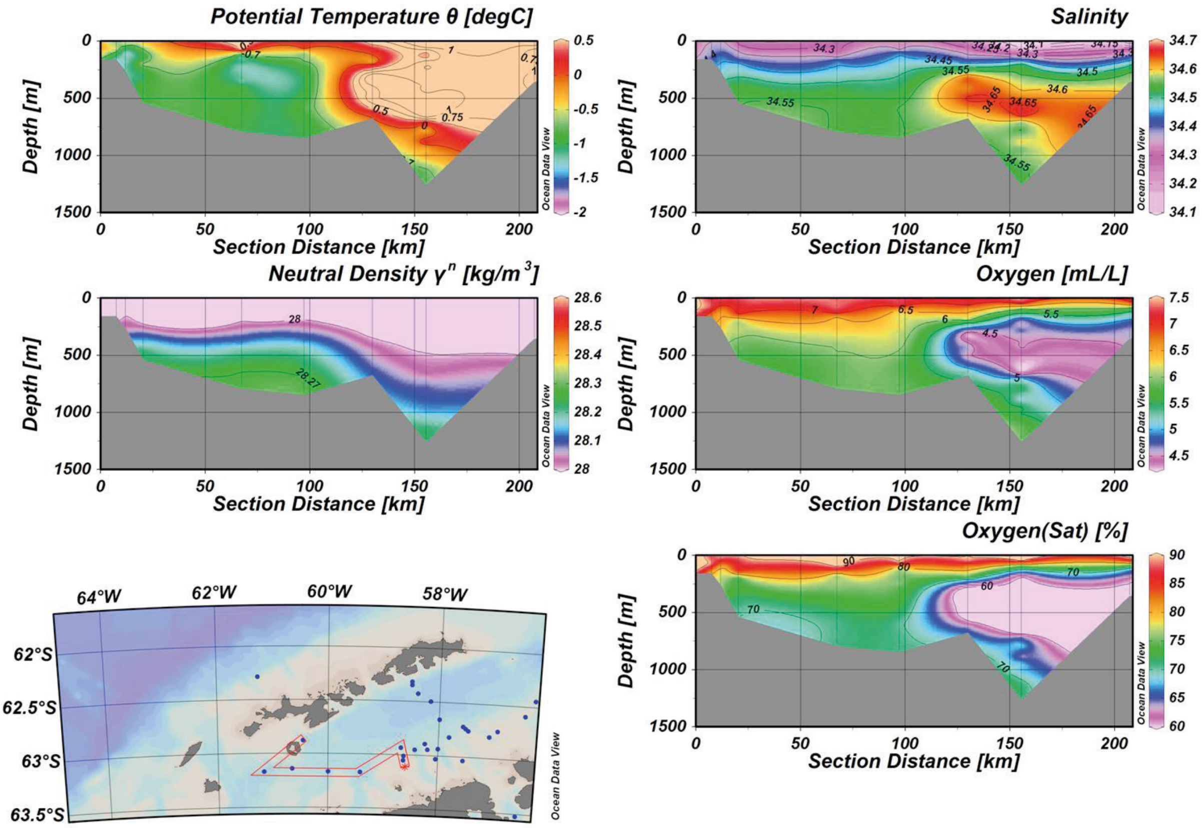

Fig. 4.1.9: CTD transect Hw (see fig.4.1.1) in the west of Bransfield Strait

Data management

All oceanographic data sets will be calibrated on board or after return of the sensors from the manufacturer at the institute, quality controlled, published in a peer reviewed journal, and will then be stored in the PANGAEA Data Publisher for Earth & Environmental Science for public use.

Tab. 4.1.1: All CTD stations of ANTXXVI-3 (ship). *Heli CTD, selfcontained (last two lines). Station 198-7 and station 228-1 (marked with x) were only done to test a camera attached to the ships CTD system.

Station	Cast	Date (2013)	Time (UTC)	Latitude	Longitude	Pressure max.	Water depth (m)
116	1	26-Jan	09:02:00	62° 35.502' S	56° 27.342' W	185	202
118	1	27-Jan	05:59:00	62° 26.472' S	56° 17.262' W	425	440
119	1	28-Jan	12:21:00	63° 10.080' S	54° 7.170' W	216	224
120	1	28-Jan	18:22:00	63° 4.620' S	54° 33.108' W	517	530
121	1	29-Jan	03:48:00	63° 7.638' S	54° 59.778' W	456	460
122	2	29-Jan	08:03:00	62° 56.868' S	54° 55.200' W	230	237
123	2	29-Jan	12:06:00	62° 35.730' S	55° 1.662' W	206	211
124	2	29-Jan	17:44:00	62° 15.648' S	55° 1.512' W	480	499
125	2	30-Jan	17:27:00	62° 10.182' S	54° 25.602' W	809	834
126	2	30-Jan	22:37:00	61° 56.412' S	55° 0.360' W	1206	1229
127	2	31-Jan	03:26:00	61° 36.018' S	55° 0.930' W	2188	2132
128	2	31-Jan	07:26:00	61° 16.542' S	54° 59.988' W	251	265
129	2	31-Jan	13:58:00	60° 59.952' S	55° 0.372' W	428	437
130	1	31-Jan	15:27:00	60° 53.352' S	54° 59.472' W	823	848
131	2	31-Jan	17:58:00	60° 49.218' S	55° 0.402' W	2153	2129
132	1	31-Jan	20:33:00	60° 44.850' S	55° 0.162' W	3354	3330
133	2	01-Feb	01:02:00	60° 34.848' S	55° 0.480' W	3344	3343
134	1	01-Feb	08:31:00	61° 23.532' S	54° 21.930' W	899	912
135	2	01-Feb	13:21:00	61° 30.348' S	53° 42.510' W	560	578
136	2	01-Feb	17:04:00	61° 38.448' S	53° 4.368' W	393	408
137	2	01-Feb	20:32:00	61° 43.572' S	52° 24.648' W	686	705
138	2	02-Feb	01:40:00	61° 50.580' S	51° 44.562' W	2800	2821
139	1	02-Feb	07:55:00	61° 55.788' S	51° 5.418' W	3289	3292
140	1	02-Feb	14:39:00	62° 0.948' S	50° 24.462' W	3375	3378
141	1	02-Feb	22:25:00	62° 22.632' S	51° 42.252' W	3179	3191
142	1	03-Feb	05:00:00	62° 32.838' S	52° 25.188' W	2958	2972
143	2	03-Feb	12:27:00	62° 31.752' S	53° 2.940' W	2494	2514
144	2	03-Feb	18:14:00	62° 24.582' S	53° 42.348' W	928	954
145	1	04-Feb	02:57:00	62° 41.418' S	53° 3.678' W	2275	2193
146	2	04-Feb	13:20:00	62° 39.048' S	52° 23.892' W	2968	2982
147	2	04-Feb	20:08:00	62° 46.482' S	51° 40.842' W	3271	3281
148	2	05-Feb	03:39:00	62° 53.412' S	51° 1.908' W	3402	3404
149	1	05-Feb	09:58:00	62° 59.598' S	50° 21.000' W	3445	3441
150	1	05-Feb	14:15:00	63° 2.820' S	49° 59.568' W	2379	2403
151	2	06-Feb	03:59:00	63° 59.040' S	49° 57.150' W	3095	3110
152	1	06-Feb	12:42:00	63° 50.838' S	50° 51.678' W	2451	2476
153	2	06-Feb	20:33:00	63° 43.698' S	51° 38.250' W	1884	1912
154	2	07-Feb	02:47:00	63° 37.182' S	52° 18.942' W	847	872

Station	Cast	Date (2013)	Time (UTC)	Latitude	Longitude	Pressure max.	Water depth (m)
155	1	07-Feb	09:12:00	63° 30.012' S	52° 57.072' W	476	493
156	1	07-Feb	14:28:00	63° 22.638' S	53° 39.132' W	358	373
157	1	07-Feb	18:45:00	63° 15.342' S	54° 19.770' W	195	205
158	2	07-Feb	23:25:00	63° 7.140' S	55° 0.102' W	456	454
159	2	08-Feb	09:06:00	63° 5.142' S	54° 27.990' W	462	473
160	2	08-Feb	20:45:00	63° 10.782' S	54° 6.420' W	238	247
162	1	10-Feb	08:19:00	64° 0.270' S	56° 44.280' W	210	220
163	1	10-Feb	19:24:00	63° 53.070' S	56° 26.190' W	459	468
164	1	11-Feb	11:28:00	63° 37.068' S	56° 13.530' W	187	197
165	1	12-Feb	06:38:00	63° 54.708' S	55° 31.992' W	184	186
166	1	12-Feb	13:07:00	64° 2.598' S	54° 57.660' W	385	401
167	2	12-Feb	18:09:00	64° 9.480' S	54° 26.862' W	343	357
167	3	12-Feb	19:31:00	64° 11.922' S	54° 15.552' W	548	565
168	2	13-Feb	02:55:00	64° 19.698' S	53° 37.380' W	1884	1912
169	2	13-Feb	10:07:00	64° 23.640' S	52° 50.940' W	2454	2476
170	1	13-Feb	16:52:00	64° 32.280' S	52° 14.550' W	2653	2672
171	1	13-Feb	22:02:00	64° 40.398' S	51° 34.458' W	2983	2994
172	1	14-Feb	05:28:00	64° 49.698' S	50° 51.960' W	3245	3251
173	1	14-Feb	13:28:00	64° 59.670' S	50° 0.618'W	3601	3596
174	1	15-Feb	06:58:00	65° 0.582' S	52° 16.212' W	2851	2867
176	1	15-Feb	14:02:00	64° 59.898' S	53° 0.162' W	2475	2492
177	1	15-Feb	23:36:00	65° 0.258' S	53° 42.222' W	1800	1825
178	1	16-Feb	03:56:00	65° 0.300' S	54° 8.118' W	1225	1252
179	1	16-Feb	08:53:00	64° 59.958' S	54° 41.082' W	419	436
180	1	16-Feb	23:13:00	64° 54.702' S	55° 23.580' W	420	436
181	1	17-Feb	08:59:00	64° 52.200' S	56° 17.598' W	460	477
182	2	17-Feb	16:09:00	64° 45.798' S	56° 43.020' W	370	375
183	1	18-Feb	09:25:00	64° 25.062' S	55° 50.922' W	274	281
185	5	19-Feb	15:19:00	63° 51.312' S	55° 40.320' W	308	307
189	2	20-Feb	19:04:00	63° 53.550' S	55° 35.562' W	27	27
190	1	20-Feb	20:02:00	63° 50.502' S	55° 33.648' W	395	400
191	2	22-Feb	11:52:00	63° 31.110' S	56° 31.572' W	707	701
193	1	23-Feb	05:54:00	62° 43.008' S	57° 34.158' W	569	577
193	7	23-Feb	11:07:00	62° 44.112' S	57° 31.068' W	447	446
195	1	24-Feb	05:45:00	62° 44.760' S	56° 56.520' W	176	172
196	1	24-Feb	08:35:00	62° 48.012' S	57° 4.968' W	550	567
197	2	25-Feb	07:49:00	62° 45.348' S	57° 28.278' W	228	228
198	3	26-Feb	12:06:00	63° 1.638' S	58° 2.820' W	172	174
198 x	7	26-Feb	14:49:00	63° 2.460' S	58° 7.200' W	31	180
199	3	27-Feb	07:12:00	62° 56.592' S	58° 11.742' W	241	241
202	1	27-Feb	14:01:00	62° 55.998' S	58° 0.468' W	748	758
207	1	28-Feb	18:12:00	63° 2.082' S	57° 32.850' W	108	116

Station	Cast	Date (2013)	Time (UTC)	Latitude	Longitude	Pressure max.	Water depth (m)
208	1	28-Feb	21:04:00	62° 49.188’ S	57° 48.582’ W	396	400
209	1	28-Feb	23:53:00	62° 39.690’ S	57° 59.640’ W	896	902
210	1	01-Mar	02:17:00	62° 29.778’ S	58° 10.098’ W	1817	1851
211	1	01-Mar	10:22:00	62° 25.440’ S	58° 24.048’ W	1114	1134
212	2	01-Mar	12:58:00	62° 20.712’ S	58° 30.492’ W	774	786
213	1	01-Mar	14:00:00	62° 18.972’ S	58° 30.510’ W	524	539
215	1	01-Mar	20:05:00	62° 53.568’ S	58° 14.658’ W	527	530
218	1	02-Mar	14:53:00	62° 56.928’ S	58° 25.662’ W	680	691
222	1	03-Mar	14:26:00	63° 2.988’ S	58° 38.058’ W	161	159
224	1	04-Mar	05:51:00	63° 0.480’ S	58° 37.578’ W	255	258
225	1	04-Mar	10:18:00	62° 56.070’ S	58° 40.620’ W	532	539
228 x	1	05-Mar	12:47:00	63° 9.972’ S	59° 24.912’ W	50	794
228	2	05-Mar	13:11:00	63° 9.978’ S	59° 24.942’ W	781	794
229	1	05-Mar	15:47:00	63° 9.990’ S	59° 59.952’ W	835	847
230	1	05-Mar	19:09:00	63° 8.370’ S	60° 39.300’ W	669	677
231	3	06-Mar	00:51:00	62° 52.692’ S	60° 27.342’ W	352	355
232	1	06-Mar	20:59:00	63° 10.008’ S	61° 10.038’ W	1252	1260
234	1	07-Mar	09:51:00	62° 16.992’ S	61° 16.128’ W	385	387
234	4	07-Mar	15:15:00	62° 17.520’ S	61° 9.762’ W	231	231
235	1	07-Mar	18:48:00	62° 16.302’ S	61° 10.272’ W	377	369
238	2	08-Mar	16:00:00	62° 20.730’ S	61° 20.148’ W	459	465
240	1	09-Mar	06:38:00	62° 7.002’ S	60° 34.002’ W	277	276
241	1	09-Mar	10:13:00	62° 6.630’ S	60° 36.522’ W	402	395
243	1	09-Mar	23:18:00	62° 12.270’ S	60° 44.418’ W	493	497
246	2	11-Mar	11:48:00	61° 58.692’ S	60° 4.242’ W	298	296
247	2	11-Mar	14:39:00	61° 56.898’ S	60° 7.488’ W	400	401
250	1	12-Mar	13:46:00	62° 2.280’ S	60° 12.108’ W	486	487
252	1	13-Mar	00:29:00	62° 6.672’ S	60° 43.998’ W	960	963
253	1	13-Mar	02:49:00	61° 57.252’ S	60° 51.258’ W	1574	1542
254	1	13-Mar	05:48:00	61° 47.568’ S	60° 58.200’ W	3087	2989
255	1	13-Mar	09:36:00	61° 38.322’ S	61° 5.928’ W	4242	4079
256	1	13-Mar	13:52:00	61° 29.160’ S	61° 13.092’ W	4313	4258
H*	1	07-Feb	16:50:00	63° 01.604’ S	53° 41.043’ W	272	280
131*	11	06-Mar	10:58:00	62° 58.060’ S	60° 37.015’ W	120	154

4.2 Observation of stable noble gas isotopes (^3He, ^4He, Ne) and transient tracers (CFCs)

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Objectives

Our approach aims to quantify the basal shelf ice melting in the western Weddell Sea and to investigate the related Weddell Sea Bottom Water (WSBW) composition, its formation rate and export northward, into the deeper Weddell Basin, and west through Bransfield Strait and Drake Passage. It aims to enhance our understanding how basal shelf ice melting and WSBW composition, formation, and export interact under changing climate conditions.

Observations and model studies emphasize the complex and unique interaction of the Antarctic Ocean climate components (atmosphere – sea ice – shelf ice – ocean) and their sensitivity to changing environmental conditions and response to climate change. The WSBW formation and composition is strongly related to the dynamics of the ice shelves in the western Weddell Sea (Larsen Ice Shelf). Recent observations show distinct variability or even trends in the WSBW properties (warming, freshening, water mass age increase, reduced ventilation and anthropogenic carbon uptake). However, the actual state of basal ice shelf melting, its variability and possible future trends due to changing climate conditions and its impact on the WSBW composition and formation and its variability is not yet fully understood.

Hence, investigating and quantifying basal glacial melting and WSBW formation as close as possible to its sources (Larsen Ice Shelf) will help to increase our understanding of the interaction of these unique Antarctic Ocean climate components under changing climate conditions. Tracer observations will help substantially to investigate the interaction of basal glacial melting (stable noble gas isotopes [^3He, ^4He, Ne] to quantify basal glacial melt water), basal melt rates and WSBW formation (transient trace gases [CFCs] to determine transit time scales [TTDs], formation rates, and anthropogenic carbon storage) and their variability.

The aims of our tracer observation based approach are the followings:

1. We will quantify the basal glacial melt water fraction in recently formed WSBW, to estimate the melt water inventories and the basal glacial melting rates for the remaining ice shelf in the western Weddell Sea (Larsen C Ice Shelf, i.e. at the western source region of WSBW).
2. We will quantify, how WSBW is (locally) composed (particularly to quantify contributing fractions of basal glacial melt water), how much WSBW is formed by glacial melt water addition or by other processes, and to trace its pathways and to quantify its export on the shelf and down the slope into the deeper basin and trough Bransfield Strait and Drake Passage.
3. We will estimate, how much anthropogenic carbon is stored in WSBW, which was recently formed in the western Weddell Sea and how much is exported.

4. We will provide actual reference values for basal glacial melt rates and WSBW composition and formation rates, to be able to address temporal changes in the future.

5. By incorporation of historic data, we will assess possible temporal variability or trends of basal glacial melting and of WSBW composition, formation, and export. We will investigate, if that variability can be linked to environmental variability or climate change (ambient water mass properties, local or external forcing by atmospheric or ocean warming, changing sea ice formation, or ice shelf decay). Furthermore, we will evaluate, if and how local processes and their variability can be related to basin wide or global scales (e.g., observed basin wide WSBW property changes, warming, freshening, age increase, declining ventilation, declining volumes, slowing down of CO_2 uptake, etc.).

6. We planned to investigate, if there is evidence for local variability (now ice free Larsen A, B; still ice covered Larsen C and Filchner Ice Shelf) in glacial melting and WSBW processes.

7. We wanted to test and improve a new and expected more efficient and less time consuming sampling method for noble gasses into previously evacuated glass ampoules (ampoule based water sampler, AWS). We tested their handling on sea and will compare the measurements with those from the "classic" copper tube samples by obtaining replicate samples with both methods, particularly from cold and high noble gas waters.

To reach these aims, new and spatially high resolved synoptic tracer measurements are required. We will use the stable noble gas measurements (^3He, ^4He, Ne) to quantify glacial melt water fractions and volumes and quantify the composition of newly formed WSBW at their sources. We will use the transient tracer (chlorofluorocarbon, CFC) measurements to determine the time scales of residence and circulation to quantify the formation rates of glacial melt water (basal melting rates) and of WSBW formation rates. We will use CFC data to estimate the anthropogenic carbon content and uptake in the recently formed WSBW. We will also incorporate available historic tracer data to assess possible temporal variability of glacial melting, WSBW composition, formation, and anthropogenic carbon uptake.

Approach and methods

The oceanic measurement of the low-solubility and stable noble gases helium isotopes (^3He, ^4He) and neon (Ne) provide a useful tool to identify and to quantify basal glacial melt water. Atmospheric air with a constant composition of these noble gases is trapped in the ice matrix during formation of the meteoric ice. Due to the enhanced hydrostatic pressure at the base of the shelf ice, these gases are completely dissolved in the water, when the ice is melting from below. This leads to an excess of Δ^4He = 1060 % and ΔNe = 770 % in pure glacial melt water (the Δ stands for the noble gas excess over the air-water solubility equilibrium). Frontal or surface melt water would equilibrate quickly and not lead to any noble gas excess in the ocean water. With an accuracy of <0.5 % for He measurements performed at the IUP Bremen, basal glacial melt water fractions of <0.05 % are detectable. The $^3He/^4He$ isotope ratio provides additional information. In Antarctic shelf water the ratio is low in comparison to ratios in WDW (the WDW has a maximum in

$^3He/^4He$) and provide complementary information of the composition of WSBW. Finally, primordial helium (mantle helium with a far higher $^3He/^4He$ ratio, $\delta^3He \approx 800$ %) enters the ocean from spreading regions of submarine ridge systems or other hydrothermal active sites like hydrothermal vents or submarine volcanoes.

The anthropogenic transient trace gases chlorofluorocarbons (CFC-11 and CFC-12) allow estimating the time scales of the renewal and ventilation of inner oceanic water mass transport. They enter the ocean by gas exchange with the atmosphere. Since the evolution of these transient tracers in the ocean interior is determined on first order by their temporal increase in the atmosphere and subsequently by advection in the ocean interior, they allow quantifying the time scales of deep and bottom water transport and formation. In a higher order approach, using the so-called Transit Time Distribution (TTD) method (or water mass age spectra), they allow determining the integrated advection and mixing time scale of a water mass. These CFC and TTD method based time scales of ventilated water masses integrate residence, circulation, and transport and on the shelf, slope, and deep basin and allow determining water mass ventilation and formation rates. Combined CFC based time scales with noble gas (using an optimum multiparameter ananlsis, OMP) based melt water inventories allow calculating basal glacial melting rates and the basal glacial melting induced WSBW formation rates.

Additionally, the CFCs and TTD method can be used to estimate the anthropogenic carbon content in WSBW by applying the CFC based TTDs to the well known atmospheric anthropogenic carbon history. That method is very reliable particularly in deep and bottom water and it is fully independent of carbon measurements and back calculating methods, which require additional geochemical observations or linear regression methods (which need carbon measurements from at least two different times of observations at the same location and which are not available in the area of our investigation).

Work at sea

We took water samples for stable noble gas isotopes (^3He, ^4He, Ne) (407 in copper tubes, 186 in AWS, of which 77 were replicate samples applying both sampling methods for inter-comparison) from 73 stations (profiles from bottom to surface) along 9 sections (7 in the north-western Weddell Sea, 2 in the Bransfield Strait, plus one extra station deployed from a life boat within the caldera of Deception Island; see Fig. 4.2.1). For the transient tracers (chlorofluorocarbons, CFC-11, CFC-12), we took 940 samples on 77 stations (bottom-surface-profiles) along 10 sections (7 in the north-western Weddell Sea, 2 in the Bransfield Strait, 1 in the southern Drake Passage; see Fig. 4.2.1).

Oceanic water samples for helium and neon were stored from the CTD/water bottle system into gas tight copper tubes, which are clamped of at both sides, or they are sampled into previously evacuated glass ampoules (AWS), which are filled half and are then flame sealed. The noble gas samples are analysed later in the IUP Bremen noble gas mass spectrometry lab. The copper tube water samples are processed in a first step with an ultra high vacuum gas extraction system. Sample gases are transferred via water vapour into a glass ampoule kept at liquid nitrogen temperature. For the AWS water samples this additional treatment is obsolete, because the dissolved gases degas into the headspace of the evacuated ampoule immediately during the sampling. For analysis of the noble gas isotopes the glass ampoules are connected to a fully automated ultra high vacuum mass spectrometric system equipped with a two-stage cryogenic trap system. The system is regularly calibrated with atmospheric air standards (reproducibility better ±0.2 %). Also measurements of blanks and linearity are done.

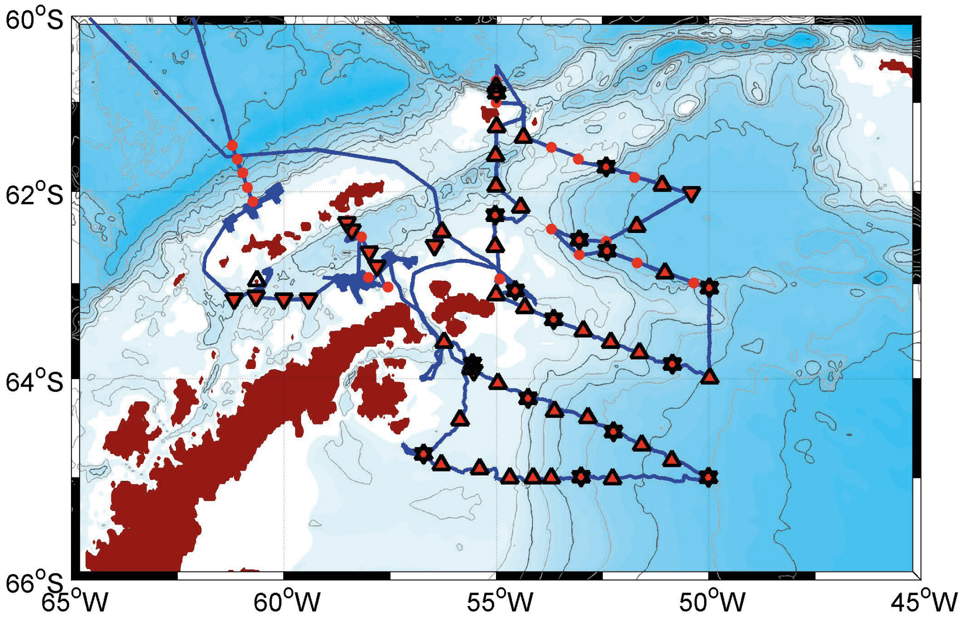

Fig. 4.2.1: Map of the northern part of the Antarctic Peninsula. Grey lines are 500, 1,500, 2,500, 3,500 meter isobaths, black lines are 1,000, 2,000, 3,000, 4,000 meter isobaths. The blue curve is the cruise track of Polarstern during ANT-XXIX/3. Red dots are positions of stations with CFC samples, triangles pointing upwards are stations with noble gas samples in copper tubes, and triangles pointing down are stations with noble gas AWS samples.

For the transient tracers (CFC) water samples from the CTD/water bottle system were collected into 100 ml glass ampoules and are flame sealed after a CFC free headspace of pure nitrogen had been applied. The CFC samples are later analysed in the CFC-laboratory at the IUP Bremen. The determination of CFC concentration will be accomplished by purge and trap sample pre-treatment followed by gas chromatographic (GC) separation on a capillary column and electron capture detection (ECD). The amount of CFC degassing into the headspace will be accounted for during the measurement procedure in the lab. The system will be calibrated by analysing several different volumes of a known standard gas. Additionally the blank of the system will be analysed regularly.

All samples will be shipped home after the expedition and will be analysed in the UHB-IUP noble gas and CFC laboratories. The measurements are expected to be completed one year after arrival in our home lab in Bremen. A careful data quality check will be carried out then.

Expected results

Even if we could not reach our initially planned working area near the Larsen Ice Shelf, we expect to reach most of our aims (at least A-E, and certainly G). The nearly synoptic 3-dimensional spatial coverage with CFC and noble gas samples in the north-western Weddell Sea (7 sections from the shallow shelf down to the foot of the slope), in the Bransfield Strait (2 sections crossing the entire strait) and in the Drake Passage is higher than from any previous expedition, where usually only single synoptic sections were realized. If this nearly synoptic and spatially dense 2-dimensional station distribution was sufficient to cover the total dense water that was formed at Larsen C (i.e., to integrate the total glacial melt water volume), will be judged, when the final noble gas and CFC data, together with the final hydrographic data, are available.

We do not expect to distinguish between the possible Larsen A, B, and C source regions properly, since we were to far off the Larsen area. However, we expect that we have covered sufficiently the area, where recently formed WSBW (composed and formed further south and west, likely by interaction with the Larsen C Ice Shelf and possibly containing significant contributions of basal glacial melt water) is transferred on the shelf northward and down the slope into the deeper Weddell Basin and also possibly westward through Bransfield Strait and Drake Passage. This will allow us to estimate the glacial melt water fraction and its inventory in WSBW and to assess the formation and export rates of WSBW.

The new noble gas AWS sampling method (aim G) could be improved and proved to be usable on sea under harsh conditions. The number of replicate samples using copper tubes and the AWS will allow an accurate quantitative comparison of both methods.

The extra station in the active caldera of Deception Island and one station within an expected active submarine volcano in the Bransfield Strait south of King George Island (Orca Seamount, a repeat station from 2009, ANT-XXV/4) might add further information into the hydrothermalism and volcanism of this tectonically active area.

Data management

All our data will be made public on the PANGAEA Data Publisher for Earth & Environmental Science as soon as we have them available (approximately one year after the cruise), carefully quality controlled, and published in a peer-reviewed journal.

5. ANTARCTIC KRILL POPULATION DYNAMICS IN THE NORTH-WESTERN WEDDELL SEA (CCAMLR)

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Objectives

Since the mid 1970s the Thünen Institute of Sea Fisheries has studied Antarctic krill stocks (*Euphausia superba*, Fig. 5.1) in the Southwest Atlantic sector of the Antarctic Ocean. The region of the Scotia Sea is inhabited by the largest krill concentrations in the Southern Ocean. However an important unanswered question has always been whether the krill stock in the Southwest Atlantic has its origin simply in the western Antarctic Peninsula region or if a second source in the western Weddell Sea substantially contributes to the high biomass in the Scotia Sea. The knowledge of the origin of krill stocks as well as their biological characteristics is of basic importance for the management of the krill resources. However, the western Weddell Sea is covered year-round by muli-year sea-ice, which presents extreme difficulties for research vessels operating there. Over the past decade satellite data has indicated an increasing number of years with less sea-ice, offering an opportunity to work in otherwise inaccessible areas. According to the original plan of the current cruise it was intended to enter the marginal ice zone of the western Weddell Sea and carry out a standardised plankton/krill research program along a station grid as far south as 66°S.

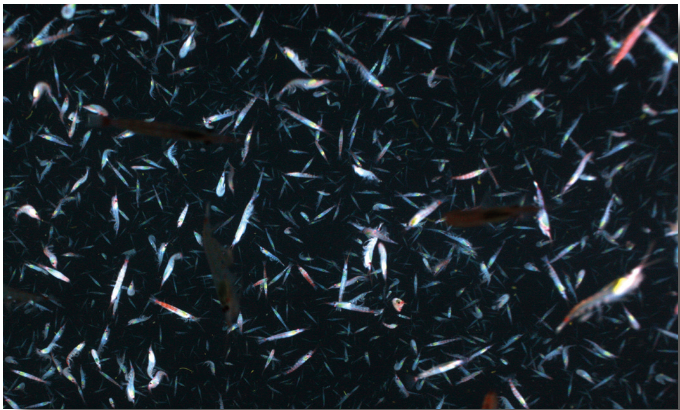


Fig. 5.1: Krill swarm in the surface layer observed by the OFOS on March 8 at the continental slope station north of Livingston Island. Photo courtesy by AWI/IPÖ

However, in the last days before the cruise, satellite images showed an unusually wide northern extension of the ice-edge. In cooperation with the physical oceanography group a joint plan B was developed, which shifted the station grid partly into open water (transect along 55°W) to allow for a collection of the krill data from the western Peninsula side. The rest of the grid was still located in the pack-ice zone but a little further to the north which was an area with a realistic chance to deploy the plankton net and yet still sample krill and zooplankton in the Weddell Sea domain.

The general objective of the krill and zooplankton study was to conduct a net-based, oceanographic krill survey in the north-western Weddell Sea. The project focused on the outflow area of the western Weddell Sea into the Scotia Sea east of the Antarctic Peninsula during the austral summer (January/February). The study was designed to address quantitative aspects of krill biology, distribution, biomass, phenology and demography (size, age, maturity composition) and population dynamics (growth, spawning timing, larval development, and recruitment), in addition to zooplankton species composition and distribution.

The first focus of the study is the relationship between the biology of krill species (especially *Euphausia superba* and *E. crystallorophias*) and other zooplankton species to environmental conditions, such as, sea-ice and the physical oceanography of the water column. A key objective is to collect and process physical oceanographic data in order to identify hydro-graphic characteristics and map different types of water masses encountered during the survey. These data will be used to describe the physical circumstances associated with various biological observations.

The objective of the RMT net sampling programme will be to collect essential krill demographic information which includes length, sex ratio, maturity stage composition, reproductive condition as well as distribution, abundance and developmental composition of the larval stages. Information useful for determining the relationships between krill distribution patterns and ambient environmental conditions will be derived from net samples taken at pre-fixed station locations and oceanographic data. The investigation will also consider a potential habitat change in the krill population and zooplankton composition as a consequence of long-term changes in sea-ice conditions in the western Weddell Sea region. The study also allows for the investigation of the summer spawning condition of krill species (which usually occurs in January-February) and the dispersion of more northern zooplankton species into the area under seasonal warming conditions. Special attention will be paid to salps as potential food competitors of krill. The study will also collect bench mark data to be compared with the follow-up winter cruise of *Polarstern* in August/September 2013.

The primary objectives of the hydroacoustic (using the EK60 multifrequency echosounder) survey will be to map the meso-scale dispersion of Antarctic krill (*Euphausia superba*) in the north-western Weddell Sea and to determine their association with water mass boundaries and bathymetry.

Work at sea

Zooplankton and krill investigations were carried out in the north-western Weddell Sea and in the Bransfield Strait area west of the Antarctic Peninsula between January 26 and March 2. The survey period fell within the normal spawning season for Antarctic krill. The revised station grid contained 59 RMT stations of which 42 standard stations along 7 transects were completed. The transects were located perpendicular to the main current flow along the outflows of the Weddell Gyre and the western Antarctic Peninsula. 8 additional stations were completed concurrent with the benthos stations in the Bransfield Strait and Drake Passage (Fig. 5.2).

The RMT1+8 plankton net (Baker et al., 1973) was used as standard gear as for all previous surveys to collect krill samples from the upper 200 m surface layer. The net was equipped with a real-time time-depth-recorder (TDR) to follow the track of the net during the double oblique tow. The total time of the net haul from the surface to maximum depth and back to the surface was approximately 40 minutes.

At some stations fishing depth was reduced due to accommodate shallower bathymetry. At a few ice stations fishing depth was reduced to approximately 180 m in order to shorten the trawling time thereby avoiding ice flows large enough to have blocked the vessel's trawling track. The net was equipped with a calibrated flowmeter to give a measure of net speed during the haul as well as the total distance travelled. The flowmeter was mounted outside the net opening to avoid clogging which may reduce the efficiency. The dependence of mouth angle to the vertical of net speed had been investigated for the RMT system (Pommeranz et al., 1982) to adjust the effective mouth opening of the net for the estimation of the volume of water filtered. The average filtered water volume of a standard RMT8 net tow was approximately 25,000 m^3.

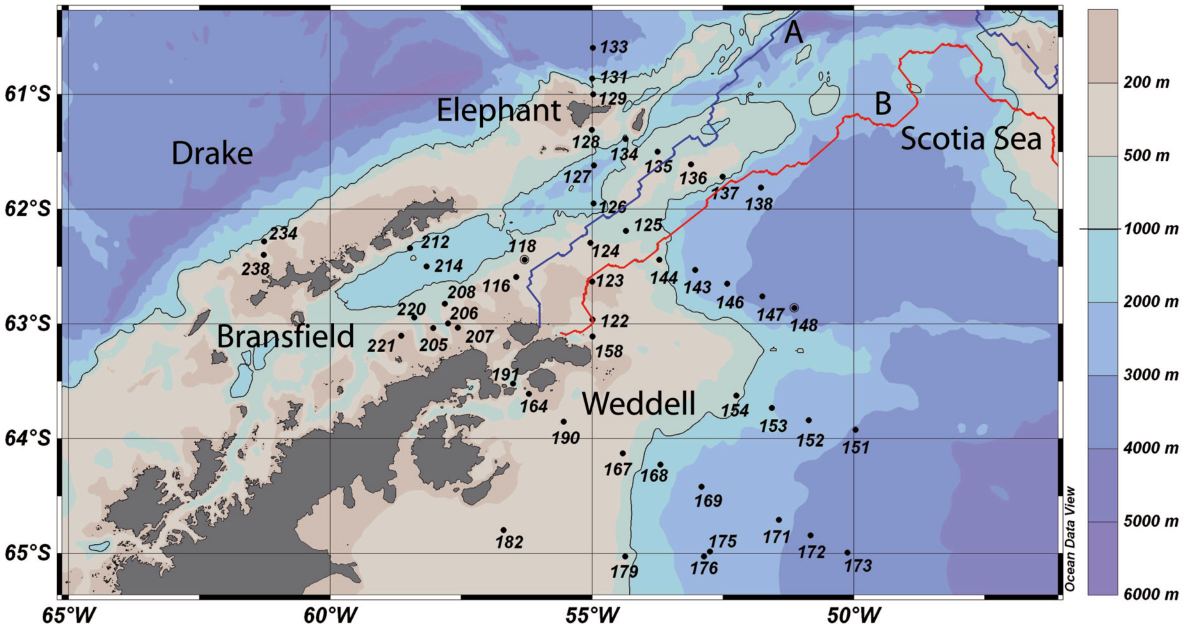


Fig. 5.2: Station chart of RMT plankton net deployments; the blue line (A) indicates the ice edge on January 26 , the red line (B) on February 17

Immediately after the tow, samples were sorted for Antarctic krill, other euphausiid species, salps and fish. These data were collected quantitatively from the RMT 8. However, if the sample size was larger than one litre then a representative subsample was taken with a Folsom plankton splitter and subsequently analysed. Krill and other euphausiids were stored in 4 % buffered formalin-seawater solution for later length measurements and sex and maturity stage analyses. These samples were usually analysed on board after two days. Biological parameters such as length, sex and maturity stage were routinely collected from all or at least 200 *E. superba* or 100 other euphausiids from each station. We used the 'Discovery' method for *E. superba*, i.e. total length from the anterior margin of the eye to the tip of the telson, whereas the other euphausiid species were measured from the tip of the rostrum according standard 1 measurement described by Mauchline (1980). The standard unit is given in mm below, with an accuracy of 1 mm size classes. All measurements were done by one person to remove observer variation. Additional information was collected for sex and maturity stages of euphausiids according to the classification of Kirkwood established by Makarov and Denys (1981). A representative fraction of the total zooplankton sample was preserved for later analysis on land. RMT1 samples were preserved in 4 % formalin sea-water solution and sorted for euphausiid larvae on board a few days later. Classification of larval stages was done according to Kirkwood (1982).

The krill data will be analysed as part of CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources) related research activities of the Institut für Seefischerei in Hamburg and results will be submitted to the CCAMLR Working Group meeting to support the monitoring of the krill stocks in the Atlantic sector and the management of the krill fishery. The studies conducted here on the spawning success, survival rates and recruitment success are essential to develop prediction models for the development of the krill stocks.

The estimation of the actual standing stock biomass will be based on data collected continuously during the survey with the multi-frequency SIMRAD EK 60 hydro acoustic equipment, which is the standard multi-frequency ecosounder agreed upon by CCAMLR. The biomass estimate resulting from this operation will help the CCAMLR working group to estimate the potential yield of the krill stock and set catch limits for commercial krill fishing operations. A close international cooperation is envisaged with the US AMLR programme.

Preliminary results

Dominant zooplankton species are listed in Table 5.1. Presence data are given as percent occurrence of the species within and outside of pack-ice and for the total survey. Several types of preferences can be described for various species. The siphonophore *Diphyes antarctica* as well as the euphausiids *E. superba* and *Thysanoessa macrura* show a wide distribution across the entire area independent of ice coverage or the proximity of shelf waters. On the other hand *Salpa thompsoni* and the hyperiid *Themisto gaudichaudii* prefer the warmer waters north of the ice-edge and are only rarely found in the pack-ice zone. Species that prefer the pack-ice zone of the Weddell Sea are the pteropod *Clio pyramidata* and the polychaetes *Tomopteris carpenteri* and *Vanadis antarctica.* The increased abundance of *E. crystallorophias* and the fish *Pleuragramma antarcticum* in the pack-ice zone is due to the fact that these are high latitude neritic species. Therefore, the differences in percent occurrence between ice-covered and open water areas were less pronounced for *E. crystallorophias* and *P. antarcticum* than for other cold water/sea-ice preferring pteropod and polychaetes.

Tab. 5.1.: Presence (percentage of occurrence) of selected zooplankton species in the ice-free, pack-ice and total survey area

Taxa	Species	Ice-free area	Pack-ice zone	Total area
Pteropoda	*Clio pyramidata*	5	70	30
Pteropoda	*Clione limacina*	40	57	50
Pteropoda	*Limacina helicina*	45	57	52
Siphonophora	*Dimophyes arctica*	35	53	46

Taxa	Species	Ice-free area	Pack-ice zone	Total area
Siphonophora	*Diphyes antarctica*	80	83	82
Polychaeta	*Tomopteris carpenteri*	10	50	34
Polychaeta	*Vanadis antarctica*	5	40	26
Chaetognatha	*Sagitta gazellae*	75	93	86
Chaetognatha	*Eukrohnia hamata*	35	33	34
Euphausiacea	*Euphausia superba*	95	97	96
Euphausiacea	*Thysanoessa macrura*	90	80	84
Euphausiacea	*Euphausia crystallorophias*	20	37	30
Euphausiacea	*Euphausia triacantha*	20	0	8
Euphausiacea	*Euphausia frigida*	10	0	4
Hyperiidae	*Themisto gaudichaudii*	35	3	16
Tunicata	*Salpa thompsoni*	65	13	34
Fish	*Pleuragramma antarcticum*	10	30	22

Antarctic krill was caught at 48 out of 50 RMT stations and these yielded a total number of more than 136,000 specimens (Fig. 5.1). Krill length measurements were taken from representative sub-samples with a minimum of 200 specimens; smaller samples were measured in their entirety. Length measurements and detailed maturity stages were identified from 5,902 krill specimens (see Table 5.2) under a stereo microscope.

Tab. 5.2: Total number of specimens caught with the RMT8 net and number of individuals measured for length frequency data and classification of sex and maturity stages according to Makarov and Denys (1981).

Species	Total catch	Sample measured
Euphausia superba	136799	5902
Euphausia crystallorophias	15574	451
Thysanoessa macrura	8398	1986
Euphausia triacantha	193	135
Euphausia frigida	10	10
Salpa thompsoni	1826	later in lab

The largest catches of Antarctic krill were taken in the southern Bransfield Strait exceeding 20,800 krill per standard tow. 41 % of all krill were caught in just three hauls on the southern shelf of the Bransfield Strait (Fig. 5.3). All three stations were dominated by two-year-old adolescent krill. The same size classes were found in the pack-ice zone of the north-western Weddell Sea (Fig. 5.4a). This age class is usually characterized by a mean size of approx 36 mm at the end of the austral summer. However, the observed mean length-at-age during our survey for two-year-olds was on average 3 mm smaller than expected. Mature krill larger than 45 mm were scarce in these two regions. Spawning krill were almost exclusively distributed north of Elephant Island and in the Drake Passage north of the South Shetland Islands, although absolute abundance was comparatively low in these outer regions.

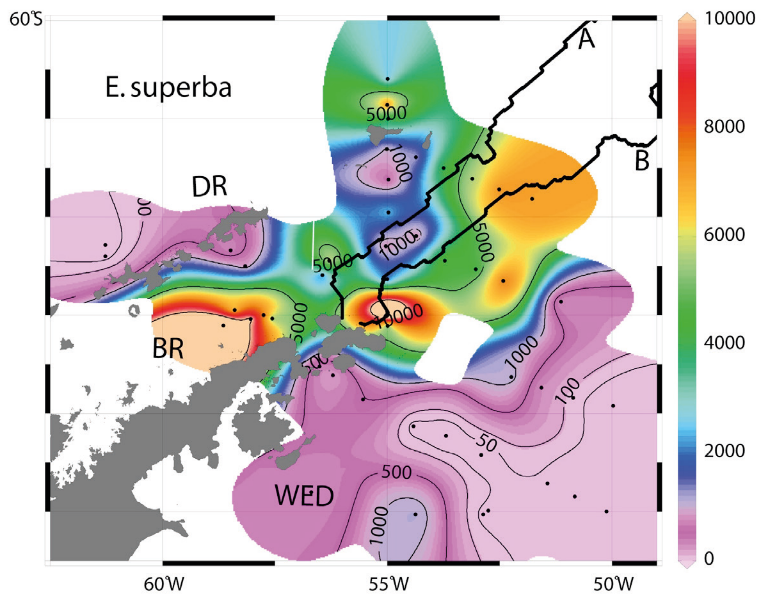
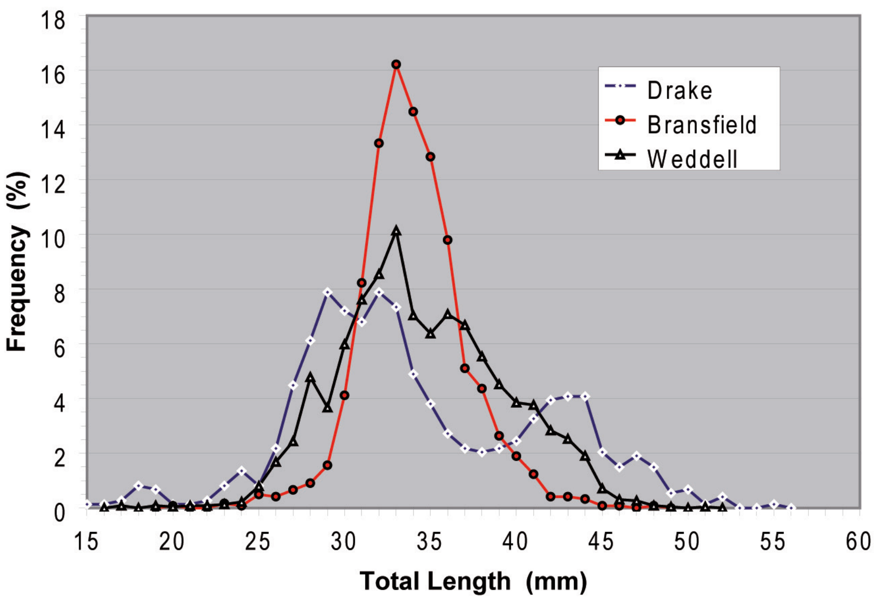


Fig. 5.3: Distribution map of Antarctic krill Euphausia superba *from RMT8 samples, abundance values are given as total numbers of specimens per standard RMT8 catch*

The data collected show one interesting aspect according to the current spawning season of krill in the north-eastern Weddell Sea region. We found few gravid females or females bearing spermatophores. Adult males also had a low occurrence of well-developed spermatophores or had empty ducti pointing to a post-spawning condition. These observations were confirmed by the finding of very low numbers of calyptopis larvae of Antarctic krill over the entire area. The maximum number of calyptopis counted was 20 in the standard RMT1 tow.

The overall mean density of Antarctic krill for the entire survey area was 109 krill 1000 m^{-3}. The longterm mean density from net sampling surveys around Elephant Island since 1978 is approximately 230 krill 1,000 m^{-3}. These results indicate that in summer 2012/13 Antarctic krill abundance mainly in the north-western Weddell Sea was approximately half of the long term average abundance west of the Antarctic Peninsula.

The other common euphausiid species was *Thysanoessa macrura*, however, this year the species was less abundant than Antarctic krill (Table 5.2). *T. macrura* was concentrated more in offshore areas to the north and outside the pack-ice zone, although it was present at most stations in the survey (Fig. 5.5). The size composition of *T. macrura* (Fig. 5.4b) shows a clear dominance of animals at an average length of 17 mm, which represents the one-year-old age class. There was no clear indication for the presence of older age groups in the survey area, although the species becomes at least three years old. As for *Euphausia superba*, the number of *T. macrura* larvae was very low in the standard RMT1 catches. A maximum of 135 calyptopis larvae were observed. Hardly any furcilia larvae were encountered in either the ice covered or in the open water region.



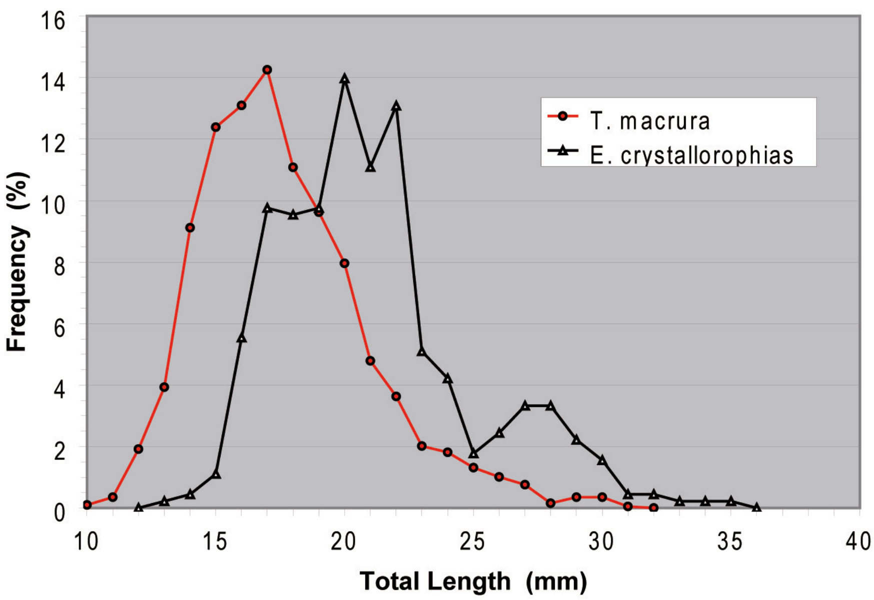


Fig. 5.4: Length frequency distributions of krill from RMT8 data a) Euphausia superba *for the subareas; Drake Passage, Bransfield Strait and Weddell Sea, b)* Thysanoessa macrura *and* E. crystallorophias *for the entire survey area*

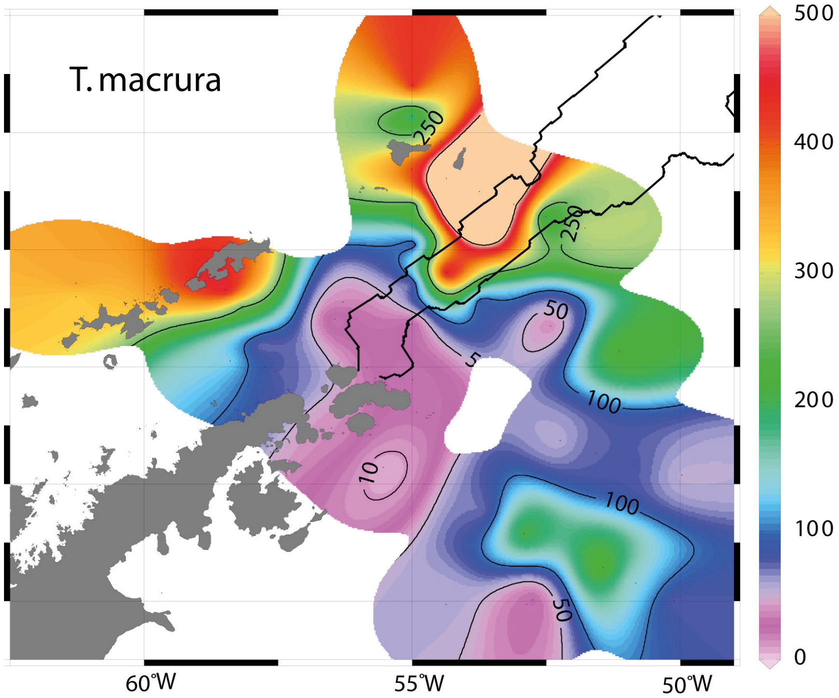


Fig. 5.5: Distribution map of krill Thysanoessa macrura *from RMT8 samples, abundance values are given as total numbers of specimens per standard RMT8 catch*

The ice-krill *Euphausia crystallorophias* is known as a high latitude neritic species and was therefore only found in relatively low numbers in the southern Bransfield Strait and in greater densities on the shelf of the western Weddell Sea (Fig. 5.6). A clearly defined tongue of high densities stretches along the eastern Antarctic Peninsula to the north with maximum densities exceeding 7,500 specimens in a standard tow indicating that this species might also form swarms like *E. superba*. The distribution pattern of *E. crystallorophias* also demonstrates that the species is associated with shelf waters of the Weddell Sea and less to the actual ice extent. The overall length frequency distribution (Fig. 5.4b) shows a broad peak at roughly 20 mm, which corresponds to age-group-1 animals and a second smaller peak at 26mm representing age-group-2. *E. crystallorophias* of age 3+ (length classes >30 mm) were scarce in our samples. Maximum number of larvae did not exceed 60 calyptopis per standard RMT1 tow. All larvae were observed at stations located on the shelf of the north-western Weddell Sea.

The epipelagic species *Euphausia triacantha* is known to have its distribution centre just south of the polar front. It does perform diel vertical migrations and consequently may appear in the upper 200 m of the water column during the night. It was therefore not surprising that this species occurred only in some of our samples in the oceanic region north of Elephant Island and at the Drake Passage stations. Samples were collected for later analysis.

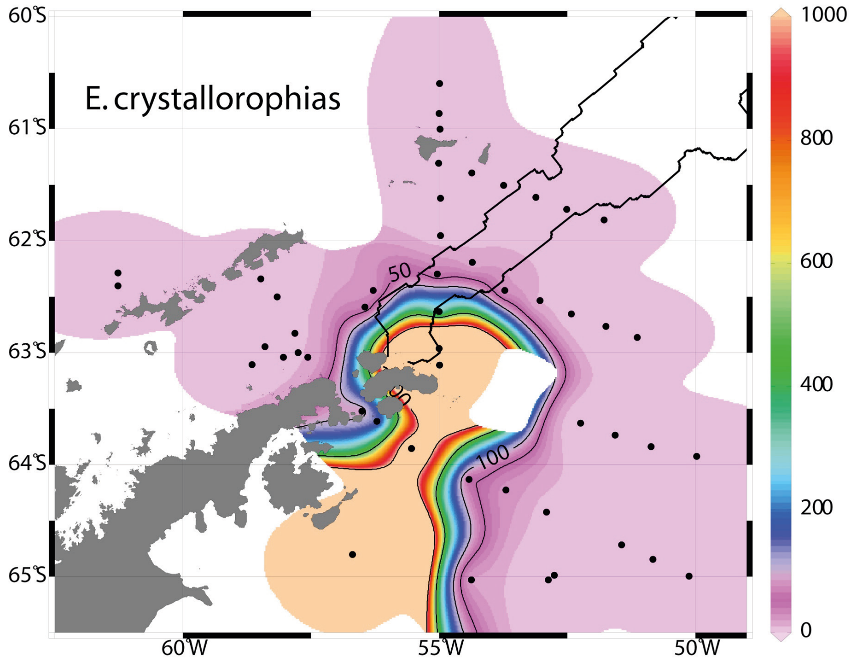


Fig. 5.6: Distribution map of ice krill Euphausia superba *from RMT8 samples, abundance values are given as total numbers of specimens per standard RMT8 catch*

The second epipelagic euphausiid species is *Euphausia frigida*, however, catches were relatively sparse and only the two stations in the Drake Passage north of Livingston Island yielded a few specimens.

Salps (*Salpa thompsoni*) were studied as an important component of the Antarctic zooplankton. Just 1826 salps were caught in total (Table 5.2) with a maximum of 550 specimens at the very northernmost station off Elephant Island. Representative subsamples from the RMT8 were preserved in 4 % seawater solution for later detailed analysis of size and developmental stages. Fig. 5.7 displays the distribution patterns of salps according to RMT8 data. The highest salp densities were observed in offshore areas while lower numbers of salps were found in the Bransfield Strait. The ice covered zone was almost devoid of salps. Aggregate forms clearly dominated the population, while solitary forms were relatively sparse. Compared with densities observed during earlier years, salp abundance was below the longterm average.

Preliminary conclusions can be drawn from the data analyzed so far. In the 2012/13 season Antarctic krill was less abundant in the north-eastern Weddell Sea than the longterm annual mean measured for the Elephant Island area since 1978. On the other hand, krill density was relatively high across the southern shelf (peninsula side) and the stock was dominated by 2 to 3-year-old krill. Age-1 recruits were underrepresented as were larger krill (45+mm) representing the actual spawning stock. Salp concentrations (salps are likely food competitors for krill) also ranged below the longterm average density. Abundance of krill larvae in the RMT1 samples and the early progress of the spawning season indicate a poor spawning and, potentially, poor recruitment for next year.

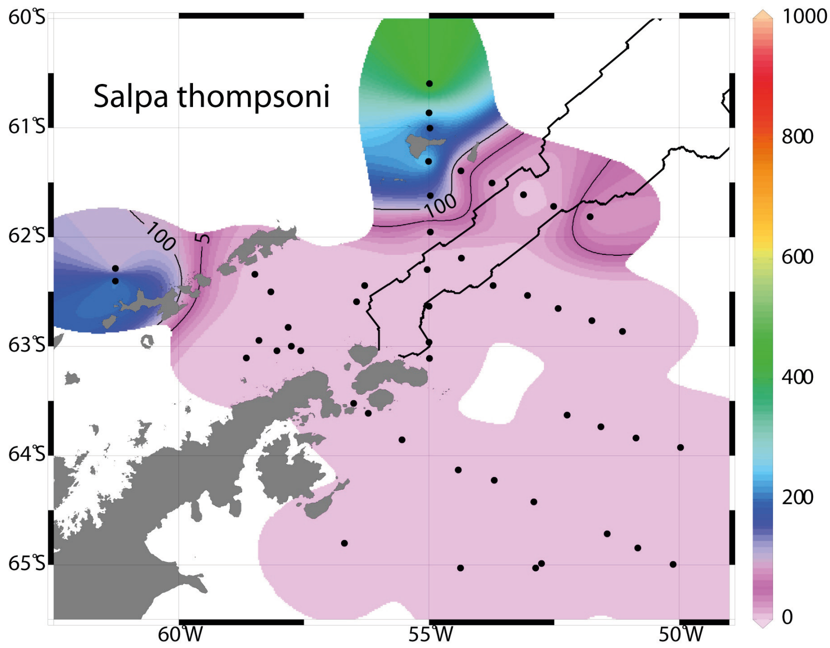


Fig. 5.7: Distribution map of salp Salpa thompsoni *from RMT8 samples, abundance values are given as total numbers of specimens per standard RMT8 catch*

Data management

Representative subsamples from the RMT catches were preserved in 4 % formalin seawater solution and will be stored at the Thünen Institut für Seefischerei in Hamburg (TI/SF). The survey data set will be stored in the TI-SF data base and a copy will be held at the US-AMLR data base (Southwest Fisheries Science Center in La Jolla, CA, USA). Another copy of the data set will be submitted to the CCAMLR secretariat data base in Hobart and be available on request following the data access rules of CCAMLR. A summary list of all RMT stations is given as Table 5.3. Acoustic raw data from the SIMRAD EK 60 echosounder will be stored in the data base of the Thünen Institute für Seefischerei in Hamburg and the PANGAEA Data Publisher for Earth & Environmental Science at the AWI in Bremerhaven. Access to all samples and data will be possible on request after processing and corrections have been finalized, but not later than January 2014; requests should include a brief description of the objectives of the work planned.

Tab. 5.3: Summary list of all RMT stations

Station No.	Date (mm-dd) 2013	Start time (UTC)	Latitude	Longitude	Bottom depth (m)	RMT depth min	RMT depth max	Filtered volume RMT8 (m^3)
116	01-26	0949	-62.59	-56.44	194	0	190	26898
118	01-27	0655	-62.44	-56.28	434	0	200	19840
122	01-29	0653	-62.96	-54.99	393	0	200	22342
123	01-29	1106	-62.63	-54.99	182	0	165	22954
124	01-29	1631	-62.29	-55.02	463	0	200	24286
125	01-30	1555	-62.19	-54.35	845	0	200	35880
126	01-30	2107	-61.95	-54.97	1277	0	200	27445
127	01-31	0146	-61.61	-54.96	2238	0	200	19723
128	01-31	0615	-61.3	-55	409	0	201	25330
129	01-31	1242	-61	-54.97	491	0	200	20639
131	01-31	1610	-60.86	-54.99	1463	0	200	29364
133	01-31	2251	-60.59	-54.98	3336	0	200	30785
134	02-01	0919	-61.39	-54.35	910	0	201	26492
135	02-01	1215	-61.5	-53.74	587	0	200	20177
136	02-01	1553	-61.61	-53.1	399	0	200	27458
137	02-01	1914	-61.71	-52.5	544	0	200	28802
138	02-01	2345	-61.813	-51.77	2764	0	200	24879
143	02-03	0951	-62.53	-53.03	2556	0	213	30307
144	02-03	1658	-62.44	-53.71	957	0	157	24689
146	02-04	0809	-62.65	-52.41	2971	0	182	30193
147	02-04	1806	-62.76	-51.74	3278	0	200	28319
148	02-05	0037	-62.86	-51.13	3404	0	200	21278
151	02-06	0103	-63.92	-49.96	3021	0	191	16632
152	02-06	1345	-63.84	-50.86	2476	0	212	18234
153	02-06	1902	-63.73	-51.56	1986	0	177	22410
154	02-07	0113	-63.62	-52.23	936	0	202	18971
158	02-07	2154	-63.11	-54.99	529	0	200	25808
164	02-11	2129	-63.61	-56.2	162	0	143	22289
167	02-12	1710	-64.12	-54.41	397	0	200	20658
168	02-12	2337	-64.22	-53.69	1698	0	179	24504
169	02-13	0819	-64.42	-52.9	2462	0	201	24900
171	02-14	0044	-64.71	-51.43	3073	0	201	16206
172	02-14	0703	-64.84	-50.82	3267	0	200	21006
173	02-14	1613	-64.99	-50.11	3570	0	201	20600
175	02-15	1101	-64.98	-52.74	2641	0	164	17542
176	02-15	1714	-65.02	-52.86	2566	0	200	20050
179	02-16	0623	-65.02	-54.36	865	0	181	11895
182	02-17	1454	-64.79	-56.68	428	0	201	29636
190	02-20	2325	-63.85	-55.54	355	0	189	28855

Station No.	Date (mm-dd) 2013	Start time (UTC)	Latitude	Longitude	Bottom depth (m)	RMT depth min	RMT depth max	Filtered volume RMT8 (m^3)
191	02-22	1028	-63.52	-56.5	668	0	200	23034
205	02-28	1423	-63.03	-58.03	201	0	201	25652
206	02-28	1628	-62.99	-57.74	236	0	200	22825
207	02-28	1833	-63.03	-57.56	111	0	95	22767
208	02-28	2129	-62.82	-57.8	323	0	205	17321
212	03-01	1137	-62.34	-58.47	804	0	200	26806
214	03-01	1600	-62.49	-58.16	1851	0	201	27358
220	03-03	1103	-62.94	-58.39	783	0	200	26056
221	03-03	1255	-63.1	-58.64	275	0	200	27310
234	03-07	1022	-62.28	-61.26	260	0	200	27260
238	03-08	1358	-62.39	-61.26	402	0	387	46717

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APPENDIX

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Name/ Last name	**Vorname/ First name**	**Institut/ Institute**	**Beruf/Profession**
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Teixidò Ullod	Núria	ICM-CSIC	Biologist
Thomas	Sara	UHAWAII	Student, biology
Vaupel	Lars	HELISERVICE	Helicopter Pilot
Veit-Köhler	Gritta	FS-DZMB	Biologist
Verheye	Marie	RBINS	Student, biology
Vogt	Martin	UHB-IUP/AWI	Oceanographer
Werth	Hildegard	ZDF	Science-journalist
Wisotzki	Andreas	AWI	Oceanographer

A.3 SHIP'S CREW

Name	Rank
Pahl Uwe	Master
Spielke, Steffen	1st Offc
Ziemann, Olaf	Ch.Eng.
Hering, Igor	2nd Offc.
Lauber, Felix	2nd Offc.
Rackele, Carola	3rd Offc
Spilok, Norbert	Doctor
Koch, Georg	R. Offc.
Kotnik, Herbert	2nd Eng.
Schnorch, Helmut	2nd Eng.
Westphal, Henning	2nd Eng.
Brehme, Andreas	Elec.Eng.
Dimmler, Werner	ELO
Feiertag, Thomas	ELO
Fröb, Martin	ELO
Winter, Andreas	ELO
Schröter, Rene	Boatsw.
Neisner, Winfried	Carpenter
Glasen, Nils	AB.
Gladow, Lothar	AB.
Guse, Hartmut	AB.
Hartwig-Lab., Andreas	AB.
Kreis, Reinhard	AB.
Kretzschmar, Uwe	AB.
Moser, Siegfried	AB.
Schröder, Norbert	AB.
Seibel Sebastian	AB.
Beth, Detlef	Storek.
Dinse, Horst	Mot-man
Fritz, Günter	Mot-man
Krösche, Eckard	Mot-man
Plehn, Markus	Mot-man
Watzel, Bernhard	Mot-man
Fischer, Matthias	Cook
Tupy, Mario	Cooksmate
Völske, Thomas	Cooksmate
Dinse, Petra	1.Stwdess

Name	Rank
Hennig, Christina	Stwd.Nurse
Chen, Quan Lun	2. Steward
Hischke, Peggy	2.Stwdess
Hu, Guo Yong	2. Steward
Streit, Christin	2. Stwdess
Wartenberg, Irina	2. Stwdess
Ruan, Hui Guang	Laundrym.

A.4 STATION LIST PS 81

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 115-1	B_JN	26.01.13	04:30:00	HS_PS	profile start	62° 26.40' S	56° 17.31' W	432.0
PS81/ 115-1	B_JN	26.01.13	08:40:59	HS_PS	profile end	62° 35.06' S	56° 27.41' W	222.5
PS81/ 116-1	B_JN_B	26.01.13	09:02:00	CTD/RO	on ground/ max depth	62° 35.50' S	56° 27.34' W	201.5
PS81/ 116-2	B_JN_B	26.01.13	09:55:00	RMT	profile start	62° 35.39' S	56° 26.04' W	192.6
PS81/ 116-2	B_JN_B	26.01.13	10:25:00	RMT	profile end	62° 34.17' S	56° 23.74' W	189.3
PS81/ 116-3	B_JN_B	26.01.13	11:57:00	OFOS	profile start	62° 33.85' S	56° 24.12' W	204.1
PS81/ 116-3	B_JN_B	26.01.13	15:39:00	OFOS	profile end	62° 33.76' S	56° 28.31' W	246.9
PS81/ 116-4	B_JN_B	26.01.13	16:42:00	AGT	profile start	62° 33.79' S	56° 27.16' W	233.3
PS81/ 116-4	B_JN_B	26.01.13	16:52:00	AGT	profile end	62° 33.79' S	56° 26.65' W	226.4
PS81/ 116-5	B_JN_B	26.01.13	18:25:00	MUC	on ground/ max depth	62° 33.71' S	56° 24.00' W	202.2
PS81/ 116-6	B_JN_B	26.01.13	19:16:01	RD	profile start	62° 33.80' S	56° 23.86' W	196.2
PS81/ 116-6	B_JN_B	26.01.13	19:36:00	RD	profile end	62° 34.02' S	56° 23.73' W	188.8
PS81/ 116-7	B_JN_B	26.01.13	20:23:00	MUC	on ground/ max depth	62° 33.85' S	56° 23.68' W	192.2
PS81/ 116-8	B_JN_B	26.01.13	20:42:00	MUC	on ground/ max depth	62° 33.89' S	56° 23.62' W	190.6
PS81/ 116-9	B_JN_B	26.01.13	21:54:00	AGT	profile start	62° 33.79' S	56° 27.81' W	248.4
PS81/ 116-9	B_JN_B	26.01.13	22:04:00	AGT	profile end	62° 33.71' S	56° 28.31' W	248.4
PS81/ 117-1	B_JN	26.01.13	22:15:00	HS_PS	profile start	62° 33.59' S	56° 28.42' W	248.2
PS81/ 117-1	B_JN	27.01.13	05:00:59	HS_PS	profile end	62° 30.71' S	56° 18.36' W	295.6
PS81/ 118-1	B_JN_U	27.01.13	05:59:00	CTD/RO	on ground/ max depth	62° 26.47' S	56° 17.26' W	439.5
PS81/ 118-2	B_JN_U	27.01.13	07:10:00	RMT	profile start	62° 27.02' S	56° 16.28' W	425.4
PS81/ 118-2	B_JN_U	27.01.13	07:25:00	RMT	profile end	62° 27.54' S	56° 15.13' W	389.6
PS81/ 118-3	B_JN_U	27.01.13	08:30:00	OFOS	profile start	62° 27.02' S	56° 17.02' W	419.8
PS81/ 118-3	B_JN_U	27.01.13	12:28:00	OFOS	profile end	62° 25.00' S	56° 17.36' W	449.5

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 118-4	B_JN_U	27.01.13	13:41:00	AGT	profile start	62° 25.95' S	56° 17.26' W	434.4
PS81/ 118-4	B_JN_U	27.01.13	13:52:00	AGT	profile end	62° 25.77' S	56° 17.27' W	437.0
PS81/ 118-5	B_JN_U	27.01.13	15:56:00	MUC	on ground/ max depth	62° 26.93' S	56° 17.05' W	425.2
PS81/ 118-6	B_JN_U	27.01.13	16:49:00	MUC	on ground/ max depth	62° 26.96' S	56° 17.05' W	423.0
PS81/ 118-7	B_JN_U	27.01.13	17:59:00	GKG	on ground/ max depth	62° 27.00' S	56° 16.96' W	422.4
PS81/ 118-8	B_JN_U	27.01.13	19:06:01	RD	profile start	62° 27.07' S	56° 16.83' W	419.0
PS81/ 118-8	B_JN_U	27.01.13	19:36:00	RD	profile end	62° 27.09' S	56° 17.31' W	414.7
PS81/ 118-9	B_JN_U	27.01.13	20:32:00	MUC	on ground/ max depth	62° 26.95' S	56° 17.14' W	423.3
PS81/ 118-10	B_JN_U	27.01.13	21:22:00	MUC	on ground/ max depth	62° 26.90' S	56° 17.19' W	427.0
PS81/ 118-11	B_JN_U	27.01.13	22:00:00	MUC	on ground/ max depth	62° 26.89' S	56° 17.22' W	427.0
PS81/ 119-1	W_JE_B	28.01.13	12:21:00	CTD/RO	on ground/ max depth	63° 10.08' S	54° 7.17' W	224.3
PS81/ 119-2	W_JE_B	28.01.13	13:03:00	GKG	on ground/ max depth	63° 10.06' S	54° 7.21' W	230.2
PS81/ 119-3	W_JE_B	28.01.13	13:55:00	GKG	on ground/ max depth	63° 10.07' S	54° 7.20' W	227.6
PS81/ 120-1	W_JE_D	28.01.13	18:22:00	CTD/RO	on ground/ max depth	63° 4.62' S	54° 33.11' W	530.4
PS81/ 120-2	W_JE_D	28.01.13	19:13:00	GKG	on ground/ max depth	63° 4.78' S	54° 32.39' W	499.1
PS81/ 120-3	W_JE_D	28.01.13	19:54:00	GKG	on ground/ max depth	63° 4.89' S	54° 31.93' W	504.8
PS81/ 120-4	W_JE_D	28.01.13	20:49:00	MUC	on ground/ max depth	63° 4.78' S	54° 31.45' W	493.8
PS81/ 120-5	W_JE_D	28.01.13	21:57:00	MUC	on ground/ max depth	63° 4.58' S	54° 31.00' W	503.6
PS81/ 120-6	W_JE_D	28.01.13	22:52:00	MUC	on ground/ max depth	63° 4.10' S	54° 30.86' W	484.8
PS81/ 120-7	W_JE_D	28.01.13	23:34:00	MUC	on ground/ max depth	63° 3.72' S	54° 30.87' W	436.8
PS81/ 121-1		29.01.13	03:48:00	CTD/RO	on ground/ max depth	63° 7.64' S	54° 59.78' W	460.3
PS81/ 122-1		29.01.13	07:09:01	RMT	profile start	62° 57.39' S	54° 58.51' W	304.7
PS81/ 122-1		29.01.13	07:33:00	RMT	profile end	62° 56.78' S	54° 56.30' W	245.6
PS81/ 122-2		29.01.13	08:03:00	CTD/RO	on ground/ max depth	62° 56.87' S	54° 55.20' W	237.1

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 123-1		29.01.13	11:07:00	RMT	profile start	62° 37.93' S	54° 60.00' W	165.9
PS81/ 123-1		29.01.13	11:46:00	RMT	profile end	62° 35.93' S	55° 1.21' W	208.3
PS81/ 123-2		29.01.13	12:06:00	CTD/RO	on ground/ max depth	62° 35.73' S	55° 1.66' W	210.6
PS81/ 124-1		29.01.13	16:47:01	RMT	profile start	62° 17.03' S	55° 1.53' W	463.5
PS81/ 124-1		29.01.13	17:12:00	RMT	profile end	62° 15.84' S	55° 1.41' W	497.1
PS81/ 124-2		29.01.13	17:44:00	CTD/RO	on ground/ max depth	62° 15.65' S	55° 1.51' W	499.0
PS81/ 125-1		30.01.13	16:18:01	RMT	profile start	62° 10.88' S	54° 23.66' W	842.1
PS81/ 125-1		30.01.13	16:52:00	RMT	profile end	62° 10.08' S	54° 25.99' W	835.3
PS81/ 125-2		30.01.13	17:27:00	CTD/RO	on ground/ max depth	62° 10.18' S	54° 25.60' W	834.4
PS81/ 126-1		30.01.13	21:10:00	RMT	profile start	61° 57.11' S	54° 58.43' W	1293.1
PS81/ 126-1		30.01.13	21:52:00	RMT	profile end	61° 56.33' S	55° 1.22' W	1211.9
PS81/ 126-2		30.01.13	22:37:00	CTD/RO	on ground/ max depth	61° 56.41' S	55° 0.36' W	1229.0
PS81/ 127-1		31.01.13	02:00:00	RMT	profile start	61° 36.91' S	54° 58.79' W	2252.9
PS81/ 127-1		31.01.13	02:24:00	RMT	profile end	61° 36.55' S	55° 0.61' W	2257.9
PS81/ 127-2		31.01.13	03:26:00	CTD/RO	on ground/ max depth	61° 36.02' S	55° 0.93' W	2132.2
PS81/ 128-1		31.01.13	06:30:01	RMT	profile start	61° 17.90' S	54° 59.97' W	294.4
PS81/ 128-1		31.01.13	06:55:00	RMT	profile end	61° 16.83' S	54° 59.98' W	272.5
PS81/ 128-2		31.01.13	07:26:00	CTD/RO	on ground/ max depth	61° 16.54' S	54° 59.99' W	265.3
PS81/ 129-1		31.01.13	12:54:00	RMT	profile start	60° 59.99' S	54° 59.71' W	497.2
PS81/ 129-1		31.01.13	13:20:00	RMT	profile end	60° 59.83' S	55° 2.06' W	315.3
PS81/ 129-2		31.01.13	13:58:00	CTD/RO	on ground/ max depth	60° 59.95' S	55° 0.37' W	437.1
PS81/ 130-1		31.01.13	15:27:00	CTD/RO	on ground/ max depth	60° 53.35' S	54° 59.47' W	848.3
PS81/ 131-1		31.01.13	16:27:01	RMT	profile start	60° 50.92' S	55° 0.07' W	1395.8
PS81/ 131-1		31.01.13	16:55:00	RMT	profile end	60° 49.54' S	55° 0.64' W	2031.6

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 131-2		31.01.13	17:58:00	CTD/RO	on ground/ max depth	60° 49.22‘ S	55° 0.40‘ W	2129.3
PS81/ 132-1		31.01.13	20:33:00	CTD/RO	on ground/ max depth	60° 44.85‘ S	55° 0.16‘ W	3330.1
PS81/ 133-1		31.01.13	22:55:00	RMT	profile start	60° 35.62‘ S	54° 59.23‘ W	3323.3
PS81/ 133-1		31.01.13	23:40:00	RMT	profile end	60° 34.83‘ S	55° 2.21‘ W	3357.0
PS81/ 133-2		01.02.13	01:02:00	CTD/RO	on ground/ max depth	60° 34.85‘ S	55° 0.48‘ W	3343.4
PS81/ 134-1		01.02.13	08:31:00	CTD/RO	on ground/ max depth	61° 23.53‘ S	54° 21.93‘ W	911.8
PS81/ 134-2		01.02.13	09:20:00	RMT	profile start	61° 23.45‘ S	54° 21.60‘ W	895.6
PS81/ 134-2		01.02.13	10:05:00	RMT	profile end	61° 23.91‘ S	54° 17.51‘ W	1323.0
PS81/ 135-1		01.02.13	12:30:00	RMT	profile start	61° 30.03‘ S	53° 43.58‘ W	587.7
PS81/ 135-1		01.02.13	12:53:00	RMT	profile end	61° 30.24‘ S	53° 42.07‘ W	582.7
PS81/ 135-2		01.02.13	13:21:00	CTD/RO	on ground/ max depth	61° 30.35‘ S	53° 42.51‘ W	578.4
PS81/ 136-1		01.02.13	16:11:01	RMT	profile start	61° 37.15‘ S	53° 5.70‘ W	398.4
PS81/ 136-1		01.02.13	16:36:00	RMT	profile end	61° 38.02‘ S	53° 4.42‘ W	405.2
PS81/ 136-2		01.02.13	17:04:00	CTD/RO	on ground/ max depth	61° 38.45‘ S	53° 4.37‘ W	408.3
PS81/ 137-1		01.02.13	19:32:01	RMT	profile start	61° 43.31‘ S	52° 28.53‘ W	543.1
PS81/ 137-1		01.02.13	19:58:00	RMT	profile end	61° 43.63‘ S	52° 25.90‘ W	610.5
PS81/ 137-2		01.02.13	20:32:00	CTD/RO	on ground/ max depth	61° 43.57‘ S	52° 24.65‘ W	704.5
PS81/ 138-1		02.02.13	00:00:00	RMT	profile start	61° 49.37‘ S	51° 46.03‘ W	2761.5
PS81/ 138-1		02.02.13	00:29:01	RMT	profile end	61° 50.47‘ S	51° 45.31‘ W	2796.3
PS81/ 138-2		02.02.13	01:40:00	CTD/RO	on ground/ max depth	61° 50.58‘ S	51° 44.56‘ W	2821.1
PS81/ 139-1		02.02.13	07:55:00	CTD/RO	on ground/ max depth	61° 55.79‘ S	51° 5.42‘ W	3291.5
PS81/ 140-1		02.02.13	14:39:00	CTD/RO	on ground/ max depth	62° 0.95‘ S	50° 24.46‘ W	3377.7
PS81/ 141-1		02.02.13	22:25:00	CTD/RO	on ground/ max depth	62° 22.63‘ S	51° 42.25‘ W	3190.9
PS81/ 142-1		03.02.13	05:00:00	CTD/RO	on ground/ max depth	62° 32.84‘ S	52° 25.19‘ W	2971.5

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 143-1		03.02.13	09:55:00	RMT	profile start	62° 31.84' S	53° 1.47' W	2559.6
PS81/ 143-1		03.02.13	10:37:00	RMT	profile end	62° 31.88' S	52° 57.23' W	2646.3
PS81/ 143-2		03.02.13	12:27:00	CTD/RO	on ground/ max depth	62° 31.75' S	53° 2.94' W	2513.8
PS81/ 144-1		03.02.13	17:14:01	RMT	profile start	62° 25.89' S	53° 42.49' W	958.4
PS81/ 144-1		03.02.13	17:38:00	RMT	profile end	62° 25.00' S	53° 41.50' W	975.0
PS81/ 144-2		03.02.13	18:14:00	CTD/RO	on ground/ max depth	62° 24.58' S	53° 42.35' W	953.8
PS81/ 145-1		04.02.13	02:57:00	CTD/RO	on ground/ max depth	62° 41.42' S	53° 3.68' W	2192.6
PS81/ 146-1		04.02.13	08:10:00	RMT	profile start	62° 39.13' S	52° 25.33' W	2971.6
PS81/ 146-1		04.02.13	08:35:00	RMT	profile end	62° 39.27' S	52° 27.92' W	2953.3
PS81/ 146-2		04.02.13	13:20:00	CTD/RO	on ground/ max depth	62° 39.05' S	52° 23.89' W	2981.9
PS81/ 147-1		04.02.13	18:24:01	RMT	profile start	62° 46.05' S	51° 43.06' W	3265.2
PS81/ 147-1		04.02.13	18:50:00	RMT	profile end	62° 46.65' S	51° 41.13' W	3276.6
PS81/ 147-2		04.02.13	20:08:00	CTD/RO	on ground/ max depth	62° 46.48' S	51° 40.84' W	3280.7
PS81/ 148-1		05.02.13	00:52:01	RMT	profile start	62° 51.66' S	51° 9.07' W	3403.4
PS81/ 148-1		05.02.13	01:17:01	RMT	profile end	62° 51.30' S	51° 11.03' W	3401.1
PS81/ 148-2		05.02.13	03:39:00	CTD/RO	on ground/ max depth	62° 53.41' S	51° 1.91' W	3404.0
PS81/ 149-1		05.02.13	09:58:00	CTD/RO	on ground/ max depth	62° 59.60' S	50° 21.00' W	3441.0
PS81/ 150-1		05.02.13	14:15:00	CTD/RO	on ground/ max depth	63° 2.82' S	49° 59.57' W	2402.6
PS81/ 151-1		06.02.13	01:18:00	RMT	profile start	63° 55.72' S	49° 58.59' W	3016.2
PS81/ 151-1		06.02.13	01:38:00	RMT	profile end	63° 56.24' S	49° 59.20' W	3019.1
PS81/ 151-2		06.02.13	03:59:00	CTD/RO	on ground/ max depth	63° 59.04' S	49° 57.15' W	3110.0
PS81/ 152-1		06.02.13	12:42:00	CTD/RO	on ground/ max depth	63° 50.84' S	50° 51.68' W	2475.6
PS81/ 152-2		06.02.13	13:58:02	RMT	profile start	63° 50.81' S	50° 51.66' W	2476.5
PS81/ 152-2		06.02.13	14:21:01	RMT	profile end	63° 51.55' S	50° 51.08' W	2467.4

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 153-1		06.02.13	19:17:01	RMT	profile start	63° 43.91' S	51° 35.14' W	1987.9
PS81/ 153-1		06.02.13	19:38:00	RMT	profile end	63° 43.92' S	51° 37.26' W	1922.3
PS81/ 153-2		06.02.13	20:33:00	CTD/RO	on ground/ max depth	63° 43.70' S	51° 38.25' W	1912.3
PS81/ 154-1		07.02.13	01:29:00	RMT	profile start	63° 37.40' S	52° 15.60' W	922.4
PS81/ 154-1		07.02.13	01:52:00	RMT	profile end	63° 37.00' S	52° 17.18' W	898.8
PS81/ 154-2		07.02.13	02:47:00	CTD/RO	on ground/ max depth	63° 37.18' S	52° 18.94' W	871.5
PS81/ 155-1		07.02.13	09:12:00	CTD/RO	on ground/ max depth	63° 30.01' S	52° 57.07' W	492.7
PS81/ 156-1		07.02.13	14:28:00	CTD/RO	on ground/ max depth	63° 22.64' S	53° 39.13' W	372.7
PS81/ 157-1		07.02.13	18:45:00	CTD/RO	on ground/ max depth	63° 15.34' S	54° 19.77' W	204.8
PS81/ 158-1		07.02.13	21:55:00	RMT	profile start	63° 6.66' S	54° 59.48' W	477.8
PS81/ 158-1		07.02.13	22:36:00	RMT	profile end	63° 5.09' S	54° 57.51' W	391.4
PS81/ 158-2		07.02.13	23:25:00	CTD/RO	on ground/ max depth	63° 7.14' S	55° 0.10' W	453.7
PS81/ 159-1	W_JE_D	08.02.13	04:40:00	OFOS	profile start	63° 4.88' S	54° 32.71' W	518.6
PS81/ 159-1	W_JE_D	08.02.13	08:31:00	OFOS	profile end	63° 5.29' S	54° 28.95' W	474.0
PS81/ 159-2	W_JE_D	08.02.13	09:06:00	CTD/RO	on ground/ max depth	63° 5.14' S	54° 27.99' W	472.9
PS81/ 159-3	W_JE_D	08.02.13	10:02:00	AGT	profile start	63° 4.77' S	54° 30.22' W	488.2
PS81/ 159-3	W_JE_D	08.02.13	10:12:00	AGT	profile end	63° 4.76' S	54° 30.61' W	489.4
PS81/ 159-4	W_JE_D	08.02.13	12:29:00	RD	profile start	63° 3.50' S	54° 26.09' W	460.5
PS81/ 159-4	W_JE_D	08.02.13	13:00:00	RD	profile end	63° 3.37' S	54° 25.68' W	451.4
PS81/ 160-1	W_JE_B	08.02.13	16:38:00	OFOS	profile start	63° 10.19' S	54° 7.00' W	214.9
PS81/ 160-1	W_JE_B	08.02.13	20:14:00	OFOS	profile end	63° 10.98' S	54° 5.85' W	247.9
PS81/ 160-2	W_JE_B	08.02.13	20:45:00	CTD/RO	on ground/ max depth	63° 10.78' S	54° 6.42' W	246.8
PS81/ 160-3	W_JE_B	08.02.13	21:41:00	AGT	profile start	63° 10.57' S	54° 6.66' W	237.8
PS81/ 160-3	W_JE_B	08.02.13	21:51:00	AGT	profile end	63° 10.71' S	54° 6.37' W	243.8

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 160-4	W_JE_B	08.02.13	23:17:00	RD	profile start	63° 9.86' S	54° 6.42' W	235.6
PS81/ 160-4	W_JE_B	08.02.13	23:37:01	RD	profile end	63° 9.77' S	54° 6.67' W	237.3
PS81/ 161-1	W_ET_B	09.02.13	22:20:01	OFOS	profile start	64° 0.45' S	56° 43.94' W	216.4
PS81/ 161-1	W_ET_B	10.02.13	02:16:00	OFOS	profile end	64° 0.17' S	56° 40.02' W	250.7
PS81/ 161-2	W_ET_B	10.02.13	02:39:00	HS_PS	profile start	64° 0.06' S	56° 40.10' W	252.7
PS81/ 161-2	W_ET_B	10.02.13	05:00:59	HS_PS	profile end	64° 0.70' S	56° 42.47' W	221.1
PS81/ 162-1	W_ET_B	10.02.13	08:19:00	CTD/RO	on ground/ max depth	64° 0.27' S	56° 44.28' W	219.6
PS81/ 162-2	W_ET_B	10.02.13	08:52:00	GKG	on ground/ max depth	64° 0.11' S	56° 44.43' W	222.9
PS81/ 162-3	W_ET_B	10.02.13	09:31:00	MUC	on ground/ max depth	64° 0.11' S	56° 44.28' W	222.1
PS81/ 162-4	W_ET_B	10.02.13	10:04:00	MUC	on ground/ max depth	64° 0.07' S	56° 44.20' W	223.4
PS81/ 162-5	W_ET_B	10.02.13	10:38:00	MUC	on ground/ max depth	64° 0.14' S	56° 44.33' W	221.9
PS81/ 162-6	W_ET_B	10.02.13	11:17:00	MUC	on ground/ max depth	64° 0.12' S	56° 44.12' W	223.8
PS81/ 162-7	W_ET_B	10.02.13	13:11:00	AGT	profile start	63° 58.78' S	56° 46.24' W	215.6
PS81/ 162-7	W_ET_B	10.02.13	13:21:00	AGT	profile end	63° 59.02' S	56° 46.26' W	213.9
PS81/ 162-8	W_ET_B	10.02.13	14:48:00	RD	profile start	63° 59.04' S	56° 47.28' W	202.5
PS81/ 162-8	W_ET_B	10.02.13	15:18:00	RD	profile end	63° 59.06' S	56° 47.81' W	195.9
PS81/ 163-1	W_ET_D	10.02.13	19:24:00	CTD/RO	on ground/ max depth	63° 53.07' S	56° 26.19' W	468.0
PS81/ 163-2	W_ET_D	10.02.13	20:00:00	OFOS	profile start	63° 53.09' S	56° 26.34' W	467.0
PS81/ 163-2	W_ET_D	10.02.13	23:34:00	OFOS	profile end	63° 51.16' S	56° 25.43' W	513.9
PS81/ 163-3	W_ET_D	11.02.13	00:30:00	MUC	on ground/ max depth	63° 50.97' S	56° 25.24' W	517.0
PS81/ 163-4	W_ET_D	11.02.13	01:29:00	MUC	on ground/ max depth	63° 50.95' S	56° 24.43' W	517.6
PS81/ 163-5	W_ET_D	11.02.13	02:22:00	MUC	on ground/ max depth	63° 51.01' S	56° 23.97' W	516.6
PS81/ 163-6	W_ET_D	11.02.13	03:07:00	MUC	on ground/ max depth	63° 51.03' S	56° 23.68' W	517.1
PS81/ 163-7	W_ET_D	11.02.13	03:53:01	RD	profile start	63° 50.98' S	56° 23.24' W	517.4

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 163-7	W_ET_D	11.02.13	04:18:00	RD	profile start	63° 51.03' S	56° 22.81' W	517.1
PS81/ 163-7	W_ET_D	11.02.13	04:38:00	RD	profile end	63° 51.10' S	56° 22.41' W	516.8
PS81/ 163-8	W_ET_D	11.02.13	06:40:01	AGT	profile start	63° 50.32' S	56° 20.05' W	533.7
PS81/ 163-8	W_ET_D	11.02.13	06:50:00	AGT	profile end	63° 50.19' S	56° 19.76' W	536.6
PS81/ 163-9	W_ET_D	11.02.13	08:42:00	AGT	profile start	63° 47.76' S	56° 18.60' W	550.9
PS81/ 163-9	W_ET_D	11.02.13	08:52:00	AGT	profile end	63° 47.55' S	56° 18.58' W	544.3
PS81/ 164-1	W_DI_B	11.02.13	11:28:00	CTD/RO	on ground/ max depth	63° 37.07' S	56° 13.53' W	196.7
PS81/ 164-2	W_DI_B	11.02.13	11:58:01	OFOS	profile start	63° 37.17' S	56° 13.56' W	197.1
PS81/ 164-2	W_DI_B	11.02.13	15:59:00	OFOS	profile end	63° 36.87' S	56° 8.87' W	100.1
PS81/ 164-3	W_DI_B	11.02.13	17:29:00	GKG	on ground/ max depth	63° 37.17' S	56° 13.41' W	191.7
PS81/ 164-4	W_DI_B	11.02.13	18:30:01	AGT	profile start	63° 37.28' S	56° 9.11' W	101.8
PS81/ 164-4	W_DI_B	11.02.13	18:40:00	AGT	profile end	63° 37.29' S	56° 9.58' W	113.6
PS81/ 164-5	W_DI_B	11.02.13	19:52:01	RD	profile start	63° 36.84' S	56° 10.28' W	122.1
PS81/ 164-5	W_DI_B	11.02.13	20:22:00	RD	profile end	63° 36.72' S	56° 10.46' W	120.8
PS81/ 164-6	W_DI_B	11.02.13	21:30:00	RMT	profile start	63° 36.67' S	56° 12.31' W	166.4
PS81/ 164-6	W_DI_B	11.02.13	22:05:00	RMT	profile end	63° 35.35' S	56° 14.41' W	199.6
PS81/ 165-1		12.02.13	06:38:00	CTD/RO	on ground/ max depth	63° 54.71' S	55° 31.99' W	186.0
PS81/ 166-1		12.02.13	13:07:00	CTD/RO	on ground/ max depth	64° 2.60' S	54° 57.66' W	400.8
PS81/ 167-1		12.02.13	17:24:01	RMT	profile start	64° 8.25' S	54° 25.50' W	398.2
PS81/ 167-1		12.02.13	17:44:00	RMT	profile end	64° 9.24' S	54° 26.24' W	358.5
PS81/ 167-2		12.02.13	18:09:00	CTD/RO	on ground/ max depth	64° 9.48' S	54° 26.86' W	356.5
PS81/ 167-3		12.02.13	19:31:00	CTD/RO	on ground/ max depth	64° 11.92' S	54° 15.55' W	565.4
PS81/ 168-1		12.02.13	23:52:02	RMT	profile start	64° 14.17' S	53° 42.18' W	1697.9
PS81/ 168-1		13.02.13	00:21:00	RMT	profile end	64° 14.99' S	53° 43.45' W	1693.8

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 168-2		13.02.13	02:55:00	CTD/RO	on ground/ max depth	64° 19.70' S	53° 37.38' W	1911.9
PS81/ 169-1		13.02.13	08:20:00	RMT	profile start	64° 25.20' S	52° 53.38' W	2463.0
PS81/ 169-1		13.02.13	09:03:00	RMT	profile end	64° 23.81' S	52° 50.94' W	2476.8
PS81/ 169-2		13.02.13	10:07:00	CTD/RO	on ground/ max depth	64° 23.64' S	52° 50.94' W	2476.2
PS81/ 170-1		13.02.13	16:52:00	CTD/RO	on ground/ max depth	64° 32.28' S	52° 14.55' W	2672.4
PS81/ 171-1		13.02.13	22:02:00	CTD/RO	on ground/ max depth	64° 40.40' S	51° 34.46' W	2994.4
PS81/ 171-2		14.02.13	00:57:01	RMT	profile start	64° 42.51' S	51° 24.20' W	3075.8
PS81/ 171-2		14.02.13	01:17:01	RMT	profile end	64° 41.97' S	51° 22.69' W	3079.4
PS81/ 172-1		14.02.13	05:28:00	CTD/RO	on ground/ max depth	64° 49.70' S	50° 51.96' W	3251.4
PS81/ 172-2		14.02.13	07:18:01	RMT	profile start	64° 50.20' S	50° 48.92' W	3270.1
PS81/ 172-2		14.02.13	07:39:00	RMT	profile end	64° 49.71' S	50° 47.09' W	3275.4
PS81/ 173-1		14.02.13	13:28:00	CTD/RO	on ground/ max depth	64° 59.67' S	50° 0.62' W	3595.9
PS81/ 173-2		14.02.13	16:26:01	RMT	profile start	64° 59.81' S	50° 8.14' W	3570.6
PS81/ 173-2		14.02.13	16:45:00	RMT	profile end	64° 59.85' S	50° 9.89' W	3562.8
PS81/ 174-1		15.02.13	06:58:00	CTD/RO	on ground/ max depth	65° 0.58' S	52° 16.21' W	2866.5
PS81/ 175-1		15.02.13	11:03:00	RMT	profile start	64° 59.22' S	52° 44.76' W	2640.6
PS81/ 175-1		15.02.13	11:35:00	RMT	profile end	64° 59.62' S	52° 42.29' W	2655.0
PS81/ 176-1		15.02.13	14:02:00	CTD/RO	on ground/ max depth	64° 59.90' S	53° 0.16' W	2491.9
PS81/ 176-2		15.02.13	17:30:01	RMT	profile start	65° 1.17' S	52° 51.14' W	2565.7
PS81/ 176-2		15.02.13	17:51:00	RMT	profile end	65° 0.44' S	52° 50.39' W	2578.7
PS81/ 177-1		15.02.13	23:36:00	CTD/RO	on ground/ max depth	65° 0.26' S	53° 42.22' W	1824.5
PS81/ 178-1		16.02.13	03:56:00	CTD/RO	on ground/ max depth	65° 0.30' S	54° 8.12' W	1252.2
PS81/ 178-2		16.02.13	06:34:01	RMT	profile start	65° 1.37' S	54° 22.37' W	853.8
PS81/ 178-2		16.02.13	06:47:00	RMT	profile end	65° 0.90' S	54° 23.05' W	829.8

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 179-1		16.02.13	08:53:00	CTD/RO	on ground/ max depth	64° 59.96' S	54° 41.08' W	436.3
PS81/ 180-1		16.02.13	23:13:00	CTD/RO	on ground/ max depth	64° 54.70' S	55° 23.58' W	436.1
PS81/ 181-1		17.02.13	08:59:00	CTD/RO	on ground/ max depth	64° 52.20' S	56° 17.60' W	476.9
PS81/ 182-1		17.02.13	15:12:02	RMT	profile start	64° 47.21' S	56° 41.90' W	428.0
PS81/ 182-1		17.02.13	15:40:00	RMT	profile end	64° 46.02' S	56° 42.50' W	374.0
PS81/ 182-2		17.02.13	16:09:00	CTD/RO	on ground/ max depth	64° 45.80' S	56° 43.02' W	375.0
PS81/ 183-1		18.02.13	09:25:00	CTD/RO	on ground/ max depth	64° 25.06' S	55° 50.92' W	281.3
PS81/ 184-1	W_VO	18.02.13	16:39:00	HS_PS	profile start	63° 52.86' S	55° 40.37' W	134.0
PS81/ 184-1	W_VO	19.02.13	05:24:59	HS_PS	profile end	63° 52.45' S	55° 39.48' W	094.0
PS81/ 185-1	W_VO_U	19.02.13	06:29:00	OFOS	profile start	63° 53.22' S	55° 37.58' W	033.7
PS81/ 185-1	W_VO_U	19.02.13	10:26:00	OFOS	profile end	63° 51.21' S	55° 36.33' W	386.0
PS81/ 185-2	W_VO_U	19.02.13	11:04:00	GKG	on ground/ max depth	63° 52.20' S	55° 36.67' W	232.0
PS81/ 185-3	W_VO_U	19.02.13	12:10:00	AGT	profile start	63° 51.34' S	55° 41.11' W	296.0
PS81/ 185-3	W_VO_U	19.02.13	12:33:01	AGT	profile end	63° 51.52' S	55° 41.43' W	261.0
PS81/ 185-4	W_VO_U	19.02.13	13:43:01	RD	profile start	63° 51.53' S	55° 40.74' W	255.0
PS81/ 185-4	W_VO_U	19.02.13	14:41:00	RD	profile end	63° 51.53' S	55° 40.43' W	253.0
PS81/ 185-5	W_VO_U	19.02.13	15:19:00	CTD/RO	on ground/ max depth	63° 51.31' S	55° 40.32' W	307.0
PS81/ 186-1	W_VO_U	19.02.13	16:32:00	OFOS	profile start	63° 54.14' S	55° 34.54' W	019.8
PS81/ 186-1	W_VO_U	19.02.13	20:36:00	OFOS	profile end	63° 51.93' S	55° 33.78' W	361.8
PS81/ 187-1	W_VO	19.02.13	20:56:00	HS_PS	profile start	63° 51.85' S	55° 33.52' W	374.3
PS81/ 187-1	W_VO	20.02.13	05:30:59	HS_PS	profile end	63° 52.17' S	55° 28.83' W	384.6
PS81/ 188-1	W_VO_D	20.02.13	06:30:01	OFOS	profile start	63° 52.25' S	55° 34.01' W	315.5
PS81/ 188-1	W_VO_D	20.02.13	10:30:01	OFOS	profile end	63° 50.42' S	55° 33.67' W	400.0
PS81/ 188-2	W_VO_D	20.02.13	11:49:00	GKG	on ground/ max depth	63° 51.86' S	55° 34.39' W	339.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 188-3	W_VO_D	20.02.13	12:35:00	GKG	on ground/ max depth	63° 52.01' S	55° 35.15' W	310.0
PS81/ 188-4	W_VO_D	20.02.13	13:52:01	AGT	profile start	63° 50.36' S	55° 37.42' W	425.0
PS81/ 188-4	W_VO_D	20.02.13	14:21:00	AGT	profile end	63° 50.53' S	55° 37.52' W	427.0
PS81/ 188-5	W_VO_D	20.02.13	15:44:01	RD	profile start	63° 50.92' S	55° 37.66' W	402.0
PS81/ 188-5	W_VO_D	20.02.13	15:59:00	RD	profile end	63° 50.93' S	55° 37.52' W	407.0
PS81/ 189-1	W_VO_B	20.02.13	17:26:01	OFOS	profile start	63° 53.57' S	55° 35.51' W	017.6
PS81/ 189-1	W_VO_B	20.02.13	18:26:00	OFOS	profile end	63° 53.17' S	55° 34.72' W	174.0
PS81/ 189-2	W_VO_B	20.02.13	19:04:00	CTD/RO	on ground/ max depth	63° 53.55' S	55° 35.56' W	016.4
PS81/ 190-1	W_VO_D	20.02.13	20:02:00	CTD/RO	on ground/ max depth	63° 50.50' S	55° 33.65' W	400.0
PS81/ 190-2	W_VO_D	20.02.13	20:45:00	GKG	on ground/ max depth	63° 50.64' S	55° 33.67' W	398.0
PS81/ 190-3	W_VO_D	20.02.13	21:44:00	MUC	on ground/ max depth	63° 50.63' S	55° 33.53' W	398.0
PS81/ 190-4	W_VO	20.02.13	23:25:00	RMT	profile start	63° 51.29' S	55° 32.40' W	382.0
PS81/ 190-4	W_VO	21.02.13	00:14:01	RMT	profile end	63° 53.02' S	55° 33.88' W	237.0
PS81/ 190-5	W_VO_D	21.02.13	01:10:00	MUC	on ground/ max depth	63° 50.66' S	55° 31.48' W	387.0
PS81/ 190-6	W_VO_D	21.02.13	01:46:00	MUC	on ground/ max depth	63° 50.58' S	55° 31.66' W	389.0
PS81/ 190-7	W_VO_D	21.02.13	02:45:00	MUC	on ground/ max depth	63° 50.75' S	55° 32.14' W	390.0
PS81/ 190-8	W_VO_D	21.02.13	03:44:00	MUC	on ground/ max depth	63° 50.71' S	55° 32.58' W	392.0
PS81/ 190-9	W_VO_D	21.02.13	04:16:00	MUC	on ground/ max depth	63° 50.74' S	55° 32.57' W	393.0
PS81/ 191-1		22.02.13	10:28:00	RMT	profile start	63° 31.29' S	56° 30.37' W	758.0
PS81/ 191-1		22.02.13	11:10:00	RMT	profile end	63° 30.87' S	56° 33.82' W	562.0
PS81/ 191-2		22.02.13	11:52:00	CTD/RO	on ground/ max depth	63° 31.11' S	56° 31.57' W	701.0
PS81/ 192-1	B_E_C	22.02.13	19:00:00	OFOS	profile start	62° 44.03' S	57° 30.97' W	450.0
PS81/ 192-1	B_E_C	22.02.13	23:00:00	OFOS	profile end	62° 43.37' S	57° 26.93' W	418.5
PS81/ 192-2	B_E	22.02.13	23:21:00	HS_PS	profile start	62° 42.99' S	57° 25.48' W	408.1

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 192-2	B_E	23.02.13	04:52:59	HS_PS	profile end	62° 39.35' S	57° 28.64' W	735.1
PS81/ 193-1	B_E_S	23.02.13	05:54:00	CTD/RO	on ground/ max depth	62° 43.01' S	57° 34.16' W	577.0
PS81/ 193-2	B_E_S	23.02.13	06:37:00	MUC	on ground/ max depth	62° 43.03' S	57° 34.19' W	577.0
PS81/ 193-3	B_E_S	23.02.13	07:23:00	MUC	on ground/ max depth	62° 43.02' S	57° 34.26' W	580.0
PS81/ 193-4	B_E_S	23.02.13	08:17:00	MUC	on ground/ max depth	62° 43.03' S	57° 34.23' W	577.0
PS81/ 193-5	B_E_S	23.02.13	09:10:00	MUC	on ground/ max depth	62° 43.03' S	57° 34.24' W	579.0
PS81/ 193-6	B_E_S	23.02.13	10:01:00	MUC	on ground/ max depth	62° 43.03' S	57° 34.25' W	578.0
PS81/ 193-7	B_E_S	23.02.13	11:07:00	CTD/RO	on ground/ max depth	62° 44.11' S	57° 31.07' W	446.0
PS81/ 193-8	B_E_S	23.02.13	12:10:00	AGT	profile start	62° 43.73' S	57° 29.04' W	428.0
PS81/ 193-8	B_E_S	23.02.13	12:20:00	AGT	profile end	62° 43.80' S	57° 29.40' W	431.0
PS81/ 193-9	B_E_S	23.02.13	14:08:00	AGT	profile start	62° 43.50' S	57° 27.92' W	420.0
PS81/ 193-9	B_E_S	23.02.13	14:18:01	AGT	profile end	62° 43.53' S	57° 28.28' W	428.0
PS81/ 193-10	B_E_S	23.02.13	15:44:00	RD	profile start	62° 43.69' S	57° 28.72' W	421.0
PS81/ 193-10	B_E_S	23.02.13	16:04:00	RD	profile end	62° 43.79' S	57° 28.53' W	416.0
PS81/ 194-1	B_E_B	23.02.13	18:28:01	OFOS	profile start	62° 44.85' S	56° 56.58' W	170.0
PS81/ 194-1	B_E_B	23.02.13	22:25:00	OFOS	profile end	62° 43.82' S	56° 53.39' W	184.0
PS81/ 194-2	B_E	23.02.13	22:52:00	HS_PS	profile start	62° 42.79' S	56° 53.92' W	195.5
PS81/ 194-2	B_E	24.02.13	05:13:59	HS_PS	profile end	62° 44.74' S	56° 59.15' W	181.4
PS81/ 195-1	B_E_B	24.02.13	05:45:00	CTD/RO	on ground/ max depth	62° 44.76' S	56° 56.52' W	172.0
PS81/ 195-2	B_E_B	24.02.13	06:29:01	AGT	profile start	62° 44.64' S	56° 54.75' W	177.0
PS81/ 195-2	B_E_B	24.02.13	06:39:00	AGT	profile end	62° 44.70' S	56° 55.07' W	176.0
PS81/ 196-1	B_E_C	24.02.13	08:35:00	CTD/RO	on ground/ max depth	62° 48.01' S	57° 4.97' W	567.0
PS81/ 196-2	B_E_S	24.02.13	09:21:00	OFOS	profile start	62° 48.20' S	57° 6.07' W	479.0
PS81/ 196-2	B_E_S	24.02.13	13:20:00	OFOS	profile end	62° 48.06' S	57° 1.71' W	299.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 196-3	B_E_C	24.02.13	14:44:00	MUC	on ground/ max depth	62° 48.01' S	57° 4.97' W	561.0
PS81/ 196-4	B_E_C	24.02.13	15:42:00	MUC	on ground/ max depth	62° 48.00' S	57° 4.98' W	561.0
PS81/ 196-5	B_E_C	24.02.13	16:28:00	MUC	on ground/ max depth	62° 48.03' S	57° 4.97' W	567.0
PS81/ 196-6	B_E_C	24.02.13	17:19:00	MUC	on ground/ max depth	62° 48.04' S	57° 5.00' W	574.0
PS81/ 196-7	B_E_C	24.02.13	18:09:00	MUC	on ground/ max depth	62° 48.00' S	57° 4.99' W	559.0
PS81/ 196-8	B_E_C	24.02.13	19:51:01	AGT	profile start	62° 47.80' S	57° 5.35' W	580.0
PS81/ 196-8	B_E_C	24.02.13	20:01:00	AGT	profile end	62° 47.63' S	57° 5.63' W	542.0
PS81/ 196-9	B_E	24.02.13	21:20:00	HS_PS	profile start	62° 46.47' S	57° 10.64' W	361.2
PS81/ 196-9	B_E	25.02.13	00:42:59	HS_PS	profile end	62° 45.32' S	57° 6.73' W	465.4
PS81/ 197-1	B_E	25.02.13	01:50:00	HS_PS	profile start	62° 43.51' S	57° 26.10' W	382.3
PS81/ 197-1	B_E	25.02.13	07:03:59	HS_PS	profile end	62° 46.99' S	57° 29.79' W	000.0
PS81/ 197-2	B_E_U	25.02.13	07:49:00	CTD/RO	on ground/ max depth	62° 45.35' S	57° 28.28' W	228.0
PS81/ 197-3	B_E_U	25.02.13	08:25:00	OFOS	profile start	62° 45.39' S	57° 28.17' W	222.0
PS81/ 197-3	B_E_U	25.02.13	12:21:01	OFOS	profile end	62° 44.19' S	57° 25.22' W	286.0
PS81/ 197-4	B_E_U	25.02.13	12:59:00	AGT	profile start	62° 44.41' S	57° 25.95' W	285.0
PS81/ 197-4	B_E_U	25.02.13	13:09:00	AGT	profile end	62° 44.52' S	57° 26.25' W	285.0
PS81/ 197-5	B_E_U	25.02.13	14:33:00	AGT	profile start	62° 44.73' S	57° 26.79' W	273.0
PS81/ 197-5	B_E_U	25.02.13	14:43:00	AGT	profile end	62° 44.86' S	57° 27.05' W	258.0
PS81/ 197-6	B_E_U	25.02.13	15:44:01	RD	profile start	62° 45.05' S	57° 26.68' W	222.0
PS81/ 197-6	B_E_U	25.02.13	16:04:00	RD	profile end	62° 45.09' S	57° 26.47' W	210.0
PS81/ 198-1	B_C_B	25.02.13	19:05:00	HS_PS	profile start	63° 2.15' S	58° 1.42' W	205.2
PS81/ 198-1	B_C_B	26.02.13	07:03:59	HS_PS	profile end	62° 59.76' S	58° 10.66' W	213.4
PS81/ 198-2	B_C_B	26.02.13	07:43:01	OFOS	profile start	63° 2.31' S	58° 7.11' W	153.0
PS81/ 198-2	B_C_B	26.02.13	11:43:00	OFOS	profile end	63° 1.69' S	58° 2.99' W	178.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 198-3	B_C_B	26.02.13	12:06:00	CTD/RO	on ground/ max depth	63° 1.64' S	58° 2.82' W	174.0
PS81/ 198-4	B_C_B	26.02.13	12:25:00	ATC	in the water	63° 1.57' S	58° 2.57' W	162.0
PS81/ 198-5	B_C_B	26.02.13	12:53:00	AGT	profile start	63° 1.74' S	58° 3.31' W	179.0
PS81/ 198-5	B_C_B	26.02.13	13:03:00	AGT	profile end	63° 1.78' S	58° 3.65' W	180.0
PS81/ 198-6	B_C_B	26.02.13	14:08:00	RD	profile start	63° 2.37' S	58° 5.13' W	173.0
PS81/ 198-6	B_C_B	26.02.13	14:15:00	RD	profile end	63° 2.39' S	58° 5.10' W	174.0
PS81/ 198-7	B_C_B	26.02.13	14:49:00	CTD/RO	on ground/ max depth	63° 2.46' S	58° 7.20' W	149.0
PS81/ 199-1	B_C_U	26.02.13	16:00:01	OFOS	profile start	62° 57.50' S	58° 16.03' W	401.0
PS81/ 199-1	B_C_U	26.02.13	19:41:01	OFOS	profile end	62° 56.66' S	58° 11.83' W	239.0
PS81/ 199-2	B_C_U	26.02.13	20:07:00	HS_PS	profile start	62° 56.92' S	58° 12.52' W	261.3
PS81/ 199-2	B_C_U	27.02.13	06:15:59	HS_PS	profile end	62° 55.88' S	58° 1.94' W	739.9
PS81/ 199-3	B_C_U	27.02.13	07:12:00	CTD/RO	on ground/ max depth	62° 56.59' S	58° 11.74' W	241.0
PS81/ 199-4	B_C_U	27.02.13	07:49:01	AGT	profile start	62° 57.22' S	58° 14.60' W	325.0
PS81/ 199-4	B_C_U	27.02.13	07:59:00	AGT	profile end	62° 57.33' S	58° 14.95' W	339.0
PS81/ 200-1	B_C_B	27.02.13	09:34:00	OFOS	profile start	63° 0.06' S	58° 7.36' W	209.0
PS81/ 200-1	B_C_B	27.02.13	11:12:00	OFOS	profile end	63° 0.03' S	58° 5.61' W	221.0
PS81/ 201-1	B_C_B	27.02.13	11:47:01	GKG	on ground/ max depth	63° 1.81' S	58° 3.70' W	183.0
PS81/ 198-4	B_C_B	27.02.13	12:34:00	ATC	information	63° 1.57' S	58° 2.34' W	150.0
PS81/ 202-1	B_C_C	27.02.13	14:01:00	CTD/RO	on ground/ max depth	62° 56.00' S	58° 0.47' W	758.0
PS81/ 202-2	B_C_C	27.02.13	14:52:00	MUC	on ground/ max depth	62° 56.00' S	58° 0.55' W	757.0
PS81/ 202-3	B_C_C	27.02.13	15:59:00	MUC	on ground/ max depth	62° 56.00' S	58° 0.49' W	756.0
PS81/ 202-4	B_C_C	27.02.13	16:58:00	MUC	on ground/ max depth	62° 56.01' S	58° 0.52' W	756.0
PS81/ 202-5	B_C_C	27.02.13	18:01:00	MUC	on ground/ max depth	62° 55.99' S	58° 0.61' W	757.0
PS81/ 203-1	B_C	27.02.13	20:16:00	HS_PS	profile start	62° 54.56' S	58° 25.03' W	715.6

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 203-1	B_C	28.02.13	04:32:59	HS_PS	profile end	63° 4.35' S	58° 19.91' W	763.8
PS81/ 204-1	B_C_C	28.02.13	06:29:00	OFOS	profile start	62° 56.14' S	57° 59.63' W	771.0
PS81/ 204-1	B_C_C	28.02.13	10:16:00	OFOS	profile end	62° 55.99' S	57° 55.56' W	723.0
PS81/ 204-2	B_C_C	28.02.13	11:17:00	AGT	profile start	62° 56.07' S	57° 58.14' W	781.0
PS81/ 204-2	B_C_C	28.02.13	11:27:00	AGT	profile end	62° 56.08' S	57° 58.51' W	767.0
PS81/ 205-1	B_C	28.02.13	14:39:02	RMT	profile start	63° 2.35' S	58° 3.63' W	199.9
PS81/ 205-1	B_C	28.02.13	15:07:01	RMT	profile end	63° 2.67' S	58° 6.46' W	161.2
PS81/ 206-1	B_W	28.02.13	16:45:01	RMT	profile start	63° 0.10' S	57° 46.46' W	235.2
PS81/ 206-1	B_W	28.02.13	17:09:00	RMT	profile end	63° 0.44' S	57° 48.69' W	450.0
PS81/ 207-1		28.02.13	18:12:00	CTD/RO	on ground/ max depth	63° 2.08' S	57° 32.85' W	116.0
PS81/ 207-2		28.02.13	18:46:01	RMT	profile start	63° 2.07' S	57° 34.91' W	112.2
PS81/ 207-2		28.02.13	19:03:00	RMT	profile end	63° 1.94' S	57° 36.62' W	109.3
PS81/ 208-1		28.02.13	21:04:00	CTD/RO	on ground/ max depth	62° 49.19' S	57° 48.58' W	400.3
PS81/ 208-2		28.02.13	21:30:00	RMT	profile start	62° 49.47' S	57° 48.60' W	359.1
PS81/ 208-2		28.02.13	22:01:00	RMT	profile end	62° 49.87' S	57° 50.62' W	366.4
PS81/ 209-1		28.02.13	23:53:00	CTD/RO	on ground/ max depth	62° 39.69' S	57° 59.64' W	901.9
PS81/ 210-1		01.03.13	02:17:00	CTD/RO	on ground/ max depth	62° 29.78' S	58° 10.10' W	1851.2
PS81/ 211-1		01.03.13	10:22:00	CTD/RO	on ground/ max depth	62° 25.44' S	58° 24.05' W	1134.2
PS81/ 212-1		01.03.13	11:39:00	RMT	profile start	62° 20.51' S	58° 28.75' W	831.8
PS81/ 212-1		01.03.13	12:26:00	RMT	profile end	62° 20.97' S	58° 31.38' W	829.2
PS81/ 212-2		01.03.13	12:58:00	CTD/RO	on ground/ max depth	62° 20.71' S	58° 30.49' W	786.0
PS81/ 213-1		01.03.13	14:00:00	CTD/RO	on ground/ max depth	62° 18.97' S	58° 30.51' W	538.7
PS81/ 214-1		01.03.13	16:17:01	RMT	profile start	62° 30.38' S	58° 10.93' W	1844.1
PS81/ 214-1		01.03.13	16:43:00	RMT	profile end	62° 30.89' S	58° 13.28' W	1816.5

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 215-1	B_C_S	01.03.13	20:05:00	CTD/RO	on ground/ max depth	62° 53.57‘ S	58° 14.66‘ W	530.0
PS81/ 215-2	B_C_S	01.03.13	20:43:01	OFOS	profile start	62° 53.58‘ S	58° 14.76‘ W	535.0
PS81/ 215-2	B_C_S	02.03.13	00:43:00	OFOS	profile end	62° 53.48‘ S	58° 10.53‘ W	441.0
PS81/ 216-1	B_C	02.03.13	02:16:00	HS_PS	profile start	62° 59.62‘ S	58° 28.36‘ W	454.6
PS81/ 216-1	B_C	02.03.13	04:39:59	HS_PS	profile end	62° 59.14‘ S	58° 28.80‘ W	476.0
PS81/ 217-1	B_C_S	02.03.13	06:21:00	MUC	on ground/ max depth	62° 53.31‘ S	58° 14.14‘ W	527.0
PS81/ 217-2	B_C_S	02.03.13	07:00:00	MUC	on ground/ max depth	62° 53.31‘ S	58° 14.17‘ W	529.0
PS81/ 217-3	B_C_S	02.03.13	07:51:00	MUC	on ground/ max depth	62° 53.31‘ S	58° 14.12‘ W	527.0
PS81/ 217-4	B_C_S	02.03.13	08:37:00	MUC	on ground/ max depth	62° 53.29‘ S	58° 14.09‘ W	527.0
PS81/ 217-5	B_C_S	02.03.13	09:26:00	MUC	on ground/ max depth	62° 53.25‘ S	58° 14.13‘ W	532.0
PS81/ 217-6	B_C_S	02.03.13	10:45:00	AGT	profile start	62° 53.45‘ S	58° 13.06‘ W	461.0
PS81/ 217-6	B_C_S	02.03.13	10:55:00	AGT	profile end	62° 53.42‘ S	58° 13.41‘ W	483.0
PS81/ 217-7	B_C_S	02.03.13	12:47:01	RD	profile start	62° 53.64‘ S	58° 12.52‘ W	395.0
PS81/ 217-7	B_C_S	02.03.13	13:08:00	RD	profile end	62° 53.64‘ S	58° 12.37‘ W	387.0
PS81/ 218-1	B_W_C	02.03.13	14:53:00	CTD/RO	on ground/ max depth	62° 56.93‘ S	58° 25.66‘ W	691.0
PS81/ 218-2	B_W_C	02.03.13	15:33:00	MUC	on ground/ max depth	62° 56.94‘ S	58° 25.73‘ W	688.0
PS81/ 218-3	B_W_C	02.03.13	16:41:00	OFOS	profile start	62° 56.99‘ S	58° 26.60‘ W	683.0
PS81/ 218-3	B_W_C	02.03.13	20:39:00	OFOS	profile end	62° 56.55‘ S	58° 22.25‘ W	774.0
PS81/ 218-4	B_W_C	02.03.13	21:35:00	MUC	on ground/ max depth	62° 56.95‘ S	58° 25.81‘ W	689.0
PS81/ 218-5	B_W_C	02.03.13	22:28:00	MUC	on ground/ max depth	62° 56.95‘ S	58° 25.84‘ W	689.0
PS81/ 218-6	B_W_C	02.03.13	23:22:00	MUC	on ground/ max depth	62° 56.93‘ S	58° 25.81‘ W	689.0
PS81/ 219-1	B_W	03.03.13	00:51:00	HS_PS	profile start	63° 1.64‘ S	58° 33.92‘ W	229.4
PS81/ 219-1	B_W	03.03.13	04:43:59	HS_PS	profile end	63° 4.33‘ S	58° 38.68‘ W	157.8
PS81/ 220-1	B_W_C	03.03.13	06:43:01	RD	profile start	62° 56.90‘ S	58° 25.48‘ W	703.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 220-1	B_W_C	03.03.13	06:53:00	RD	profile end	62° 56.91' S	58° 25.34' W	705.0
PS81/ 220-2	B_W_C	03.03.13	08:29:00	AGT	profile start	62° 56.72' S	58° 23.63' W	782.0
PS81/ 220-2	B_W_C	03.03.13	08:38:00	AGT	profile end	62° 56.77' S	58° 23.91' W	792.0
PS81/ 220-3	B_W	03.03.13	11:03:00	RMT	profile start	62° 56.71' S	58° 23.51' W	774.0
PS81/ 220-3	B_W	03.03.13	11:50:00	RMT	profile end	62° 57.12' S	58° 27.30' W	652.0
PS81/ 221-1	B_W	03.03.13	12:44:01	ATC	on ground/ max depth	63° 0.54' S	58° 38.01' W	256.0
PS81/ 221-2	B_W	03.03.13	13:11:01	RMT	profile start	63° 0.69' S	58° 39.71' W	250.0
PS81/ 221-2	B_W	03.03.13	13:42:00	RMT	profile end	63° 0.84' S	58° 42.84' W	265.0
PS81/ 222-1	B_W_B	03.03.13	14:26:00	CTD/RO	on ground/ max depth	63° 2.99' S	58° 38.06' W	159.0
PS81/ 222-2a	B_W_B	03.03.13	14:47:00	OFOS	profile start	63° 2.98' S	58° 37.98' W	158.0
PS81/ 222-2a	B_W_B	03.03.13	16:46:00	OFOS	profile end	63° 3.05' S	58° 36.01' W	157.0
PS81/ 222-2b	B_W_U	03.03.13	17:30:00	OFOS	profile start	63° 0.47' S	58° 37.59' W	259.0
PS81/ 222-2b	B_W_U	03.03.13	21:20:00	OFOS	profile end	63° 0.48' S	58° 33.13' W	283.0
PS81/ 223-1	B_W	03.03.13	21:44:00	HS_PS	profile start	63° 0.84' S	58° 32.62' W	271.7
PS81/ 223-1	B_W	04.03.13	05:10:59	HS_PS	profile end	62° 59.96' S	58° 44.56' W	320.0
PS81/ 224-1	B_W_U	04.03.13	05:51:00	CTD/RO	on ground/ max depth	63° 0.48' S	58° 37.58' W	258.0
PS81/ 224-2	B_W_U	04.03.13	06:22:00	RD	profile start	63° 0.50' S	58° 37.53' W	254.0
PS81/ 224-2	B_W_U	04.03.13	06:32:00	RD	profile end	63° 0.54' S	58° 37.50' W	256.0
PS81/ 224-3	B_W_U	04.03.13	07:21:01	AGT	profile start	63° 0.53' S	58° 35.67' W	261.0
PS81/ 224-3	B_W_U	04.03.13	07:31:00	AGT	profile end	63° 0.58' S	58° 36.11' W	257.0
PS81/ 221-1	B_W_U	04.03.13	09:10:00	ATC	information	63° 0.58' S	58° 37.93' W	254.0
PS81/ 225-1	B_W_S	04.03.13	10:18:00	CTD/RO	on ground/ max depth	62° 56.07' S	58° 40.62' W	539.0
PS81/ 225-2	B_W_S	04.03.13	10:55:00	MUC	on ground/ max depth	62° 56.08' S	58° 40.76' W	543.0
PS81/ 225-3	B_W_S	04.03.13	11:44:00	MUC	on ground/ max depth	62° 56.04' S	58° 40.73' W	546.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 225-4	B_W_S	04.03.13	12:34:00	MUC	on ground/ max depth	62° 56.06' S	58° 40.76' W	544.0
PS81/ 225-5	B_W_S	04.03.13	13:31:00	MUC	on ground/ max depth	62° 56.05' S	58° 40.77' W	546.0
PS81/ 225-6	B_W_S	04.03.13	14:28:00	OFOS	profile start	62° 55.73' S	58° 41.61' W	569.0
PS81/ 225-6	B_W_S	04.03.13	16:01:00	OFOS	profile end	62° 56.23' S	58° 39.97' W	535.0
PS81/ 226-1	B_C	04.03.13	22:52:00	HS_PS	profile start	62° 57.04' S	58° 19.44' W	748.4
PS81/ 226-1	B_C	05.03.13	03:28:59	HS_PS	profile end	62° 58.26' S	58° 16.72' W	425.3
PS81/ 227-1	B_W_S	05.03.13	07:25:01	RD	profile start	62° 56.11' S	58° 40.38' W	532.0
PS81/ 227-1	B_W_S	05.03.13	07:32:00	RD	profile end	62° 56.11' S	58° 40.34' W	532.0
PS81/ 227-2	B_W_S	05.03.13	08:57:00	AGT	profile start	62° 55.83' S	58° 41.09' W	564.0
PS81/ 227-2	B_W_S	05.03.13	09:08:00	AGT	profile end	62° 55.76' S	58° 41.46' W	562.0
PS81/ 228-1		05.03.13	12:47:00	CTD/RO	on ground/ max depth	63° 9.97' S	59° 24.91' W	794.0
PS81/ 228-2		05.03.13	13:11:00	CTD/RO	on ground/ max depth	63° 9.98' S	59° 24.94' W	794.0
PS81/ 229-1		05.03.13	15:47:00	CTD/RO	on ground/ max depth	63° 9.99' S	59° 59.95' W	847.0
PS81/ 230-1		05.03.13	19:09:00	CTD/RO	on ground/ max depth	63° 8.37' S	60° 39.30' W	677.0
PS81/ 231-1	B_DE_S	05.03.13	21:40:00	HS_PS	profile start	62° 52.32' S	60° 20.57' W	682.7
PS81/ 231-1	B_DE_S	05.03.13	22:17:59	HS_PS	profile end	62° 52.55' S	60° 29.01' W	129.0
PS81/ 231-2	B_DE_S	05.03.13	22:33:00	OFOS	profile start	62° 52.61' S	60° 29.40' W	107.0
PS81/ 231-2	B_DE_S	06.03.13	00:22:00	OFOS	profile end	62° 52.70' S	60° 27.36' W	345.0
PS81/ 231-3	B_DE_S	06.03.13	00:51:00	CTD/RO	on ground/ max depth	62° 52.69' S	60° 27.34' W	355.4
PS81/ 231-4	B_DE_S	06.03.13	01:16:00	HS_PS	profile start	62° 53.12' S	60° 28.33' W	216.9
PS81/ 231-4	B_DE_S	06.03.13	04:00:59	HS_PS	profile end	62° 53.11' S	60° 23.56' W	598.7
PS81/ 232-1		06.03.13	20:59:00	CTD/RO	on ground/ max depth	63° 10.01' S	61° 10.04' W	1260.0
PS81/ 233-1	D_W	07.03.13	03:28:00	HS_PS	profile start	62° 17.81' S	61° 17.02' W	302.3
PS81/ 233-1	D_W	07.03.13	08:57:59	HS_PS	profile end	62° 18.15' S	61° 7.24' W	226.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 234-1	D_W_S	07.03.13	09:51:00	CTD/RO	on ground/ max depth	62° 16.99' S	61° 16.13' W	387.0
PS81/ 234-2	D_W	07.03.13	10:25:00	RMT	profile start	62° 17.03' S	61° 15.62' W	302.0
PS81/ 234-2	D_W	07.03.13	11:10:00	RMT	profile end	62° 17.04' S	61° 11.85' W	261.0
PS81/ 234-3	D_W_U	07.03.13	11:45:01	OFOS	profile start	62° 17.28' S	61° 13.97' W	232.0
PS81/ 234-3	D_W_U	07.03.13	14:31:00	OFOS	profile end	62° 17.58' S	61° 9.64' W	227.0
PS81/ 234-4	D_W_U	07.03.13	15:15:00	CTD	on ground/ max depth	62° 17.52' S	61° 9.76' W	231.0
PS81/ 234-5	D_W_U	07.03.13	16:04:01	AGT	profile start	62° 17.36' S	61° 12.06' W	251.0
PS81/ 234-5	D_W_U	07.03.13	16:14:00	AGT	profile end	62° 17.31' S	61° 12.63' W	248.0
PS81/ 234-6	D_W_U	07.03.13	17:41:01	RD	profile start	62° 17.39' S	61° 13.37' W	240.0
PS81/ 234-6	D_W_U	07.03.13	17:46:00	RD	profile end	62° 17.39' S	61° 13.30' W	243.0
PS81/ 235-1	D_W_S	07.03.13	18:48:00	CTD/RO	on ground/ max depth	62° 16.30' S	61° 10.27' W	369.0
PS81/ 235-2	D_W_S	07.03.13	19:24:00	MUC	on ground/ max depth	62° 16.35' S	61° 10.23' W	355.0
PS81/ 235-3	D_W_S	07.03.13	19:57:00	MUC	on ground/ max depth	62° 16.34' S	61° 10.22' W	355.0
PS81/ 235-4	D_W_S	07.03.13	20:36:00	MUC	on ground/ max depth	62° 16.29' S	61° 10.24' W	373.0
PS81/ 235-5	D_W_S	07.03.13	21:16:00	MUC	on ground/ max depth	62° 16.31' S	61° 10.24' W	363.0
PS81/ 235-6	D_W_S	07.03.13	21:54:00	MUC	on ground/ max depth	62° 16.35' S	61° 10.25' W	350.0
PS81/ 236-1	D_W	07.03.13	23:11:00	HS_PS	profile start	62° 18.70' S	61° 22.28' W	369.2
PS81/ 236-1	D_W	08.03.13	04:59:59	HS_PS	profile end	62° 18.21' S	61° 17.81' W	335.7
PS81/ 237-1	D_W_S	08.03.13	06:16:00	RD	profile start	62° 15.77' S	61° 12.09' W	428.0
PS81/ 237-1	D_W_S	08.03.13	06:26:00	RD	profile end	62° 15.79' S	61° 11.99' W	444.0
PS81/ 237-2	D_W_S	08.03.13	07:40:00	OFOS	profile start	62° 15.72' S	61° 12.46' W	492.0
PS81/ 237-2	D_W_S	08.03.13	11:20:00	OFOS	profile end	62° 16.79' S	61° 9.08' W	273.0
PS81/ 237-3	D_W_S	08.03.13	12:03:00	AGT	profile start	62° 15.98' S	61° 11.32' W	522.0
PS81/ 237-3	D_W_S	08.03.13	12:13:00	AGT	profile end	62° 15.88' S	61° 11.60' W	497.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 238-1	D_W	08.03.13	14:31:02	RMT	profile start	62° 22.65' S	61° 17.63' W	391.0
PS81/ 238-1	D_W	08.03.13	15:23:00	RMT	profile end	62° 20.89' S	61° 19.82' W	455.0
PS81/ 238-2	D_W_C	08.03.13	16:00:00	CTD/RO	on ground/ max depth	62° 20.73' S	61° 20.15' W	465.0
PS81/ 238-3	D_W_C	08.03.13	16:56:00	MUC	on ground/ max depth	62° 20.82' S	61° 19.95' W	459.0
PS81/ 238-4	D_W_C	08.03.13	17:45:00	MUC	on ground/ max depth	62° 20.82' S	61° 20.01' W	460.0
PS81/ 238-5	D_W_C	08.03.13	18:27:00	MUC	on ground/ max depth	62° 20.78' S	61° 20.10' W	464.0
PS81/ 238-6	D_W_C	08.03.13	19:09:00	MUC	on ground/ max depth	62° 20.80' S	61° 20.06' W	466.5
PS81/ 239-1	D_C	08.03.13	21:59:00	HS_PS	profile start	62° 8.75' S	60° 42.13' W	506.0
PS81/ 239-1	D_C	09.03.13	05:27:59	HS_PS	profile end	62° 11.50' S	60° 43.20' W	424.1
PS81/ 240-1	D_C_U	09.03.13	06:38:00	CTD/RO	on ground/ max depth	62° 7.00' S	60° 34.00' W	276.0
PS81/ 240-2	D_C_U	09.03.13	07:15:00	RD	profile start	62° 6.92' S	60° 33.86' W	277.0
PS81/ 240-2	D_C_U	09.03.13	07:25:00	RD	profile end	62° 6.91' S	60° 33.78' W	278.0
PS81/ 240-3	D_C_U	09.03.13	08:45:00	AGT	profile start	62° 7.05' S	60° 34.12' W	277.0
PS81/ 240-3	D_C_U	09.03.13	08:55:00	AGT	profile end	62° 7.17' S	60° 34.47' W	275.0
PS81/ 241-1	D_C_S	09.03.13	10:13:00	CTD/RO	on ground/ max depth	62° 6.63' S	60° 36.52' W	395.0
PS81/ 241-2	D_C_S	09.03.13	10:58:00	GKG	on ground/ max depth	62° 6.59' S	60° 36.47' W	400.0
PS81/ 241-3	D_C_S	09.03.13	11:52:00	GKG	on ground/ max depth	62° 6.60' S	60° 36.51' W	403.0
PS81/ 241-4	D_C_S	09.03.13	12:45:00	GKG	on ground/ max depth	62° 6.59' S	60° 36.50' W	403.0
PS81/ 241-5	D_C_S	09.03.13	13:36:00	GKG	on ground/ max depth	62° 6.60' S	60° 36.50' W	403.0
PS81/ 242-1	D_C	09.03.13	14:36:00	HS_PS	profile start	62° 7.76' S	60° 43.64' W	682.0
PS81/ 242-1	D_C	09.03.13	22:42:59	HS_PS	profile end	62° 12.38' S	60° 47.09' W	402.3
PS81/ 243-1	D_C_C	09.03.13	23:18:00	CTD/RO	on ground/ max depth	62° 12.27' S	60° 44.42' W	497.4
PS81/ 243-2	D_C_C	09.03.13	23:57:00	MUC	on ground/ max depth	62° 12.32' S	60° 44.48' W	497.7
PS81/ 243-3	D_C_C	10.03.13	00:50:00	MUC	on ground/ max depth	62° 12.32' S	60° 44.47' W	497.8

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 243-4	D_C_C	10.03.13	01:31:00	MUC	on ground/ max depth	62° 12.31' S	60° 44.48' W	497.7
PS81/ 243-5	D_C_C	10.03.13	02:13:00	MUC	on ground/ max depth	62° 12.31' S	60° 44.54' W	495.2
PS81/ 243-6	D_C	10.03.13	03:25:00	HS_PS	profile start	62° 13.08' S	60° 48.00' W	351.9
PS81/ 243-6	D_C	10.03.13	07:52:59	HS_PS	profile end	62° 6.62' S	60° 36.64' W	416.6
PS81/ 244-1	D_C_S	10.03.13	08:23:00	OFOS	profile start	62° 6.60' S	60° 36.36' W	392.0
PS81/ 244-1	D_C_S	10.03.13	12:17:00	OFOS	profile end	62° 7.92' S	60° 39.68' W	427.0
PS81/ 244-2	D_C_S	10.03.13	13:02:00	AGT	profile start	62° 7.53' S	60° 38.91' W	464.0
PS81/ 244-2	D_C_S	10.03.13	13:12:00	AGT	profile end	62° 7.41' S	60° 38.66' W	467.0
PS81/ 244-3	D_C_S	10.03.13	14:39:00	RD	profile start	62° 7.24' S	60° 38.00' W	431.0
PS81/ 244-3	D_C_S	10.03.13	14:56:00	RD	profile end	62° 7.24' S	60° 38.10' W	443.0
PS81/ 244-4	D_C_S	10.03.13	15:39:00	MUC	on ground/ max depth	62° 6.65' S	60° 36.51' W	393.0
PS81/ 244-5	D_C_S	10.03.13	16:23:00	MUC	on ground/ max depth	62° 6.64' S	60° 36.53' W	398.0
PS81/ 244-6	D_C_S	10.03.13	17:03:00	MUC	on ground/ max depth	62° 6.62' S	60° 36.50' W	400.0
PS81/ 244-7	D_C_S	10.03.13	17:44:00	MUC	on ground/ max depth	62° 6.65' S	60° 36.54' W	396.0
PS81/ 245-1	D_E_U	10.03.13	20:45:00	RD	profile start	61° 58.18' S	60° 6.26' W	313.8
PS81/ 245-1	D_E_U	10.03.13	20:55:00	RD	profile end	61° 58.25' S	60° 6.40' W	314.0
PS81/ 245-2	D_E	10.03.13	22:00:00	HS_PS	profile start	61° 56.07' S	60° 5.58' W	426.7
PS81/ 245-2	D_E	11.03.13	07:00:59	HS_PS	profile end	62° 0.71' S	60° 4.16' W	263.7
PS81/ 246-1	D_E_U	11.03.13	07:22:01	OFOS	profile start	62° 0.66' S	60° 3.66' W	258.0
PS81/ 246-1	D_E_U	11.03.13	11:21:00	OFOS	profile end	61° 58.65' S	60° 3.98' W	295.0
PS81/ 246-2	D_E_U	11.03.13	11:48:00	CTD/RO	on ground/ max depth	61° 58.69' S	60° 4.24' W	296.0
PS81/ 246-3	D_E_U	11.03.13	12:38:00	AGT	profile start	62° 0.23' S	60° 3.81' W	266.0
PS81/ 246-3	D_E_U	11.03.13	12:48:00	AGT	profile end	62° 0.40' S	60° 3.81' W	260.0
PS81/ 247-1	D_E_S	11.03.13	14:01:00	ATC	in the water	61° 56.50' S	60° 7.87' W	456.0

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 247-2	D_E_S	11.03.13	14:39:00	CTD/RO	on ground/ max depth	61° 56.90' S	60° 7.49' W	401.0
PS81/ 247-3	D_E_S	11.03.13	15:09:00	MUC	on ground/ max depth	61° 56.92' S	60° 7.48' W	398.0
PS81/ 247-4	D_E_S	11.03.13	15:51:00	MUC	on ground/ max depth	61° 56.93' S	60° 7.48' W	396.0
PS81/ 247-5	D_E_S	11.03.13	16:28:00	MUC	on ground/ max depth	61° 56.94' S	60° 7.51' W	397.0
PS81/ 247-6	D_E_S	11.03.13	17:30:00	MUC	on ground/ max depth	61° 56.93' S	60° 7.44' W	396.0
PS81/ 247-7	D_E_S	11.03.13	18:11:00	MUC	on ground/ max depth	61° 56.91' S	60° 7.47' W	400.0
PS81/ 247-8	D_E_S	11.03.13	19:15:01	RD	profile start	61° 56.88' S	60° 7.55' W	358.0
PS81/ 247-8	D_E_S	11.03.13	19:25:00	RD	profile end	61° 56.82' S	60° 7.55' W	364.5
PS81/ 248-1	D_E	11.03.13	20:22:00	HS_PS	profile start	61° 54.55' S	60° 7.24' W	804.5
PS81/ 248-1	D_E	12.03.13	04:58:59	HS_PS	profile end	62° 3.86' S	60° 14.87' W	361.2
PS81/ 249-1	D_E_S	12.03.13	06:21:00	OFOS	profile start	61° 57.04' S	60° 7.81' W	397.0
PS81/ 249-1	D_E_S	12.03.13	10:21:00	OFOS	profile end	61° 55.67' S	60° 4.69' W	429.0
PS81/ 249-2	D_E_S	12.03.13	11:01:00	AGT	profile start	61° 56.05' S	60° 5.56' W	421.0
PS81/ 249-2	D_E_S	12.03.13	11:12:00	AGT	profile end	61° 56.21' S	60° 5.80' W	413.0
PS81/ 247-1	D_E_S	12.03.13	12:16:00	ATC	information	61° 56.43' S	60° 7.82' W	464.0
PS81/ 250-1	D_E_C	12.03.13	13:46:00	CTD/RO	on ground/ max depth	62° 2.28' S	60° 12.11' W	487.0
PS81/ 250-2	D_E_C	12.03.13	14:17:00	MUC	on ground/ max depth	62° 2.23' S	60° 12.07' W	488.0
PS81/ 250-3	D_E_C	12.03.13	15:05:00	MUC	on ground/ max depth	62° 2.22' S	60° 12.01' W	489.0
PS81/ 250-4	D_E_C	12.03.13	15:47:00	MUC	on ground/ max depth	62° 2.24' S	60° 12.06' W	488.0
PS81/ 250-5	D_E_C	12.03.13	16:30:00	MUC	on ground/ max depth	62° 2.24' S	60° 12.03' W	488.0
PS81/ 251-1	D_C_U	12.03.13	19:10:00	OFOS	profile start	62° 7.74' S	60° 37.80' W	260.0
PS81/ 251-1	D_C_U	12.03.13	23:03:00	OFOS	profile end	62° 6.35' S	60° 34.63' W	295.0
PS81/ 252-1		13.03.13	00:29:00	CTD/RO	on ground/ max depth	62° 6.67' S	60° 44.00' W	963.0
PS81/ 253-1		13.03.13	02:49:00	CTD/RO	on ground/ max depth	61° 57.25' S	60° 51.26' W	1541.5

Station	Area	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/ 254-1		13.03.13	05:48:00	CTD/RO	on ground/ max depth	61° 47.57‘ S	60° 58.20‘ W	2988.7
PS81/ 255-1		13.03.13	09:36:00	CTD/RO	on ground/ max depth	61° 38.32‘ S	61° 5.93‘ W	4078.6
PS81/ 256-1		13.03.13	13:52:00	CTD/RO	on ground/ max depth	61° 29.16‘ S	61° 13.09‘ W	4257.8

A.5 LIST OF ABBREVIATIONS OF GEAR

Acronym	Gear
AGT	Agassiz-trawl, 3 m opening
ATC	Amphipod trap
CTD/RO	Conductivity-temperature-depth data logger with rosette water sampler
GKG	Giant box corer
HS_PS	Hydrosweep/Parasound
MUC	Multicorer
OFOS	Ocean floor observation system
RD	Rauschert dredge
RMT	Rectangular midwater trawl (1+8)

A.6 LIST OF ABBREVIATIONS OF STATION NAMES

Abbre-viation	Station name			Color code
	Area	**Core station**	**Habitat**	
W_JE_B	Weddell Sea	Joinville East	bank	
W_JE_D	Weddell Sea	Joinville East	depression	
W_ET_B	Weddell Sea	Erebus & Terror Gulf	bank	
W_ET_D	Weddell Sea	Erebus & Terror Gulf	deep shelf	
W_VO_B	Weddell Sea	volcano	bank	
W_VO_U	Weddell Sea	volcano	upper slope	
W_VO_D	Weddell Sea	volcano	deep shelf	
W_DI_B	Weddell Sea	Dundee Island	bank	
B_JN_B	Bransfield Strait	Joinville North	bank	
B_JN_U	Bransfield Strait	Joinville North	upper slope	
B_E_B	Bransfield Strait	East	bank	
B_E_U	Bransfield Strait	East	upper slope	
B_E_S	Bransfield Strait	East	slope	
B_E_C	Bransfield Strait	East	canyon	
B_C_B	Bransfield Strait	Central	bank	
B_C_U	Bransfield Strait	Central	upper slope	
B_C_S	Bransfield Strait	Central	slope	
B_C_C	Bransfield Strait	Central	canyon	
B_W_B	Bransfield Strait	West	bank	
B_W_U	Bransfield Strait	West	upper slope	
B_W_S	Bransfield Strait	West	slope	
B_W_C	Bransfield Strait	West	canyon	
B_DE_S	Bransfield Strait	Deception Island	slope	
D_W_U	Drake Passage	West	upper slope	
D_W_S	Drake Passage	West	slope	
D_W_C	Drake Passage	West	canyon	
D_C_U	Drake Passage	Central	upper slope	
D_C_S	Drake Passage	Central	slope	
D_C_C	Drake Passage	Central	canyon	
D_E_U	Drake Passage	East	upper slope	
D_E_S	Drake Passage	East	slope	
D_E_C	Drake Passage	East	canyon	

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