The Expedition ANTARKTIS XVII/3 (EASIZ III) OF RV „POLARSTERN“ in 2000

Edited by Wolf E. Arntz and Thomas Brey with contributions of the participants

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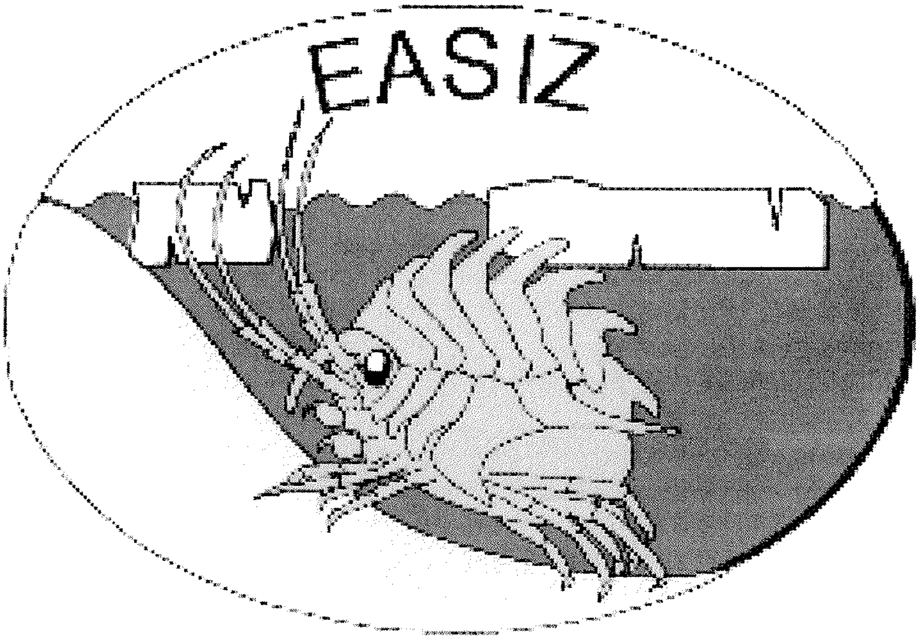

EASIZ

1 Introduction

1.1 Objectives of the Cruise (W.E. Arntz)

As during the two preceding cruises EASIZ I (1996) and EASIZ II (1998), the third "Polarstern" cruise of SCAR's international EASIZ programme was to concentrate on limited areas to be studied and a small number of joint projects ("box concept"). The principal projects to be realized included:

(i) Bentho-pelagic coupling in the high Antarctic ecosystem and the role of suspension feeders. On the preceding cruises, food analyses of benthic suspension feeders had revealed limited connection between the rain of larger particles sinking to the seafloor during the short Antarctic summer and the food of these organisms, and incubation experiments had presented evidence for the use of the fine seston fraction by certain suspension feeders. Both the food analyses and the experiments were continued and refined on EASIZ III, putting major emphasis on the quality of the food offer and the processes that make the food available to the benthos. A multidisciplinary approach was undertaken including microbial ecology, seston quality analysis, flow measurements, sediment dynamics, and the study of other variables and processes above and at the seafloor. Investigations on shallow areas which present specific environmental conditions and a special fauna of suspension feeders were intensified by means of visual methods and a large TV grab.

(ii) Effect of iceberg scour on macro- and meiobenthic, and demersal fish, communities. As on the preceding cruises, the task was to identify recurrent successional stages during the process of recolonisation after iceberg scour, and to assess the temporal and spatial scales of the processes involved. The final goal is to determine the capacity of recovery (resilience) of Antarctic benthic communities in comparison with other marine ecosystems. One of the major difficulties to be overcome is age and growth determination of those organisms that have no hard structures, and where alternative modern methods have to be applied. The combination of fish and invertebrate approaches in joint studies has once again proved to be scientifically rewarding. Improved video techniques on the Multibox corer were helpful in distinguishing between disturbed sites and "virgin" areas which did not suffer iceberg scour for a long time.

(iii) Biodiversity and evolutionary links of the high Antarctic Weddell Sea with the Antarctic Peninsula and other regions. Latitudinal diversity gradients are far from clear due to worldwide continuous changes in sampling gear and enormous difficulties in taxonomic identification. To improve this situation, the baseline material for genuine comparisons was to be complemented by the use of gear such as Multibox corer, Multicorer and Epibenthic sledge. Representative samples were taken, and the material will be worked up at a single institution, to determine total per haul, or per sample, invertebrate diversity for areas in the eastern Weddell Sea and off the Antarctic Peninsula. Genetic variability was studied in copepods and peracarid crustaceans. Other specific taxa to be investigated within the biodiversity context included cnidarians, bryozoans, amphipods, molluscs, crinoids, asteroids, and cephalopods. Light and electron microscopic studies were performed on the occurrence of parasites in Antarctic invertebrates and fish.

(iv) Adaptive strategies on the population and community level. This project was to address physiological, ecological and behavioural adaptations to the Antarctic environment in meio- and macrofauna, and in fish populations and communities. Due to the realisation of the EASIZ III cruise late in the Antarctic season, special emphasis was laid on processes and strategies in populations under autumn conditions, and on spatio-temporal distribution of demersal and pelagic fish communities in relation to environmental conditions. Taxa under specific consideration were decapod crustaceans, polychaetes, asteroids, eelpouts (Zoarcidae) and the scallop *Adamussium colbecki.*

(v) Structure and function of marine natural products in Antarctic invertebrates. Proceeding on the assumption that the Antarctic benthic system is a fairly old one, and that the manifold interactions observed between its faunal elements reflect the frequent use of secondary metabolites and other natural substances, an attempt was made to explore the biochemical and ecological significance of marine natural products in the field. Taxa to be studied included pterobranchs, priapulids, brachiopods, bryozoans, gastropods and cnidarians.

In addition to these core projects, studies were undertaken, among others, on persistent organic pollutants in the Southern Ocean ecosystem, and novel drifting buoys were deployed in the marginal ice zone to improve understanding of the mechanisms of Antarctic sea ice formation in winter.

In regional terms, the idea was to work most of the time between Atka Bay and the Drescher Inlet in the southeastern Weddell Sea, then proceed towards the northern ice edge to deploy the drifting buoys, and finally work a few days around King George Island to complement work done there during EASIZ II. This schedule had to undergo certain changes due to engine trouble before reaching the Drescher Inlet (see Itinerary), so that finally work around the South Shetland Islands gained in importance.

1.2 Summary Review of Results (W.E. Arntz)

Contrary to the preceding (summer) expeditions EASIZ I and II, the EASIZ III cruise was realized in autumn, which made the study of the living conditions during this season, and the response of the organisms to these conditions, a central question. It is current belief that most benthic animals use the short period of plankton blooms in spring and summer to fill up their resources, scraping a hard living during the long winter season when food is presumably scarce. Already during EASIZ II we observed, however, that some benthic suspension feeders prefer a continuous supply with tiny food particles throughout the year to occasional feasting in summer. During this cruise these findings were confirmed in feeding experiments with "lollipop sponges" (lat. Stylocordyla sp.) whose food ingestion rates were found to be comparable to those of related species in temperate and tropical latitudes. There are, however, many other benthic species which make use of macroscopic food offered in the water column. Near the South Shetlands, sea anemones, certain soft corals (alcyonarians) and sea stars had principally fed on salps, gelatinous zooplankters which ingest small food particles in the water column. With this pelagic food concentrated in their stomachs, they undertake vertical migrations to the seafloor where they are swallowed by the benthos – a textbook case of pelagobenthic coupling! Other benthic organisms had fed on copepods, which also occur in large quantities close to the bottom in autumn. The principal result of these findings is that the Antarctic autumn does not appear to be a period of food scarcity but, instead, of intense interaction between the water column and the seafloor. It would be very interesting to continue these studies during a winter cruise in the next years.

That the food available in autumn is used is shown also by the fact that many species are found in advanced stages of reproduction during this season. This does not agree, either, with the concept that most polar benthos should release their larvae or juveniles in spring, when they can live on abundant new primary production. Many species rather seem to produce their offspring in autumn, subsisting on resources provided by the parents and slowly growing towards a stage when they start their own food intake. Various examples for this strategy were found among cnidarians and sponges. Another solution is that the adults protect juveniles which are able to feed on very small plankton or resuspended material. Many Antarctic brooders belong to this second group, including amphipods, isopods, echinoids, asteroids, crinoids and the brood-protecting bivalves and gastropods. On the other hand, the caridean shrimps seem to migrate towards shallower water in spring to release their highly developed larvae in an environment characterised by large amounts of phytoplankton. From a trophic point of view, too, the important result of this cruise is that the differences between the summer and the winter season do not seem to be as marked as was assumed in the past.

Beside the pelagic-benthic interaction and aspects of food availability and reproduction in autumn, benthic disturbance due to iceberg scour was again a major research issue during this cruise. The first approach was to quantify these processes. Icebergs are produced by the floating edges of the ice shelves. Along a short distance (150 km) near Kapp Norvegia, the substantial amount of 104 km^2 of ice edge broke off during the past four years and started its drift as icebergs. In addition to this local production, numerous bergs pass the area after breaking off in other parts and drifting with the coastal current around the Antarctic continent. When they encounter bottoms of certain depths, mostly between 150 and 300 m, they run aground and inflict damage on the benthic communities. During the next gale or spring tide they may be liberated, run aground again, etc. In a restricted area (10x20 km) close to Kapp Norvegia, we counted >100 icebergs, most of which touched ground at least temporarily. In such iceberg rest places about 70% of the bottoms revealed iceberg tracks.

Our original intention was to identify, based on the topography, disturbed and undisturbed grounds in these rest places, however we failed. The pattern rather resembled a mosaic, with frequent changes at short distance between old, complex assemblages and freshly disturbed ones or communities in some successional stage of recovery. Interestingly, iceberg disturbance results in distinctly higher species richness at larger scales as compared to undisturbed bottoms, which may be a consequence of the large number of coexisting successional stages, each one with a characteristic set of dominant species. The bottom trawl caught on average 248 benthic species in the strongly ice-disturbed area off Kapp Norvegia whereas only 105 species were found in undisturbed areas off the Antarctic Peninsula. These differences between iceberg scoured and non-scoured areas are valid also for the meiobenthos and the demersal fish communities. Obviously disturbance creates diversity. Under these circumstances it appears absurd to speculate about the "damage" inflicted by our sampling gear, which compared with iceberg scouring only causes needle stitches to the fauna.

Looking at the biogeographic relations between the Antarctic Peninsula and the Magellan region, this cruise has provided new evidence that the Drake Passage is a very effective barrier under the present climate conditions. On the southern slope, the fauna is totally Antarctic, with great abundance, e.g. of crinoids and a total lack of reptant decapods which are highly dominant on the northern slope. Frederich's hypothesis that it is the magnesium concentration in the reptant decapods which impedes them to re-conquer the Antarctic was corroborated by experiments on the large isopod Glyptonotus. This species which normally has a low Mg concentration, became sluggish when the Mg value was raised experimentally.

Many samples taken during the EASIZ III cruise require detailed analysis, many results have yet to be discussed to allow final conclusions. It is obvious already now, however, that this cruise has yielded a large number of interesting findings which are the outcome of close international cooperation on RV "Polarstern". In many cases, cooperation and communication between the working groups led to surprising results. As an example, studying pelagobenthic coupling the planktologists provided the information on the availability of food (small plankton, copepods, salps) which elucidated the strategies of the suspension feeders to the benthologists. Data on hydrography and sediment chemistry yielded the seasonal background for trophic studies at the seafloor. Activity and variability of iceberg movement provided an explanation for the distribution of disturbed and undisturbed benthic communities, and for patterns of species richness and diversity. Physiological mechanisms such as the effects of Mg concentration served to explain empirically found distribution patterns ; interactions between organisms pointed to natural products which enable coexistence or serve as deterrents; occurrence of parasites in intermediate fish hosts elucidated the pathways of infestation in seals. Even the accidental coincidence of the drifting buoy group and a group of seal researchers on return to South America brought the surprising result that elephant seals were living far south, at 90% packice cover.

Due to the present difficulties with permits to be obtained from the Federal Environmental Agency, some time was spent during this cruise to clarify controversial questions. This concerned, on the one hand, the iceberg scour effects and the frequency of iceberg strandings in relation to the impact of trawls and corers on benthic communities, on the other the behaviour of warm-blooded animals during the employment of acoustic gear. While these data are being analysed further, the actual state of observation is that we have no evidence whatsoever of a potential damage caused by this gear to the Antarctic fauna.

Apart from the scientific results it seems worthwhile mentioning that RV "Polarstern" is a good platform for work in the high Antarctic in autumn; however more time is required than in summer. Ice thickness (at first frequently a closed cover of a few centimetres to decimetres, later pancake fields which started rafting) was only a minor obstacle because the snow cover was thin at first. The pack ice zone increased, however, towards the north with impressive speed, towards the end of the cruise the snow cover became much higher, and in the nortwestern Weddell Sea old ice occurred with considerably thicker floes. Very low temperatures below –20°C caused us trouble with the use of gear on deck and during lowering and heaving; in some cases the equipment had to be heated under a canvas or exposed to warm water for some time. Due to the enormous width of the vessel trawling from the stern caused no problems even under medium ice cover whereas trawling from the side was problematic. More time has to be spent for clearing the ice away on the starbord side for ROV deployment, recovery of moorings, etc. Stronger winds in autumn cause some problems, too, not only on the way down from Cape Town when the vessel started rolling despite maximum weight but also in the pack where there is no swell, but the use of light equipment such as CTD and small plankton nets is hardly possible at wind force 9 or more. Lows with strong winds were following each other in an almost regular rhythm and lasted usually 3 days, mostly interrupted by 2 days of fair weather. The shelf ice edge does not provide any shelter, on the contrary: due to the katabatic winds wind forces are normally at least 2 Bft higher than further outside. At the Antarctic Peninsula the best way is to work on the lee side of the islands during strong winds. The Drake Passage was very calm on this cruise; a major problem can be the strong swell which may prevent the use of gears such as the Multibox corer or the ROV due to heavy vertical movement of the aft deck.

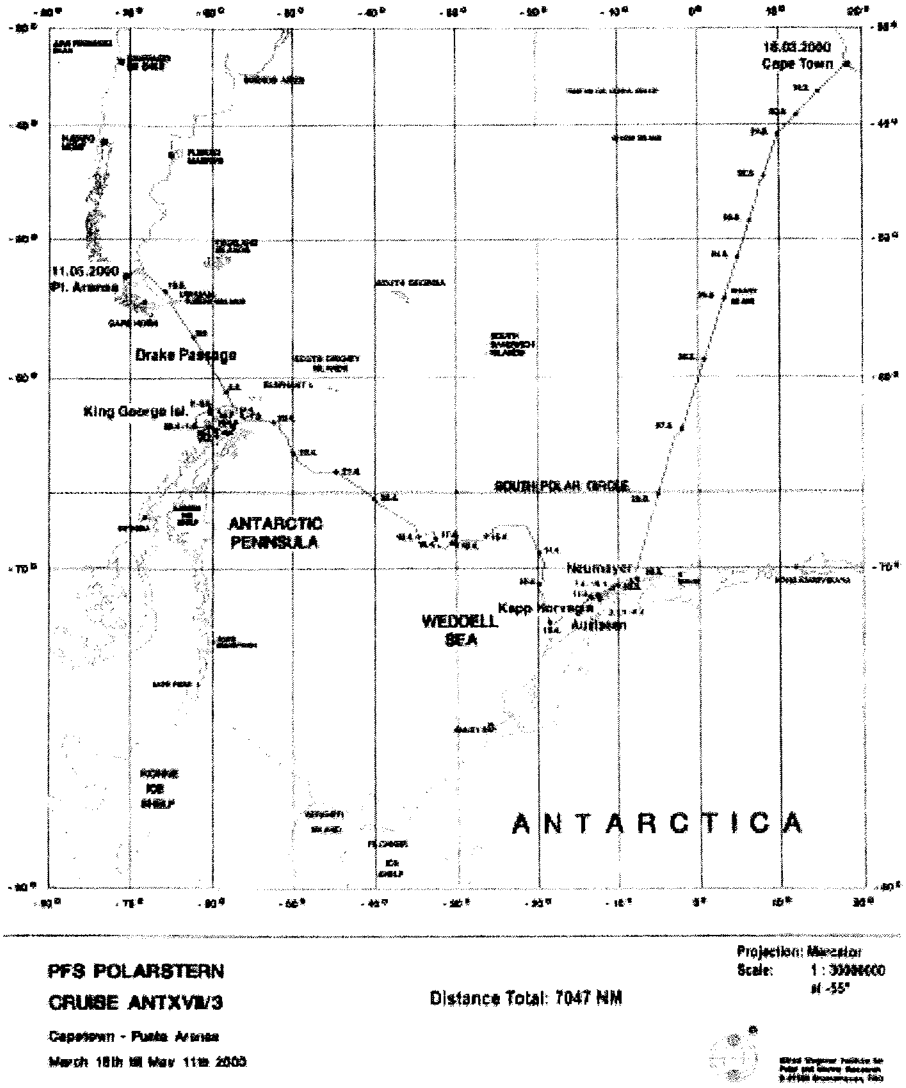


Fig.1 Track of PFS Polarstern during ANT XVII/3

1.3 **Itinerary** (W.E. Arntz)

RV „Polarstern" left Cape Town (South Africa) on March 18, 2000 with an international team of 56 marine scientists from 7 European countries, Chile, Colombia, Mexico and the United States, enforced by 2 meteorologists, 4 helicopter pilots and technicians, and 45 crew. As during the EASIZ II cruise, Spain contributed the largest foreign group on board.

During the first days of the crossing to Atka Bay (Fig.1), „Polarstern" encountered calm conditions. On March 21, a deep-sea Multicorer sample was taken for AWI geologists at 40°57'S, 09°53'W, and at a first station „north of Antarctic Convergence" zooplankton was collected and a CTD deployed. A second station (51°09'S, 05°03'W) south of the Antarctic Convergence, which was not very clearly marked during this cruise, also provided zooplankton and CTD data. Low wind and calm sea conditions prevailed until Bouvet Island, which was passed on March 25.
From March 26, „Polarstern" rolled under the impact of strong westerlies until she reached the first pack ice fields on March 28. Before arriving in Atka Bay, a search was started by helicopter for an iceberg that had drifted away from the ice edge off Sanae station with 125,000 l gasoline „on board". It turned out unsuccessful because the iceberg was no longer at its last position as suggested by satellite images, nor did it show up further west during the remainder of the cruise.
While the vessel remained in Atka Bay which was covered by a thin ice sheet, the Pancake buoy group installed an antenna at Neumayer station, those that had not visited the station before took the chance for a helicopter shuttle in bright sunshine, and benthic shallow-water work was initiated using the Giant Box Corer and a Remotely Operated Vehicle (ROV). Working conditions here and in the following weeks were hampered to some extent by very low temperatures around −20°C, particularly when the winds were coming from the Antarctic ice cap. On March 30, „Polarstern" left Atka and steamed along the ice edge to Kapp Norvegia, deploying a mooring on the way at the Auståsen iceberg rest place. Two further moorings were deployed off Kapp Norvegia. Much to our surprise, large „presumably undisturbed" areas off Kapp Norvegia were covered by icebergs whose movements were followed during our work from the bridge and by helicopter. In addition, the course of the shelf ice edge was measured from the helicopter to compare it with data obtained four years before.

Between March 31 and April 10, intense work was carried out using all available gear off Kapp Norvegia, at the Four Seasons Inlet hilltop studied already during EASIZ II, and at the Auståsen iceberg rest place. It mainly concerned the programmes „Comparison of disturbed and undisturbed benthic communities" and „Pelagobenthic coupling", making use of benthic samples also for other purposes such as „Biodiversity" and „Natural Substances", and doing zooplankton and CTD work mostly during the nights (see „List of stations" in Annex 3.2). Despite cold and sometimes very stormy weather, the goals of the two principal programmes were almost fully accomplished. On April 09, an emergency recovery had to be executed of a mooring that was threatened by a moving iceberg. The provision of more material from greater depths for various programmes planned after the work at Auståsen was postponed due to a heavy storm on April 11 when a decision was made to continue steaming to Drescher Inlet.
On April 12, forty-five miles from Drescher Inlet, one of the vessel's portside engines broke down. Considering the late season, the rapidly increasing thickness of the ice sheet under the prevailing low temperatures, and the daily increment of the snow cover on the ice, we decided to cancel work in the Drescher Inlet and to get out of the pack ice zone. The remaining moorings, which were to be recovered on return to Kapp Norvegia, had to be left back.

The crossing of the pack lasted until April 15. Once we reached the northern margin of the sea ice zone, the Pancake buoy researchers started looking for a suitable area to deploy the buoys. This was done satisfactorily until April 20, making use of the time between the deployments for ROV observations under the ice, CTD casts and pancake fishing. The next day „Polarstern" continued her way towards Bransfield Strait under calm sea conditions, arriving on Easter monday (April 24). Until April 28, sampling mainly for the Biodiversity and Biogeography programmes was carried out on the Peninsula side of Bransfield Strait and a transect to serve the Pelagobenthic Coupling programme was initiated, which included a canyon sampled by the Spaniards two years ago. Work was then continued towards the other side of Bransfield Strait, off Deception Island, until May 01. Besides using the usual game of trawled gear, bottom samplers, ROV and photo sledge, some CTD and zooplankton work was done, and baited traps were deployed. There was also a short exchange with the Argentinian icebreaker „Almirante Irízar" which was relieving a summer station at Deception.

Due to exceptionally favourable weather, „Polarstern" headed for the Drake Passage on the evening of May 01 and worked a benthos and fish transect between 200 and 800 m to collect material for a direct comparison with the northern (Magellan) shelf and slope. During this work the vessel encountered seven trawlers from various nations fishing north of King George Island.
After return to the Bransfield Strait, baited traps were deployed in Admiralty Bay, cargo was taken aboard from the Dallmann laboratory by helicopter, and scientists on „Polarstern" were given the opportunity to visit the lab and Jubany station. In return, a strong Argentinian group visited the vessel. The baited traps were deployed again off the Potter Cove, and the photosledge was used a last time, before on May 07 five AWI scientists, who had been working at the Dallmann lab, were taken aboard, and „Polarstern" started her return to South America. After an exceptionally quiet crossing of the Drake Passage, the vessel sailed along the Tierra del Fuego east coast and into the Straits of Magellan, to arrive on schedule in Punta Arenas in the night of May 10/11.

1.4 Meteorological and Ice Conditions (R. Strüfing, H. Köhler, Max Coon)

Cape Town – Atka Bay (March 18 – 28)

Leaving Cape Town on 18 March "Polarstern" encountered calm and sunny weather. Between 40° and 50°S temperatures dropped and on 23 March winds rose to southwesterly gale force for the first time when a secondary low developing along a low pressure region affected "Polarstern" weather. On 25 March clearing clouds enabled a rare sight of Bouvet Island. Again winds increased for a short time to force 8 to 9 when another depression passed. But patience of crew and scientists was really stressed when on 27 March a gale force low caused northwesterly winds Beaufort 9 with 7 m waves crosswise. Especially near 60°S water temperatures dropped considerably below the values measured nearly 20 days before during the home leg of ANT XVII/2, suggesting that this relatively fast cooling was initiated by strong cyclogenesis east of "Neumayer" leading to abnormally intense southeasterly winds. The first sea ice was sighted at 15:00h on March 28 and by 18:00h there was a 50% ice cover.

Weddell Sea (March 29 –April 23)

On 29 March brilliant sun shine over the shelf ice permitted 40 scientists and crew to visit the "Neumayer" station by helicopter shuttle. Atka Bay had new thin (4-10 cm) ice with 90% concentration. At this time temperatures of –17°C together with easterly winds of 20 kn caused a wind chill effect of –40°C thus indicating the progressing autumn season, as did the winds on 1 April when near Kapp Norvegia the southeasterlies rose to Beaufort 11 due to an intense low amplified by catabatic effects.

But autumn has periods with calm and sunny weather as well, which "Polarstern" experienced at Auståsen during the following days culminating in a polar light observed on 6 April, apparently an event of global dimensions even observed in Europe. Until 12 April mixed weather affected "Polarstern", gale force lows with up to Beaufort 10 were alternating with calmer high pressure intervals. During this period the coordination of scientific work was dominated by the quite complete ice coverage and the surprisingly fast drift of icebergs.

After work in Drescher Inlet had to be cancelled "Polarstern" experienced more easterly gales between 12 and 15 April on the way out of the Weddell Sea ice. During the period of pancake ice research near 69°S 30°E high pressure over the northern Weddell sea caused calm weather ideal for the deployment of the buoys. The easterly gale, however, moved the ice to the west along the ice edge between 20° and 30°W and the buoys were deployed between 30° and 40°W in new pancake ice.

Due to intense cyclogenesis west of the Antarctic Pensinsula some secondary lows developed east of this area causing northerly winds sometimes of gale force intensity and poor visibility. Extensive ice coverage and a long chain of icebergs inhibited the rounding of the Peninsula which was finally accomplished on Easter sunday, April 23.

Bransfield Strait and South Shetland Islands (April 24 – May 7)

By the time "Polarstern" reached this area the central low over the Amundsen Sea had disappeared giving way to a weather situation of weak pressure gradients, partly with bad visibilities and often with low clouds. When stronger cyclogenesis started again, this time over the Weddell Sea on 25 April easterly winds acted to dissolve the clouds so the Trinity mountains of the Antarctic Peninsula could be seen in full splendour. Around 30 April westerly winds rose for short periods to force 8 around Deception Island but hardly any waves developed. During 2 and 3 May when scientific work took place in the Drake Passage, wave heights of around 2 metres occurred caused by southwesterly winds.

South Shetland Islands to Punta Arenas (May 7 – 11)

During the home leg a high pressure system developed northwest of the Drake Passage moving east. The mainly southerly winds were accelerated for a short period only by cyclogenesis near the Falkland Islands. Therefore the Drake Passage was traversed in favourable conditions continuing along the Tierra del Fuego coast where westerly winds persisted.

During ANT XVII/3 only on very few occasions scientific work was interrupted by meteorological conditions. This is true also for the ice conditions which worsened considerably according to the season. It is assumed that an itinerary further to the north would have been much more affected by wind and waves than this cruise with long periods in the ice.

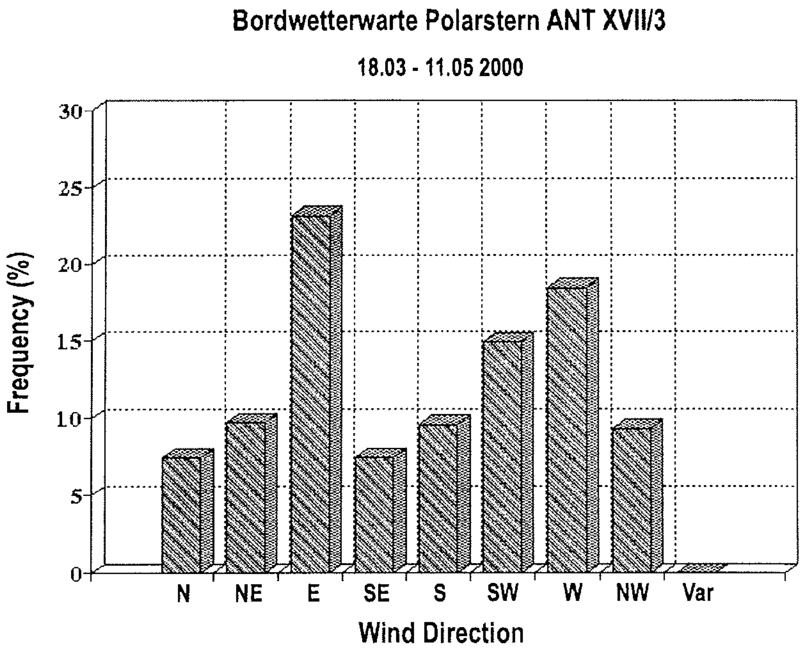


Fig.2 Frequency of wind direction between March 3 and May 11.

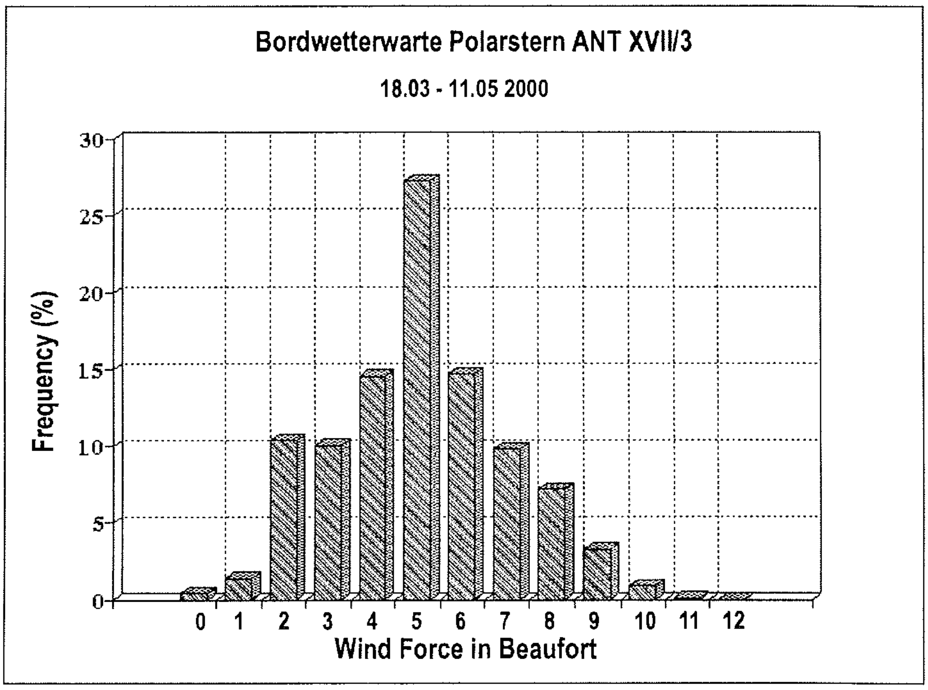


Fig. 3 Frequency of wind force between March 18 and May 11.

2. Results

2.1 Pelagobenthic Coupling and the Role of Benthic Suspension Feeders (J.M. Gili, I.Alfonso, J. M.Gasol, E. Isla, P. López-González, C. Orejas, C. Pedrós-Alió, S. Rossi, F. Sabater, F. Pagès, S. Piraino, N. Teixidó, D. Gerdes, W.E. Arntz)

Introduction and Objectives

Recent data on the natural diet of some benthic suspension feeders and of variations in the diet due to changes in availability of food in the water column and varying hydrodynamic conditions suggest that these benthic communities may play an overall regulatory role in the ecosystem (Gili and Coma, 1998). While work in temperate ecosystems has shown that dense assemblages of suspension feeders have a high impact on plankton communities, their role in Antarctic systems is still an open question.

Many benthic assemblages in Antarctica are rich in abundance and taxonomically diverse, and the largest proportion of the Antarctic benthic communities is made up of sessile suspension feeders, e.g. sponges, bryozoans, ascidians, and certain echinoderms. Average benthic biomass of these organisms in the Antarctic is higher than in temperate and subtropical communities.

The main objective of this working group was to test some hypotheses about the mechanisms of ecological success of benthic Antarctic suspension feeder communities. The research plan was developed based on recent empirical work in the Antarctic benthic ecosystem, mostly during the previous EASIZ "Polarstern" cruises. Therefore, aspects related to the trophic ecology of suspension feeders and to environmental conditions which facilitate the processes of energy transfer between the benthic and water column systems have been emphasized. In particular we have asked the following questions: Is the formation of organic matter (primary production) in the water column significant for suspension feeders? What do we know about the fate of this organic material and what is available in near-bottom waters or at the sea floor? Which processes (vertical transport, resuspension or lateral advection) are responsible for the availability of food to suspension feeders? To what extent are the abundance and patchiness of suspension feeder communities a consequence of biological and environmental factors which favour the development of this kind of benthic communities?

Objectives

a) Water flow measurements throughout the water column and near the bottom, and sediment composition: identification of the processes that cause resuspension and/or transport events, which influence the variability of particle fluxes, their transfer offshore, and the formation of near-bottom nepheloid layers.

b) Water column seston analysis including pico-, nano-, micro- and zooplankton. Main emphasis to be placed on the comparison between surface and near-bottom waters.

c) Small-scale studies at three stations selected according to the high or low density of benthic suspension feeder communities in the Weddell Sea and at the Antarctic Peninsula.

d) Biological and chemical characteristics of, and processes in, the water column especially near the bottom: organic and inorganic particle concentration, microbial activity and organic nutrient concentration.

e) Study of natural diet and feeding rates of the sponge *Stylocordia borealis* (active suspension feeder) and gut content analyses of the hydroid *Corymorpha* *parvula* and the alcyonarian *Anthomastus bathyproctus* (passive suspension feeders) in relation to specific prey availability.

f) Stoichiometric analysis (lipids, proteins and carbohydrates) of several species of gorgonians in relation to the composition of these substances in the sediments and in the water column.

g) Relationship between zooplankton abundance close to the bottom and suspension feeder prey capture.

h) Reproductive strategies,quantification of gonad production and larval release in several species of gorgonians. Abundance and spatial heterogeneity of the more abundant species of this group on the continental shelf of the Weddell Sea.

i) Diversity of several groups of organisms involved in the procesess of bentho-pelagic coupling both in the water column and at the sea floor.

2.1.1 Water Column Features

Objectives

To develop a sound idea of the environmental conditions at the sea floor it is necessary to determine the water characteristics above it and to elucidate the way the two subsystems are related. Obviously, many processes which are of importance to benthic suspension feeder communities (availability of particles and suspended food) and properties of these communities themselves (structure, biomass, diversity) depend largely on water characteristics near the bottom.

A high-resolution experiment at small scale was considered an efficient tool to get sensitive information when trying to define particular areas since slight spatial differences and/or microenvironments can be detected. Comparison between different environments was to improve the understanding of water column characteristics and the relationships with benthic communities. The use of moored instruments was essential to measure temporal changes at one particular point, for example current speed and direction which is the main factor controlling food supplies. The coupling of both data sets with their temporal and spatial differences should enable us to arrive at a general idea of how a benthic environment behaves under certain pelagic conditions. To determine the relation between water column gradients and the sea floor, temperature, salinity, turbidity, nutrients, pigments, proteins and microorganisms were measured.

Work at sea

34 CTD stations were performed as three transects and one grid (Fig. 4). Four sites were selected to evaluate and compare water column characteristics and its interaction with the bottom. All stations reached between 5 and 10 meters above the bottom.

In the high Antarctic the Kapp Norvegia, Hilltop, and Auståsen areas were studied because of their differences in benthic suspension feeder communities whereas in the western Bransfield Strait basin the Orleans Canyon was studied because of its very peculiar oceanographic conditions.

A grid with three transects of 5 stations each was done at Kapp Norvegia as a "high resolution at small scale" experiment. Distance between stations was around 2 nautical miles. The grid was completed in a 16-h period with a replica station after 48 h at the centre of the grid. Depth ranged from 296 to 440 m.

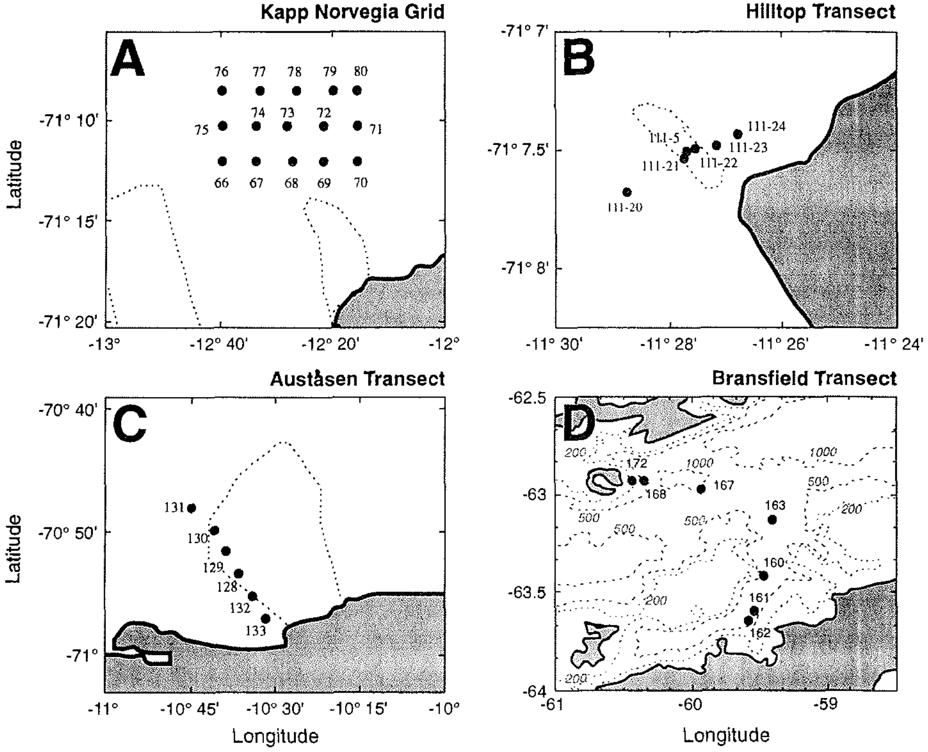


Fig. 4 Study areas and station numbers. The dotted lines at Kapp Norvegia and at Auståsen indicate iceberg rest places, at Hilltop the 100 m isobath.

The 6-station transect at Auståsen was carried out in a high-density area of icebergs. It was developed perpendicularly to the ice edge and across the main current pattern of the Weddell gyre, and performed in 4.5 h. Mean distance between stations was 2 nautical miles. Depth varied between 209 and 476 m.

Two moorings were deployed. Each one had a set of two Anderaa current meters, one model RCM 7 and one RCM 9. Both instruments measured conductivity, depth, temperature and current speed and direction. The RCM 9, closer to the bottom was also equipped with a turbidity sensor.
The mooring at Kapp Norvegia could not be recovered during the cruise due to technical problems. The other one, at the central position of the Auståsen transect, was recovered after a 9 days sampling period. Data acquisition frequency was 5 minutes. The sensors were 8 and 68 meters above the bottom (mab) at a depth of 235 m.

The transect at Hilltop comprised 6 stations and was performed in 2.5 h, parallel to the ice edge and along the main current pattern of the Weddell gyre. The depth of the casts done at this iceberg-free, shallow area varied between 64 and 145 m. Distance between stations was only between 250 and 1800 m.
The 7-station transect in the western basin of the Bransfield Strait was developed along the Orleans Canyon from the Antarctic Peninsula to Deception Island. Depth range varied from 398 to 1014 m.

Preliminary results

A) Kapp Norvegia grid

Salinity

Two different layers of stable salinity were detected, at the surface and just above the bottom at approximately 300-350 m depth (Fig. 5). The transition between these two layers was more evident in the northern (stations 67-70) and southern (stations 76-80) transects than in the central one where the salinity profiles were steeper. The halocline within the southern transect, which was the closest to the ice-edge, was about 125-175 m deeper than in the rest of the grid.
The fast change observed in the northern transect may have been caused by the intrusion of deeper water. The fast but deeper change in the southern transect could be due to its proximity to the ice edge and icebergs, and the slight change within the central transect could be the result of a transition between both adjacent transects. The profile of station 67 matches better with those of the casts of the central transect, maybe because it is not as close to the ice edge as the rest of the southern transect.

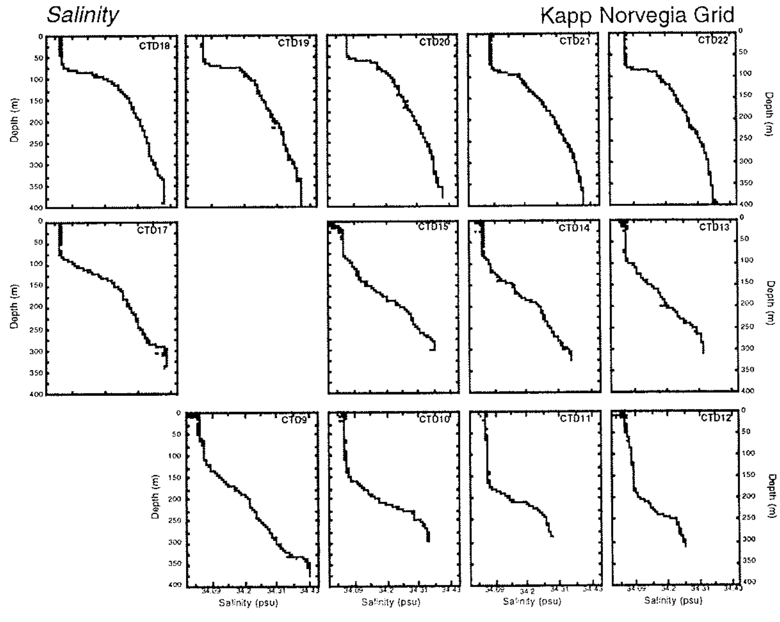


Fig. 5 Salinity profiles registered at the Kapp Norvegia grid. Sequence of stations as in Fig. 4. Empty spaces: CTD did not work.

Temperature

Temperature profiles showed two stable layers, one at the surface and another, warmer, at approximately 300-350 m depth (Fig. 6). Stations 67, 69, 70, 71, and 75 did not show this warm layer but a stable value around −1.85°C along the whole profile. This stability of the water column could be the result of the influence of the ice edge and the presence of an iceberg close to stations 69 and 70, where the profiles were completely flat. There was an increase in temperature at approximately 100 m depth in the central and northern transects. A thin warm water layer was found at the most oceanic stations (72, 73, 75-80) that could be a reminiscent summer layer isolated from the surface by rapid ice formation.

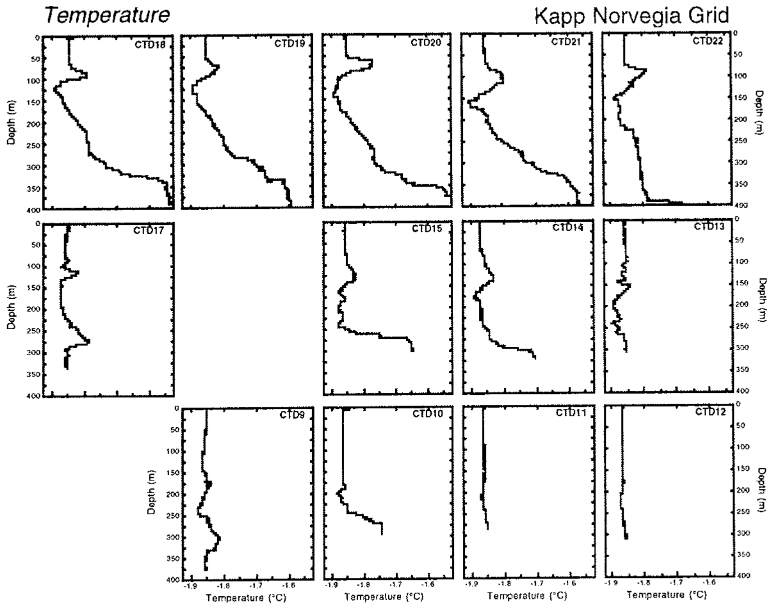


Fig. 6 Temperature profiles registered at Kapp Norvegia grid. Sequence of stations as in Fig. 4. Empty spaces: CTD did not work.

The temperature and salinity increases at the bottom could be due to the intrusion of Circumpolar Deep Water advected from the Antarctic Circumpolar Current due to the action of the Weddell gyre. The occurrence of both the thermocline and the halocline in deeper layers at the most coastal stations may have been the consequence of the action of Ekman transport and convection (Fahrbach et al., 1997), among other factors as ice presence.
The most notorious changes occurred in a gradient from the ice edge to the open sea, which means, across the main circulation pattern of the Weddell gyre. These changes happened within approximately 4 to 9 nautical miles.

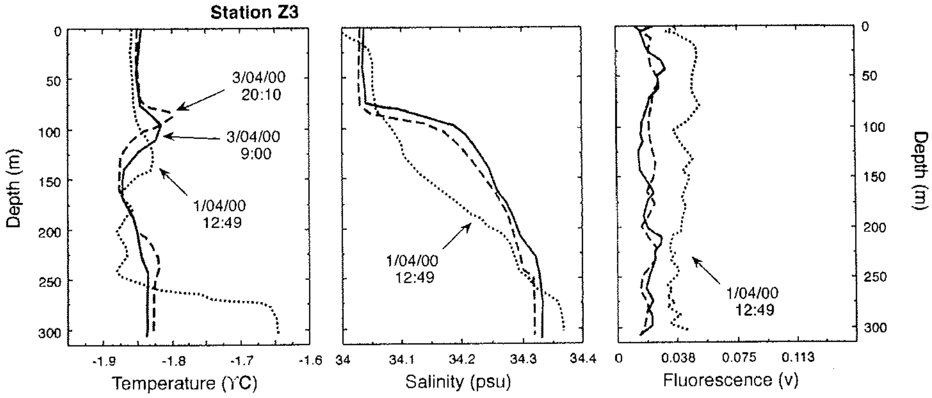


Fig. 7 Variations within a 48 h period at station 73, Kapp Norvegia grid.

The replica station, st. 73, showed very little differences after 48 h in any measured variable except temperature (Fig. 7). The increase in temperature around 300 m vanished and the profile became almost flat as in the most coastal stations. Since salinity did not change it is possible that the presence of an iceberg stabilised the water column, leading to a temperature decrease near the bottom.

Turbidity

Turbidity values increased towards the bottom at each station (Fig. 8), following the salinity patterns closer than those of temperature. It is possible to associate turbidity changes with density gradients caused by salinity changes.

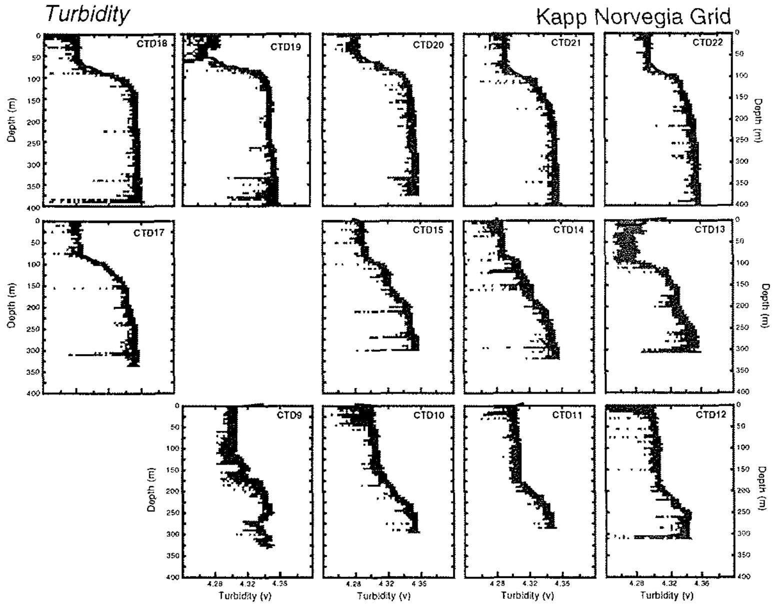


Fig. 8 Turbidity profiles registered at the Kapp Norvegia grid. Sequence of stations as in Fig. 4. Empty spaces: CTD did not work.

B) Auståsen transect

This transect was almost (except station 130) surrounded by icebergs (Fig. 4) and was located just about 2 nautical miles from the ice edge.

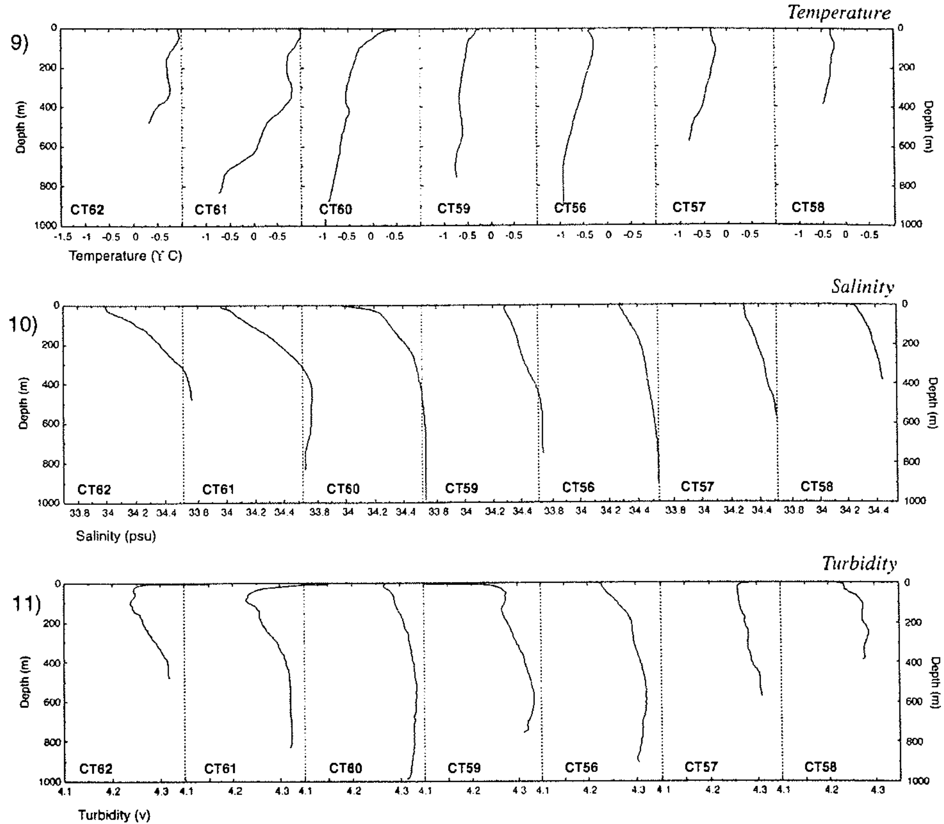
Salinity

Salinity profiles were almost homogenous at each station (Fig. 9). Stations 130 and 131 were located in the most off-shore and deepest area and their salinity profiles showed an increase towards 150 m depth. This change could be due to both the effect of icebergs and the bottom topography that allowed the intrusion of deep water. Surface salinity in this area had the same values, around 34 psu as the surface values on the Kapp Norvegia grid.

Temperature

Temperature profiles were homogenous, around -1.87°C, but again stations 130 and 131 showed a different pattern (Fig. 10). Surface temperatures were like those on the Kapp Norvegia grid but instead of an increase with depth, at Auståsen a decrease was detected. This cold water should be related to iceberg occurrence since intrusion of Deep Warm Water seems to be the main process in this area (Gouretsky and Danilov, 1992). The little increase around 100 m detected on the Kapp Norvegia grid is not reflected here, but at station 131 a slight increase occurred near 170 m depth.

Bransfield Transect



Figs. 9/10/11 Temperature, salinity and turbidity profiles registered at the Auståsen transect.Left is North, right is South (cf. Fig. 4).

Turbidity

Turbidity profiles were homogenous at each station (Fig. 11), they did not reveal the changes that the salinity profiles showed. Turbidity values were like those on the Kapp Norvegia grid.

Mooring

The average current speed at 68 mab was 8.54 cm/s while at 8 mab it was 14.92 cm/s (Fig. 12). Both speeds are able to develop important resuspension events.
The water at 68 mab was slightly fresher and cooler than that detected near the bottom at 8 mab. The former had –1.84ºC and 34 psu while the latter had –1.8ºC and 34.12. These differences were probably caused by icebergs. Conductivity and temperature profiles were quite constant along the study period.
Turbidity had low but measurable values and was constant during the sampling period, with occasional peaks. Current direction showed variations similar to tide movements.

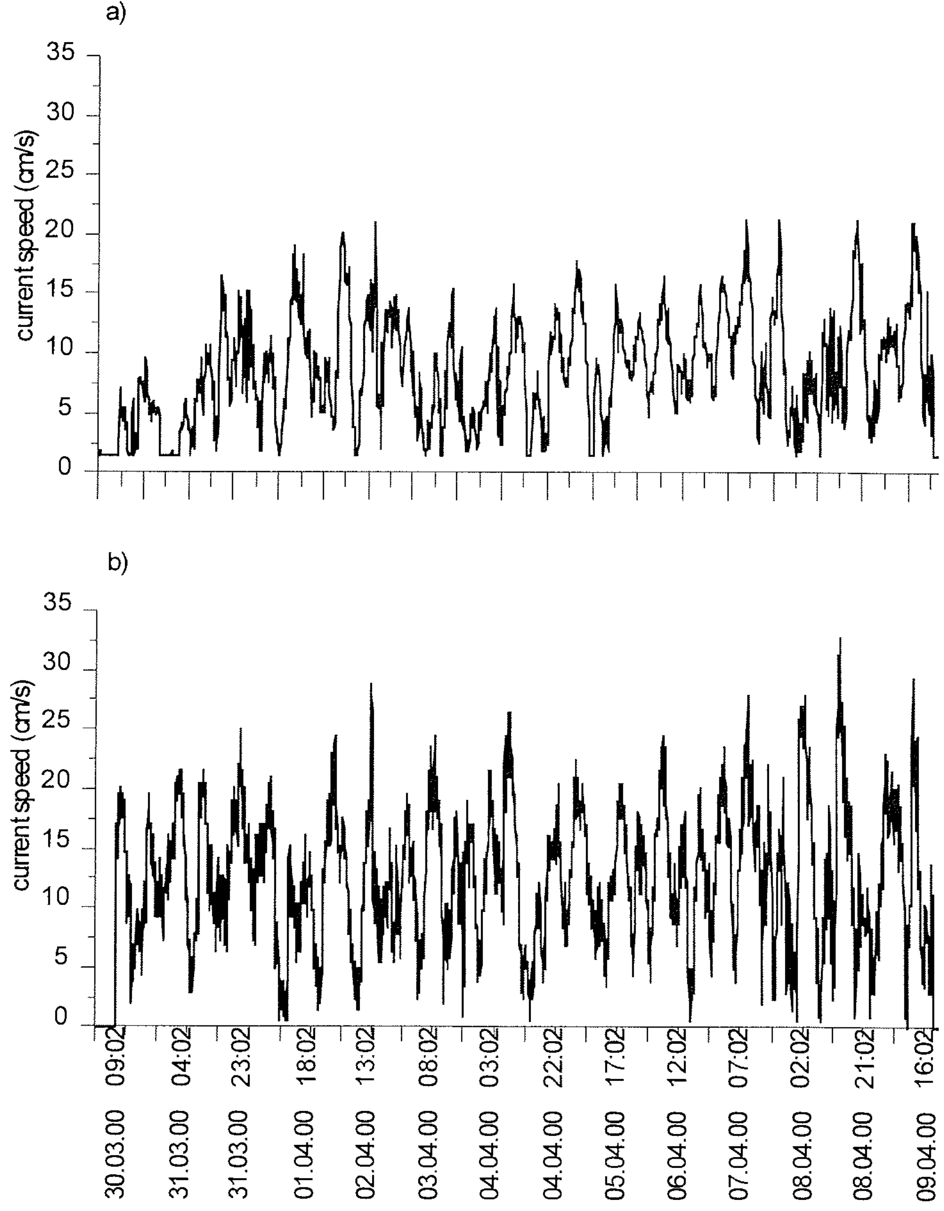


Fig. 12 Current speed at the mooring site at Auståsen. Profile a represents speeds at 68 metres above bottom (mab), profile b represents speeds at 8 mab.

C) Hilltop transect

Salinity

Salinity profiles showed no variation (Fig. 13). All stations were shallow and since they were located along the main current pattern it is highly probable that the same water was detected during all the measuring period and depth had no influence on conductivity values. All these values were like those at the surface in the Auståsen and Kapp Norvegia areas.

Temperature

Temperature profiles were more variable than those of salinity but changes were not higher than 0.01°C (Fig. 14). Surface temperature was the same as in the Auståsen and Kapp Norvegia areas.

Turbidity

Turbidity values were higher than those at the Auståsen and Kapp Norvegia stations and showed no variation with depth (Fig. 15). The highest value was found at the shallowest station, the top of the hill, which may receive suspended particulate matter from down hill due to current transport.

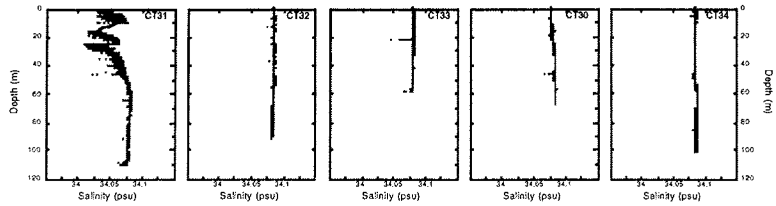


Fig. 13 Salinity registered at the Hilltop transect. Stations begin in the Southwest (left) and end in the Northeast (cf. Fig. 4).

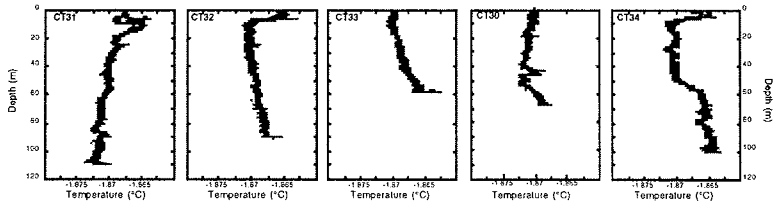


Fig. 14 Temperature profiles registered at the Hilltop transect.

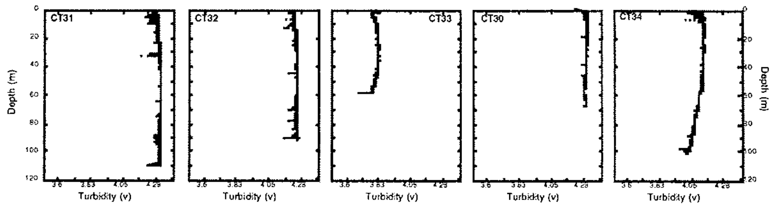


Fig. 15 Turbidity profiles registered at the Hilltop transect.

D) Bransfield Strait transect

Salinity

Two different water masses were identified at the surface, one group of stations along the Orleans canyon and another one close to Deception Island (stations 172 and 168, with fresher water) (Fig. 16). According to the surface circulation pattern in the Strait (García et al., 1994), the type of water detected at the stations above the canyon was probably surface water from the Weddell Sea and the water detected close to Deception Island was coming from the Bellingshausen Sea. All stations showed a salinity increase with depth.

At station 167 salinity increased sharply and acquired the same pattern as the water above the canyon.

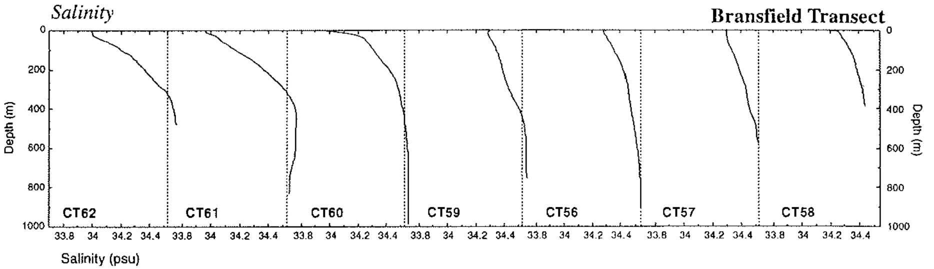


Fig. 16 Salinity profiles registered at the Bransfield transect. Stations start in the South, at the Antarctic Peninsula (left) and end in the North, off Deception Island (right) (cf. Fig. 4).

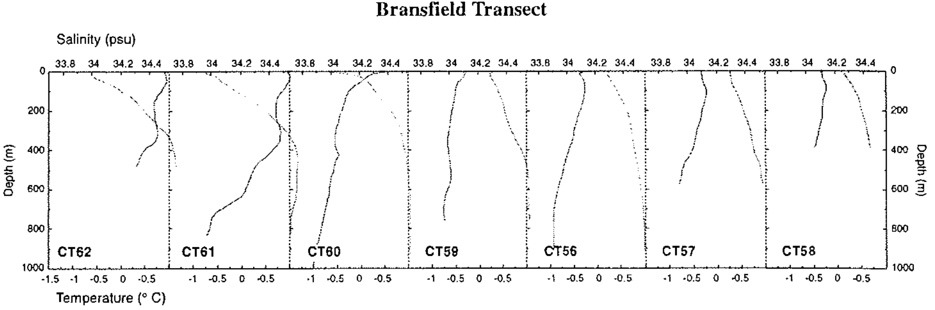


Fig. 17 Temperature profiles registered at the Bransfield transect.

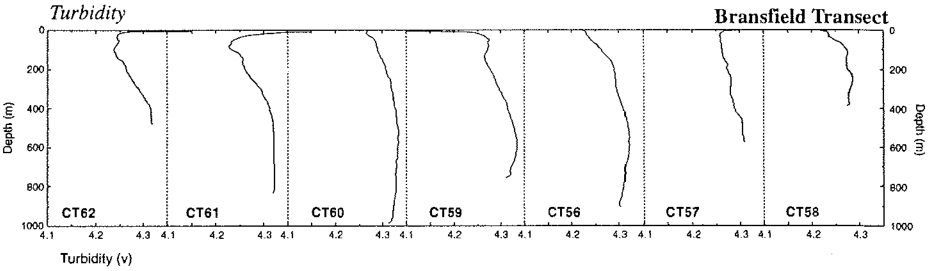


Fig. 18 Turbidity profiles registered at the Bransfield transect.

Temperature

Surface temperature could be divided in two groups as well, warm water at the stations close to Deception Island, stations 168 and 172, and colder water along the Orleans Canyon (Fig. 17). Station 167 calls attention again because its surface temperature value was between the two groups. Presumably this reflects two water masses, one salty and cold from the Weddell Sea along the Orleans Canyon, and the other one warm and fresher from the Bellingshausen Sea. Station 167 still had influence of Weddell Sea water as can be seen from the temperature profile. The possible front between these different waters should have been closer to Deception Island than station 167.

There was no water mixing as revealed by the temperature profiles so the increase of salinity found at station 172 and 168 must be due to other reasons.

Turbidity

Turbidity showed a decrease towards the bottom and each profile behaved like those of salinity (Fig. 18). No zonal differences were detected.

2.1.2 Sediment Features

Objectives

Sediments represent an important and throughout the year constant, food source to benthic communities. To determine the biochemical nature and other characteristics of possible food sources at the sea floor, sediment analysis represents an important research task within the bentho-pelagic coupling context.

Resuspended sediment can directly or indirectly be a source of food for benthic organisms. The quality of this material (i.e. organic material, protein, carbohydrate and lipid concentrations) can be evaluated and compared between sites. Our goal was to evaluate this potential availability of food, following the protocols of Grémare et al. (1997).

Work at sea

31 surface sediment samples were taken at Kapp Norvegia, Hilltop, Auståsen and in the Bransfield Strait. This sampling was enforced with 8 cores taken at Kapp Norvegia, Auståsen and in the Bransfield Strait. Surface sediment samples were taken from material obtained by Giant and Multibox corers and the TV grab. At Auståsen 9 sediment samples and one 22 cm core were taken. Depth range varied between 200 and 700 m. 4 stations were performed in the Hilltop area. Only surface sediments were taken and the depth range varied between 63 and 106 m. At Kapp Norvegia 13 surface sediment samples and 2 cores (8.5 and 16 cm) were taken. Samples were obtained between 295 and 421 m depth. 5 cores and 7 surface sediment samples were taken in the Bransfield Strait, along the Orleans Canyon and close to Deception Island. These samples were collected from water depths between 279 and 990 m.

Preliminary results

A) Kapp Norvegia grid

Samples were mainly fine dark sediment.

B) Auståsen transect

We found fine sediment: At some stations, e. g. 130, fine green to grey sediment with a high quantity of spicules up to 50 cm depth was recovered.

C) Hilltop transect

Samples at this area had mainly fine dark sediment as at Kapp Norvegia. Maybe these areas have the same sediment sources.

D) Bransfield Strait transect

Close to Deception Island, stations 172 and 168, the sediment was coarse black, presumably volcanic ashes from the island. The samples from the Orleans Canyon were intense olive green fine sediment presumably with high amounts of organic matter.

The most striking feature was found at station 160 where a thick, 14 cm, layer of fine black sediment was present. This layer had a notorious smell of H_2S and organic matter. The 14 cm below this layer were intense olive green. It is probable that the black layer prevented sediments from being transformed.

Total organic and inorganic carbon analysis will be performed at the sedimentology lab at ICM Barcelona, as well as total nitrogen, proteins, total lipids and their fractions, carbohydrates and grain size analysis. Radiometric analysis (Pb ^{210}) will be practised in order to establish particles and elementary sedimentary components and accumulation rates. This information will be very useful when constructing biogeochemical cycles for these areas densely populated by benthic communities.

At this point is possible to state that the Orleans Canyon is a very rich organic matter reservoir when compared with the bottom environments studied in the eastern Weddell Sea.

2.1.3 Water Column Nutrients

Objectives

One of the main objectives of this cruise was to determine the importance of bentho-pelagic coupling between the water column and the sea floor in the Weddell Sea (high Antarctic), where pelagic production is noticeable during summer and benthic biomass of the suspension feeder community on the shelf is well-developed. Within this context, nutrient analyses of the water column were carried out in order to understand decomposition rates of the organic particles sinking along the depth profile instead of estimating the amount of those compounds which are removed by primary producers. Dissolved nutrient analyses including the main Nitrogen compounds (from the most reduced to oxidized molecules: Dissolved Organic Nitrogen, Ammonia, Nitrite, and Nitrate), Phosphate (detected as Solute Reactive Phosphate, SRP) and Dissolved Organic Carbon (DOC) at different depths, from the surface to the bottom, allowed us to relate microbial activity with the concentration of organic compounds such as Lipids, Proteins, and Carbohydrates. Considering that most nutrients and DOC remained in the water column as a record of the amount of primary production from an earlier period (spring-summer), the relationship between reduced compounds of Nitrogen depletion along the column and the increase of Nitrate (the most oxidized compound of Nitrogen) allows us to calculate rates of mineralization of the settling organic matter. Since it is well known that high nutrient levels in surface waters promote high rates of synthesis of organic matter, stoichiometric analyses of Nitrogen and Phosphorus should enable us to hypothesize on the degree of new pelagic production which is available for the sessile communities of suspension feeders. Benthic communities may also exert an important impact on the water column, and enhance processes related with organic matter mineralization or nutrient recycling.

Work at sea

Samples were taken from four stations as described above, three situated in the Weddell Sea and the fourth located in the western Bransfield Strait (Fig. 4).

At each station we collected vertical profile data on temperature, salinity, depth, and nutrient concentrations (Nitrate, Nitrite, Ammonia, Total Dissolved Nitrogen, and

Phosphate). Temperature, salinity and depth profiles were obtained from CTD casts.

Triplicate samples for nutrient analyses were collected from selected depths at each sampling station (seven or six depths, depending on the pycnocline or vertical stratification of the water column) using Niskin bottles attached to a Rosette sampler, from the bottom to the surface. All samples were gently syringe filtered through 0.4 µm pore-size Watmann GFF and analyzed immediately on board. Nutrients were determined by colorimetric methods, using a Technicon autoanalyzer III. For calibration eight standards were run with the samples in each set of 25 samples. Ammonium was analyzed manually on filtered samples using spectrophotometer with 5 cm cells.

Preliminary Results

A) Kapp Norvegia grid

Concentrations of dissolved nutrients on the Kapp Norvegia grid indicate that, overall, Phosphorus and Nitrogen concentrations increased substantially along the profile of the water column.

Dissolved Organic Nitrogen (DON) values varied roughly between 10 µM in surface waters and exceptionally to nearly 100 µM close to the bottom (Fig. 19). Nevertheless, values of DON ranged, in average, between 10 and 40 µM at sites with depths higher than 400 m. In contrast, sites of the grid at lower depths and closer to the ice pack displayed DON concentrations, which were relatively higher than the rest, with maximum values between 60 to 110µM (Fig. 19). Although there was a consistent maximum centered at about 300 m depth, occasionally high values were found in the upper water column at 20 m depth.

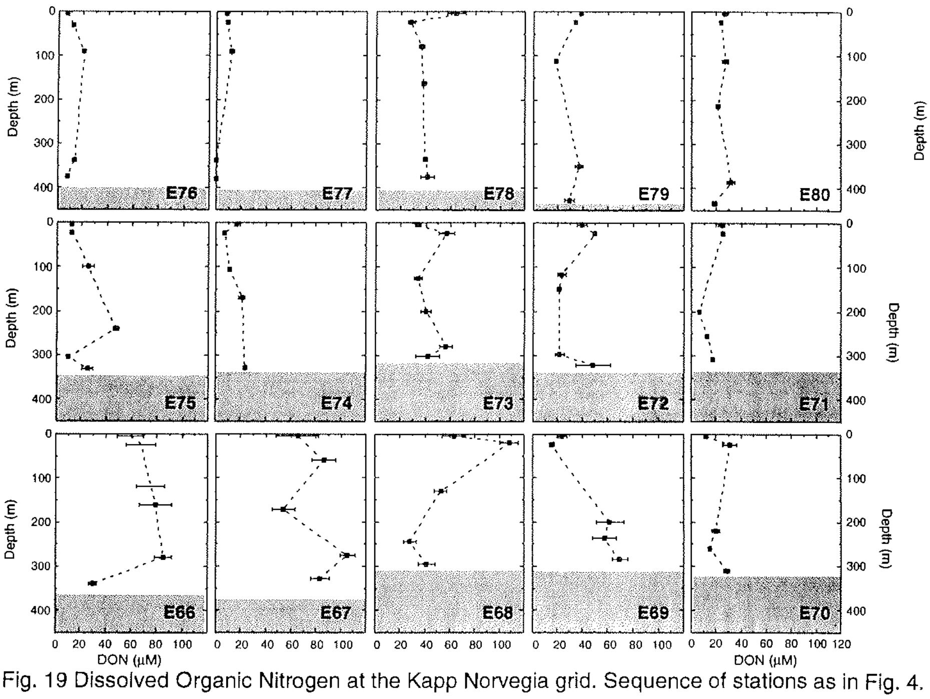


Fig. 19 Dissolved Organic Nitrogen at the Kapp Norvegia grid. Sequence of stations as in Fig. 4.

Dissolved Inorganic Nitrogen (Ammonium + Nitrate) concentrations increased substantially along the depth profile. The gross features of the vertical distributions of nitrate and ammonium did not appear to change significantly among the various sites of the grid (Fig. 20). There were two distinct opposite patterns between Ammonium and Nitrate concentrations. Ammonium values decreased with depth and ranged, on average, from 1.7 µM at the surface to less than 0.5 µM in deep waters. In contrast, Nitrate concentrations increased from 24 to 32 µM , with the highest values near the bottom. Ammonium levels figured around 1.5 µM in the upper part of column water or in the euphotic zone, and values of less of 0.5 µM in depths below the euphotic zone. There was a conspicuous pattern in the ammonium profiles that compared the different sites of the grid. The sites situated closer to the ice pack and at lower depths displayed higher ammonium concentrations than the rest, with values above 1.5µM. Nitrate profiles showed a clear increase below the euphotic zone. Below 150 m depth, changes in nitrate concentrations were negligible (Fig. 20).

Solute Reactive Phosphate (SRP) values were between 1.3 and 2.2 uM throughout the area of Kapp Norvegia (Fig. 21). In overall, SRP increased with depth. However, the greatest change of the profile gradient occurred below 100m depth (below the euphotic zone). The lowest values were found in surface waters at points situated farther away from the coast. In contrast, at sites of the grid near the coast with less depth, SRP concentrations in surface waters were significantly higher, between 1.8 and 2.2 µM. These values are similar to those found in deep waters (Fig. 21).

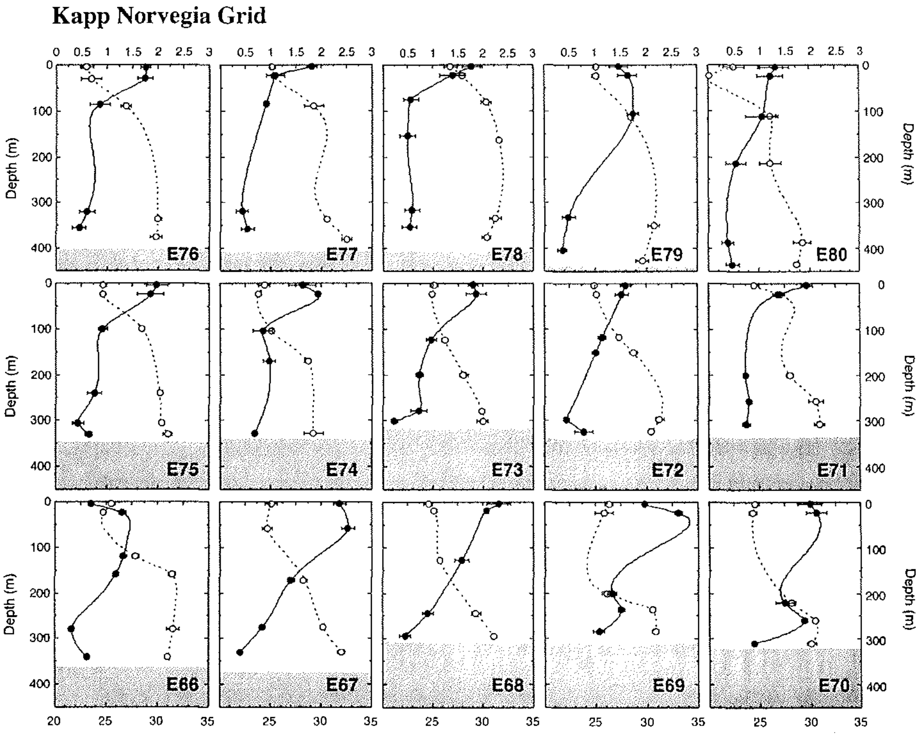


Fig. 20 Dissolved Inorganic Nitrogen (cicles: Ammonium, dots: Nitrate) at the Kapp Norvegia grid. Sequence of stations as in Fig. 4.

Kapp Norvegia Grid

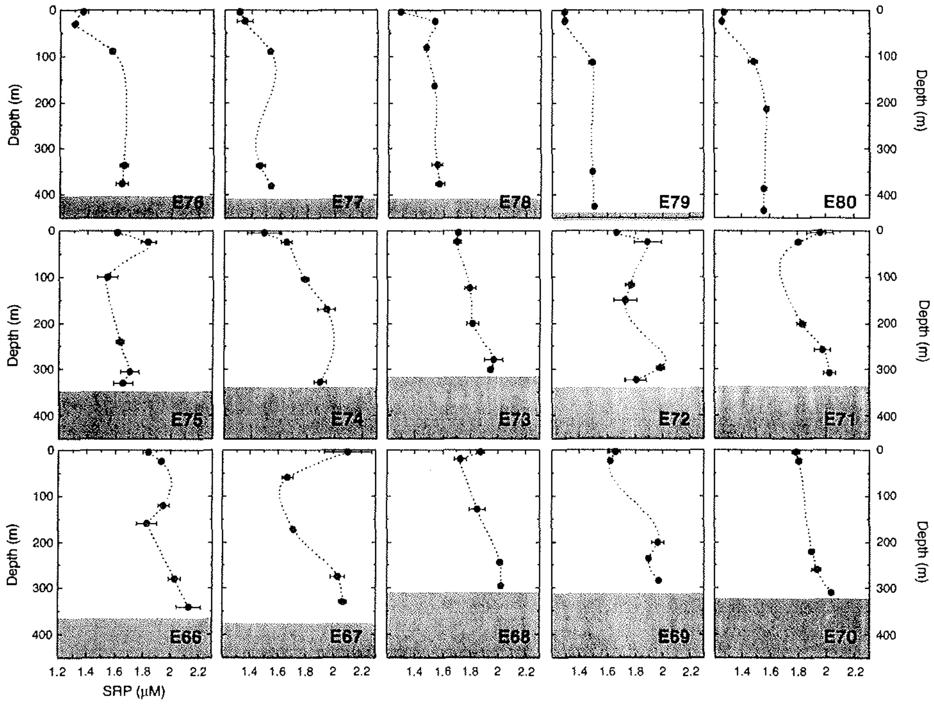


Fig. 21 Solute Reactive Phosphate at the Kapp Norvegia grid. Sequence of stations as in Fig. 4.

B) Auståsen transect

In all profiles along the transect of Auståsen, concentrations of dissolved nutrients varied roughly from 2.5-0.5 μM, 20-32 μM and 1.1-1.55 μM for Ammonium, Nitrate and Phosphate, respectively. Total Dissolved Inorganic Nitrogen and Phosphorus particularly increased at depths, which were very close to the bottom (Fig. 22).

Profile distributions of Nitrate and Ammonium did not appear to be significantly different along the transect, from sites further offshore at 500 m depth to sites close to the coastal domain at 200 m depth (Fig. 22). Ammonium and Nitrate concentrations showed distinct opposite profile patterns. Ammonium concentrations decreased with depth. In surface waters, we found values around 2-3.2 μM, and in deep waters less than 2 μM. However, we noticed differences between sites at lower and greater depths. In deep waters and at the two sites farther away from the coast, ammonium levels never reached 1 uM. In contrast, sites with 200 m depth, on average, showed Ammonium concentrations around 2 μM.

There were clear differences in Nitrate profile distributions comparing the site with greatest depth of the transect with the rest of the sites with less than 300 m depth. Nitrate concentrations in deep waters reached 32 μM at the deepest site (at ~500 m depth), whereas sites at lower depths showed values of 28 μM (Fig. 22).

Solute Reactive Phosphate (SRP) values increased with depth, ranging, on average, from 1.2 to 1.5 μM. In general, the highest change of the profile gradient occurred close to the bottom. There were no significant differences among various profile patterns along the transect (Fig. 22).

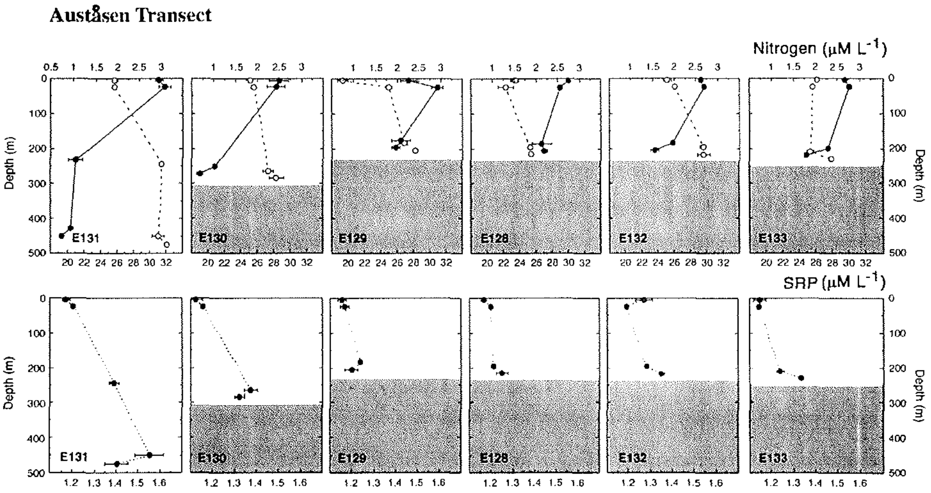


Fig. 22 Dissolved Inorganic Nitrogen (circles: Ammonium; dots: Nitrate) and Solute ReactivePhosphate at the Auståsen transect. Sequence of stations as in Fig. 9.

C) Hilltop transect

Besides one point of the transect, at the greatest depth, there were no significant differences along the profile depth gradient of dissolved nutrient concentrations for the profiles at Hilltop (Fig. 23). These values varied approximately from 1.5-0.8 µM, 24-26 µM and 1.6-1.9 µM for Ammonium, Nitrate and Phosphate, respectively. In comparison with other sampling stations, the range of nutrients along the water column is very narrow.

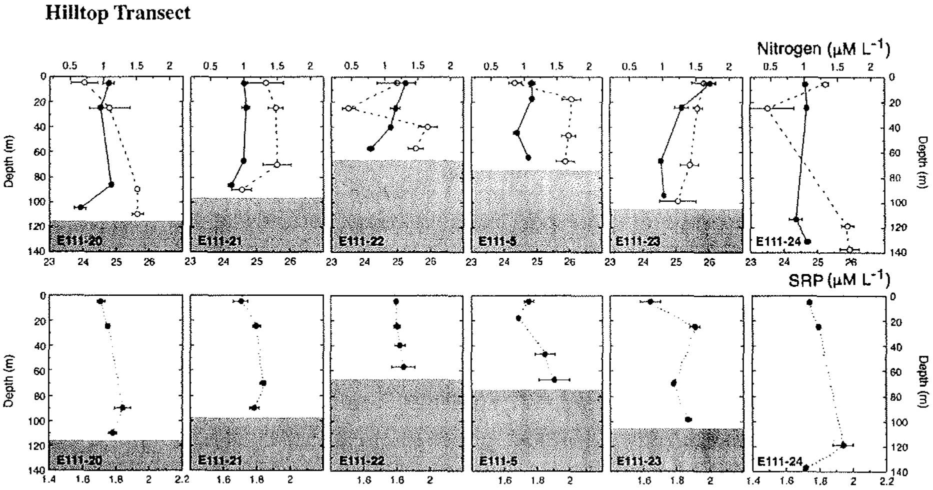


Fig. 23 Dissolved Inorganic Nitrogen (circles: Ammonium; dots: Nitrate) and Solute Reactive Phosphate at the Hilltop transect. Sequence of stations as in Fig. 13.

Profile values between Nitrate and Ammonium did not seem significantly different along the Hilltop transect. However, small differences were noticed between Ammonium concentrations, where values tended to decrease with depth; and between Nitrate concentrations which tended to be higher in deep waters. In surface waters, we found mean values of 1.3 µM and 23.5 µM; and in deep waters (beyond 100 m), about 0.9 µM and 25.2 µM for Ammonium and Nitrates, respectively.

Solute Reactive Phosphate (SRP) values slightly increased with depth, going, on average, from 1.6 to 1.9 µM. But in general, there were no significant differences along the profile (Fig. 23).

D) Bransfield Strait transect

Analysis of concentrations of dissolved nutrients on the Orleans Canyon transect demonstrates that, overall, total dissolved inorganic Phosphorus and Nitrogen concentrations increased substantially along the profile of the water column (Fig. 24).

Dissolved Inorganic Nitrogen (Ammonium + Nitrate) values varied in round numbers between 32 µM in surface waters to 36 µM close to the bottom. The main characteristic of the vertical distributions of Ammonium is that it decreased with depth from values of 1.5 µM in surface waters to less than 0.3 µM in deep waters. In contrast, Nitrate concentrations increased from 28 to 36 µM, with highest values near the bottom. Therefore, Ammonium and Nitrate profiles, compared with other sampling stations, demonstrated a large gradient along the water column. However, in shallower waters close to the coast, the gradient was lower (Fig. 24).

Solute Reactive Phosphate (SRP) concentrations were, on average, between 1.8 and 2.1 µM along the transect. In all profiles, a clear increase with depth in Phosphate concentrations was found. Steep changes of the profile gradient not always occurred below the euphotic zone; occasionally, the maximum increase in the profile took place close to the bottom. In contrast, the lowest values were always found in samples from the surface waters. Only at one site of the transect, which had the lowest depth (400 m) and which was situated close to the coast, no significant differences in Phosphate concentrations were found along the profile depth gradient (Fig. 24).

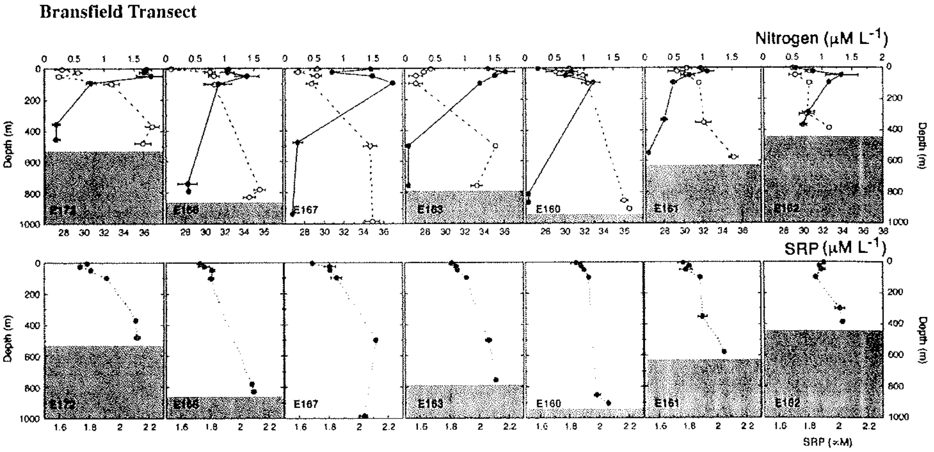


Fig. 24 Dissolved Inorganic Nitrogen (circles: Ammonium; dots: Nitrate) and Solute Reactive Phosphate at the Bransfield transect. Sequence of stations as in Fig. 16.

Preliminary conclusions

Total dissolved Phosphorus and Nitrogen concentrations increased substantially along the profile of the water column. Dissolved Organic Nitrogen (DON) values varied roughly between 10 µM in surface waters and nearly 40 µM close to the bottom. A consistent maximum is is situated at 20 m depth. Ammonium and Nitrate concentrations showed distinctly opposite depth patterns, Ammonium decreased and Nitrate increased with depth. Ammonium levels at the Weddell Sea and Orleans Canyon stations varied around 1.5 µM in the euphotic zone and values <0.5 µM below, as found by von Bodungen et al. (1988). Shallower sites and those situated closer to the pack ice displayed higher Ammonium concentrations above 1.5µM.

The three sampling regions situated in the Weddell Sea (Kapp Norvegia, Auståsen and Hilltop) registered similar values of Nitrate between 20 and 32 µM. These results are lower than those measured at the Orleans Canyon station, where we recorded values between 28 and 36 µM.

Solute Reactive Phosphate (SRP) values increased with depth, ranging, on average, from 1.2 to 1.5 µM in the Weddell sea. These results were also lower than those measured at the Orleans Canyon station. The values recorded at this station varied between 1.8 and 2.1 µM.

Levels of Nitrate and Phosphate recorded during autumn in the Weddell Sea were found to be similar in comparison with values found by other authors during spring-summer (Nelson et al. 1989). The distribution pattern along the profiles of these nutrients showed features similar to the physical properties which were found on the transects at each sampling station.

In general, the high values of Nitrate, dissolved Phosphorus and Nitrogen near the bottom in relation to the values observed in the water column are a n evidence that benthic communities are involved in the organic matter mineralization and nutrient recycling. Particularly relevant are the elevated concentrations of Nitrite close to the bottom because this molecule is present when organic matter is oxidized and mineralized. The low values of Ammonium close to the bottom could be related to its utilization by microorganisms living in the benthic boundary layer which also contribute to nutrient recycling. The scarce information available on nutrients near the bottom give great relevance to this set of data, which support the hypothesis that the effect of benthic communities on total water column production balance is higher than previously thought.

2.1.4 Chlorophyll and Particulate Organic Matter

Objectives

Food analyses of benthic suspension feeders (mostly cnidarians) revealed limited connection between the rain of larger particles sinking to the sea floor during the short Antarctic summer and the food of these organisms, and incubation experiments presented evidence for the use of the fine seston fraction by certain suspension feeders. The study of the quality and of the particulate matter available for the suspension feeders in the water column was one of the main objectives of this cruise for the bentho-pelagic coupling group.

Work at sea

Water was collected in Niskin bottles with the Bio-Rosette at 3-4 different depths at each station of the grid or transect, picking up two samples (two Niskin bottles) from each depth to have two replicates of each depth point. The sea water was prefiltered by 100(m mesh to 1) take the fine fraction (from 2 to 80 µm) available to benthic suspension feeders, 2) obtain the fraction that is more difficult to count with the binocular microscope (<100µm) and 3) avoid large variance on the replicates. Water was then filtered with 150mmHg pressure with GF/F precombusted (450 °C, 5h) filters (0,4(µm porus) for the different parameters. These parameters were a) Chlorophyll a + Pheophytin a (500ml filtered per replicate), b) Total Carbon and Nitrogen (800ml filtered per filter), c) Organic Carbon and Nitrogen (800ml filtered per filter) and d) Proteins (1000ml filtered per filter). Filters were then immediately frozen at -27 °C to be processed on the ship. A total of 260 filters were processed (KN 120, Hilltop 36, Auståsen, 48, Bransfield Str. 56).

Chlorophyll a and Pheophytin a were extracted in the dark at 4 °C with 90% acetone (6ml each filter) overnight (24h). The Chlorophyll a was read with a fluorometer; adding 2-3 drops of HCl 1N we read Pheophytin a.

Total Carbon and Nitrogen filters were dried 24h at 60°C. After that, a catalyzer was added (V2O5) and the filters were packed inside stannum foil to proceed later with an Elemental Analyser (Carlo Erba). For Organic Carbon and Nitrogen, after drying the filters 24h at 60 °C, we proceeded to leave them inside a sealed plastic box; inside the box there was HCl (36%) saturated. Filters were inside the box 48h, and dried again in the dry-oven for 24h. The process to prepare filters for further analysis was the same as with Total C/N.

Proteins were processed with the Lowry et al. 1951 method. Filters were ground and proteins extracted with NaOH 1N at cold temperatures. The absorbency of the colorimetry was read with a spectrophotometer Shimanzhu 112-E with 5cm wide glass cuvettes, after calibration with standard of Albumin serum + blank filters.

Preliminary results

A) Kapp Norvegia grid

Chlorophyll a and Pheophytin

Both pigments are always more concentrated in the surface layers (5 and 25m depth) than at the bottom. Pheophytin (non-active degraded chlorophyll) is always more abundant than Chlorophyll a. In the bottom samples the difference between degraded and non-degraded Chlorophyll was even more acute (sometimes 4-5 times more Pheophytin than active Chlorophyll a). Surface values of the grid seemed to be constant, as were the bottom ones. The stations far from the coast (# 76-80) had, in the surface and bottom samples, more Pheophytin and Chlorophyll a than those near the coast (stations 66-70) (Fig. 25).

Proteins

The protein pattern of distribution was not constant at different depths. In the surface layers (5 and 25m) and at the bottom the oscillations were strong (surface: 42-161 g/l; bottom: 24-122 g/l. There was no tight relation of pigments with protein concentration. In the samples taken in the vicinity of the sea floor there is a slight decrease in the concentration from the coast towards stations further offshore. All the near-bottom samples were low in concentration of proteins, but the water column samples (30-50m above the bottom) had more irregular concentrations (Fig. 25).

B) Auståsen transect

Chlorophyll a and Pheophytin

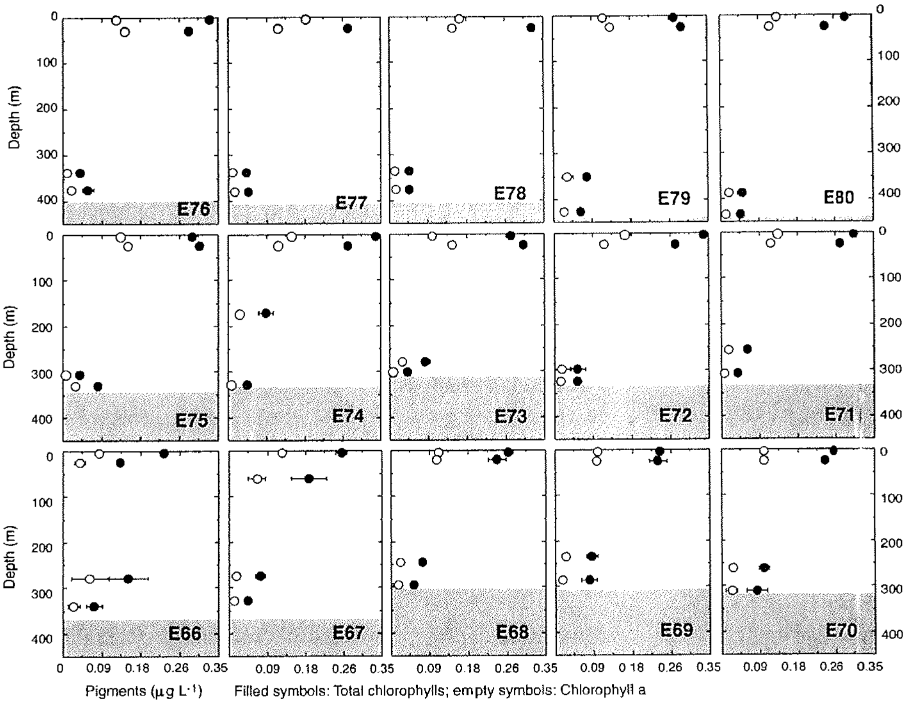
Surface (5 and 25m) samples of Pheophytin and Chlorophyll a seemed to be affected by iceberg influence. Stations 128,129, and 130 showed less concentration than those on the periphery. The bottom samples of the same depth (stations133-130) had similar concentrations, except # 129 (theoretically the more influenced by the icebergs) that shows a sudden increase in the concentration (Fig. 26).

Proteins

In the near-bottom samples of all the stations there was an increase of concentration in total protein from the coast to the open ocean (except in station 131, off the coast and at 480m depth). The subsurface layer (25m depth) seemed to behave in the opposite way, from more (coast) to less concentrated (open ocean). There was a strong coincidence with the iceberg influence zone in this steep decrease. The surface layer (5m) had a practically constant concentration of proteins (Fig. 26).

Kapp Norvegia

(A) Plant pigments



(B) Proteins

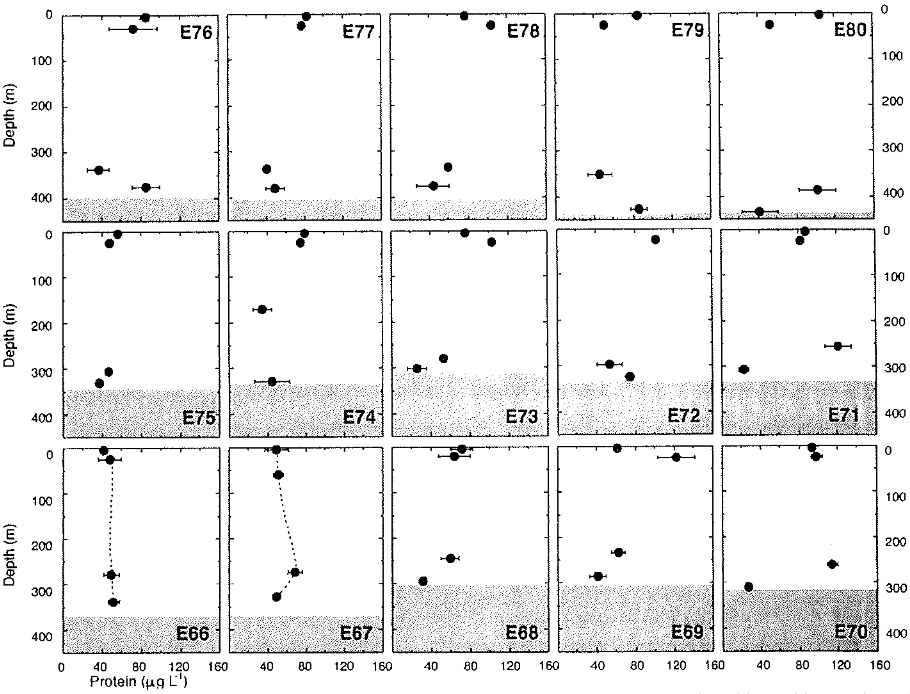


Fig. 25 Chlorophyll a and pheophytin (above) and protein profiles (below) at Kapp Norvegia grid.

Auståsen

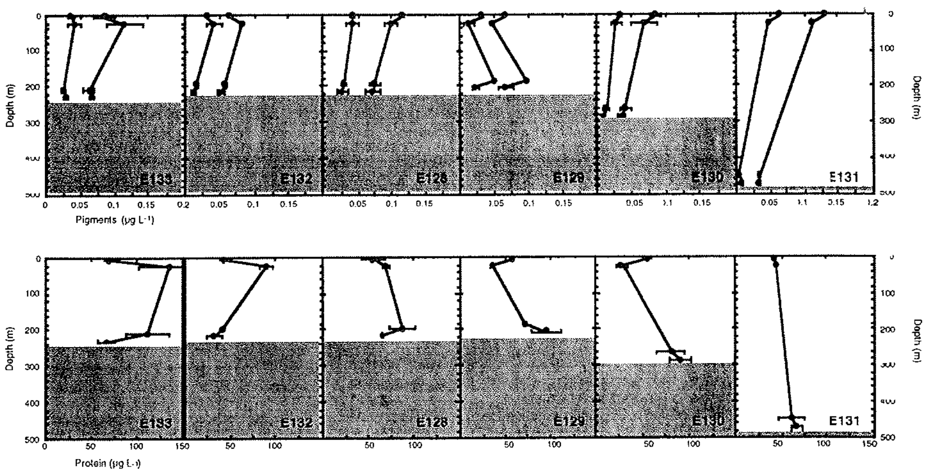


Fig. 26 Chlorophyll a (above, left) Pheophytin (above, right) and Protein profiles (below) at the Auståsen transect. Sequence of stations as in Fig. 9.

C) Hilltop transect

Chlorophyll a and pheophytin

The surface (5m depth) samples of both pigments had a constant proportionality (i.e. the difference between them is constant). No tendency was observed in this layer. In the near-bottom samples, the concentrations were similar, except at the station 111-21, where a sudden increase of pigment was observed. The concentration of pigments in the bottom samples was higher than in all other transects studied (Fig. 27).

Proteins

Except station 111-24 (near the coast), all the surface samples (5m depth) were constant in the low concentration of proteins. In the bottom samples the concentration was higher on the sides of the Hilltop than on its peak (Fig. 27).

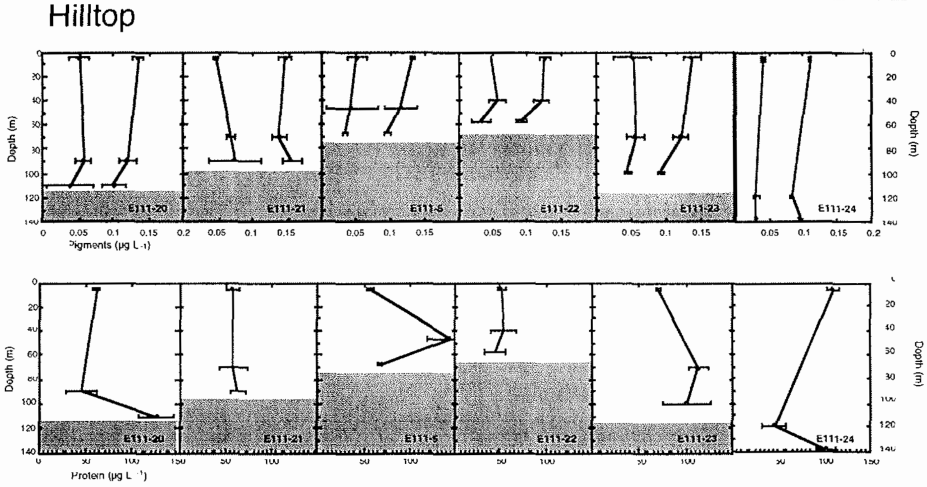


Fig. 27 Chlorophyll a (above, left) Pheophytin (above, right) and Protein profiles (below) at the Hilltop transect. Sequence of stations as in Fig. 13.

D) Bransfield Strait transect

Chlorophyll a and Pheophytin

The pigments of the Bransfield Strait revealed more active Chlorophyll a than the Weddell Sea transects. The difference between pheopigments and Chlorophyll a was greater at all the stations, and the concentration of pigments was higher than on the other transects. There was a strong difference between the surface samples (5 and 25m depth) and the near-bottom ones (up to 10 times more concentrated at the surface) (Fig. 28).

Proteins

As in other transects in the Weddell sea, the surface proteins (5m depth) seemed to be more concentrated off the coast than near it (stations 162-160). In the other part of the transect (stations 172-163) the concentrations did not change at this depth. Near-bottom samples had low concentrations, except the stations 168-167 where there was a sudden increase of protein concentration (Fig. 28).

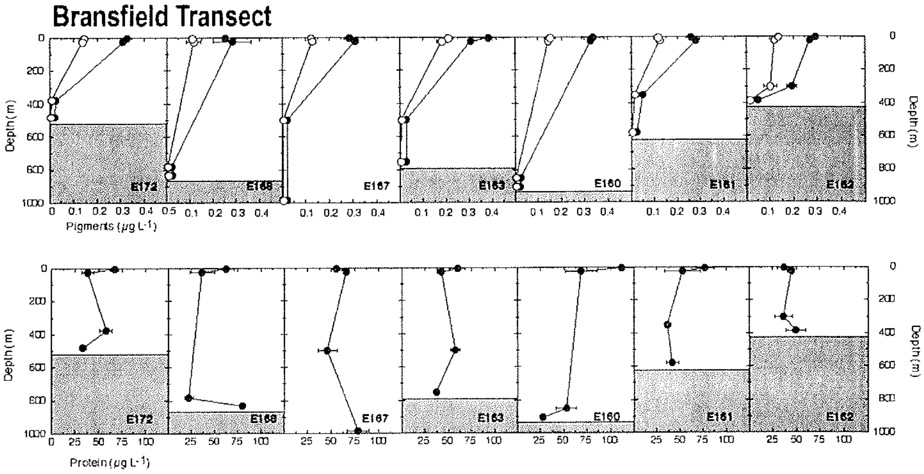


Fig. 28 Chlorophyll a (above, left) Pheophytin (above, right) and Protein profiles (below) at the Bransfield Strait transect. Sequence of stations as in Fig. 16.

Preliminary conclusions

Chlorophyll was found to be at maximum in the upper part of the vertical profiles almost at all the stations (maximum 0,390 g/l, minimum 0,020 g/l. As can be expected this contrast was more evident on the Bransfield transect, as the difference in depth between the surface (5 and 25m) and the bottom (400-1000m) samples is greater than on the Weddell Sea transects. The Chlorophyll concentration in Bransfield was, at the surface, double or even three times higher than on the Kapp Norvegia, Hilltop and Auståsen transects. The difference between active Chlorophyll and Pheophytin (degraded chlorophyll) was lower in the bottom samples and more acute in the surface ones both in the Weddell Sea and at the Antarctic Peninsula. However, in the Weddell Sea (see Figures 25-27), the process of degradation seemed more advanced, as the Chlorophyll was less abundant and the proportion of Pheophytin was more prominent.

Proteins fit with previous values recorded in similar areas (but in a different season) in the order of magnitude (maximum 160 g/l, minimum 22 g/l) (Berdalet et al. 1997). The abundance of the particulate proteins seemed to have no relation with Chlorophyll a in the bottom samples, and only a slight relation in the surface (5-25m depth) ones. The amount of this parameter is seemingly independent of the concentration of primary production in the transects studied. Sometimes the concentration of proteins was higher in the bottom water than at the surface, but this was not the general rule. The amount of protein is a good indicator of available particulate food for benthic suspension feeders. Its abundance in the bottom samples (quite high sometimes) can be the key to understand the potential availability of energy during this autumn-winter time, when primary production has decreased sharply and the rain of food coming from the upper layers has become thin.

2.1.5 Biochemistry of Antarctic benthic and pelagic organisms

- Stoichiometric composition of *Ainigmaptilon antarticus* and *Fannyella nodosa*

Objectives

The stoichiometric balance of organic macromolecules (i.e. proteins, carbohydrates and lipids) of Antarctic benthic animals is poorly understood. In different times of the year when seasonality is strong (as in the Mediterranean or Antarctic seas), the balance of these molecules can change depending on the needs of each organism and its ecological strategy. The aim of this work was to compare two gorgonians with similar morphologies (and perhaps similar feeding strategies), *Ainigmaptilon antarticus* and *Fannyella nodosa*, from two different sites (Weddell Sea and Antarctic Peninsula) at different times of the year (i.e. spring-summer during ANT XV/3, and autumn-winter during ANT XVII/3), in their stoichiometric balance.

Work at sea

As can be seen from Table 1, several samples of each species were collected from various bottom trawls and the TV grab in the Weddell Sea and the Bransfield Strait. The gorgonians were identified and immediately frozen (-27°C) until further analysis in the laboratory.

Table 1 Species that have been collected with bottom trawls and TV Grab at different stations for biochemical analysis.

Benthic species	Area	Stations	Nº of colonies or individuals	Size classes	Different colony parts
Alcyonacea	Weddell S.	85,109,111,119-1,124	9	No	No
Umbellula sp	Weddell S.	85, 109, 119-1,	4	No	No
Notisis sp	Weddell S.	85, 102, 109	10	No	No
Thouarella sp	Weddell S.	85, 102, 109, 119-1, 124	52	No	No
Fannyella rossii	Weddell S.	85	2	No	No
Dasystenella sp	Weddell S.	85, 102, 109	20	No	No
Tokoprimna sp	Weddell S.	85, 119-1, 124	7	No	No
Ainigmaptilon antarticus	Weddell S.	102, 109, 119-1, 124, 135, 136	79	Yes	Yes
Primnoisis sp	Weddell S.	102,109,119-1,124	31	No	No
Primnoella sp	Weddell S.	111	10	No	No
Fannyella spin.	Weddell S.	111	2	No	No
Oswaldella sp	Weddell S.	111, 136	16	No	Yes
Fann. nodosa	Peninsula	155-7, 158-1	32	Yes	No
Anthomastus bathyproctus	Peninsula	178-2	40	Yes	Yes
Actinaria sp1	Peninsula	178-2	40	No	No
Pelagic species					
Salpa thompsoni	Peninsula	180	50	Yes	No

- Lipid composition of Antarctic benthic cnidarians

Objectives

Benthic organisms may accumulate lipids in their tissues to counteract the effect of limited food, especially in strongly seasonal environments (Clarke 1985). A possible response is to increase the lipid proportion with regard to the other components of the tissue (i.e. proteins and carbohydrates). The aim of this project was to analyse the total lipid, carbohydrate and protein content together with the lipid fraction of several benthic cnidarians in two seasons (i. e. spring-summer 1998, and autumn-winter 2000) to infer possible strategies to resist the impoverishment of the water column in Antarctic winter. The possibility to compare different places at relatively short distances (Weddell Sea: Kapp Norvegia, Hilltop, Auståsen, each with a different density of benthic suspension feeders) is an interesting new approach. Additional comparisons will be made with the Bransfield Strait populations.

Work at sea

Several samples of cnidarian species were collected from bottom trawls and theTV grab in the Weddell Sea and the Bransfield Strait (Table 1). The gorgonians were identified and immediately frozen (-27°C) until further analysis in the laboratory. All the material will be processed at ICM Barcelona.

- Bentho-pelagic coupling: evidence for a trophic chain microplankton-*Salpa thompsoni*-*Anthomastus bathyproctus* through lipid analysis.

Objectives

In the Antarctic ecosystem, some recent approaches have been made to understand the impact of passive suspension feeders (e.g. cnidarians) on the water column. One way to understand the relevance of a species in the overall system is the study of its diet. Another mechanism is to follow the whole trophic chain for an organism. As *Anthomastus bathyproctus* had fed on *Salpa thompsoni*, which was found to be full of water column organisms (ciliates, phytoplankton, etc.), we decided to follow trace molecules (e. g. specific lipids synthesised by a specific group) along this food chain. A prerequisite is that the trophic chain is linear, i. e. with a clear predator-prey pattern. The objective is to study trace lipids to see the importance of each link of the chain in the energy budget of each species.

Work at sea

Samples of *Anthomastus bathyproctus* and *Salpa thompsoni* were collected at the Antarctic Peninsula with bottom trawl and multinet, respectively. Some *Salpa thompsoni* specimens were observed under the microscope to evaluate the gut contents. The trace lipids will be processed in the ICM laboratories.

2.1.6 Water Column Picoplankton

Objectives

The objective of this project was to determine the abundance, biomass and heterotrophic activity (BHP) of the picoplankton in as many different areas as possible. Whereas there are substantial numbers of studies of Antarctic picoplankton in spring and summer, the information available from autumn and winter is extremely scarce. Our purpose was to test two different hypotheses about the activity of Antarctic picoplankton during autumn:

a) Are bacterial activities during autumn similar to those found in summer? Primary production tends to occur in a single spring bloom. During this time and the subsequent summer, BHP represents a very small fraction of primary production (between 5 and 10%; in temperate ecosystems this fraction is usually 50% or larger). We hypothesize that low temperatures cause a long delay in the use of primary production by bacteria in Antarctic waters. If this is the case, we should see similar levels of activity in the autumn to those found during spring and summer.

b) Are activities close to the bottom higher than those at the surface? One could expect that the remains of spring primary production would sink to the bottom.

Thus, during autumn, a considerable portion of the organic matter available to bacteria should be close to the bottom. If this is the case, we might expect to detect elevated levels of bacterial activity at the bottom with respect to the surface (extreme hypothesis). At least, we should find levels of activity comparable to those at the surface (mild hypothesis).

Work at sea

At a total of 40 stations samples were collected with the CTD-Rosette for determination of picoplankton abundance, biomass and activity at different depths. Aliquots were fixed and frozen for determination of abundance and biomass through flow cytometry in Barcelona. Samples for BHP were incubated with tritiated leucine and processed on board. In addition we carried out six incubation experiments (named EPS experiments, see Fig. 4 for locations where the samples were taken) to determine conversion factors from leucine incorporation to bacterial production, as well as to study the influence of different factors (temperature, inorganic nutrients, organic matter and trace metals) on the activity of the bacteria. Altogether, this implied 600 samples for leucine incorporation (3000 including replicates) and 700 samples for flow cytometry.

Preliminary results

Fig. 29 shows results from experiments EPS3 and EPS4. These correspond to surface and bottom samples, respectively, from a station in the coastal Weddell Sea, and illustrate the kind of results these experiments provide. In these two experiments we tested the effect of temperature and organic matter additions on bacterial growth. We had four treatments: K0 (no organic matter added, incubation at 0 degrees), C0 (glucose and acetate added, 0 degrees), K4 (no additions, 4 degrees), and C4 (glucose and acetate added, 4 degrees). Both experiments showed the same pattern, suggesting that the bottom and surface bacterial assemblages had similar levels of activity and were probably controlled by the same environmental factors. If we examine results from EPS3, for example, it is clear that temperature affected the growth rate, but not the final levels of leucine incorporation (an indicator of the biomass yield). On the other hand, organic matter additions affected the final yield, but not the growth rate. The complete analysis of these experiments will be carried out when data of bacterial abundance and biomass become available. Fig. 30 shows the vertical profiles analyzed in the Kapp Norvegia grid as an example of the transects studied.

As a preliminary test of the second hypothesis, we compared the shallowest and deepest samples from the 34 profiles of bacterial activity that reached the bottom (thus excluding the three Weddell Sea profiles). The deepest sample showed less activity than the surface one in 17 profiles, the activities were equal in 15 profiles and the deepest sample was more active than the shallowest sample in 2 profiles. As can be seen in the Kapp Norvegia example, vertical profiles of bacterial activity were relatively uniform, and the differences just discussed were in most cases small. Altogether, these data argue for similar levels of activity at the surface and at the bottom of the water column. Therefore, our most extreme hypothesis (higher activity at the bottom) can be rejected. The fact that activities were approximately equal, however, suggests that available organic matter was distributed throughout the water column. In conclusion we accept our "mild" hypothesis.

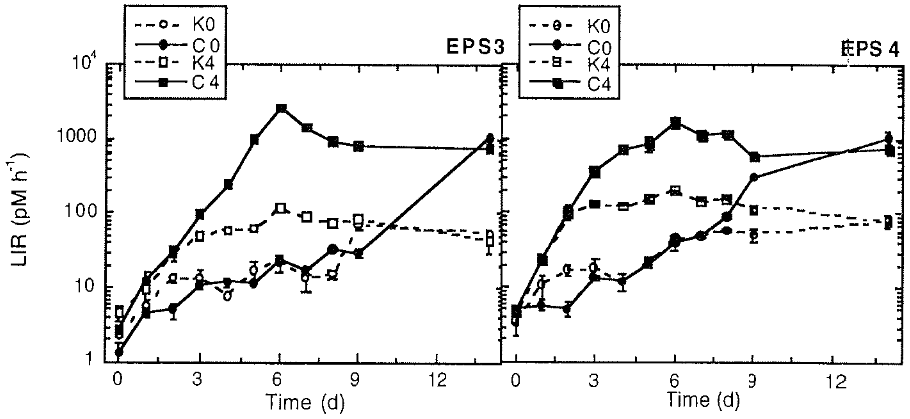


Fig. 29 Experiments to calculate conversion factors. LIR (leucine incorporation rate) versus incubation time in experiments EPS3 and EPS4 (see Figure 4 for locations of the sampling stations). Codes are: K0 no addition 0 degree, C0 organic matter addition 0 degrees, K4 no addition 4 degrees, C4 organic matter addition 4 degrees.

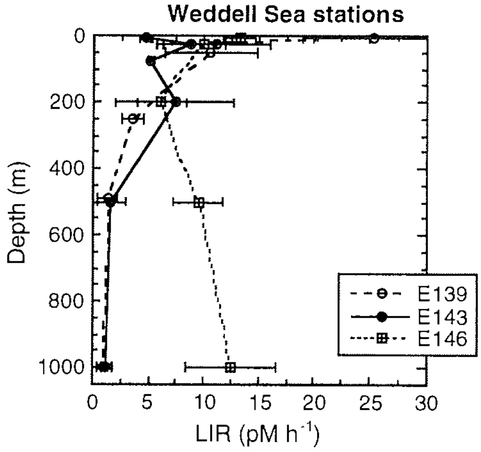


Fig. 30 Leucine incorporation rate (LIR) versus depth for three depth profiles at the Kapp Norvegia grid. (E=experiment)

Results relevant for the first hypothesis are presented in Table 2, where we compare average values from the present cruise to those from other cruises at different times of the year. As can be seen, values from the ANTXVII/3 autumn cruise were similar to those from spring or summer cruises. Therefore, we can confirm the hypothesis that bacterial activity in autumn may be at least as high as that at earlier times of the year.

In the Fig. 31, 32, 33 we present all the vertical profiles of leucine incorporation rates carried out during the cruise at the different transects and of the laboratory experiments (Fig. 34). There are samples for counting picoplakton by flow cytometry for all of these profiles. These samples have not been processed yet.

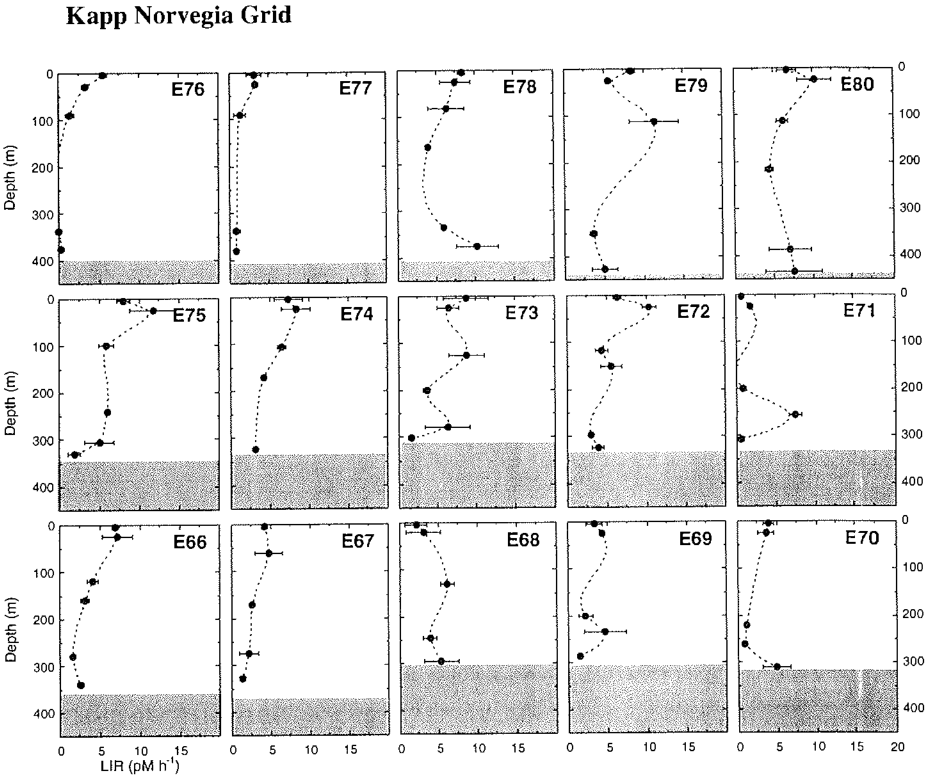


Fig. 31 Vertical profiles of leucine incorporation rates (LCR) at Kapp Norvegia. Sequence of stations as in Fig. 4.

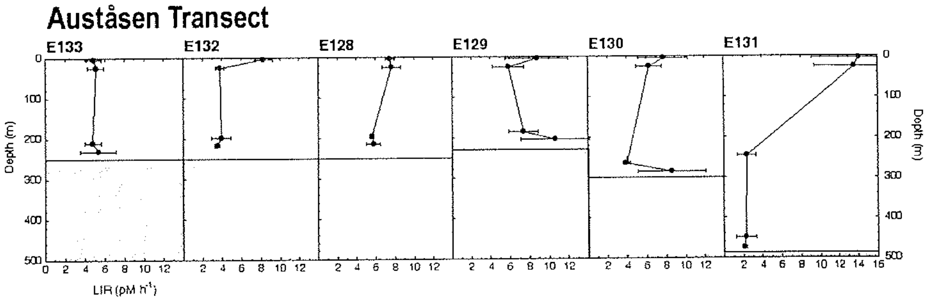


Fig. 32 Vertical profiles of leucine incorporation rates (LCR) at the Auståsen transect. Sequence of stations as in Fig. 9.

Hilltop transect

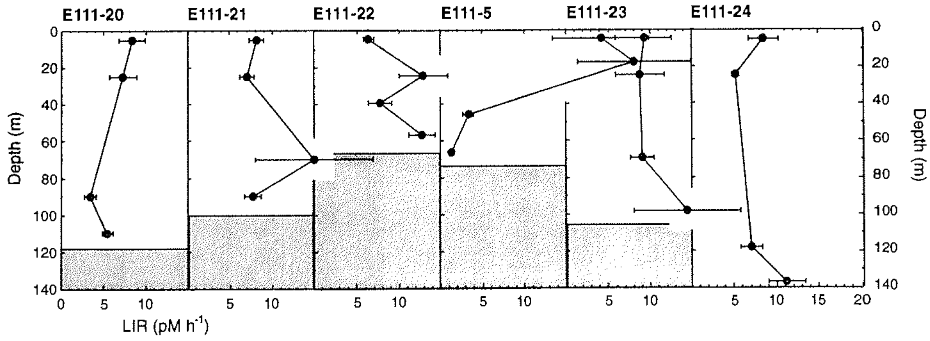


Fig. 33 Vertical profiles of leucine incorporation rates (LCR) at the Hilltop transect. Sequence of stations as in Fig. 13.

Table 2 Average values of bacterial activity (leucine incorporation in (nmols Leu/l/d) in several cruises at different times of the year.

Cruise	Month	Year	Bacterial Activity Average	S.E.
FRUELA	Dec	1995	0.488	0.137
DHARMA	Dec	1998	0.111	0.016
FRUELA	Jan	1996	0.159	0.030
ECOANTAR	Jan	1994	0.245	0.041
DOVETAIL	Feb	1996	0.059	0.006
EASIZ III	Apr	2000	0.158	0.012
EASIZ III - Auståsen	Apr	2000	0.137	0.010
EASIZ III - Hilltop	Apr	2000	0.217	0.023
EASIZ III - Kapp Norvegia	Apr	2000	0.104	0.013
EASIZ III - Weddell Sea	Apr	2000	0.282	0.087
EASIZ III - Bransfield W	Apr	2000	0.180	0.037

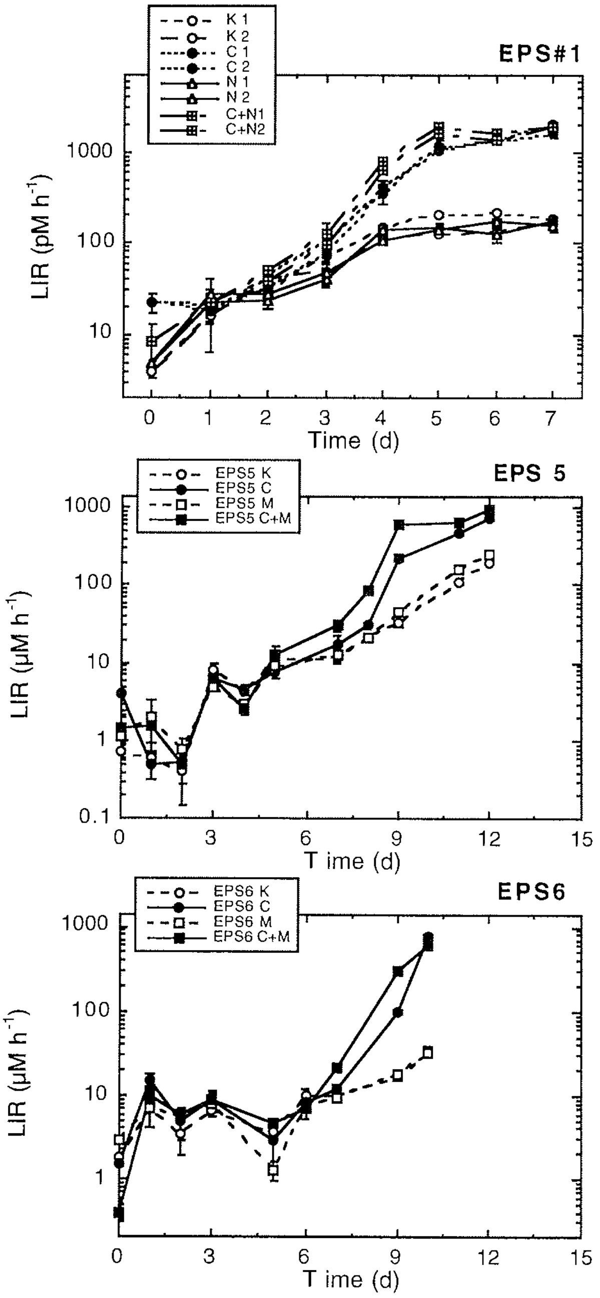


Fig. 34 Experiments to determine the effect of organic and inorganic nutrient additions on bacterial heterotrophic activity. LIR (leucine incorporation rate) versus incubation time in different experiments. Codes in boxes are: K = no addition, C = organic matter addition, M and N = nitrogen and phosphorous additions.

2.1.7 Feeding Experiments with Active Filter Feeders

Introduction

Studies carried out during the EASIZ II cruise (Orejas et al in press) have demonstrated the wide range of diets of several Antarctic cnidarians. This indicates opportunistic behaviour by feeding on different sources taking advantage of the available food sources. Zooplankton is probably important in the diet of sessile benthic cnidarians. To corroborate this hypothesis, we concentrated on studying the diet of two species. Another relevant observation was that some passive suspension feeders such as gorgonians and hydroids capture very small prey. This fine fraction is also the main food source for active filter feeders such as sponges and ascidians, which are very abundant in Antarctic benthic communities. To study this subject filter feeding rates were studied on board using specimens of the sponge *Stylocordyla borealis*.

- The sponge *Stylocordyla borealis*

Introduction and Objectives

Most likely sponges play an important role among the benthic suspension feeders on the Weddell Sea shelf. During the EASIZ III cruise feeding experiments were carried out with an active suspension feeder, the sponge *Stylocordyla borealis*. *Stylocordyla borealis* is abundant, it is a sponge easy to identify, and we had some previous background that these animals survived quite well in aquaria.

The principal objectives of the experiments were to study the natural diet of an active suspension feeder in the Antarctic ecosystem and to compare it with the diet and ecological role of other sponge species also in other latitudes. Our work focused on three main questions:
a) What planktonic taxa do these sponges feed on?
b) What is the capture rate on these taxa?
c) What is the role of benthic suspension feeders capturing small particles in the Antarctic microbial food web?

Work at sea

Specimens of *Stylocordyla borealis* were collected using bottom and Agassiz trawl and TV Grab. Depth of samples varied between 100 and 400 meters. The animals were kept in aquaria at 1°C until the experiments were carried out. Individuals were kept in the cool container with non filtered sea water until their use in incubation experiments.
Predation on the fine fraction (picoplancton to microplancton) has been assessed using continuous flow incubation chambers placed on a cool container following the methodology developed by Ribes (1999). The potential prey items in this fraction included heterotrophic bacteria, eucaryotic picoplancton, ciliates and phytoplankton (diatoms and dinoflagellates).

The plexiglass incubation chambers (one for the organisms and one as control) held approximately 5 l in volume. Each chamber was connected to a pump that recirculated sea water through it at a speed of 5 l min^{-1}. Predation was calculated from decrease in prey concentration in the sponge chamber relative to the control chamber. At the beginning of each experiment, a sponge was placed in the "organism chamber". When the animals looked in good condition to start the experiment (osculum completely open), both incubation chambers were closed and water samples of 1500 ml (initial water samples) were collected from both chambers. After 4 hours water samples were collected again (final water samples).
We also measured bacterial activity through the uptake of tritium-labelled leucin. Samples were processed following the methodology of Simon and Azam (1989).

A set of 11 experiments were carried out adding FLBs (Fluorescent Labelled Bacteria) to the chambers, in order to have a control group of possible preys which are not able to reproduce. A set of 6 experiments was performed with FLBs and FLAs (Fluorescent Labelled Algae). A set of 6 experiments was also performed with filtered sea water using for the first test a live animal, for the second test a dead animal and for the third set putting an organism for half an hour in the aquarium removing it after this time. This last set of experiments was used as a control versus the other sets of experiments.

To quantify heterotrophic bacteria, and picoeukaryotes, 2 ml water samples were preserved for flow cytometry by standard protocols (Gasol and del Giorgio, 2000), stored in liquid nitrogen and after that at -27 ºC. The samples are then unfrozen, stained with SYTO 13 (Molecular probes) at 1.6 µM (diluted in DMS), let 15 minutes to stain in the dark and run through a flow cytometer. Samples will be analyzed using a bench machine FACScalibur of Becton and Dickinson with a laser emitting at 488nm. Samples are run at low speed (approx. 12 µl min^{-1}) and data are acquired in log mode until around 10000 events have been acquired. Bacteria are detected by their signature in a plot of Side Scatter (SSC) vs. FL1 (green fluorescence). The settings are adapted for each sample as the populations and their fluorescence may change a lot from sample to sample. For quantification of picoplancton, water samples have been fixed in Glutaraldehyde 10%, stored at 4°C and afterwards stained with DAPI. Counting will be made under an epifluorescence microscope by measuring between 200 and 400 cells of each group.

To quantify phytoplankton and ciliates, 350 ml water samples were preserved with acid Lugol (10 % final concentration). Subsamples of 100 ml will be allowed to settle and observed with an inverted microscope using the Utermöhl technique (Utermöhl, 1958). Dominant groups of diatoms and dinoflagellates will be quantified in this study. From each subsample, the diameters of 20 individuals of the most common diatom and dinoflagellate groups will be measured and the volumes will be estimated from their ellipsoidal or cylindrical shape (Edler, 1979).

Water samples of 10 ml have also been kept in order to analyze the variation of dissolved organic carbon. Water samples of 150 ml and 300 ml, respectively, were also filtered in order to know Chla concentration values and Particulate Organic Carbon values at the beginning and at the end of the experiment. Samples of 50 ml were analysed on board in order to know the values of Nitrites, Nitrates and Ammonium.

Depletion rates of the fine fraction, and also of particulate and dissolved compounds will be calculated from the equations based on the computation of the grazing coefficient g (time $^{-1}$) (Frost, 1972; Saiz, 1993):

$$g = k_c - k_e$$

$$k = \ln (C_1 / C_0) / (t_1 - t_0)$$

k (time $^{-1}$) is the estimated prey growth rate computed for the control chamber (k_c) and for the experimental chamber (k_e). C_0 and C_1 are the prey concentrations in the chamber at the initial time t_0 and at the final time t_1.

Preliminary results

From the whole set of fractions to be analyzed we processed the nutrients and also the bacteria on board. The other fractions have to be processed at the home lab.

Our preliminary results are shown in Fig. 35. The results shows a clear tendency to decreasing bacteria concentrations in the experimental chamber, contrary to the situation in the control chamber where the number of bacteria increased.

Ammonium concentration increased considerably after the experimental time in the chamber which contained the sponges, remaining practically constant in the control chambers. Phosphates also revealed a small increase in the experimental chambers (1.5-2µM/l). Nitrates and Nitrites presented constant values without clear differences between control and experimental chambers (around 20-25µM/l for the Nitrates and 0.5 –0.8 µM/l for the Nitrites). Other elements have not yet been analyzed.

The results obtained from this cruise corroborate that bacteria are the selected prey item of this Antarctic sponge. This fact also contributes to understanding the relevance of the fine fraction of seston in the diet of benthic suspension feeders .

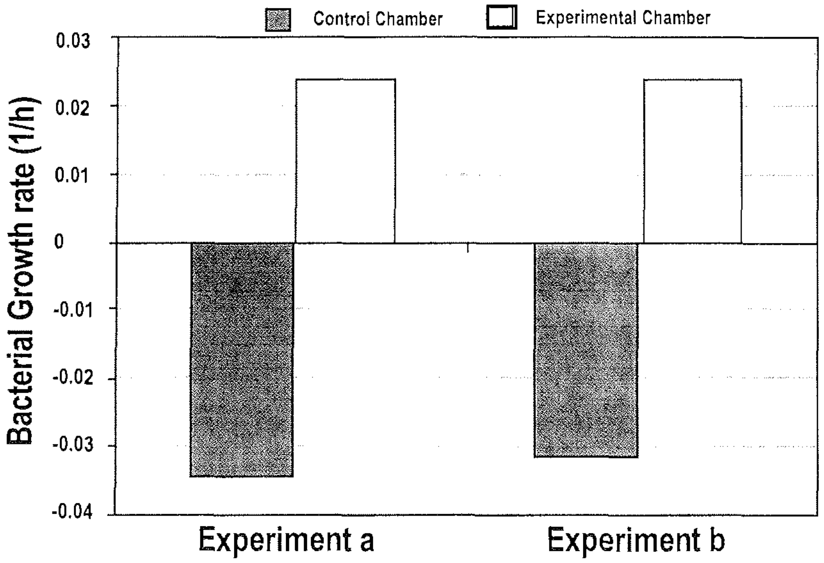


Fig. 35 Net growth rates of bacteria in the experimental and control chamber in two experiments (a and b) carried out with *Stylocordyla borealis* on board.

- The hydroid *Corymorpha parvula*

Objectives

Corymorpha sp. is an abundant benthic hydrozoan in the Weddell Sea. The diet of these passive suspension feeders is far from well known, and there are no observations from the autumn season. To assess the impact of these hydrozoans on the benthic and pelagic communities, several polyps were dissected under the binocular microscope and the gut contents described and measured.

Work at sea

On 5/04/00 (Stations 111-9 and 111-17, TVGrab) 30 polyps were collected and immediately fixed with 6% formalin. Their contents were identified and measured under a binocular microscope.

Preliminary results

The mean number of prey/polyp was 9.8, which is very high compared with other hydrozoans (Table 3). Although the main prey were benthic diatoms (75%), many organisms occasionally caught (as one amphipod, a sea urchin juvenile or a hydrozoan) represent the largest amount of available energy if compared in terms of carbon (20 diatoms= 0.28 mgC, 1 amphipod= 11.2 mgC) (transformation units from Coma et al. 1994). The full polyps accounted for 93%, which is a very high ratio, too. Detrital particulate matter (7%), nematodes (4%) and invertebrate eggs (4%) were, among other items, part of the natural diet of *Corymorpha* sp.

From these results we suggest that the diet of *Corymorpha* sp. is based mainly on benthic prey. There are three possible mechanisms for the capture: 1) preys are resuspended from the sediment, 2) preys crawl on the hydrozoan and are intercepted by the polyp mouth, 3) the hydrozoan has the capability of bending itself, picking up the preys with the tentacles directly from the substrate. Prey capture seems high enough to sustain a fast growth, because the energy input from this kind of prey is very high.

Table 3 *Corymorpha parvula*: Polyp gut contents, type and size of prey (Stations 111-9, 111-17).

Mouth size (mm)	Total prey items	Diatoms N (µm)	Other Phytopl. N (µm)	POM N (µm)	Eggs N (µm)	Copepods N (µm)	Nema-Tods (µm)	Others (specified, size µm)
15.9	13	9 (130)				2 (640)		
18.8	25	13 (220)	2 (70)	2 (660)	4 (170)		1 (2000)	1 Naupl. (200), 1 Appendicul (800), 1 Amphi (6200). 1 Unident. (140)
10.4	51	44 (160)		2 (250)	2 (120)	1 (260)	1 (600)	1 Crust fragment (200)
12.5	24	19 (170)		1 (400)	1 (120)	2 (360)	2 (450)	1 Crust fragment (600)
7.0	16	14 (130)		1 (320)	1 (120)			
14.2	21	18 (140)	2 (60)	1 (500)				
5.3	12	9 (140)		1 (640)	1 (120)			1 Spicule (360)
11.9	35	31 (160)		1 (300)		1 (500)	1 (500)	1 Spicule (1000)
14.4	18	12 (140)		1 (600)		3 (1700)		4 Crust fragments (660), 1 Salp (620)
3.1	17	14 (180)	2 (30)					
3.0	0							
15.2	5	3 (470)		1 (240)	1 (100)			
12.2	9	6 (150)		1 (600)	1 (120)		1 (200)	
9.1	17	15 (130)		2 (410)				
7.0	3	2 (220)		1 (640)				
10.2	11	7 (130)	1 (20)			2 (410)	1 (1300)	
13.1	15	10 (110)				1 (640)	4 (1460)	
4.7	0							
11.1	24	21 (130)		2 (480)				1 Unidentified (200)
12.5	9	7 (90)			1 (220)		1 (240)	
5.2	7	5 (150)			1 (240)		1 (800)	
5.1	4	2 (310)					1 (1200)	1 Polychete seta (4200)
6.6	12	4 (100)		2 (140)				

13.7	4	2 (110)	1 (200)	1 (220)		
5.2	10	7 (170)		1 (260)	1 (4200)	
12.5	3	1 (240)	2 (620)			
10.3	10	8 (120)	1 (240)		1 (3200)	
10.1	7	2 (90)		1 (120)		2 Crust fragm (1000), 1 Hydroz (1000), 1 Sea urchin (9300)
10.7	9	6 (180)				1 Crustacean fragment (1600), 2 Hydrozoan (1400)
13.2	7	3 (180)	3 (400)			1 Hydrozoan (13000)

- The anthozoan *Anthomastus bathyproctus*

Objectives

Little information exists on the trophic ecology of cnidarian species, and many other benthic suspension feeders, in Antarctic communities. Considering the various potential food sources for these suspension feeders, the objective of the present study was to determine the diet of the anthozoan *Anthomastus bathyproctus* whose diet was dominated by big zooplankton prey, as had already been observed during the previous EASIZ II cruise (Fig. 36).

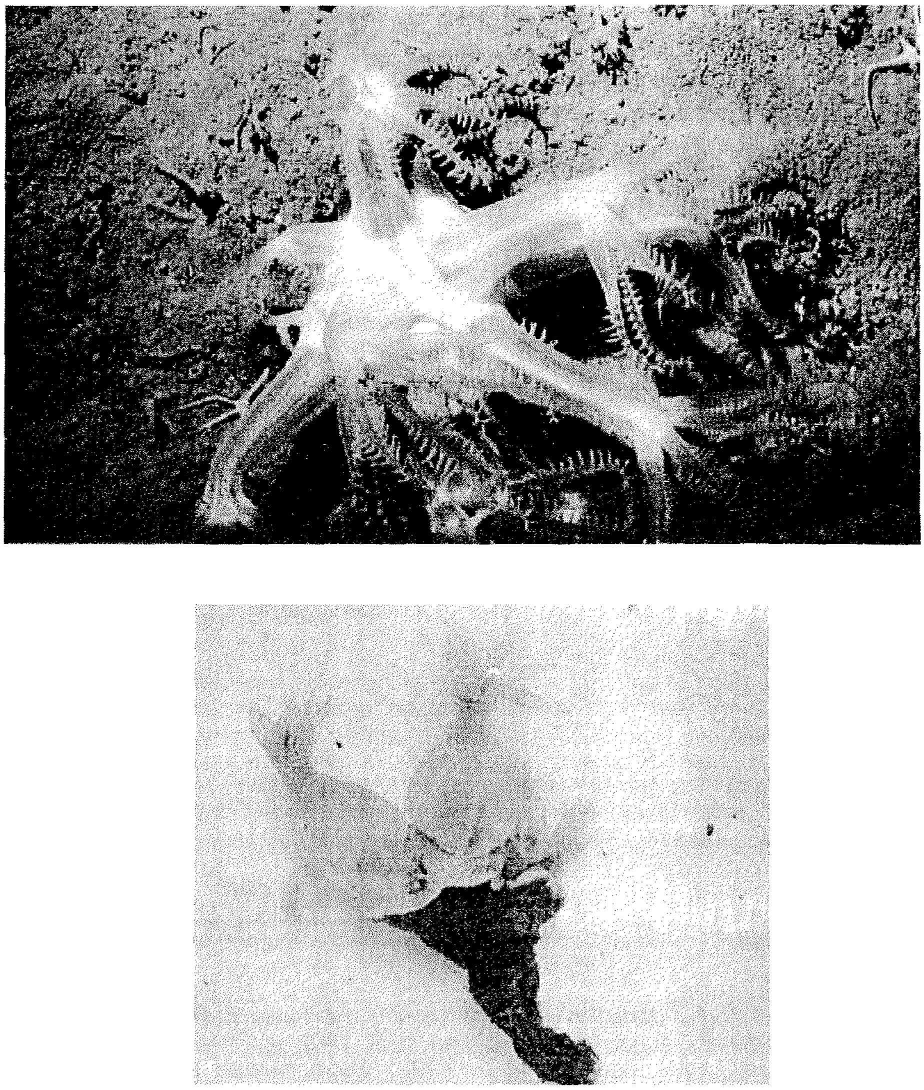


Fig. 36 One living colony of the alcyonarian *Anthomastus batyproctus* in the Bransfield Strait (200 m depth), and one colony showing the polyps "inflated" full of salps.

Work at sea

At station 178-2 in the Bransfield Strait about 650 *Anthomastus bathyproctus* and 400 Anemona sp1 were collected from the bottom trawl catch. 100 polyps of *A. bathyproctus* were dissected on board the ship and observed under the binocular microscope to study the natural diet of these organisms. The rest of contents (also of Anemone sp1) will be analyzed at the ICM Barcelona with the same techniques.

Preliminary results

The 35 studied colonies of *A. bathyproctus* contained a total of 105 polyps. Salps belonging to the species *Salpa thompsoni* were found in 82 (79%) of them whereas 23 (21%) were empty. The mean number of prey per polyp was 1.3 (± 0.9). The size of the salps was between 25 and 60 mm. Many polyps contained other items (mainly diatoms of the genus *Corethron*, and also centric diatoms and fecal pellets of small size). It seems, however, that these items came from prey gut contents, which were also dissected.

The diet of *Anthomastus bathyproctus* is probably related to the patchiness of plankton. They seem to profit from episodes of high food availability, as during nekton vertical migration. The occurrence of gelatinous zooplankton close to the sea floor has been shown to be an important phenomenon in some cases. Vertical migration of zooplankton to the sea bed is quite well studied for some Antarctic groups, e. g., for salps (Casareto and Nemoto 1986). Two possible strategies might be applied by *A. bathyprocthus*: 1) they might feed on zooplankton in an opportunistic way, i. e. on large prey that occasionally passes by, but use the "fine fraction" of seston, too, using the "sieving" mechanism; 2) they might feed episodically only on big prey items. This last possibility does not appear to be realistic because they would depend completely on the Antarctic summer production to survive. A more realistic scenario is that they use, in different proportions, both resources.

2.1.8 Reproduction studies

- Quantification of sexual reproduction in hydrozoans

Objectives

Timing and duration of sexual reproduction of hydroids has been reported in the literature, but very few papers deal with the quantification of the reproductive output. To estimate reproductive output, number of oocytes generated were monitored in different colonies of three species of common benthic hydroids in the Antarctic. To know the number of offspring and, especially, its relationship with the size of the progenitor colonies, is the first step in order to evaluate the reproductive effort (and the dispersion capability) of colonial benthic species.

Work at sea

The development stages of gonangia of three species, *Schizotricha turqueti*, *Schizotricha glacialis* and *Staurotheca dichotoma* were counted on board (Table 4).

Preliminary results

Based on gonangial densities recorded during the fertile period, on the mean lifetime of the gonangial generations (Coma et al. 1996) and the mean abundance of each species in the area (Gili et al. 1999) we estimated the total gonangial production over the entire sexual reproduction period:

Schizotricha turqueti : 3200 gonangia colony^{-1} and 38,400 gonangia m^{-2}
Schizotricha glacialis: 2000 gonangia colony^{-1} and 24,000 gonangia m^{-2}
Staurotheca dichotoma: 2700 gonangia colony^{-1} and 32,400 gonangia m^{-2}

Accordingly, oocyte production (two per gonangium) was calculated to be between 48,000 and 76,800 oocytes m^{-2}. Observed fertilization rates yielded an estimate of at least 50,000 planulae m^{-2} released by each species.

Table 4 Development stages of gonothecae and their percentage in three species of hydrozoans: A, empty gonothecae, B, young female gonangium, C, intermediate-age female gonangium, D, completely developed female gonangium with two larvae ready to be released.

Gonotheca development stage (4 colonies)

Species	A % empty	B % with larvae released	C % with larvae just released	D % with larvae to be released
Schizotricha turqueti	63.1	18.2	12.1	6.6
Schizotricha glacialis	26.9	12.6	37.7	22.8
Staurotheca dichotoma	53.8	18.6	-	27.6

Gonotheca abundance (4 colonies)

Species	x cm of branch (hydrocladia)	total per colony (approx.)	colony size (cm)
Schizotricha turqueti	9.9 ± 4.0	3200	32, 34, 29, 30
Schizotricha glacialis	7.6 ± 3.9	2000	25, 27, 25, 23
Staurotheca dichotoma	18.2 ± 5.1	2700	15, 12, 16, 12

Few data seem to exist in the literature to compare with the production of larvae by these three Antarctic species. Larval production was similar to that estimated by Coma et al. (1996) for the Mediterranean species *Campanularia everta* (64,000 planulae m^{-2}) and by Orejas et al. (2001) for *Obelia geniculata* in the Pacific (52,000 planulae m^{-2}).

Total gonangium production m^{-2}, the gradual release of larvae over the fertile period, the direct formation of planulae without going through a medusan stage, and the low dispersive ability may all be mechanisms consistent with an optimum reproductive strategy to maintain the population within its habitat. Generation of large numbers of larvae with low dispersive capabilities is a strategy followed by many benthic species that develop dense local populations (Cornelius 1992).

- Sexual / asexual production of propagules in actinians from the Weddell Sea and the Antarctic Peninsula

Objectives

Mode of reproduction is a major determinant of the spatial and temporal limits of a species' niche. Asexual reproduction propagates locally well-adapted genotypes, whereas sexual reproduction produces variation to meet challenges from unpredictable environments (Williams, 1975). Many sea anemones display both sexual and asexual reproduction. Clone formation ensures high fitness heritability and the maintenance of genotypes best adapted to competition for space in an unchanging environment (Lin et al., 1992). The purpose of the present study was to investigate the sexual or asexual origin of embryos in Antarctic sea-anemones and discuss the presence of these reproductive patterns in polar environments.

Work at sea

Fragments or whole individuals were frozen for further alloenzyme and population studies. In order to know the sexual or asexual production of embryos in Antarctic sea-anemones, some couples (parent + young) of the actiniarian *Epiactis georgiana* were frozen separately. Individuals collected from different hauls were also frozen in order to study the genetic variability between populations.

Preliminary results

Presence of embryos and young has been stated in some species of sea-anemones such as *Epiactis georgiana* (Fig. 37), however, no results about the sexual or asexual origin of these propagules can be provided before genetic analyses. All molecular techniques will be carried out in three laboratories, the Laboratorio de Biologia Moleculare of the University of Rio de Janeiro (Brazil), the ICM Barcelona and the Laboratorio de Biología Marina of the University of Sevilla (Spain).

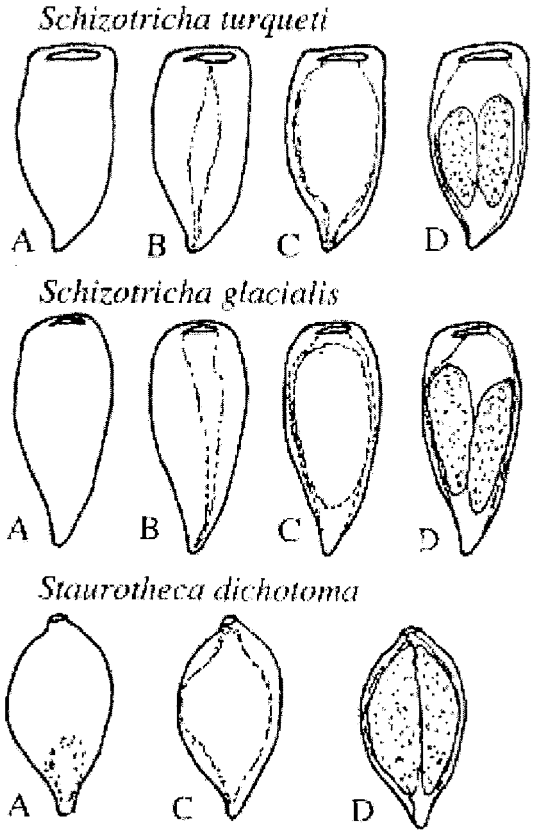


Fig. 37 Embryos and young individuals reorded in one specimen of *Epiactis georgiana*.

- Reproduction in Antarctic octocorals (comparison between the situation in summer and in autumn)

Objectives

Description of the reproductive biology of Antarctic gorgonians will allow the comparison of their reproductive effort with other geographical areas and provide a better understanding of their life history traits. Reproduction patterns of the species *Ainigmaptilon antarcticus* were studied during the EASIZ I and II cruises during the Antarctic summer. The goal of the present study is to know the reproductive features of this species during autumn.

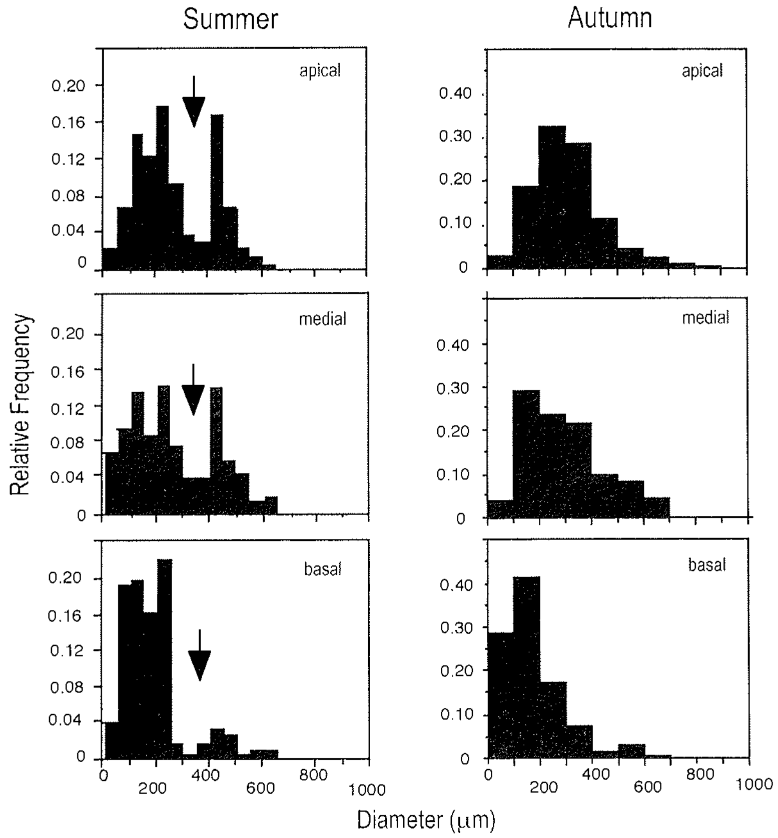


Fig. 38 Oocyte size classes in summer (left) and in autumn (right) in the colonies of *Ainigmaptilon antarcticus.*

Work at sea

20 colonies (10 male and 10 female) of *Ainigmaptilon antarcticus* were collected to do the reproduction studies. Each colony length was measured and two polyp leaves from its basal, medial and distal portions were removed for study. Polyp and egg number per polyp leaf were counted. Length and width of 60 polyps were measured as well as the diameter of 100 eggs. The same procedure had been used to study the same number of colonies of *Ainigmaptilon antarcticus* from the two previous cruises.

Preliminary results

As a first approach to the reproductive biology of the species, it seems to be clear that the distal portion of the colony is the most actively growing zone whereas the eggs are bigger and more abundant in the medial part of the colony. The most important and consistent pattern is that the presence of two oocyte size classes in summer contrasts with the presence of just one class (the immature one) in autumn, showing that the mature colony portions have been fecund and spawned (Fig. 38). This pattern confirms the biannual pattern of reproduction for the species. The presence of larvae in the studied colonies shows the species to be a brooder.

- Asexual reproduction in Antarctic sponges

Objectives

In contrast to ROV images from former expeditions, a high abundance of sponges of the *Rossella nuda* type with spectacular structures on their surfaces was found at one shallow station (Stn 059, 117 m depth, Atka Bay). This phenomenon was also recorded at other deeper stations (*e.g.* Stn 127, 245 m depth, Auståsen) but there the dominance of this species was lower (Fig. 39).

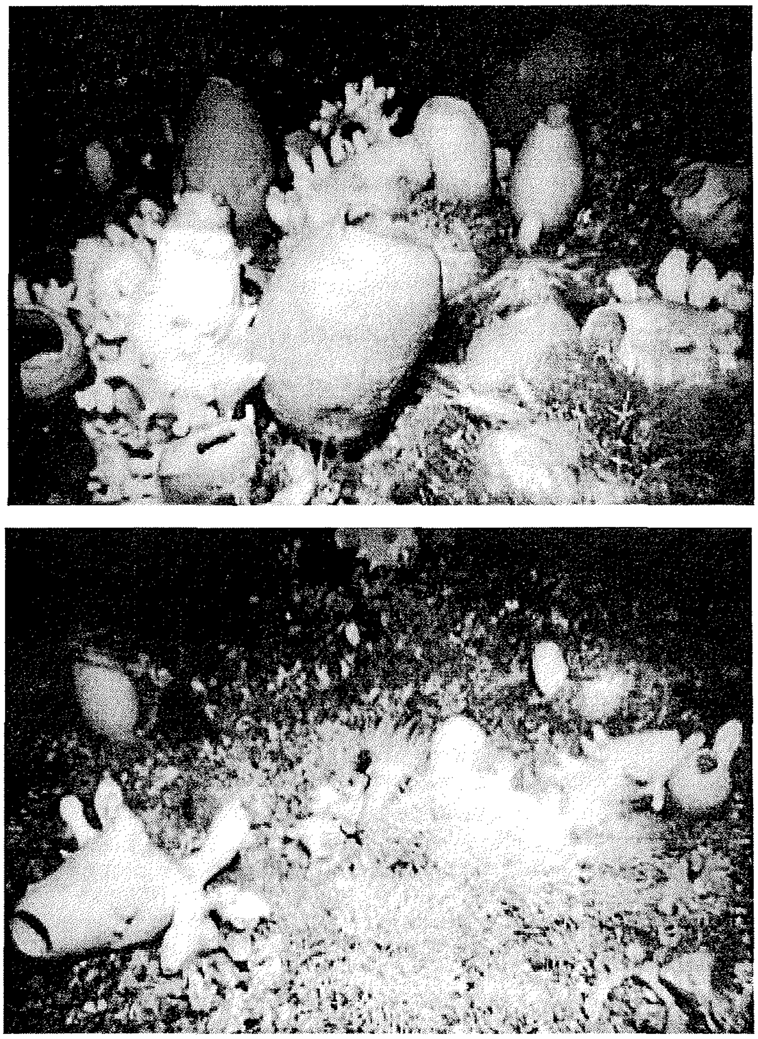


Fig. 39 ROV images from the EASIZ III expedition, where a high abundance of *Rossella nuda* type with "buds" is shown (Stn 059, 117 m depth, Atka Bay, and Stn 127, 245 m depth, Auståsen Fotos: J. Gutt).

Until now, it is not known whether these spectacular outgrowths ("buds") can increase the filtration surface or whether they may be considered propagules, and therefore a type of asexual reproduction. Budding could be a faster way of reproduction than settling larvae, resulting in slow dispersion that can generate monospecific patches with a highly patchy distribution. Dayton (1979) found budding as a main reproduction type of *R. racovitzae*.

Work at sea

To find out whether the individuals of one species found in a determined area belong to the same clone, we collected 4 different species of sponges with bottom trawl and TVgrab for genetic analysis. Each individual was measured (perimeter, height and fresh weight), and 2 g of each individual were frozen at -27°C for later Random Amplified Polymorphic DNA analysis (RAPD). The complete list of species, number of individuals, and stations where they were collected is shown in Table 4.

Table 4 List of sponges for RAPD analysis.

Stn	Area	Depth (m)	Operation	Species	Freezing (no.of specimens)
119-1	AUS	237	GSN	Cinachyra barbata	50
				Rossella racovitzae	50
				Rossella antarctica	4
124-1	AUS	269	GSN	Cinachyra barbata	50
				Rossella racovitzae	8
155-7	BFS	96	TVgrab	Monosyringa longispina	50

Areas. AUS: Auståsen, BFS: Bransfield Strait.

Preliminary results

The preliminary results are based on first analyses of the videos from both ROV stations. Stn 059 is a shallow station dominated by rigid forms of bryozoans and has strong aggregations of different hexactinellid sponges. Stn 127 is a deeper station with a relatively high abundance of hexactinellid sponges, some gorgonians and flexible bryozoans. These results provide us with initial quantitative data about the abundance of *R. nuda* type and the number of propagules per sponge.

We counted the number of individuals with and without propagules of the *R. nuda* type in 2 situations: when this species was in a very patchy, or in a non-patchy distribution. The total area sampled was 3 areas of 10 m^2 for a patchy distribution and 2 areas of 10 m^2 for non-patchy distribution. Within the individuals that presented propagules, we distinguished between primary propagules (formed from the primordial tissue of the parent) and secondary (formed from another propagule). All the individuals were divided in 2 size classes (smaller and bigger than 10 cm). Table 5 shows the results from this analysis at Stn 059.

Around 30 and 40% of the individuals of the *R. nuda* type exhibit between three and five propagules/individual, at both non-patchy and patchy distribution, respectively. Comparing these results with the data from the deeper station, the number of individuals forming the patches is much lower than at the shallow station, but the relative percentage of the individuals with propagules keeps constant, with the presence of 30% of individuals with approx. three propagules. Detailed analysis of the images will be carried out at home and we will compare them with videotransects from the two previous cruises EASIZ I and II to examine whether these outgrowths could be a seasonal phenomenon.

Table 5 Number of individuals and propagules of *Rossella nuda* type at Stn 059. No. big ind.: number of big individuals>10 cm; No. small ind.: number of small individuals<10cm; No. I prop.: number of primary propagules; No. II prop.: number of secondary propagules.

	without propagules		with propagules				
	nº big ind.	nº small ind.	nº big ind	nº I prop	nº II prop	nº small ind	nº prop
Patchy distribution (30m^2)							
Total	32	67	33	142	14	9	11
Mean ± SD	10.6 ± 4.2	222.6± 2.1	11 ± 4.5	47 ± 35.4	7 ± 0	4.5 ± 2.12	5.5 ± 0.7
Non-patchy distribution (20m^2)							
Total	17	31	11	33	4	6	5
Mean ± SD	8.5 ± 0.7	15.5 ± 12	5.5 ± 0.7	16.5 ± 13.4		3 ± 0	2.5 ± 0.7

2.1.9 Ecology of Epibiotic Benthic Hydrozoans

Objectives

The lack of hard substrata in Antarctica favours the strategy of "living on the second floor", that is epibiosis of small organisms on erect or large animals. Polychaete structures, like tubes of sabellids and terebellids, are known to act as a substrate for many epibiotic species. But, until now, direct settlement on dead polychaetes was unreported. The objective of this study was to demonstrate the close relationship between the features of the substratum and the life history of the colonizer.

Work at sea

Different *Koellikerina* sp. colonies growing on dead *Flabelligera* sp. specimens where collected and studied on board.

Other epibiotic hydroids have been collected during the ANT XVII/3 and they will increase the number of hydrozoan species known from the previous EASIZ expeditions. Three different hydractiinid colonies have been found, with species-specific relationships, on gorgonian axis, one ophiuroid, and on shells of the gastropod *Aforia multispira*. Samples were all preserved both in formalin and alcohol for combined morphological and molecular analysis of phylogenetic relationships.

Preliminary results

The bougainvilliid hydrozoan *Koellikerina* sp. has a previously unknown polyp stage with a peculiar niche, its colony living on the jelly coat of dead *Flabelligera* sp. specimens. Living *Flabelligera* sp. specimens are always free of any kind of overgrowing organisms, possibly because the polychaete jelly coat may contain some antifouling compounds (Goerke, pers. comm.). After death, such antifouling property is presumably lost. A substrate-specific planula settlement is known for many hydrozoan species, but the case of *Koellikerina* sp. is unique, showing an unknown "necrophylic" behaviour. Decomposition of *Flabelligera* sp. seems to require a long time, since the growth of large hydroid colonies (>1000 polyps) has been observed on well-preserved, dead *Flabelligera* polychaetes. Some polyps were excised from one of the colonies to assess their potential to grow on alternative substrata, namely rock, calcareous skeleton of a stylasterid Hydrozoa, or glass slides (on which most hydroid species can be easily cultured in laboratory rearings). However, in spite of retaining their good shape (of typical bougainvilliid polyps) and ability to prey on Artemia, the polyps did not produce stolons on these substrates.

From the hydroid colonies on the dead polychaetes we obtained the liberation of several medusae (1 mm diameter at liberation), which have been raised in small aquaria for five weeks, until the end of the cruise. This is, to our knowledge, the first laboratory raising of jellyfish in Antarctica. The medusa development was rather slow, despite continuous feeding with *Artemia* nauplii or newly caught zooplankton. We observed the development of secondary tentacular bulbs, a generic feature of diagnostic value to identify the genus *Koellikerina*, but, due to the end of the cruise, we could not raise the medusae to maturity to ascertain their specific identity.

Dealing with autumn aspects of hydrozoan reproduction, most of the species showed ongoing sexual reproduction. A few exceptions were represented by *Eudendrium* spp., a family with high potential of overcoming the adverse season as resting stolons. Small branched colonies with few gastrozooids and no gonozooids have been recorded. On the other hand, almost all large erect species belonging to Plumulariidae, Sertulariidae and Haleciidae families are progenetic (without the medusa stage), showing gonothecae with different degrees of development. Many of these species from Antarctic waters have already been collected during other expeditions, and most of these collections reported gonothecae throughout the year. This may have two different explanations: a) these species have non-seasonal reproductive patterns (as it is often claimed), or b) sexual reproduction is seasonal, and, once spawning has occurred, gonothecae do not shed from the colonies for a long time. Few studies are available on the occurrence of planula larvae both in the benthos and the water column, but the existing data show strongly seasonal behavior, mostly limited to summer months.

Developmental plasticity can be an important overwintering mechanism for hydrozoans with a free medusa stage, like *Koellikerina*. Regulation of the rate of development is known also in medusae from temperate and tropical seas, which may allow to reduce metabolic costs in periods of food scarcity in the water column. Specific projects on seasonal rate of development of adult and larval stages (planula, polyp) would contribute significantly to a better understanding of the Antarctic puzzle of invertebrate reproductive strategies.

2.1.10 The Role of Meiobenthos in the Food Web (T. Janssens, A. Dewicke)

Objectives

Meiobenthos is known to play an important role in the detrital food web, by increasing the decomposition and remineralisation rates of the organic material (Giere, 1993 and references therein). The metazoan meiobenthic communities of the eastern Weddell Sea shelf attain similar densities during summer as communities from similar depth elsewhere (Vanhove *et al.*, 1995), although the food supply from the pelagic is a short but very intense phenomenon in the Antarctic. This study focussed on the contribution of the meiobenthos community (and especially the most abundant taxon, the nematodes) in the C-flux of the Antarctic benthic ecosystem (Jarre-Teichmann at al., 1997). In literature, reports on responses of meiobenthic communities to the deposition of organic matter from the pelagial are often contradictory or unclear.

The first aim was to study the role of the meiobenthos in this highly seasonal environment in an experimental way, by following a ^{13}C tracer through the community. The ^{13}C assimilation by the meiobenthic community was investigated in an incubation experiment with a simulated plankton bloom, during a period of two weeks (by four-night intervals) and in a vertical sediment profile. Additional comparisons of relative label uptake will be made with other endobenthic organisms (e.g. food competition of nematodes with forams: Gooday et al., 1996).

Secondly, the role of the meiobenthos was studied in a comparative way, by the use of data concerning the natural ^{14}N/^{15}N & ^{12}C/^{13}C ratios of the meiobenthos. The natural stable isotope ratios will be compared with those from the suspended particulate matter in the near-bottom water and with other organisms from this endobenthic community to deduce their relative positions in the benthic food web.

Work at sea

The station at which sediment was obtained for the experiment was located in the Bransfield Strait (Stat. 148, ±230 m, 24/04/00). Three replicate MUC drops (148(1), 148(2) and 148(4) respectively) were taken. The sediment was almost devoid of epifauna. Chemical analysis of the near-bottom water from the sediment cores revealed that this station is located on a putative methane seep (Weber, pers. comm.). Three cores (one core of each drop) were sampled for quantitative community analysis and immediately sliced up into a vertical profile (0-1 cm; 1-2 cm; 2-5 cm and 5-10 cm depth). Two cores (one core each from drop 1 and 2) were used for environmental variables (granulometry, C/N and chloroplastic pigments; an additional subsample was taken for the natural stable isotope ratios in the (meio)benthos; ^{15}N/^{14}N & ^{13}C/^{12}C) after slicing them in the same vertical profile. Additionally, from each drop 1l of near-bottom water from the MUC cores was filtered over a pre-weighed Millipore GFF filter for analysis of the natural stable isotope ratios (^{14}N/^{15}N & ^{12}C/^{13}C) of the SPM. All the remaining cores were incubated at –1°C with 4mg of ^{13}C labeled freeze-dried algal cells (Cambridge Isotope Laboratories) applied frozen in a seawater icecube, for better suspension. In each sediment core, nearbottom water was left at 20 cm height above sediment level. After 4, 8, 12 & 16 days, incubation was stopped (Table 3) and the respective cores were split up according to the vertical sediment profile. From each slice of the ^{13}C tracer cores a subsample for C/N and chloroplastic pigments was taken. Each time, one core (from the second MUC drop) was kept for a non-replicate community analysis. All sediment and water samples for the analysis of stable isotopes, chloroplastic pigments and C/N were stored frozen at –20°C. The samples for the community analysis were fixed by a hot (±70°C) neutralised 4% formalin solution.

Table 6 The experimental design

	Purpose	MUC 1	MUC 2	MUC 3
Station		148(1)	148(2)	148(4)
#cores		6	9	5
24/04/00	Community analysis	1	1	1
24/04/00	Environmental variables + natural 14N/15N & 12C/13C ratios	1	1	
29/04/00	13C-tracer	1		1
29/04/00	Community analysis		1	
3/05/00	13C-tracer	1	1	1
3/05/00	Community analysis		1	
7/05/00	13C-tracer	1	1	1
7/05/00	Community analysis		1	
10/05/00	13C-tracer	1	1	1
10/05/00	Community analysis		1	

Mass-spectrometrical analysis of the isotope ratios and community analysis will be executed in cooperating labs and at the home lab respectively. The resolution of the isotope analyses (community, genus or species level) depends on community composition, but will be as high as possible.

2.2 Iceberg Dynamics and the Impact of Drifting Icebergs on Benthos and Fish Fauna (W. Arntz, M. Baumgartner, M. Boche, T. Brey, A. Dewicke, W. Dimmler, D. Gerdes, U. Hoge, C. Hohmann, T. Janssens, R. Knust, U. Lahrmann, K. Mintenbeck, A. Montiel, A. Schröder, A. Starmans, I. Suck, B. Zepick)

Iceberg scouring must be considered the principal disturbance for the benthic and demersal fish fauna on the continental shelf of the SE Weddell Sea. Drifting icebergs are supplied by breakoffs of the shelf ice edge and they are transported preferably in SW direction due to coastal currents and driven by wind. They mostly have heights above sea level between 20 and 50 m, corresponding to a draught of 120 to >300 m. They run aground preferably in those areas where the shelf topography falls into this depth contour. Thus typical areas are called "Iceberg Cemeteries" by various authors. However, as most icebergs move on after a while due to tide action and strong winds, "Iceberg Rest Places" may be a more adequate term.

Grounding icebergs may severely affect benthos and demersal fish communities. The knowledge of community resilience after disturbance events is of essential importance for ecosystem conservation. There are obvious differences in the resistance of a community to environmental stress. Some strongly fluctuating marine ecosystems may withstand quite a lot of impact whereas other highly persistent systems such as Antarctic benthic communities are supposed to be sensitive or even fragile. However, the data on which this paradigm is based are still poor.

Our recent EASIZ I and II studies demonstrated that part of the benthos and the demersal fish community inhabiting the high Antarctic shelf is regularly affected by iceberg scouring. Grounding icebergs cause considerable damage to meio- and macrobenthic communities. Sessile organisms are erradicated and pioneer species begin to grow in high abundances. Recovery of affected communities follows complex pathways of succession and in the case of macrobenthos it may take a long time to return to their old appearance, whereas meiobenthos recovery seems to occur on shorter timescales (months to few years). Scour marks are found in all different stages of recolonization, thus providing an insight in the whole process of succession.
The goal of our studies is to provide an improved data base which may finally enable us to quantify recolonization and succession processes in high Antarctic meio- and macrobenthic communities and demersal fish assemblages, both spatially and temporally.

Gears applied for our synoptic studies on iceberg effects are imaging methods such as ROV and Photo sledge for mega-epifauna, UW-video guided Multibox Corer for meio- and macro-infauna, Epibenthic sledge, Otter Trawl and Agassiz trawl for epi- and fish fauna collection, CTD and the Hydrosweep system for finding scour marks and prior survey of their position and intensity.

2.2.1 Iceberg Dynamics (R. Knust, W. Arntz, M. Boche, T. Brey, D. Gerdes, C. Hoffmann, U. Lahrmann, A. Starmans, B. Zepick)

Objectives

Due to the floating Antarctic ice sheet the contour of the shelf ice edge may vary considerably. The shelf areas off Kapp Norvegia and Auståsen are known to be heavily affected by icebergs calving from the shelf ice edge.

The main questions were: How many icebergs do occur in these areas, how do these icebergs move and where do they preferably run aground to form the "Iceberg Rest Places" . Furthermore in which way did the shape of the shelf ice edge change in the past years?

Work at sea

The shelf ice edge was measured on several helicopter flights in an area between 70°40'S / 009°30'W and 71°43'S / 013°00'W (Fig.40). The helicopter followed the shelf ice edge at a height of 100 m and a speed of about 150 km/h. Every 15 seconds, or at distinct changes of the direction of the self ice edge, the coordinates of the board GPS were recorded.

Iceberg concentrations off Auståsen and Kapp Norvegia were mapped by ship radar measurements and by helicopter flights. The iceberg movements (direction and speed) were plotted by radar on the bridge of RV Polarstern during periods of three (Auståsen) and four days (Kapp Norvegia), respectively.

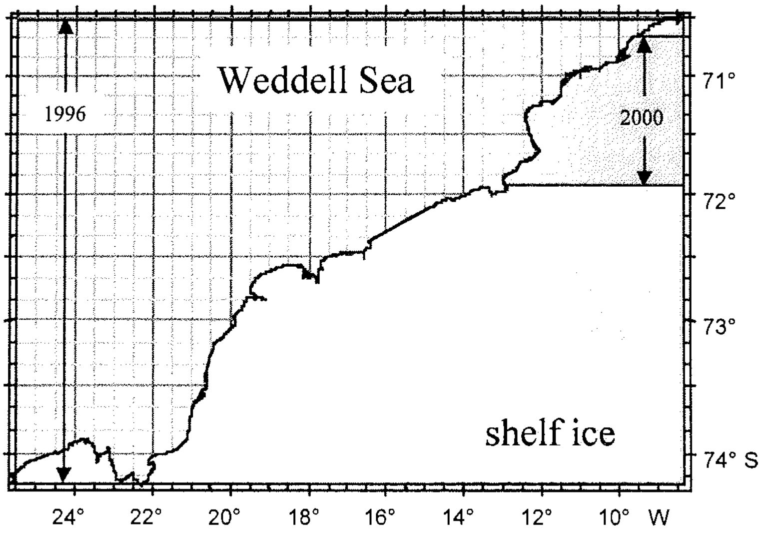


Fig. 40 Shelf ice measurement by helicopter in 1996 and 2000

Preliminary results

The comparison of the helicopter measurements in 1996 and 2000 showed a significant loss at two areas near Auståsen with dimensions of 21 x 3 km and 12 x 3 km (Fig. 41). At other locations the shelf ice edge did not show any differences between the 1996 and the 2000 measurements, thus indicating a high degree of accuracy of the helicopter measurements and a relative stable shelf ice edge without greater calving events during the last four years (cf. Fig. 40).

On the shelf between Auståsen and Kapp Norvegia seven areas with iceberg concentrations were detected (Fig. 42). All aggregations were found at water depths <400 m. The extensions of these iceberg rest places were calculated by means of a geographic information system (GIS). The smallest field had an area of 7.2 x 5.9 km, the largest of approximately 41.8 x 14.4 km. About 7% of the total shelf area at water depths between 400 to 200 m were covered by these iceberg concentrations (Fig. 42).

Observations in two of these iceberg rest places off Auståsen and Kapp Norvegia (No. 1 and 3, see Fig. 42) revealed, to our surprise, a rather unstable situation. In both areas grounded icebergs floated during high spring tide and drifted in southwestern direction, probably driven by strong wind and the coastal current. During our observations five icebergs drifted over distances between 0.5 and 12.5 nautical miles before running aground again (Fig. 43).

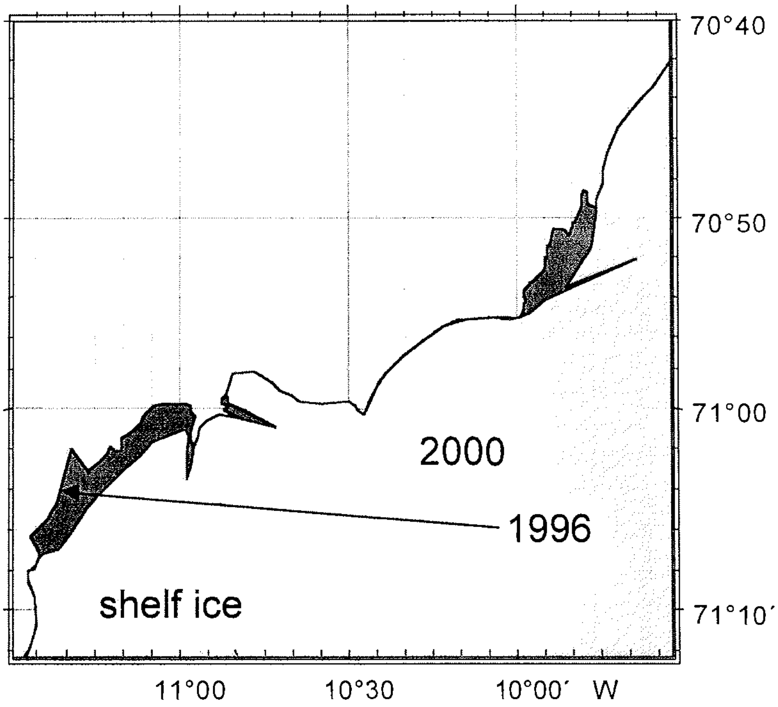
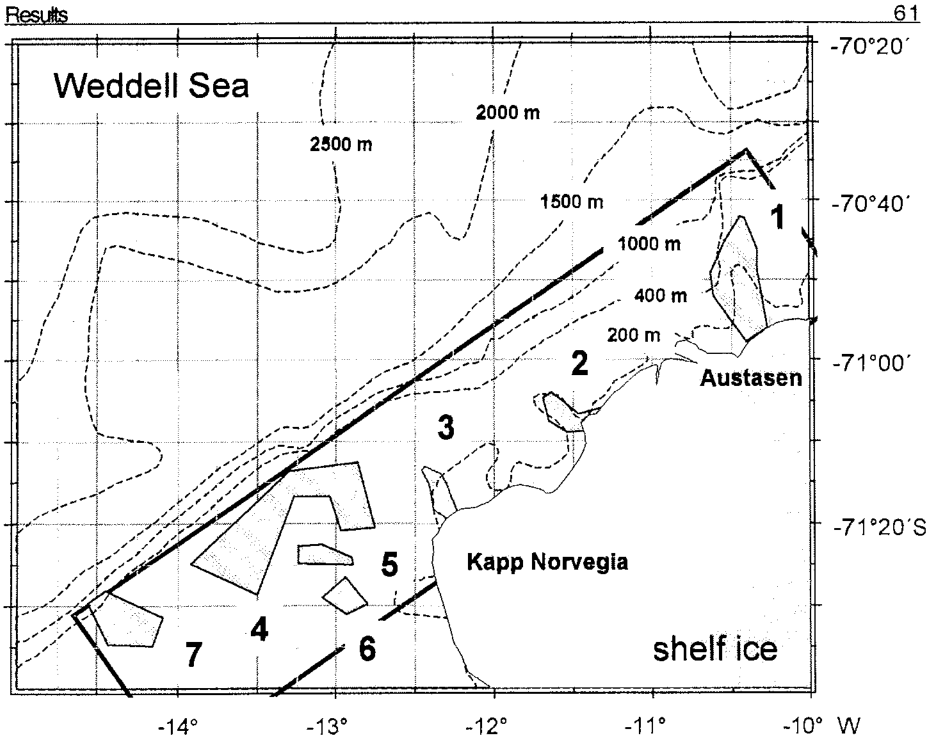


Fig. 41 The shelf ice edge in 1996 and 2000 in the region of Auståsen. Shaded areas correspond to parts of the ice shelf which broke off during this interval.

One iceberg grounded at about 250m water depth was examined in more detail. The iceberg contour at the sea bottom was determined by detailed hydrosweep scanning. In combination with above water level observations area and volume of this iceberg could be estimated. The area above sea level was 2.12 km^2 and that on the sea floor about 1.25 km^2. The height of the iceberg above the sea surface varied between 30 and 49m, i.e. its volume was approximately 0.0848 km^3. The under water volume of this iceberg was about 0.4214 km^3, and the total volume was about 0.51 km^3.



▭ = iceberg aggregations ("rest places")

1: 29.0 x 11.5 km = 334 km^2
2: 10.4 x 4.6 km = 48 km^2
3: 12.3 x 3.9 km = 48 km^2
4: 41.8 x 14.4 km = 602 km^2
5: 12.5 x 4.2 km = 53 km^2
6: 7.2 x 5.9 km = 43 km^2
7: 16.0 x 10.1 km = 162 km^2

= 7% of the shelf area indicated by ◇

Fig. 42 Areas with aggregations of iceberg rest places

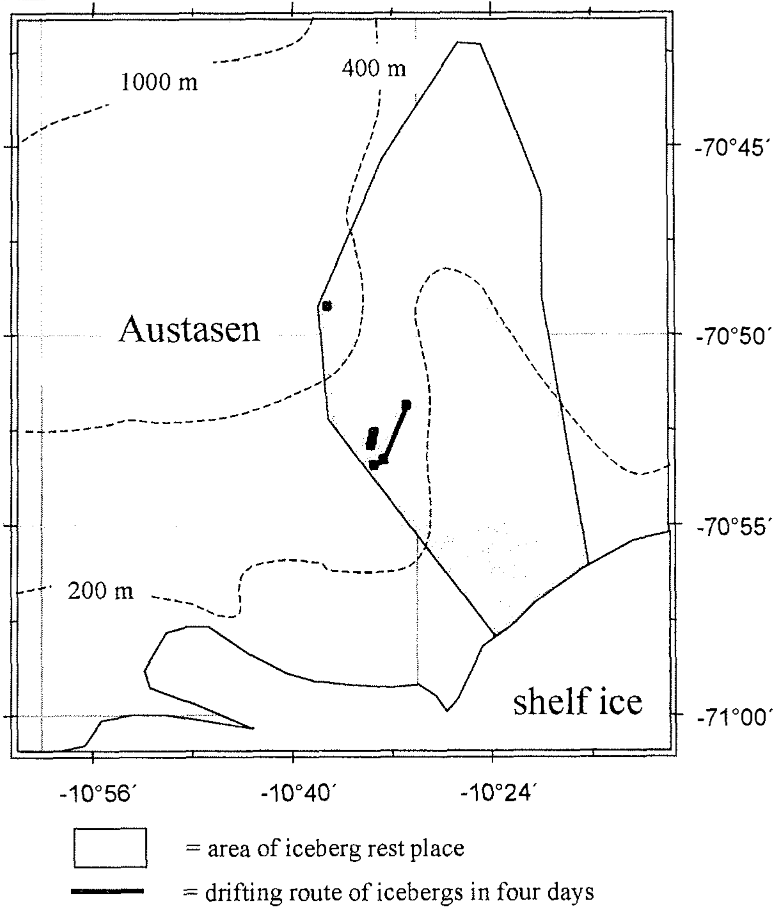


Fig. 43 Route of drifting icebergs in the iceberg rest place at Auståsen

2.2.2 Iceberg Effects on the Benthic Fauna (A. Dewicke, D. Gerdes, U. Hoge, T. Janssens, A. Montiel)

Work at sea

- Macro- and meiobenthos work based on the multibox corer

a) SE Weddell Sea Shelf

On the SE Weddell Sea Shelf off Kapp Norvegia and Auståsen the multibox corer was deployed at 10 stations and yielded a total of 63 samples for macro-endofauna and meiobenthos analyses. The samples for macrobenthos analyses were sieved over 500 µm mesh size and stored in 4 % buffered formalin prior to sorting in the home laboratory. For meiobenthos community analysis, two 10 cm cores were taken from two boxes and sliced in a vertical profile (0-1, 1-2, 2-5, and 5-10 cm). Two additional 30 cm cores were taken for the analysis of granulometry, C/N and chloroplastic pigments of the same vertical profile. The samples for meiobenthos community analysis were fixed in buffered, hot (±70°C) 4% formaldehyde solution and will be extracted by a combination of decantation over a 38 µm sieve and following application of the centrifugal flotation method with a

1.18 Ludox HS solution. The subsamples for C/N and chloroplastic pigments were stored at –20°C.

Table 7 Multibox corer stations on the SE Weddell Sea Shelf off Kapp Norvegia and Auståsen

Date	Station	Lat. (S), Long. (W)	Depth	MG No.	No. of cores1)	Remarks
02.04.00	90	71°12.52' 12°39.64'	365	1	6/3	semidisturbed
03.04.00	98	71°10.87' 12°27.95'	314	2	5/2	semidisturbed
04.04.00	108	71°08.64' 12°14.74'	441	3	8/1	semidisturbed
06.04.00	112	71°06.10' 12°43.10'	567	4	6/3	undisturbed
06.04.00	113	70°49.91' 10°36.77'	275	5	6/3	undisturbed
07.04.00	114	70°46.18' 10°43.20'	753	6	2/0	undisturbed
08.04.00	120	70°50.34' 10°35.04'	271	7	3/1	disturbed
08.04.00	121	70°53.63' 10°34.21'	249	8	6/3	undisturbed
10.04.00	136-6	70°50.16' 10°34.52'	256	9	2/0	disturbed
10.04.00	137	70°50.20' 10°34.70'	272	10	3/0	disturbed

1) share of cores between macro- and meiobenthos work

The attached UW video system provided 1.5 hours of video material of disturbed and undisturbed areas in water depths between 249 and 753 m and enabled controlled sampling at both sites. Areas were classified as being disturbed by icebergs if an abrupt change in the epibenthic structure occurred, which could not be explained by other physical or biological processes. 3 multibox corer stations off Auståsen were worked up at totally disturbed sites (MGs 7, 9, 10), 4 stations represent undisturbed sites (MGs 4, 5, 6, 8) and 3 stations in the 'Gili grid' off Kapp Norvegia appeared semidisturbed, i.e. these sites appeared to characterize an advanced recolonisation stage.

Preliminary results

On the shelf off Auståsen 3 drops at totally disturbed sites yielded 8 cores for macrobenthic analyses and 1 for meiobenthos. The sediments in the devastated areas appeared extremely overcompacted and even increase of the multibox corer's weight by additional lead weights did not yield in complete sample series and higher penetration into the sediment. The positions of the drops coincide with the positions of the otter trawls taken in disturbed areas. Also the ROV was deployed here, thus enabling us to analyse for the first time the whole benthic and demersal fish fauna synoptically on the basis of all gears available.

2.2.3 Comparative Community Analysis by Imaging Methods (W. Dimmler, J. Raguá-Gil, A. Starmans, I. Suck, N. Teixidó)

Objectives

In general the faunas of the high Antarctic Weddell Sea and the Antarctic Peninsula are considered to belong to different zoogeographical regions. These two regions strikingly differ by some physical factors. For example, the Antarctic Peninsula has a real coast with true littoral areas whereas about 95 % of the coastline and nearshore region of the high Antarctic are covered by floating or grounded glacier ice, making extreme shallow areas very scarce. However, in the Weddell Sea two sites with water depths of only 60 m are known: the inner parts of Atka Bay and a recently discovered shallow bank, the Hilltop off Four Seasons Inlet (NE of Kapp Norvegia).

One major objective of this cruise was a detailed study of the communities of organisms that live in these shallow waters, in order to compare these assemblages with studies of shallow water sites of Marguerite Bay, Antarctic Peninsula, and off the South Shetlands. If no apparent differences at community level are discernible, it may be assumed that benthic communities that live in the shallow waters of Antarctica have a circumpolar distribution, provided that suitable habitats exist.

If differences between communities exist, the question arises how these differences can be explained. Do certain physical processes determine the benthic fauna at different shallow sites or, are the differences just a result of limited larval dispersion since extreme shallow areas are very scarce in the high Antarctic?

An additional objective was to compare the faunas of very shallow sites (approx. 50-100 m) on the eastern Weddell Sea shelf with deeper shelf areas (below 100 m up to 600 m), which are thought to differ remarkably in faunal composition and community structure. We introduced a new approach based on the Landscape Ecology techniques using underwater photographs. This approach is founded on the assumption that communities can be viewed as a patch mosaic at any scale, where patches correspond to different categories defined according to the spatial scale considered. From this perspective, community structure is analyzed according to the characteristics of the patch mosaic. Thus, community structure study involves the description of (i) the composition, features associated with the presence and amount of each patch type (e.g. species) and (ii) the configuration, features associated with the physical distribution of patches found in the patch mosaic. Additionally, in order to complete the existent set of data, stations at depths between 300 and 500 m were selected using the photo sledge.

Work at sea

Two different imaging methods were applied to investigate abundances and dispersion patterns of epibenthic populations: videography (using a remotely operated vehicle) and still photography (using a photo sledge).

The remotely operated vehicle (ROV) is equipped with five thrusters, a compass, a depth sensor, two video cameras (black and white, colour), a still camera and lights and strobes which can be tilted. Two laser beams appear in the images, generating two points at a distance of 33 cm apart on the objects observed. To achieve the straightest transects, the vehicle and the underwater winch were used together with the ship acting mainly as a drifting system. Normal ROV casts were carried out for approx. 1 hour. In addition to the videography a minimum of 100 still photographs were taken at each station.

Table 8 List of ROV stations

Stn	Area	Position start	Position end	Depth (m)	Transect length (m)
059-1	AB	70°40.43' S 7°41.15' W	70°40.32' S 7°40.65' W	120	439
111-1	N/KN	71°07.57' S 11°28.00' W	71°07.53' S 11°27.65' W	62-111	316
111-3 *	N/KN	71°07.50' S 11°28.05' W	71°07.50' S 11°27.72' W	63-111	477
154-1 *	BFS	63°03.95' S 57°31.10' W	63°03.62' S 57°31.70' W	100	823
171-2	BFS	63°00.02' S 60°30.83' W	63°00.05' S 60°29.63' W	30-170	1087
171-4	BFS	60°00.10' S 60°31.72' W	63°00.03' S 60°31.02' W	28-32	774

Areas: AB: Atka Bay, N/KN: north of Kapp Norvegia, BFS: Bransfield Strait
* Stations with TVgrab samples

Table 9 List of photographic stations

Stn	Area	Position start	Position end	Depth (m)	No. of photos	Transect length (m)
059-5	AB	70°40.28' S 7°40.24' W	70°40.28' S 7°40.34' W	106-107	50	286
082-1	KN	71°14.84' S 12°32.45' W	71°14.85' S 12°33.25' W	356-366	50	452
083-1	KN	71°14.73' S 12°29.91' W	71°14.72' S 12°30.90' W	304-322	50	655
094-1	KN	71°07.34' S 12°38.10' W	71°07.46' S 12°39.76' W	420-428	50	448
111-2	N/KN	71°07.53' S 11°27.56' W	71°07.48' S 11°28.46' W	65-91	22	541
111-4	N/KN	71°07.54' S 11°27.93' W	71°07.53' S 11°27.81' W	96-71	30	101
111-26	N/KN	71°07.46' S 11°27.66' W	71°07.34' S 11°26.94' W	68-145	76	623
125-1	AUS	71°45.94' S 10°33.96' W	70°45.92' S 10°33.67' W	314-302	50	479
197-1	KG	62°15.58'S 58°44.13'W	62° 15.51'S 58°44.68'W	290-319	70	1140

Areas AB: Atka Bay, AUS: Auståsen, KN: Kapp Norvegia, N/KN: north of Kapp Norvegia, KG: King George Island

The still camera system (FTS) consists of a vertically oriented camera combined with two strobes and provides high resolution images of the seafloor. At each station a series of between 40 and 70 pictures were taken, imaging approx. 1 m^2 of the seafloor each, and distributed along a transect of approx. 500 m length. These photographs provide "in situ"-views of epibenthic habitats and will be analysed to study the structural changes of the communities with increasing depth. All information on ROV and photographic stations are listed in Tables 8 and 9. A complementary TVgrab was used in order to provide reference material for identification purposes.

Preliminary results

The seafloor videos and photos will be analysed at home but a following first impression of the images can be given:

Atka Bay

At the shallow stations in Atka Bay (around 100 m depth) no "unusual" faunal community could be distinguished. The fauna belongs to the Eastern Shelf Community dominated by sessile suspension feeders such as sponges (*Rossella nuda, R. racovitzae, R. antarctica*), bryozoans (*Bostrychopora dentata, Chondriovelum adeliensis*), gorgonians (*Thouarella* spp.), ascidians (*Cnemidocarpa verrucosa*) and hydrozoans.

Hilltop (Four Seasons Inlet)

At this station the fauna is quite different from that of deeper bottoms in the eastern Weddell Sea, and the depth zonation of the epibenthic community is very remarkable (Fig. 44):

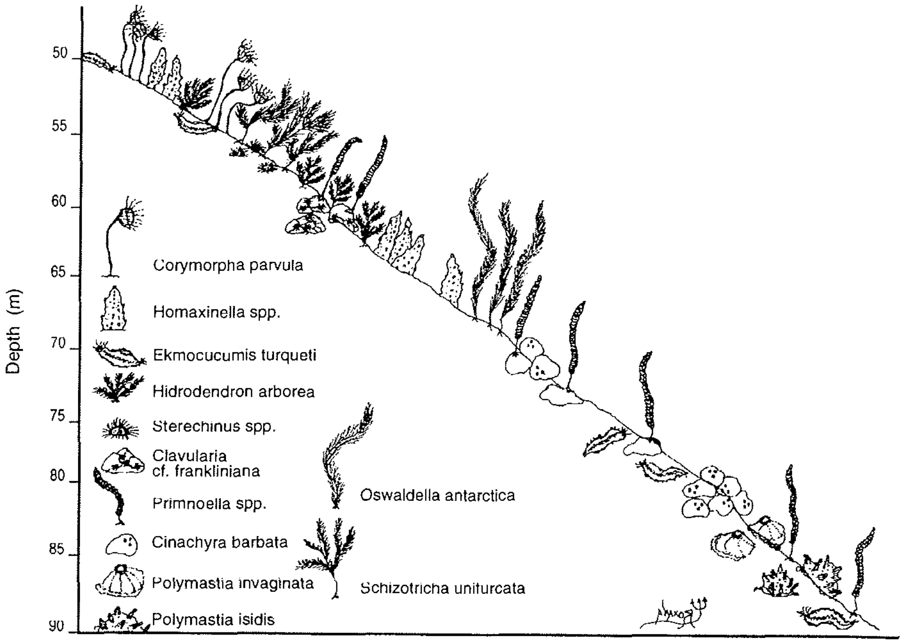


Fig. 44 Schematic zonation along a depth gradient of the Hilltop epibenthic community, north-east off Kapp Norvegia, Weddell Sea

At depths between 90-75 m, the gorgonian *Primnoella* sp. is abundant and a variety of sponges are also present: *Polymastia isidis*, *Polymastia invaginata* and *Cinachyra barbata*, the latter with a special patch at a depth of 82 m. Also the holothurian *Ekmocucumis turqueti* is quite representative at this zone.

Between 75-65 m the hydrozoan *Schizotricha unifurcata* is very dominant, the genus *Primnoella* continues to be present and abundant and the sponge *Homaxinella* appears with a low number of individuals.

The hydrozoan *Oswaldella antarctica* and the sea urchin *Sterechinus* sp. are very abundant at depths between 65-55 m, also the number of *Homaxinella* individuals increases and the hydrozoan *Hydrodendron arborea* and the octocoral *Clavularia cf. frankliniana* become representative species. The gorgonian *Primnoella* sp. is still present and *Corymorpha parvula* begins to appear.

The high abundance of *Corymorpha parvula* up to 55 m is quite impressive, the hydrozoan *Hydrodendron arborea* decreases in number, *Homaxinella* is still abundant and *E. turqueti* appears again with representative numbers.

Antarctic Peninsula

The continental shelf area off the Antarctic Peninsula at a depth of 100 m at the entrance of the Antarctic Sound was mainly influenced by strong currents and thus dominated by flexible byrozoans (e. g. Flustridae) and gorgonians (*Fannyella* spp., *Primnoella* spp.). Only a few sponges (*Mycale acerata, Monosyringa longispina*), some of them enormous in size and cushion shaped, were found.
At a depth of 30 m off Deception Island a typical "beach situation" appeared showing ripples and a poor epifauna dominated by abundant patches of a small solitary ascidian, a vast number of amphipods and some specimens of the starfish *Labidiaster annulatus.* This situation is mainly caused by strongly moving sediments due to wave action. Even at greater depth of 100 m the megabenthic epifauna was rare except hydrozoans and the abundant starfish *Labidiaster annulatus.*

2.2.4 **Impact on demersal fish communities** (R. Knust, K. Mintenbeck, A. Schröder)

Objectives

Former investigations during EASIZ II (1998) provided evidence that the distribution of several fish species is affected by iceberg disturbance (KNUST & SCHRÖDER, 1999). On this cruise the following hypotheses were to be examined: Iceberg scours build "new" habitats. These "new" habitats can be colonized by those fish species, which are specialised on food sources found in those areas. The disturbance of the benthic system by iceberg scouring increases the number of habitats on the eastern shelf of the Weddell Sea and increases, therefore, the fish biodiversity in that region.

Table 10 Average depth and trawling duration (on ground – off ground) of the study areas (gear: bottom trawl).
The exact positions are given in the station list in the Annex.

Area	Station No.	Character	Depth [m]	Trawling time [min.]
Kapp Norvegia	56/065	undisturbed	632	27
	56/085	undisturbed	314	30
	56/102	undisturbed	318	19
	56/109	undisturbed	314	20
Auståsen	56/119	disturbed	246	16
	56/124	undisturbed/disturbed	258	12
	56/135	disturbed	274	43
	56/136	disturbed	261	13

Work at sea

In a synoptic approach with the benthic working groups samples were taken on the shelf off Kapp Norvegia and Auståsen using a 140 feet bottom trawl (Table 10). Fish weight, length, sex, maturity stage and gonad weight were measured and all fish were determined to species level. Furthermore, otoliths were taken for age determinations. To investigate the diet of various species (e.g. *Trematomus* spp.), stomachs were removed and stored in 10 % formalin. Disturbed and undisturbed areas were indicated by the by-catch composition (presence/absence of sponges).

Preliminary results

For comparison of the demersal fish fauna in disturbed and undisturbed areas only those trawls where used which were caught at water depths between 450 and 200m and which could be clearly assigned to disturbed or undisturbed areas on the basis of the by-catch composition. Abundance and biomass of species were calculated for standardised 15 minutes trawling time.

In total 38 species were identified. 28 species were found in undisturbed areas, 27 species were present in disturbed areas. Based on the abundance data the Bray-Curtis similarity index was calculated and a cluster analysis clearly grouped the stations into two clusters, which represent trawls from disturbed areas and undisturbed areas (Fig. 45). The similarity between catches in undisturbed and disturbed areas is quite low.

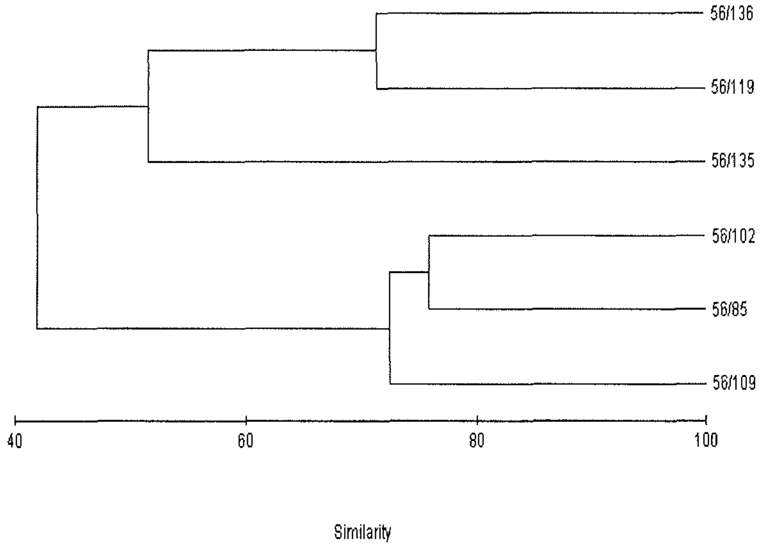


Fig. 45 Dendogram of similarities (Bray-Curtis-Index; transformation: 4th root) in species composition between the trawled stations.

In both areas more than 99% of the species belonged to the suborder Notothenioidei (Perciformes). Beside these, only two *Bathyraja* species (Rajiformes) were present. Shares of individuals and biomass of the families within the Notothenioidei are shown in Fig. 46. The family Nototheniidae dominated in all regions, both in number of individuals and also in biomass. In undisturbed areas this family was mainly represented by the species *Trematomus eulepidotus*, whereas *T. pennellii* was the most common species in disturbed areas.

The genus *Trematomus* constituted more than 90% of this family. *Trematomus* spp. showed a characteristic distribution: *T. pennellii* and *T. nicolai* were mainly found in disturbed areas, whereas *T. scotti* and *T. eulepidotus* were commonly represented in undisturbed areas. The family Channichthyidae took a higher percentage in undisturbed regions, where it was mainly represented by *Cryodraco antarcticum*. *Chaenodraco wilsoni* and *Chionodraco hamatus* were the most common species in disturbed areas, while *Pagetopsis macropterus* seemed to avoid these places. The Bathydraconidae were hardly present in undisturbed regions but quite numerous off Auståsen. Individuals of *Prionodraco evansii* were the most frequent fish species in this area. Concerning the Artedidraconidae both areas were mainly colonised by *Artedidraco orianae.*

Consequently, iceberg groundings definitely affected the composition of the demersal fish fauna. Some species, such as *Prionodraco evansii* and *Trematomus pennellii*, clearly preferred disturbed areas, whereas *Trematomus scotti* and *Pagetopsis macropterus* avoided these regions.

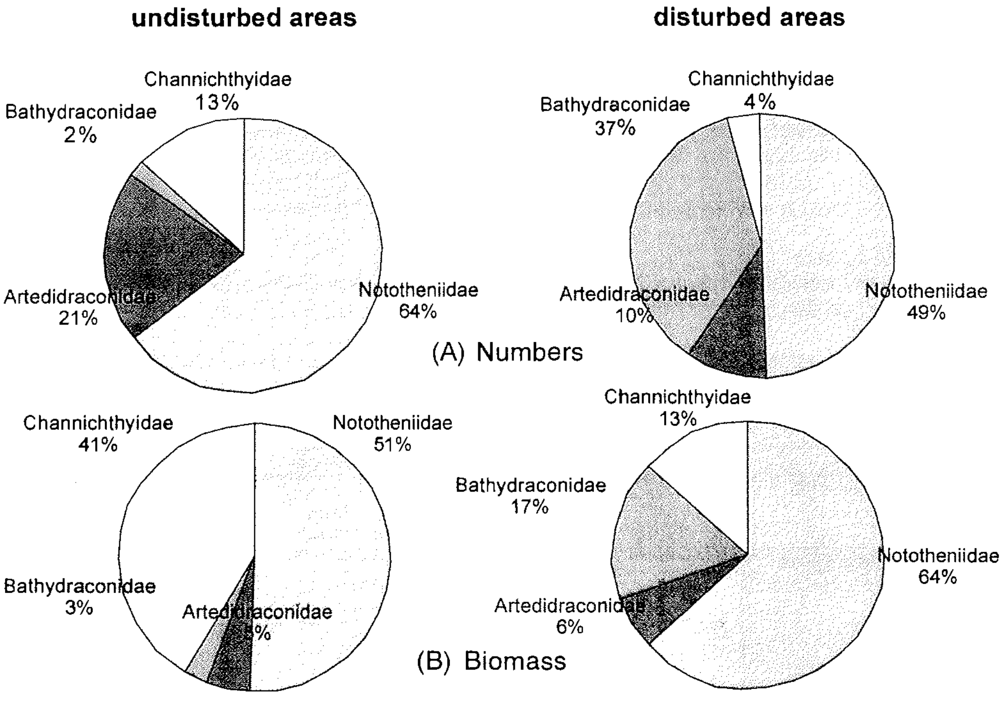


Fig. 46 Percentage of families within the suborder Notothenioidei in undisturbed and disturbed areas. A = percentage of individuals, B = percentage of biomass.

2.3 Biodiversity and Biogeography

2.3.1 **Demersal Fish Fauna** (A. Schroeder, B.Artigues, J. Gonzales, K. Mintenbeck, R. Knust)

Objectives

The aim of this study was to investigate the zoogeography and biodiversity of the demersal fish fauna of the high Antarctic in the eastern Weddell Sea and the low Antarctic at the northern end of the Antarctic Peninsula.

Data were collected fulfilling the main tasks of studying the fish fauna in iceberg scourings as well as its feeding ecology and role in the benthic food web. The planned investigation of the fish fauna in the Drescher Inlet as potential food for seals could not be conducted due to the changes in the cruise schedule because of an engine breakdown.

The Antarctic fish fauna is dominated by only one suborder, the Notothenioidei (within the order Perciformes). Mainly five families within this suborder account for more than 50% of the species and more than 90% of the fish biomass on the Antarctic shelf (Gon & Heemstra 1990). Nevertheless the Nothothenioidei, comprising more than 100 closely related species, cover a whole range of ecotypes from sluggish demersal species over predators up to herring-like pelagic shoaling species. In other geographic areas these are normally represented by a variety of higher taxa. Despite this low diversity on higher taxonomic level, the demersal fish fauna of the Antarctic shelf comprises several highly diverse communities on species level (Hubold 1992), which are in a pristine status, being free from anthropogenic influences and especially from fisheries.

On the one hand the demersal fish communities show a gradual transition with increasing water depth and on the other, they differ between geographical areas, which allows a comparison of the Weddell Sea and the Peninsula fish fauna.

Work at sea

Species composition and relative abundances of the demersal fish fauna were studied on the basis of material from 14 otter trawls and 6 Agassiz trawls (Tab.11).

Table 11 Samples taken during ANT XVII/3: Exact positions and depth data are given in the station list in the Annex.

Area	Gear	Station number	Depth zone
Kapp Norvegia	GSN	65	630m
		85, 102, 109, 124	250-350m
		119*, 135*, 136*	250-350m*
Bransfield Strait	GSN	166	670m
		173	360m
		177	200m
	AGT	149, 164	900m
		165	600m
		193	360m
		159	200m
		158	100m
Drake Passage	GSN	178	850m
		184	350m
		183	200m

* disturbed area of iceberg rest place

Apart from one haul at 630m depth, GSN stations on the Weddell Sea shelf were situated in shallow areas between 250 and 350m to allow the comparison of disturbed and undisturbed areas whereas stations at the Peninsula were chosen to cover the depth range from about 200m to 850m on the continental slope for biodiversity studies. Additionally AGT samples were taken at the Peninsula from 100 to 900m depth. Geographical differences were investigated in three areas, around Kapp Norvegia in the Weddell Sea, within the Bransfield Strait and on the northern slope of King George Island towards the Drake Passage.

After collecting the fish from the sometimes enormous amount of sponges and other bycatch, the fishes were whenever possible identified to species level. Reference material was taken from every species at first occurrence. All fish that could not be identified to species level on board were stored either frozen or in 10% formalin for later identification by taxonomic experts (mainly Zoarcidae, Liparididae and juveniles/larvae). Each individual fish was measured (TL) and weighed whole and eviscerated, and the reproductive state and gonad weight were recorded. Stomachs and gonads of the dominant species (all *Trematomus* spp. plus several other Nototheniidae and Channichthyidae) were fixed in 10% formalin and otoliths were kept dry for later analysis. Several specimens of selected nototheniid species were frozen for later phylogenetic and molecular biological studies.

Some living specimens of Zoarcidae, *Trematomus eulepidotus* and *T. pennellii* were kept in aquaria for physiological studies (chapter 2.4), subsamples of selected species were frozen for chemical analyses (chapter 2.5), and selected specimens of most species were supplied for investigation of parasites (chapter 2.6).

Preliminary results
The following results are derived from the analysis of the abundance data of all fish caught with the GSN only.

Comparison Weddell Sea shelf – Antarctic Peninsula shelf
For the comparison of the fish fauna of these two areas, only the results from the hauls of less than about 650m depth were considered, as there were no deeper hauls in the Weddell Sea.

39 species were found in the Weddell Sea, and 29 species at the Antarctic Peninsula. Only 14 species occurred in both regions (Tab. 12). The total number of species will increase after identification of those specimens that were so far only identified to family level. [Additionally 10 species were caught in the deepest haul (860m) at the Peninsula, that were not caught in shallower hauls (see chapter on depth distribution).]

Interestingly at the Peninsula only two species of the Artedidraconidae were caught, both of the genus *Pogonophryne*, whereas in the Weddell Sea this family was represented by ten species with four genera. Also the Bathydraconidae were only represented by three species at the Peninsula whereas six species occurred in the Weddell Sea. Within the Channichthyidae and Nototheniidae the number of species does not differ significantly between the areas, but the species spectrum does greatly. While *Trematomus* is the dominant genus in the Weddell Sea, its place is taken at the Peninsula by similar looking species of the genus *Lepidonotothen* and by *Gobionotothen gibberifrons*. Also the Channichthyidae were represented by similar looking but different species (Fig. 47)

Table 12 List of all fish species caught on ANT XVII/3 in the eastern Weddell Sea and at the Antarctic Peninsula [N = total number in all GSN].

Weddell Sea		**Antarctic Peninsula**	
Species	**n**	**Species**	**n**
Artedidraconidae			
Artedidraco loennbergi	23		
Artedidraco orianae	75		
Artedidraco shackletoni	29		
Artedidraco skottsbergi	49		
Dolloidraco longedorsalis	1		
Histiodraco velifer	8		
Pogonophryne macropogon	1	*Pogonophryne permittini*	7
Pogonophryne marmorata	7	*Pogonophryne sp.*	1
Pogonophryne phyllopogon	2		
Pogonophryne scotti	4		
Bathydraconidae			
Akarotaxis nudiceps	1		
Bathydraco marri	11		
Cygnodraco mawsoni	30		
		Gerlachea australis	1
Gymnodraco acuticeps	**11**	***Gymnodraco acuticeps***	**5**
Prionodraco evansii	**181**	***Prionodraco evansii***	**2**
Racovitzia glacialis	5	*Vomeridens infuscipinnis*	1
		Bathydraconidae juv.	2
Channichthyidae			
		Chaenocephalus aceratus	53
Chaenodraco wilsoni	**13**	***Chaenodraco wilsoni***	**1**
Channichthyidae juv.	3		
		Champsocephalus gunnari	73
		Chionobathyscus dewitti	74
Chionodraco hamatus	19	*Chionodraco rastrospinosus*	248
Chionodraco myersi	13		
Cryodraco antarcticus	**45**	***Cryodraco antarcticus***	**19**
Dacodraco hunteri	4		
Pagetopsis macropterus	3		
Pagetopsis maculatus	16		
		Neopagetopsis ionah	5
		Pseudochaenichthys georgianus	7
Nototheniidae			
Aethotaxis mitopteryx	**2**	***Aethotaxis mitopteryx***	**11**
Dissostichus mawsoni	**1**	***Dissostichus mawsoni***	**5**
		Gobionotothen gibberifrons	75
		Lepidonotothen kempi	39
		Lepidonotothen larseni	110
		Lepidonotothen nudifrons	88
		Notothenia coriiceps	4

		Notothenia rossii	1
Pleuragramma antarcticum	**15**	***Pleuragramma antarcticum***	**51**
Trematomus bernachii	6		
Trematomus eulepidotus	**302**	***Trematomus eulepidotus***	**8**
Trematomus hansoni	**25**	***Trematomus hansoni***	**8**
Trematomus lepidorhinus	140	*Trematomus newnesi*	3
Trematomus nicolai	17		
Trematomus pennellii	281		
Trematomus scotti	**116**	***Trematomus scotti***	**8**
Trematomus juv.	14		
Nototheniidae juv.	23		
Gempylidae			
		Paradiplospinus gracilis	5
Liparidae			
Liparidae spp.	3	*Liparidae spp.*	12
Macrouridae			
Macrourus whitsoni	4	*Macrourus whitsoni*	239
Melamphaidae			
		Poromitra crassiceps	1
Moridae			
		Antimora rostrata	12
		Lepidion ensiferus	2
Myctophidae			
		Electrona antarctica	24
		Gymnoscopelus nicholsi	616
		Gymnoscopelus sp.	1
Paralepididae			
Notolepis coatsi	4	***Notolepis coatsi***	3
Rajidae			
Bathyraja maccaini	4		
Bathyraja sp.	**2**	***Bathyraja sp.***	**15**
		Raja georgiana eggs	32
Zoarcidae			
		Zoarcidae spp.	32

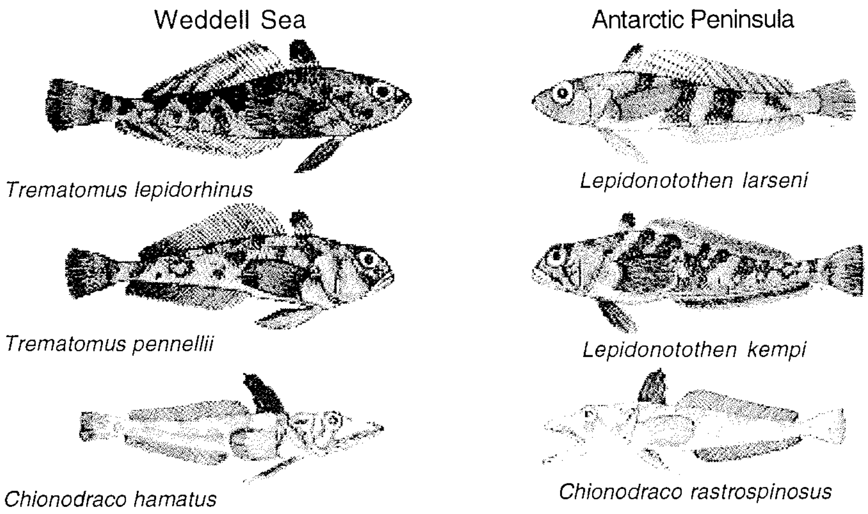


Fig. 47 Resembling species from the Weddell Sea and the Antarctic Peninsula (Fish drawings modified after Gon & Heemstra 1990)

In the Weddell Sea 98.8% of the individuals caught belong to four families within the suborder Notothenioidei (Perciformes), with 62% Nototheniidae, 16% Bathydraconidae, 13% Artedidraconidae and 8% Channichthyidae (Tab.3.1.2). Within the Nototheniidae, 96% of the individuals belong to the genus *Trematomus*, with the dominant species *Trematomus eulepidotus* and *T. pennellii*.

Regarding total numbers, the most numerous species at the Peninsula was the mesopelagic myctophid *Gymnoscopelus nicholsi* accounting for 43% of the catch, but this high value is due to only one haul where about 586 individuals were caught. Excluding this species, also at the Peninsula 97% of the individuals belong to the Notothenioidei, but the family Nototheniidae with 44% is not as dominant as in the Weddell Sea. The Channichthyidae occur more often and account for 51% (mainly the dominant species *Chionodraco rastrospinosus* [32%]), whereas Artedidraconidae and Bathydraconidae each represent only 1%.

Table 13 The 10 dominant species at both locations.

Weddell Sea	Dom.	Antarctic Peninsula	Dom.
Trematomus eulepidotus	20.0%	Chionodraco rastrospinosus	31.5%
Trematomus pennellii	18.6%	Lepidonotothen larseni	13.7%
Prionodraco evansii	12.0%	Champsocephalus gunnari	9.3%
Trematomus lepidorhinus	9.3%	Gobionotothen gibberifrons	7.7%
Trematomus scotti	7.7%	Lepidonotothen nudifrons	7.5%
Artedidraco orianae	4.9%	Chaenocephalus aceratus	6.7%
Artedidraco scottsbergi	3.2%	Lepidonotothen kempi	4.9%
Cryodraco antarcticus	3.0%	Pleuragramma antarcticum	4.8%
Cygnodraco mawsoni	2.0%	Cryodraco antarcticus	2.4%
Artedidraco shackletoni	1.9%	Liparididae spp.	1.5%

Species diversity (Shannon Wiener index H' with base ln) was considerably higher in the Weddell Sea (H'= 2.17 ±0.21 CI95%;0.24 SD) than at the Peninsula (H'= 1.57 ±0.67; 0.54 SD).

Depth distribution at the Antarctic Peninsula

The demersal fish communities at the Antarctic Peninsula varied with depth (Tab. 14). *Lepidonotothen nudifrons* was restricted to the shallow hauls around 200m while *L. larseni*, *Gobionotothen gibberifrons* and *Champsocephalus gunnari* showed their maximum abundance at this depth with declining abundance in deeper hauls. On the other hand other species such as *Chionodraco rastrospinosus* and Zoarcidae increased in abundance with depth, showing maximum numbers in the haul at 670m depth. *Aethotaxis mitopterx* had its maximum abundance in the deepest haul at 850m, where also ten species were found, which were not present in any shallower haul. These species represent the deeper notothenioid shelf fauna *Vomeridens infuscipinnis*, *Chionobathyscus dewitti*, *Neopagetopsis ionah* while other species like *Macrourus whitsoni*, *Notolepis coatsi*, *Paradiplospinus gracilis*, *Poromitra crassiceps*, *Antimora rostrata* and *Lepidion* c.f. *ensiferus* belong to a more general deep-sea fauna. Many of these species have a wide distribution and are not restricted to Antarctic waters.

Table 14: Depth distribution at the Peninsula.

Depth	Species	Family	N	%
200	*Lepidonotothen larseni*	Nototheniidae	83	25.1%
200	*Champsocephalus gunari*	Channichthyidae	65	19.6%
200	*Lepidonotothen nudifrons*	Nototheniidae	59	17.8%
200	*Chaenocephalus aceratus*	Channichthyidae	51	15.4%
200	*Gobionotothen gibberifrons*	Nototheniidae	42	12.7%
200	*Trematomus scotti*	Nototheniidae	8	2.4%
200	*Chionodraco rastrospinosus*	Channichthyidae	7	2.1%
200	*Pseudochaenichthys georgianus*	Channichthyidae	5	1.5%
200	*Notothenia coriceps*	Nototheniidae	4	1.2%
200	*Dissostichus mawsoni*	Nototheniidae	3	0.9%
200	*Notothenia rossii*	Nototheniidae	1	0.3%
200	*Bathyraja* sp.	Rajidae	1	0.3%
200	*Trematomus hansoni*	Nototheniidae	1	0.3%
200	Zoarcidae spp.	Zoarcidae	1	0.3%
			331	100.0%
350	*Chionodraco rastrospinosus*	Channichthyidae	51	30.4%
350	*Lepidonotothen kempi*	Nototheniidae	35	20.8%
350	*Lepidonotothen larseni*	Nototheniidae	23	13.7%
350	*Gobionotothen gibberifrons*	Nototheniidae	19	11.3%
350	*Cryodraco antarcticus*	Channichthyidae	17	10.1%
350	*Champsocephalus gunari*	Channichthyidae	8	4.8%
350	Zoarcidae spp.	Zoarcidae	6	3.6%
350	*Chaenocephalus aceratus*	Channichthyidae	2	1.2%
350	*Dissostichus mawsoni*	Nototheniidae	2	1.2%
350	*Trematomus hansoni*	Nototheniidae	2	1.2%
360	*Pseudochaenichthys georgianus*	Channichthyidae	2	1.2%
350	*Pleuragramma antarcticum*	Nototheniidae	1	0.6%
			168	100.0%
670	*Chionodraco rastrospinosus*	Channichthyidae	190	65.7%
670	*Pleuragramma antarcticum*	Nototheniidae	37	12.8%
670	Liparididae spp.	Liparididae	12	4.2%
670	*Aethotaxis mitopteryx*	Nototheniidae	9	3.1%
670	*Trematomus eulepidotus*	Nototheniidae	8	2.8%
670	*Pogonophryne permittini*	Artedidraconidae	7	2.4%
670	*Gymnodraco acuticeps*	Bathydraconidae	5	1.7%
670	*Lepidonotothen kempi*	Nototheniidae	4	1.4%
670	*Trematomus hansoni*	Nototheniidae	4	1.4%
670	*Trematomus newnesi*	Nototheniidae	3	1.0%
670	*Cryodraco antarcticus*	Channichthyidae	2	0.7%

Depth	Species	Family	N	%
670	*Lepidonotothen larseni*	Nototheniidae	2	0.7%
670	*Prionodraco evansii*	Bathydraconidae	2	0.7%
670	*Chaenodraco wilsoni*	Channichthyidae	1	0.3%
670	*Gerlachea australis*	Bathydraconidae	1	0.3%
670	*Pogonophryne* sp.	Artedidraconidae	1	0.3%
670	Zoarcidae spp.	Zoarcidae	1	0.3%
			289	100.0%
860	*Macrourus whitsoni*	Macrouridae	239	54.8%
860	*Chionobathyscus dewitti*	Channichthyidae	74	17.0%
860	*Raja georgiana* eggs	Rajidae	32	7.3%
860	Zoarcidae spp.	Zoarcidae	23	5.3%
860	*Bathyraja* sp.	Rajidae	14	3.2%
860	*Pleuragramma antarcticum*	Nototheniidae	13	3.0%
860	*Antimora rostrata*	Moridae	12	2.8%
860	*Raja georgiana*	Rajidae	6	1.4%
860	*Neopagetopsis ionah*	Channichthyidae	5	1.1%
860	*Paradiplospinus gracilis*	Gempylidae	5	1.1%
860	*Notolepis coatsi*	Paralepididae	3	0.7%
860	*Aethotaxis mitopteryx*	Nototheniidae	2	0.5%
860	*Lepidion ensifern*	Moridae	2	0.5%
860	*Gymnodraco acuticeps*	Bathydraconidae	1	0.2%
860	*Gymnoscopelus* sp.	Myctophidae	1	0.2%
860	Liparididae spp.	Liparididae	1	0.2%
860	*Poromitra crassiceps*	Melamphaidae	1	0.2%
860	*Trematomus hansoni*	Nototheniidae	1	0.2%
860	*Vomeridens infuscipinnis*	Bathydraconidae	1	0.2%
			436	100.0%

2.3.2 Anthozoan Distribution and Biodiversity

Objectives

The main objective during the EASIZ III cruise has been to complement the preliminary list of anthozoan species collected during the previous EASIZ II cruise. The anthozoans, mainly gorgonians and sea-anemones, are one of the most important components of Antarctic benthic suspension feedersin terms of biomass and number of colonies / individuals.

Work at sea

From the present cruise, 93 anthozoan species have been collected, part of them identified to species level on board, while others remain at generic level waiting for further studies in laboratory. This material has been sampled from 38 stations, and more than 2000 colonies or solitary polyps were sorted, labelled and fixed conveniently (4% formalin, Glutaldheide-Cacodylate 2.5%, 75º ethanol or frozen) for further studies (taxonomy, anatomy, reproductive biology, DNA sequences, alloenzime analyses, secondary metabolites etc.).

Preliminary results

Of the 93 anthozoan species collected during the EASIZ III cruise, 45 belong to the Octocorallia, and 48 to the Hexacorallia. Within the octocoral species there were one Stolonifera, 4 Alcyonacea, 35 Gorgonacea, and 5 Pennatulacea. Within the hexacoral species there were one Zoantharia, one Ceriantharia, one Ptycodactyaria, 42 Actiniaria, and 3 Scleractinia.

With respect to the preliminary results obtained from the EASIZ II cruise, where 63 anthozoan species were collected, we can observe a significantly higher number of species collected during the present cruise. This increment is mainly due to

Gorgonacea, Pennatulacea and Actiniaria, being other orders collected for the first time in these EASIZ cruises such as Ptycodactyaria and Ceriantharia.

Among the alcyonacean species, the alcyoniid *Anthomastus bathyproctus* Bayer will be one of the target species to study reproductive and feeding strategies. Some of the most interesting species of Gorgonacea collected during this cruise include *Primnoella gracilis* Molander, *Thouarella* (*Euthouarella*) sp., *Thouarella* (*Epithouarella*) sp., *Ophidiogorgia* sp., and Primnoidae gen. Among the Pennatulacea, the collection of *Pennatula phosphorea* var. antarctica will permit the comparison with other varieties of this "cosmopolitan" species.

The actinian material collected is of great interest because of the presence of several *Abasiliaria* species, a difficult group of sea anemones from a taxonomic point of view. In addition, a collection of colour slides of all the sea anemones and most of the octocoral species has been completed thanks to the kind assistance of Dr. Martin Rauschert. This iconographic material will be very useful for further studies on Antarctic benthic ecology, permitting the correct identification of the most common species only based on external anatomy and colour pattern.

Also remarkable is the finding of a specimen of Ptychodactyaria, *Dactylanthus antarcticus*, and the collection of some specimens of an unidentified Ceriantharia. The collection of a single colony of the zoantharian *Parazoanthus antarcticus* will be used in the re-description of this species based on EASIZ II and III material. From nearly all anthozoan species, small fragments were preserved for DNA analyses in order to compare phylogenetic relationships between the different genera, families and orders in the class.

The eastern Weddell Sea (Atka Bay, Kapp Norvegia and Auståsen) and the Antarctic Peninsula (Bransfield Strait, and King George Island) were the two main areas where anthozoans were collected with a similar sampling effort, 22 and 18 stations, respectively. The number of species collected was 41 in the eastern Weddell Sea, and 73 at the Antarctic Peninsula.

As to the bathymetric distribution of the 93 anthozoan species collected (Table 15), some species showed a wide depth range, such as *Notisis* sp.2, *Glyphoperidium bursa*, and *Hormathia lacunifera.* Contrarily, several other species showed a very narrow depth range, e.g. *Fannyella mawsoni*, *Primnoella* cf. *biserialis*, and *Halcampella* sp. Only 26 species (about 27 % of total) have been collected in shallow waters (< 200 m depth), 72 species (77.5 %) were present between 200 and 400 m depth, while 17 species, mainly actiniarian and scleractinian, were exclusively found in moderately deep water (600 - 1000 m depth).

Table 15 Bathymetric distribution of the Anthozoa collected during the ANT XVII/3 cruise.

Species	Depth (m)	25	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100
Euthouarella sp.			*																					
Fannyella sp. 2			*																					
Hormathia sp. 7			*																					
Notisis sp. 3			*																					
Actiniaria sp. 17			*	*	*																			
Fannyella nodosa			*	*	*																			
Primnoella gracilis			*	*	*	*																		
Fannyella spinosa			*	*	*	*																		
Isosicyonis sp. 1			*	*	*	*																		
Thouarella sp. 3			*	*	*	*																		
Primnoella antarctica			*	*	*	*																		
Primnoisis sp. 2			*	*	*	*	*																	
Isosicyonis alba			*	*	*	*	*	*	*	*	*													
Primnoella sp. 2			*	*	*	*	*	*	*	*	*													
Thouarella sp. 1			*	*	*	*	*	*	*	*	*													
Fannyella sp. 1			*	*	*	*	*	*	*	*	*	*												
Ophidiogorgia sp.			*	*	*	*	*	*	*	*	*	*												
Thouarella sp. 2			*	*	*	*	*	*	*	*	*	*												
Clavularia cf. frankliniana			*	*	*	*	*	*	*	*	*	*	*	*	*									
Alcyonidae sp.			*	*	*	*	*	*	*	*	*	*	*	*	*	*								
Notisis sp. 2			*	*	*	*	*	*	*	*	*	*	*	*	*	*								
Glyphoperidium bursa			*	*	*	*	*	*	*	*	*	*	*	*	*	*								
Notisis sp. 1				*	*	*	*																	

```
Species      Depth (m)       25   50   100   150   200   250   300   350   400   450   500   550   600   650   700   750   800   850   900   95    10    10    11
                                                                                                                                              0    00    50    00
Hormathia lacunifera                    ****************************************************************************
Tenuisis microspiculata                      *******
Epiactis georgiana                           *******************************************
Dactylanthus cf antarcticus                        ***
Fannyella mawsoni                                  ***
Primnoella sp. 3                                   ***
Primnoella sp. 4                                   ***
Primnoidae gen.                                    ***
Primnoella cf biserialis                           ***
Virgularia sp.                                     ***
Hormathia sp. 2                                    *******
Hormathia sp. 5                                    *******
Primnoella n. sp.                                  *******
Ainigmaptilon antarcticus                          ***********
Primnoella vanhoeffeni                             ***********
Thouarella sp. 5                                   ***********
Actiniaria sp. 12                                  ****************
Abasiliaria sp. 3                                  ****************
Ceriantharia sp.                                   ****************
Gersemia sp. 1                                     ****************
Umbellula lindhali                                 ****************
Hormathia cf. lacunifera                           **************************************
Acontiaria sp.                                     *******************************************
Bolocera sp.                                       *******************************************
Abasiliaria sp. 2                                  **************************************************************
```

Species Depth (m)	25	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100
Ainigmaptilon virgularoides					*	*	*	*	*	*	*	*	*	*	*	*							
Anthomastus bathyproctus					*	*	*	*	*	*	*	*	*	*	*	*							
Actiniaria sp. 1					*	*	*	*	*	*	*	*	*	*	*	*							
Capnea cf. georgiana					*	*	*	*	*	*	*	*	*	*	*	*							
Flabellum impensum					*	*	*	*	*	*	*	*	*	*	*	*							
Hormathia sp. 3					*	*	*	*	*	*	*	*	*	*	*	*							
Isosicyonis sp. 2					*	*	*	*	*	*	*	*	*	*	*	*							
Umbellula magniflora					*	*	*	*	*	*	*	*	*	*	*	*							
Actiniaria sp. 2					*	*	*	*	*	*	*	*	*	*	*	*							
Hormathia sp. 1						*																	
Actiniaria sp. 4						*	*	*	*	*	*	*	*	*	*	*							
Actiniaria sp. 5						*	*	*	*	*	*	*	*	*	*	*							
Fannyella rossii							*																
Gersemia sp. 2							*																
Primnoisis antarctica							*																
Primnoisis sp. 3							*																
Actiniaria sp. 3							*	*															
Actiniaria sp. 13							*	*															
Echinisis spicata							*	*															
Dasystenella acanthina							*	*	*	*	*												
Actiniaria sp. 9							*	*	*	*	*	*	*	*	*	*							
Pennatula phosphorea var. antarctica							*	*	*	*	*	*	*	*	*	*							
Actiniaria sp. 14								*															
Halcampella sp.								*															
Pennatulaceo gen. sp.								*															

Species	Depth (m)	25	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100
Actiniaria sp. 11									*	*	*	*												
Amphilaphis sp.									*	*	*	*	*											
Actiniaria sp. 15									*	*	*	*	*	*	*	*	*							
Actiniaria sp.														*										
Amphilaphis grandiflora														*	*	*	*							
Bolocera kerguelensis														*	*	*	*	*	*					
Abasiliaria sp. 1														*	*	*	*	*	*					
Actiniaria sp. 6															*									
Actiniaria sp. 7															*									
Actiniaria sp. 8															*									
Actiniaria sp. 10															*									
Thouarella sp. 4															*									
Epiactis sp.															*									
Parazoanthus antarcticus																*								
Actiniaria sp. 16																		*	*					
Caryophyllia sp.																		*	*					
Fungyacyathus marenzelleri																		*	*					
Hormathia sp. 6																		*	*					
Abasiliaria sp. 4																				*				
Hormathia sp. 4																				*				

2.3.3 Phylogenetic Relationships between Primnoid Genera

Objectives

The family Primnoidae (Octocorallia, Gorgonacea) is the best-represented and dominant gorgonian family in Antarctic waters. About 30 genera are now known, most of them exclusive of the Southern Hemisphere, and 19 present in Antarctic and Subantarctic waters, with a high grade of endemic genera. The taxonomy of this family is mainly based on the branching pattern, arrangement of the polyps on the branches, type of sclerites, and number and arrangement of these on the polyp body. However the presence of determined features repetitively in groups apparently not closely related made the separation in subfamilies and some genera clearly artificial. In addition, the diagnoses of some genera are so narrow that they do not permit the inclusion of other species, whereas other genera are obviously inflated with a large number of species and variability of characters. In this scenario, additional characters are in need to complement those classifications constructed basically on morphological ones. The main objective in this part was to obtain abundant samples for genetic studies (DNA sequences) from as many species as possible of primnoid gorgonians.

Work at sea

Small samples from all primnoid species were fixed directly in ethanol 80% for DNA analyses. More than 175 genetic samples of about 25 species were obtained and maintained at 4ºC waiting for further studies.

2.3.4 Bryozoa (B. Bader)

Objectives

The main purpose of this work was the study of bryozoan communities with regard to their distribution, density and structure. In contrast to their systematics, the role of bryozoans in the Antarctic benthic ecosystem is largely unknown. Investigations on the structural potential of bryozoan communities in forming different habitats and on the special settlement strategies and succession of bryozoans in bryozoan dominated benthos communities should elucidate the structure and history of these communities. Growth bands in the bryozoan skeleton relate to seasonality and enable an interpretation of their life cycle. Isotope studies on selected species may allow this question to be answered. The study of entire colonies of *Melicerita obliqua* and *Cellarinella* species with regard to astogenetic stages of colonies can be used for the interpretation of asexual or sexual reproduction and the interpretation of recolonization of iceberg disturbed areas. Analysis of growth forms should help explain their adaptation to the environment.

Work at sea

Bryozoans, together with other benthic organisms in general, were mainly collected by means of TV grab, giant box corer (GKG), bottom trawl (GSN) and Agassiz trawl (AGT). Only the vertical grabs (GKG, TV grab) sampled entire colonies; in the GSN all colonies were broken. After sorting out the bryozoan specimens each species was photographed with a digital camera. Special attention has been paid to the study of colours, which can help in the discrimination of species but are quickly lost after fixation (Tab. 1). Reproductive status has been studied under the microscope by noting the presence of embryos (Tab. 1). Bryozoans were fixed in 4% formalin, alcohol or dried for comparative study.

Preliminary results

Spatial pattern: There is no clear spatial pattern for species richness on the shelf of the Weddell Sea. It seems that there is no bathymetric pattern in water depths of 200-800 m but at shallower stations like Hilltop the bryozoan fauna is much poorer in species richness. All growth forms are present from encrusting sheets to flexible and rigid erect colonies. A high amount of erect species like *Cellarinella rogickae* are anchored by rootlets in the sediment (Fig. 1). This seems to be a good adaptation to the fine grained sediment on the shelf. The absence of strong distribution patterns of bryozoan species can probably be related with current regimes and topography.

In comparison with the Weddell Sea, samples from the Antarctic Peninsula are very poor in bryozoan species. Mostly species of the family Flustridae are common (Fig. 49).

Table 16 Reproductive status, colour of embryos and colonies.

Species	Embryos and colour	Colour of colony
Isosecuriflustra angusta	x, white	beige
Isosecuriflustra tenuis	x, cream coloured	beige
Isosecuriflustra thysanica	x, white	beige
Austroflustra vulgaris	x, white	beige or brownish, brownish tops
Nematoflustra flagellata		orange
Caberea darwinii		beige
Notoplites drygalskii		beige
Cellaria diversa	x, red	beige
Cellaria aurorae		light orange, white tops
Cellaria monilorata		beige
Cellaria sp.	x, dark orange	beige
Swanomia membranacea	x, orange	beige-light brown
Melicerita obliqua	x, cream coloured	beige
Melicerita flabellifera	x, cream coloured	beige
Arachnopusia aquilina		beige
Polyrhabdotus inclusum		yellow, brownish tops
Cellarinella nodulata		beige, yellow-orange tops
Cellarinella nutti		beige
Cellarinella rogickae	x, white	beige-brownish, brown tops
Cellarinella watersi		beige, brown tops
Cellarinella njegovanae	x, white	beige, yellow tops
Cellarinelloides crassus		beige
Systenopora contracta		lemon yellow, dark yellow tops
Celleporella alia	x, white	dirty white
Isoschizoporella virgula		light pink
Isoschizoporella tricuspis		beige
Kymella polaris		beige
Smittina directa		lilac, white tops
Smittina antarctica		beige
Thrypticocirrus contortuplicata		light yellow
Thrypticocirrus rogickae		light pink
Bostrychopora dentata	x, white	orange-brown colony
Reteporella hippocrepis	x, white	light orange-pink
Orthoporidra compacta	x, red	white
Osthimosia sp.1		white
Osthimosia sp.2	x, red	light red
Crisia sp.		white

Reproductive stage: Nearly all species showed reproductive structures (ovicells or gonozooids) and a lot were observed to be fertile in this season. Different colours of the embryos seem to be a specific characteristic of species. Not all species are easy to check for the presence of growing embryos inside the ovicells because, like in the *Cellarinella* species, the ovicell is included in the zooid and for that reason not visible. Observations on this cruise show that in autumn a lot of species are reproducing. It seems that the bryozoans breed over winter and the larvae are released in spring. Hence, contrary to the suggestion of Zabala et al. (1997), summer time is not the only reproductive season for most of the bryozoan species.

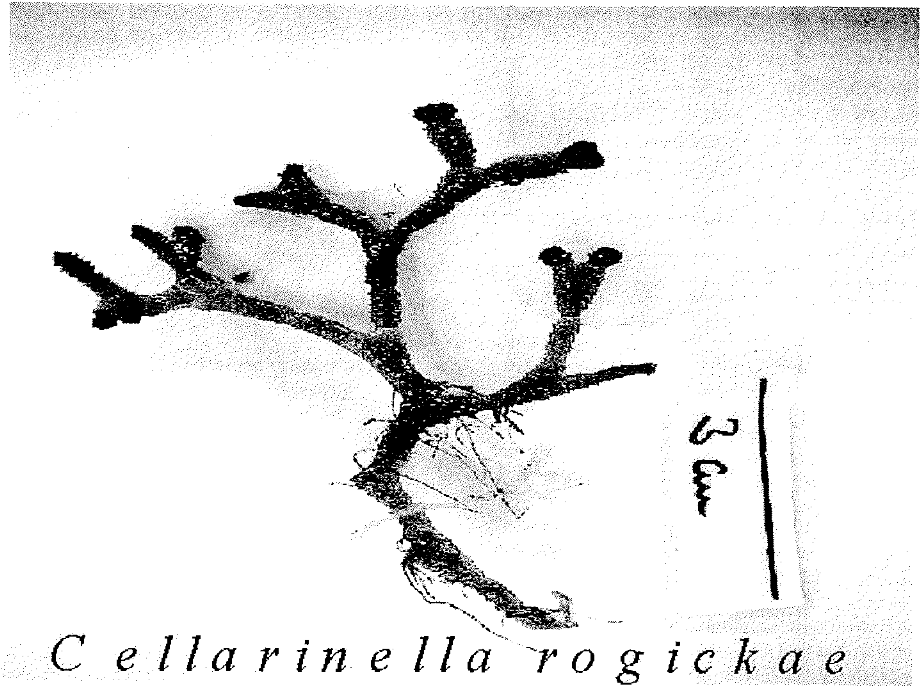


Fig. 48 *Cellarinella rogickae* is a common species in the Weddell Sea and anchored by a bundle of rootlets in the sediment.

Fig. 49 *Austroflustra vulgaris* dominate the bryozoan fauna in the Bransfield Street.

An interesting aspect of propagation is the asexual or/and sexual reproduction of bryozoan species with regard to the recolonization of disturbed areas. Some *Cellarinella* species are able to originate from broken colony fragments. Winston (1983) supposes that asexual propagation in these species is more significant in maintaining the population than sexual propagation. But the question of asexual propagation in disturbed areas is not applicable. Observations of underwater videos and samples of TV-grabs show that *Cellarinella* species are one of the first bryozoans which colonize iceberg disturbed areas. Their distribution is assumed to originate from sexual production when larvae settle. All colonies were of nearly the same height and a single appearance. If specimens originated from broken colony fragments it is likely that the colonies would have different heights and ages ranging from large old colonies to small young colonies. Furthermore, colonies would have to build denser regenerating thickets.

I would like to thank Michael Schrödl for using his wonderful digital camera and Boris Klein for repairing a lot of broken bryozoan colonies.

2.3.5 **Mollusc Biodiversity and Ecology** (B. Sirenko, M. Schrödl)

Introduction and objectives

The mollusk fauna of Antarctica is very particular. The endemism of its species is more than 65% (Powell, 1965; Dell, 1964, 1969, 1972, 1990). In spite of the long period of study the taxonomic biodiversity of Antarctic mollusks is still poorly known. During the past ten years more than 60 new species of Antarctic mollusks have been described (Dell,1990; Numanami,1996; Egorova,1998).

The Weddell Sea fauna and especially its eastern part was studied very carefully during the last years. Stefan Hain (1990) found 134 species of mollusks (bivalves and gastropods) in the Weddell Sea. Field identification of samples which were taken during the Antarctic Expedition XIII/3 in 1996 revealed 134 species (including Polyplacophora, Aplacophora, Gastropoda and Bivalvia). Later, in the Zoological Institute, St.Petersburg, the number of species was increased to 262. This is a result of the careful sorting of the material, especially small specimens selected from samples which were washed and sifted on sieves with 1x1mm mesh size (Drs E.Egorova and A.Martinov).

The main goals of our investigation were:

- To investigate the faunistical, ecological and zoogeographical features of distribution of mollusks in the eastern Weddell Sea and near the Antarctic Peninsula
- To contribute by faunistic material and ecological data to the preparation of the "Synopsis of Antarctic Chitons" (B.Sirenko), "Atlas of Antarctic prosobranch gastropods and bivalves" (E.Egorova), and „Identification key to Antarctic Opisthobranchia" (M.Schrödl).
- To collect material of poorly known and enigmatic taxa such as Monoplacophora and *Tomthompsonia*, to fix it for molecular, histological, and ultrastructural study, and to carry out phylogenetical analyses.

Work at sea

Material was collected from 8 trawl catches (GSN), 2 EBS and 5 Rauschert dredge catches, as well as from subsamples of 7 GKG and 8 TVG samples. Mollusks were gathered both from unsifted and sifted samples. After gathering of mollusks by hand from the trawl catch on deck we washed and sifted most of the remains of each catch on a set of three sieves with 10x10, 5x5 and 1x1mm meshes. Most Antarctic mollusks are very small (less than 4-5mm) and in order to collect more species it is important to sift sediments. Preliminary identification was made by use of available publications (Hain, 1990; Dell, 1990). Most shelled mollusks were fixed in 75% alcohol, specimens of selected taxa were relaxed with 10% $MgCl_2$ and fixed in 4% buffered formaldehyde, 96% ethanol or 3.7% glutardialdehyde buffered with cacodylate. Most shelled material collected during the cruise will be distributed among Russian taxonomists for exact identification, opisthobranchs and material with special fixations will be studied at the ZSMunic.

Preliminary results

146 species of mollusks (except cephalopods) were preliminarily identified:

Aplacophora	4
Polyplacophora	3
Monoplacophora	1
Gastropoda (Prosobranchia)	77
Gastropoda (Opisthobranchia)	21
Scaphopoda	2
Bivalvia	38

There are several new species for the Weddell Sea (*Leptochiton kerguelensis, Trophon minutus, Yoldiella sabrina, "Montacuta" nimrodiana* and others) and perhaps new for science (Monoplacophora sp., *Trophon* sp.1, *Turritellopsis* sp., *Submargarita* sp., *Limatula* sp. and others) among the collected mollusks.

It is interesting to note some differences in the species composition of an underwater mound, known as Hilltop (stations 111-5, 111-6, 111-7, 111-18, depths of 65-105m) and other stations (depth >200m). Several widespread mollusks including *Callochiton gaussi, Nuttallochiton mirandus, Trichoconcha mirabilis, Torellia smithi, Limatula hodgsoni* and others were met in all or most regions excluding the shallow Hilltop. Several other species (*Leptochiton kerguelensis, Submargarita cf. notalis, Trophon minutus, Limopsis lilliei,* and

Laternula elliptica) were met alive at Hilltop only. Some of these species are very abundant in northern regions and, thus, there is some connection between the faunas of Hilltop and Subantarctic regions.

Presented here is some new information about the habitat and reproductive biology of several Antarctic mollusks.

Capulus subcompressus is a rather seldom collected mollusk in the Weddell Sea. It was found at 6 stations, only 8 % of all stations studied by S.Hain (1990). We collected a few empty shells in 1996 in the eastern Weddell Sea and several shells were gathered in the same region in 1998 (Gili *et al.*,1999). However this mollusk is quite common in the Ross Sea (Dell, 1990). It has a very strange shell shape for the genus *Capulus*. While other congeners have low, usually flattened shells, *C. subcompressus* has a very tall shell and a strange curved aperture designed for attachment to a cylindrical object (Fig.1). Several authors suggested that *C. subcompressus* lives on spines of sea urchins (Pelsener, 1903; Powell, 1958 and Arnaud, 1972), or even on the anterior canals of fusiform gastropods (Powell, 1958). But until this expedition, *C. subcompressus* had not yet been recorded attached to any host. In all catches, specimens of *C. subcompressus* were collected without their host because material is very mixed and damaged in the big trawls. Fortunately Martin Rauschert's small dredge gently captured a serpulid tube to which *C. subcompressus* was attached (Fig. 1). This is the first record of *C. subcompressus* with its host. In comparison to the other species of the genus *Capulus*, which live on bivalve shells, the Antarctic *Capulus* attaches to a worm tube. Like other species of *Capulus*, which sit on the edge of shell of bivalves, *C. subcompressus* attaches to the edge of the tube where the worm thrusts its radioles forward. Just opposite the mollusk, the edge of the tube is broken. Apparently the mollusk breaks the edge of the tube in order to penetrate the radioles of the worm more easily (Fig. 50, b). Growth rings on the serpulid tube are regular before the place of the first settlement of the young mollusk and become irregular after that place (Fig. 50,s). Perhaps *Capulus* removes part of the food of the serpulid with its long proboscis (Fig. 50,p).

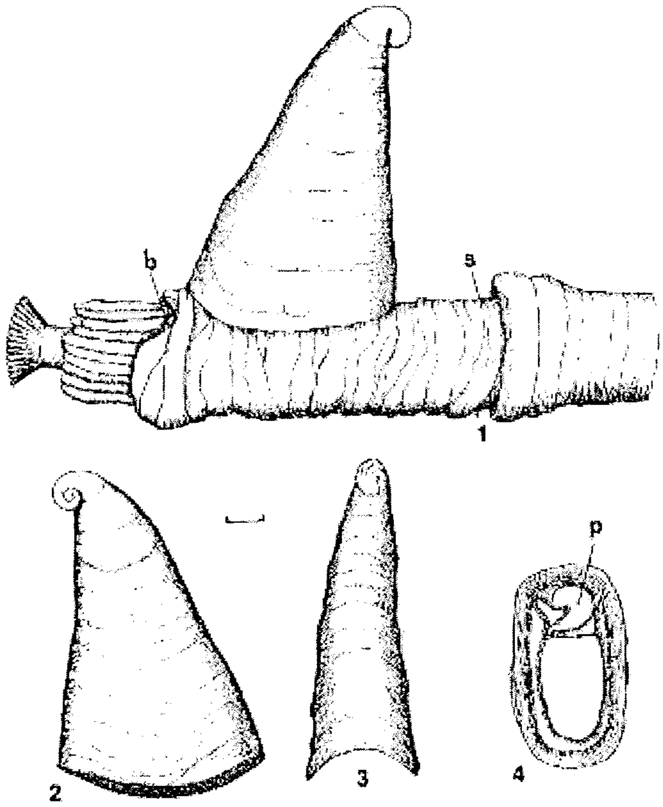


Fig. 50 Symbiosis of mollusk and polychaete. Prosobranch mollusk *Capulus subcompressus* on the serpulid's tube (1), shell of *C. subcompressus*, lateral view (2), dorsal view (3), ventral view (4). b – broken edge of serpulid's tube; s – the likely place of first settlement of young *C. subcompressus*; p – proboscis of *C. subcompressus*. Scale bar – 1 mm. Orig.

The polyplacophoran mollusk *Leptochiton kerguelensis* has a very wide distribution in Antarctica, especially in Subantarctic regions, but no specimens have ever been found in the Weddell Sea. On this cruise we found this species when we worked on Hilltop, at depths of 106-112m (st.111-5, 111-18). Eight specimens of *L. kerguelensis* were taken there. We found that this tiny chiton (body length up to 4.5mm) is a brooding species. Two females had embryos in their pallial grooves. The first female had 3 embryos (body length 0.35mm) in the process of shell formation. The second had 6 juveniles (body length 0.65mm) with 8 shell valves (Fig. 51). These juveniles were ready to leave their mother and live on the bottom. This species therefore joins *Hemiarthrum setulosum*, which is another Antarctic chiton that broods its embryos in the pallial groove.

The prosobranch gastropod *Pontiothauma ergata* is one of the largest Antarctic mollusks. Two egg capsules belonging to this species were found in a bottom trawl (st. 136-1). Both capsules had a very similar surface structure. The bigger capsule (16mm) contained about 200 eggs (diameter 0.45mm) (Fig.2). The smaller capsule (13.5mm) contained 12 juveniles (shell height 4-5mm (Fig.2). Identification of the juvenile shell was by comparison with the protoconch of an adult

Pontiothauma ergata, which was found in the same trawl. Apparently, a dozen or so eggs in any one capsule are fertilized and develop, whereas the others serve for the feeding of the embryos.

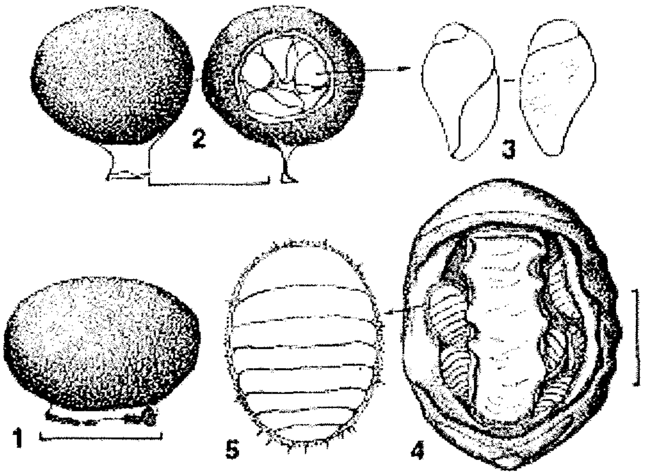


Fig. 51 Egg capsules and brooding habits of mollusks. Capsules of prosobranch gastropod *Pontiothauma ergata* with eggs (1) and with juveniles (2), parts of two capsule shells are removed; juveniles, ventral and dorsal view (3); chiton *Leptochiton kerguelensis* with juveniles in the pallial groove (4); juvenile *L. kerguelensis* with eight valves of shell ready to leave its mother. Scale bar – 1 mm. Orig.

Table 17: Mollusca (ex Cephalopoda) collected during ANTXVII/3 in the eastern Weddell Sea. A = alive

	58-2	59-1	59-2	59-3	59-4	65-1	85-1	97-1	100-1	102-1	109-1	110-6	111-5	111-6	111-7	111-9	111-16	111-18	TVG 111-19	111-29	111-30	119-1	122-1	TVG 122-2	124-1	GSN 133-2	135-1	GSN 136-1	GSN 138-1	138-1 D
Prosobranchia:																														
Anatoma euglypta (Pelseneer, 1903)				A	A					A					S								S					A		
Puncturella conica (d'Orbigny, 1841)	S					A																								
Parmaphorella mawsoni Powell, 1958					A	A	A		A	A	A											A	S							
Iothia coppingeri (Smith, 1881)								A					A	A	A			A	S				S							
Calliotropis sp.																							A							
Falsimargarita gemma (Smith, 1915)																												A		
Margarella refulgens (Smith, 1907)		S		S			A			A	A				S								S							
Margarella biconica Numanami, 1996							A			A	A								S						A			A		
Submargarita cf notalis (Strebel, 1908)		S											A	A	A			A	S											
Submargarita sp.				A											S				S				S					A		
Solariella cf antarctica Powell, 1958		S												A	S			A				S	S							
Lissotesta sp.		S																					A							
Cyclotrematidae sp.																												S		
Leptocollonia innocens (Thiele, 1912)																							S							
Eatoniella sp.																							S		S		S			
Rissoidae sp.		S											S	A	S				S				S	S				S		
Onoba spp.				S									S	A	S				S				S	S			S	A		
Turritellopsis sp.	S	S																												
Cerithiella cf erecta Thiele, 1912										A			S		S				S				S							
Cerithiella cf lineata Egorova, 1982											S								S				S							
Cerithiella sp. 1																			S											
Cerithiella sp. 2																							S							
Cerithiella sp. 3				A											S				S											
Eumetula strebeli Thiele, 1912	A						S							A	A				S				A					S		

	58-2	59-1	59-2	59-3	59-4	65-1	85-1	97-1	100-1	102-1	109-1	110-6	111-5	111-6	111-7	111-9	111-16	111-18	TVG 111-19	111-29	111-30	119-1	122-1	TVG 122-2	124-1	GSN 133-2	135-1	GSN 136-1	GSN 138-1	138-1	D
Balcis tumidula (Thiele, 1912)				A			A			A	A			A					A			A	A								
Balcis antarctica (Strebel, 1908)																							S		A						
Trichoconcha mirabilis Smith, 1907						S	A			A	A											A	S		A		A	A			
Trichoconcha planispira (Smith, 1915)				S																		A					A				
Trichoconcha sp.				S																			S								
Torellia smithi Warén, Arnaud & Cantera, 1986							A			A	A											A	S				A	A			
Torellia insignis (Smith, 1915)																												A			
Capulus subcompressus Pelseneer, 1903				S																											
Amauropsis cf rossiana Smith, 1907							A																					A			
Falsilunatia sp. 1	S	S	S										S	S				S					S	S				A			
Falsilunatia sp. 2							S												S												
Falsilunatia cf delicatula (Smith, 1902)																						A						A			
Falsilunatia cf soluta (Gould, 1848)																												A			
Marseniopsis antarctica Vayssière, 1906																															
Marseniopsis conica (Smith, 1902)																											A				
Marseniopsis mollis (Smith, 1902)							A								A							A						A			
Marseniopsis sp. 1							A			A	A																	A			
Pareuthria cf innocens (Smith, 1907)													A	A					S				S								
Pareuthria plicatula Thiele, 1912											A								S												
Pareuthria sp.																							S								
Neobuccinum eatoni (Smith, 1875)						A	A			S				A									S				A				
Antarctodomus thielei (Powell, 1958)							S																								
Probuccinum cf costatum Thiele, 1912																												S			
Probuccinum tenerum (Smith, 1907)		S	S																				S	S				A			
Prosipho cf chordatus Strebel, 1908																							S				S				
Prosipho crassicostatus (Melvill & Standen, 1907)																			S									A			

D

	58-2	59-1	59-2	59-3	59-4	65-1	85-1	97-1	100-1	102-1	109-1	110-6	111-5	111-6	111-7	111-9	111-16	111-18	TYG 111-19	111-29	111-30	119-1	122-1	TYG 122-2	124-1	GSN 133-2	135-1	GSN 136-1	GSN 138-1	138-1
Prosipho glacialis Thiele, 1912	S			S	S										S				S						S			A		
Prosipho hedleyi Powell, 1958		S		S																			S							
Prosipho tuberculatus Smith, 1915				S											S				S				S							
Prosipho sp. 1	S	A					S							A					S											
Prosipho sp. 2														A																
Prosipho sp. 3																			S				S							
Prosipho sp. 4																						A			S					
Trophon drygalskii Thiele, 1912	S																						S							
Trophon scotianus Powell, 1951																											A			
Trophon shackletoni Hedley, 1911						A													S											
Trophon minutus Strebel, 1907													A	A				S	S											
Trophon sp. 1																			S											
Trophon sp. 2																												A		
Harpovoluta charcoti (Lamy, 1910)						A	A				A											A					A	A		
Nothoadmete cf delicatula (Smith, 1907)																			S											
Nothoadmete cf antarctica (Strebel, 1908)																												A		
Nothoadmete sp.		S	S	S																		A	A				S			
Belaturricula sp.						A																								
Turridae sp.						A																								
Marginella hyalina Thiele, 1912																			S						A					
Aforia magnifica (Strebel, 1908)						S	S			A												A	S							
Lorabela plicatula (Thiele, 1912)														A					S					S				A		
Belalora striatula (Thiele, 1912)																							S	S						
Pleurotomella frigida (Thiele, 1912)																			S											
Pleurotomella simililana Thiele, 1912																												A		
Pleurotomella sp.																			S											
Pontiothauma ergata Hedley, 1916										S	S											A						A		
Opisthobranchia:																														

	58-2	59-1	59-2	59-3	59-4	65-1	85-1	97-1	100-1	102-1	109-1	110-6	111-5	111-6	111-7	111-9	111-16	111-18	TVG 111-19	111-29	111-30	119-1	122-1	TVG 122-2	124-1	GSN 133-2	135-1	GSN 136-1	GSN 138-1	138-1	D
cf Neactaeonina edentula (Watson, 1883)																							S								
Toledonia cf globosa Hedley, 1916		S		S	A										S				S												
Toledonia cf perplexa Dall, 1902				S							S		S	S	S			S	S												
Toledonia sp.																							S								
Newnesia antarctica Smith, 1902		S			S														S				S								
Diaphana sp. 1																							S								
Diaphana sp. 2																		S						S							
Cylichna gelida (Smith, 1907)					A																								A		
Scaphander sp.																														A	
Philine cf alata Thiele, 1912			S							A	A								S			A	S				A	A			
Philine cf antarctica Smith, 1902					S																										
cf Bathyberthella antarctica Willan & Bertsch, 1987										A																		A			
Tomthompsonia antarctica (Thiele, 1912)				S			A																						A	A	
Austrodoris kerguelenensis (Bergh, 1884)							A	A		A	A					A	A					A					A	A			
Aegires albus Thiele, 1912								A			A																				
Doto sp.																	A														
Tritonia challengeriana Bergh, 1884						A										A											A	A			
Tritoniella belli Eliot, 1907							A									A	A			A	A	A					A				
Notaeolidia depressa Eliot, 1905												A				A	A			A	A										
Eubranchus cf glacialis (Thiele, 1912)								A			A																				
Eubranchidae sp.																					A										
Bivalvia:																															
Yoldiella antarctica (Thiele, 1912)	S						A																					A			
Yoldiella sabrina (Hedley, 1916)																												A			
Yoldiella valettii (Lamy, 1906)																							A				A	A			
Yoldiella oblonga (Pelseneer, 1903)																											S				
Propeleda longicaudata (Thiele, 1912)	A										S												S								

	58-2	59-1	59-2	59-3	59-4	65-1	85-1	97-1	100-1	102-1	109-1	110-6	111-5	111-6	111-7	111-9	111-16	111-18	TVG 111-19	111-29	111-30	119-1	122-1	TVG 122-2	124-1	GSN 133-2	135-1	GSN 136-1	GSN 138-1	138-1	D
Limopsis enderbyensis Powell, 1958																			S				S								
Limopsis lilliei Smith, 1915							S			S				A				A	S												
Limopsis marionensis Smith, 1885						A	S			A									S				S		S						
Philobrya barbata Thiele, 1912						A													S						S			A			
Philobrya cf quadrata (Pfeffer, 1886)	S																						A								
Philobrya sublaevis Pelseneer, 1903		S		S		S	A			A	A		A	S				S	S			A	S		A		A	A			
Adacnarca limopsoides (Thiele, 1912)	S	S		S		A							S		S				S			A	S		S		A				
Adacnarca nitens Pelseneer, 1903	S	S	A	S			A			A	S								S			A	S	S	A		S	A			
Adacnarca wandelensis (Lamy, 1906)		S		S											S							A			A		A	A			
Lissarca notorcadensis Melvill & Standen, 1907		S	S	S		A	A			A	A				S				S			A			A		S	A			
Dacrydium albidum Pelseneer, 1903						S																	S								
Cyclopecten cf pteriola (Melvill & Standen, 1907)				S																											
Cyclopecten sp.			S																												
Adamussium sp.		S																													
Limatula hodgsoni (Smith, 1907)		S	S	S		S	A			A	S								S			S	A	S	S		A	A			
Limatula ovalis (Thiele, 1912)		S								A													A		S			S			
Limatula simillana (Thiele, 1912)																							S								
Limatula sp.	S						A								S				S					A							
Cyclocardia astartoides (Martens, 1878)	S	S	S	S		A	S			A	A		A	A	A				A	A		A	S		A		A				
Cyamiomactra robusta Nicol, 1964	S	S	A															A	S				A	S			A				
Ptychocardia vanhoeffeni Thiele, 1912		S																	S				S								
„Montacuta“ nimrodiana Hedley, 1911														S													A				
Genaxius bongraini (Lamy, 1910)		A											A	A	A									S							
Pseudokellya gradata Thiele, 1912																								S							
Mysella miniscula (Pfeffer, 1886)														A								A						S			
Mysella charcoti (Lamy, 1906)																								A							

	58-2	59-1	59-2	59-3	59-4	65-1	85-1	97-1	100-1	102-1	109-1	110-6	111-5	111-6	111-7	111-9	111-16	111-18	TVG 111-19	111-29	111-30	119-1	122-1	TVG 122-2	124-1	GSN 133-2	135-1	GSN 136-1	GSN 138-1	138-1	D
Lyonsia arcaeformis Martens, 1885			S							A									S				S								
Thracia meridionalis Smith, 1885						S	A			S					S			A	S			A	A		A		A				
Poromya adelaidensis (Hedley, 1916)				S																		S									
Laternula elliptica (King & Broderip, 1831)																		A													
Cuspidaria infelix Thiele, 1912																												A			
Cuspidaria tenella Smith, 1907	S					S													S				S								
Cuspidaria sp.							A																								
Scaphopoda: 2(-3) spp.								1			1														1						
Monoplacophora: 1 sp.																													1		
Polyplacophora:																															
Leptochiton kerguelensis Haddon, 1886													A					A													
Callochiton gaussi Thiele, 1908	A	A	A	A	A	A	A			A	A								A			A	A		A		A	A			
Nuttallochiton mirandus (Thiele, 1906)		S		A		A	A				A								S			A			A		A	A			
Solenogastres: 4 spp.		1	1	1		1	3	2		2			1	2				2				3	4		2		2	2			

2.3.6 Cephalopod Taxonomy and Biology (L. Allcock)

Objectives

Research on Antarctic cephalopods is still in its infancy. The ecological importance of cephalopods in the Southern Ocean food chain is acknowledged, but detailed information on predator prey interactions is lacking. Squid are a major food source for albatrosses, penguins and marine mammals yet little is known about their abundance, life cycle and general biology. This cruise provided an opportunity to extend the temporal sampling window and examine the squid populations in autumn.

The taxonomy of the octopods needs a considerable overhaul, and the unsettled systematics have hindered the collection of life history and ecological data in the past. Taxonomy was a major focus of the octopod research on board, including the collection of parasites that appear to be species specific, but information on reproduction, feeding and general biology was gathered wherever possible. Nothing is known about the age the animals attain (which hinders our interpretation of maturity data) and the statoliths are unstructured and unhelpful. Beaks from Antarctic octopods are currently being analysed by researchers at the Centro Oceanografico de Canarias and this cruise provided an opportunity to validate results using a fluorescent marker.

Work at sea

All cephalopods were collected from every catch. Standard measurements (dorsal mantle length, arm length, tentacle length, mass) were recorded for all squid specimens and beaks, statoliths and stomachs were removed for subsequent analysis.

Octopods of the genus *Pareledone* that survived the trawl were maintained in aquaria for physiological studies (see Sartoris *et al.* this volume). A small proportion of these were treated with a non toxic growth marker. These animals will be maintained alive as long as possible and the hard structures will be analysed after death. All octopods were identified to the lowest possible taxon, and dorsal mantle length (MLd), total length, sex and maturity stage were recorded. Further measurements and drawings were made from specimens of taxonomic interest. Stomach contents were analysed and the gills of all specimens were examined visually for the presence of parasites. In addition gill preparations were made for microscopic examination (see Mehlhorn, this volume).

Examples of all species (65 lots in total) were relaxed in 5% ethanol and preserved in 4% formalin and have been registered at the National Museums of Scotland under the catalogue number NMSZ 2000081 for subsequent morphological work on the undescribed species, and tissue samples have been preserved in ethanol for DNA analysis.

Preliminary results

Squids were caught at five stations at depths ranging from 200-930 m (Table 1). Dorsal mantle lengths of *Psychroteuthis glacialis* ranged from 131-220 mm and all specimens were of maturity stage 2 (Lipinski scale). Stomach content analysis showed that they were feeding mainly on polychaetes and crustacea, particularly euphausids, although some stomachs still have to be analysed. There was a notable absence of myctophid otoliths. In 1996 an undescribed species of *Brachioteuthis* was captured in the Peninsula area and it is likely that the *Brachioteuthis* specimens caught this cruise also belong to this species. This will be investigated on our return.

Over 200 octopod specimens were captured, the majority of which came from the GSN or AGT, although the EBS, Rauschert dredge and MG also provided samples.

Table 18 Squid catches during ANT XVII/3

Station	Area	Species	No. of whole animals
65-1	Kapp Norvegia	Psychroteuthis glacialis	34
85-1	Kapp Norvegia	Psychroteuthis glacialis	2
166-1	Bransfield Strait	Psychroteuthis glacialis	10
178-1	West of Deception	Brachioteuthis sp.	1
183-1	West of Deception	Brachioteuthis sp.	1

In the Weddell Sea only 31 specimens were available for dissection. Since these comprised 6 species, there are insufficient data to comment on the autumnal aspects of reproductive maturity in the high Antarctic. All catches were searched for molluscan eggs and, where these were found, these were opened and examined under the binocular microscope. However, all were revealed to be gastropod rather than cephalopod in origin.

In the Bransfield Strait and off the islands of the Antarctic Peninsula 14 species of octopod were captured. These comprised 1 cirrate, *Cirroctopus glacialis* (NMSZ 2000081.046), and 13 species of the family Octopodidae, 10 of which were determined as belonging to the genus *Pareledone*. Stomach analysis of *Pareledone turqueti* and *Pareledone polymorpha* revealed that the most common prey items were decapod crustaceans and polychaetes. Even food items in the crop were extremely well digested and it is likely that a degree of external digestion takes place making identification extremely difficult. Parasites were found in the gills of only two specimens, both of which were large *Megaleledone setebos*. Initial investigations suggest the parasites are nematodes but this will be investigated further by parasitologists. That parasites were almost completely absent is most unusual. In spring and summer they are extremely abundant in octopods and it is possible that this is a seasonal effect associated with the life cycle of the parasites. In contrast to the squid, octopods of all maturity stages were found. It was not uncommon to find juveniles, submature and mature animals of a single species in the same trawl, but insufficient numbers of each species were available to investigate trends.

Trawling in deeper water off the Antarctic Peninsula produced some specimens which were extremely interesting from the taxonomic viewpoint. 17 specimens of the rare species *Megaleledone setebos* were collected. This genus is currently being redescribed so this collection provided a unique opportunity to study fresh material, and provides a reference collection for future workers (NMSZ 2000081.014, NMSZ 2000081.024, NMSZ 2000081.038, NMSZ 2000081.047, NMSZ 2000081.054, NMSZ 2000081.061). The dorsal mantle lengths of the specimens ranged from 16 to 280 mm. The largest specimen was a mature male and only 4 other mature male specimens are extant in museum collections. Post preservation measurements are likely to reveal that this is the largest specimen ever captured.

Three specimens of a new species were found (NMSZ 2000081.026, NMSZ 2000081.029). This species probably also belongs in the so far monotypic genus *Megaleledone*: the web is deep, the mantle is as wide as it is long, the hectocotylus is simple. Post fixation characters, such as the funnel organ, will confirm its placement. It differs from *M. setebos* in the number of gill lamellae (typically 13 in *M. setebos* and approx 8 in the new species) and in size at maturity. A mature male (MLd: 53 mm) and a mature female (MLd: 68 mm) were examined.

Nine specimens of an undescribed species of the deep-water genus *Thaumeledone* were also caught. 7 specimens have been captured previously and these were tentatively ascribed to the species *T. brevis*. The latter is known from only 3 immature specimens (MLd of lectotype: 16 mm) captured in 1876 in 600 fathoms off Monte Video and the type material (which is also the type of the genus) is in poor condition. There are therefore problems surrounding *Thaumeledone* that need to be resolved in tandem with the new description. The additional material (NMSZ 2000081.052, NMSZ 2000081.057) will substantially aid this process.

2.3.7 Polychaete Autumn Diversity and Reproductive Biology (S. Piraino, A. Montiel)

Objectives

The diversity and reproductive strategies of polychaetes in the Weddell Sea and Peninsula shelves started to be explored during the first two EASIZ expeditions (Gambi 1997, Gambi 1999 a,b), both under summer conditions. Due to their abundance and ecological importance, scale worms (Aphroditidae and Polynoidae) and fan worms (Sabellidae) were thouroughly studied in many aspects concerning their distribution, population structure, trophic ecology, symbiotic relationships, and reproductive biology. EASIZ III offered an invaluable opportunity to expand the time window for sampling. Autumn ecology and biology of the overall polychaete assemblages from the Weddell Sea and the South Shetland Island shelves are the main targets of our investigations, with reference to a) species composition, b) abundances of dominant species, c) distribution along depth and geographical gradients, d) feeding ecology of key species, e) symbiotic relationships (including parasitism), and f) autumnal reproductive strategies and adaptations.

Work at sea

Polychaetes were collected by means of all available bottom gears. However, due to the needs of parallel research projects, samples were mostly taken by bottom trawls (14 samples), and Agassiz trawl (6 samples), but also occasional (qualitative) sampling was obtained by the Rauschert sledge (4 samples), TV grab (3 samples), epibenthic sledge (2 samples), and the box corer (1 sample). All collected specimens were anaestheticised by menthol, sorted under the stereomicroscope and fixed either in borate-buffered 4% formaldehyde solution in seawater, or 95% alcohol for genetic analysis, or cacodylate-buffered 2.5% glutaraldehyde solution in seawater for electron microscopy. Identification of the recognizable taxa (Tab. 1) was carried out at the lowest taxonomic level possible, mainly following Hartman's (1964, 1974) monographs, and will be completed at the Stazione Zoologica of Naples and the AWI of Bremerhaven.
Large populations of two dominant species (the aphroditid *Laetmonice producta* and the onuphid *Paronuphis antarctica*) were counted and all specimens measured. For *L. producta*, size measurements (length, width) were taken on the basis of a 1 mm precision scale. To roughly estimate the number of eggs produced by each female, four medium-sized (11-12 cm long), ripe specimens were dissected. The number of segments with ripe gonads was recorded and two segments from the central body portion were excised from each specimen, and all eggs from these two segments were isolated and counted on a grid slide under the stereomicroscope. Egg size measurements were taken under a light microscope on the basis of a 10 µm precision scale. Gut contents were also examined in freshly collected specimens of *L. producta* and some other species by dissection under a stereomicroscope. Ecto-and endoparasites of aphroditids and polynoids

were isolated for further studies or given to specialists on board (P. López; H. Mehlhorn). All specimens of *Paronuphis antarctica* from a large catch by Agassiz trawl were counted, and the overall wet weight with tubes recorded. 20 specimens were taken out of their tubes and jointly weighed with three replicate measurements to give a preliminary estimate of the biomass available to the higher trophic levels. All aphroditids, polynoids and sabellids and several other species were examined for their reproductive status (sex, ripeness), and for detection of potentially brooding specimens. Egg masses and brooded embryos were isolated from the parent, transferred to the cold room in small glass bowls, and reared in 0.2 µm-filtered seawater to follow further stages of development. H. Mehlhorn kindly realized a Super VHS footage of larval development from two *Hermadion* spp. polynoids.

Preliminary results

Diversity. Some unexpected results came out from the polychaete group, possibly also due to differences in the sampling depth range and to the population patchiness. Polychaetes belonging at least to 20 families have been collected (Table 19). During the ANT XVII/3 cruise, Polynoidae spp. were recorded at almost all stations sampled by GSN and AGT, being the most frequent family, together with Terebellidae and Sabellidae (Fig. 52).

Table 19 Preliminary list of the identified species of polychaetes from the overall stations.

Ampharetidae sp.1
Ampharetidae sp.2
Ampharetidae sp.3
Aphrodita alta
Laetmonice producta
Glyceridae sp.
Lumbrinereidae sp. 1
Lumbrinereidae sp. 2
Nereidae sp.
Polyeunoa laevis
Barrukia cristata
Eulagisca gigantea
Eulagisca corrientis
Eucranta molllis
Harmothoe spinosa (light form)
Harmothoe spinosa (dark form)
Harmothoe sp.
Hermadion cf ferox
Hermadion cf magalhensis
Eunoe sp.
Polynoidae sp. 1
Polynoidae sp. 2
Polynoidae sp 3.
Euphrosinidae sp.
Flabelligera cf. mundata
Maldane sarsi
Maldane sp. 1
Maldane sp. 2
Aglaophamus macroura
Paronuphis antarctica
Travisia sp.
Phyllodocidae sp. 1
Phyllodocidae sp. 2
Phyllodocidae sp. 3
Myxicola sp.
Perkinsiana sp.1
Perkinsiana sp.2
Scalibregmatidae sp.
Sternaspis scutata.
Trypanosyllis sp
Syllidae sp
Amphitrite sp.
Pista corrientis
Pista cf spinifera
Pista mirabilis
Trychobrachidae sp.

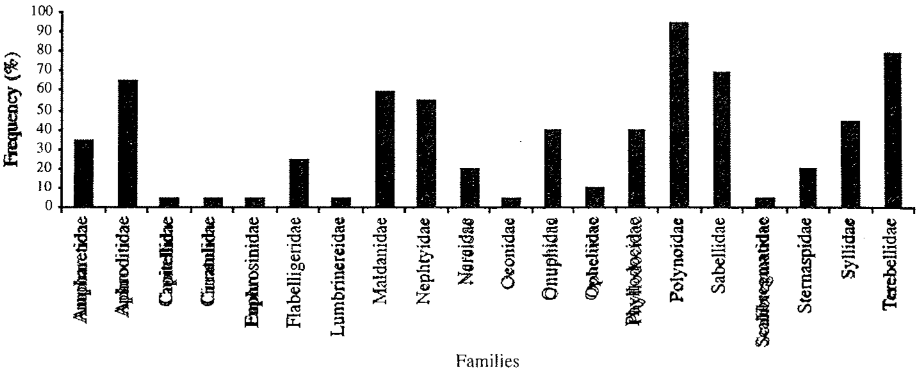


Fig. 52 Overall frequency of polychaete families at the sampling stations

The Ampharetidae, the most common family during the two previous EASIZ expeditions, were also represented in more than 60% of the samples. Most of the families showed a wide range of distribution along a depth gradient. Polynoidae, Phyllodocidae, and Sternaspidae were the most eurybathic families, being present from the shallowest (-95m) to the deepest sampled stations (-910 m), followed by Ampharetidae, Aphrodiditae, Maldanidae, and Sabellidae (Fig. 53). Nephtyidae, with the common species *Aglaophamus macroura*, were restricted to shallow waters (down to 350 m). However, species with different ecological adaptations are included in the family rank, and distributional differences among phylogenetically related species are expected from further analysis at species level.

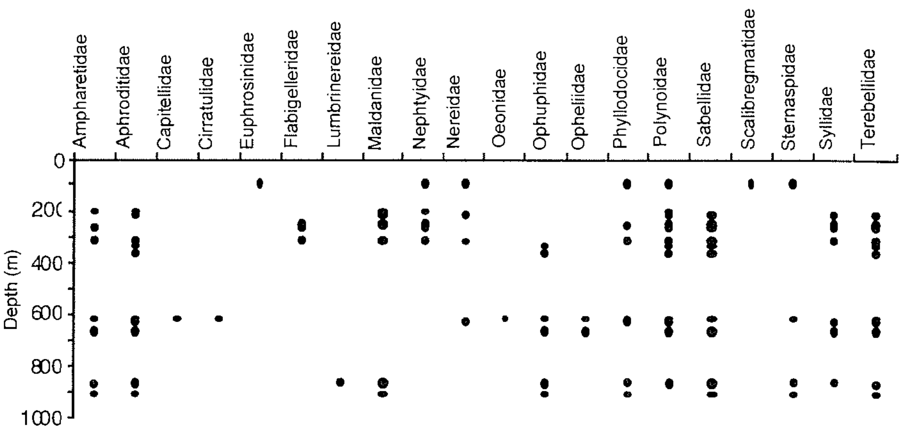


Fig. 53 Depth distribution of polchaete families

Polychaete family richness is not significantly different between samples from the Weddell Sea (8 stations) and from the Peninsula (12 stations) (Fig. 54). The highest number of families in a single sample has been observed from an AGT station at the Peninsula (13 families), but large variability is determined by a combination of several factors, related mainly to depth, bottom morphology, granulometry of sediments, type of gear, and patchiness of benthic communities. Sedentaria were mostly represented, as usual, by Terebellidae spp. and Maldanidae spp. In comparison to previous findings, quite a few sabellid worms appeared both in the Weddell Sea and at the Peninsula, with *Perkinsiana* as the most frequent genus.

Distinct geographical differences among our samples were recorded in the occurrence of the large aphroditid *Laetmonice producta*. This was one the most abundant species in summertime, at the high Antarctic stations during the EASIZ I and II expeditions, but unexpectedly very few specimens occurred in our autumn samples from the Weddell Sea. This might be due to the fact that most trawls in the Weddell Sea were hauled at shallow depths, whereas 80% of *L. producta* populations are normally located below 350 m depth (Stiller, 1996). On the other hand, in the Bransfield Strait *L. producta* was the dominant species at several stations (from 668 up to 204 m depth), where high biomass and specimen numbers (up to 328 large individuals in a single trawl catch) witness for its ecological importance in the overall community. Examination of *L. producta* gut contents showed a high predatory impact (27 full guts out of 50 examined specimens) and a large selection of food items, mainly amphipods, isopods, polychaetes (especially Flabelligeridae), but also ophiuroids and pycnogonids.

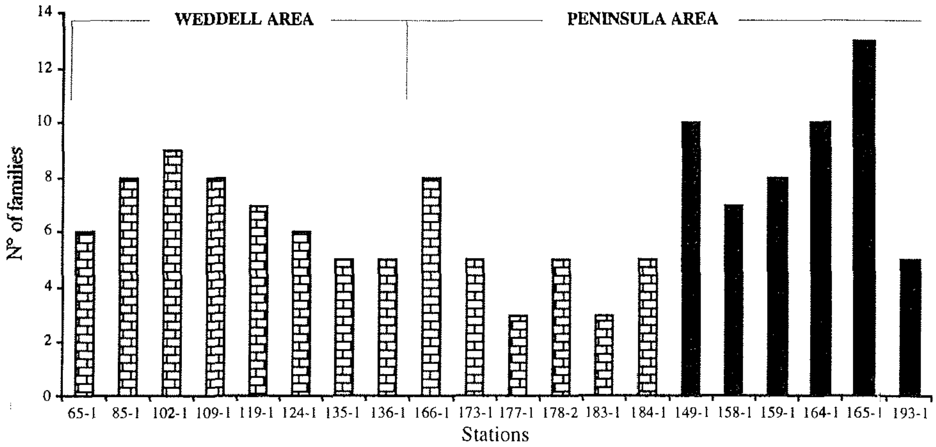


Fig. 54 Number of families at each station.

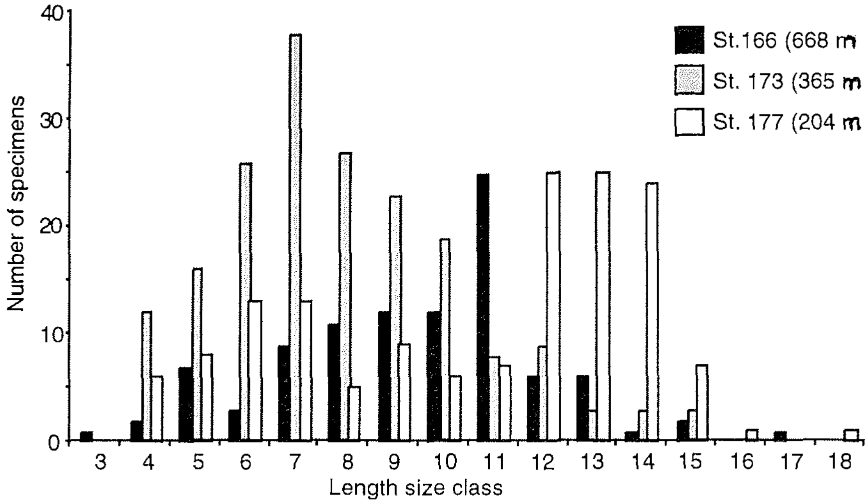


Fig. 55 Class distribution of body length in three *L. producta* populations.

Measurements of body length of *L. producta* from three station at different depths (-668, -365, -204 m) showed three different class distributions (Fig. 55) with modes at the 7 cm size class (-365 m), 11 cm size class (-668 m), and 12-13 cm size classes (-204 m), possibly due to different population ages. As previously observed by Gambi (1996) in the Weddell Sea during EASIZ I, deep stations are dominated by smaller specimens. This may support the suggestion of a zonation along depth, with smaller and likely younger specimens favoured in deeper areas. Only in the Peninsula, the onuphid *Paronuphis antarctica* reaches extremely large numbers. 1428 specimens were counted from a single catch by the Agassiz trawl, for a total wet weight of 258 g (without tubes).

Many species of ectoparasitic copepods (*Herpilobius* spp.) were found on different body parts of polynoids and given to P. López for further SEM morphological analysis. An endoparasitic polychaete (Lumbrinereidae sp.) was found living in the celomic cavity of *Laetmonice producta.* A video footage of this parasite worm was kindly made by H. Mehlhorn. Several specimens were fixed both in formalin and glutaraldehyde solution for further analysis.

Reproduction. Many of the commonest species of polychaetes showed ripe gonads, some producing small eggs of less than 100 µm (Maldanidae sp., Terebellidae sp., *Flabelligera* sp., *Paronuphis antarctica, Polyeunoa laevis, Eulagisca gigantea*), others producing larger eggs like *L. producta.* In this species, egg sizes up to 300 µm were inversely related to a small number of oocytes (approx. 60.000 in specimens 10 cm long). The finding of different egg sizes (from 60 up to 300 µm) also in this season confirms an overlapping production of gametes, a typical reproductive feature of long-living species (Fig. 56).

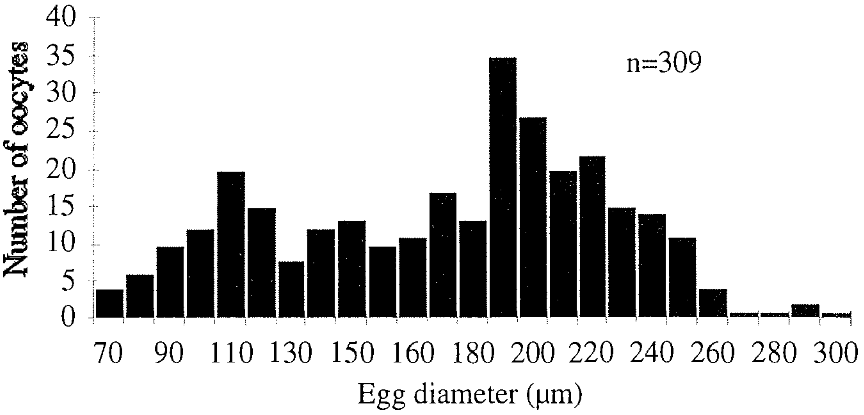


Fig. 56 Size distribution of oocytes in *Laetmonice producta*

More generally, sexual reproduction was ongoing in several species belonging to 12 families (out of 20). A single specimen of *Harmothoe spinosa* (light form) was found brooding eggs under its elythrae, while Gambi (1997, 1999) recorded several brooding specimens during her summer samplings. However, other two polynoids (*Hermadion* spp.) were found to brood their embryos in the high Antarctic, at different stage of development. *Hermadion* sp. 1 was brooding embryos at morula stage composed by 250-300 cells, which did not develop further in the laboratory rearings. *Hermadion* sp. 2 was bearing advanced embryos which soon hatched for egg cases in the cold room rearings and, contrary to previous assumptions, developed after two weeks into lecitotrophic benthic larvae. These larvae were reared on board for more than one month, showing a very slow development of early juvenile features (pigidium, pharingeal tract). Even within species with small egg sizes, among polychaetes there seems to be a tendency to avoid planktonic phases: fully formed juveniles were also found on the setae of a 1 mm-long euphrosinid worm. In many polychaetes living in tubes, such as terebellids, or in *Paronuphis antarctica,* the retaining of early developmental stages of larvae in the tubes was observed as a common reproductive strategy.

We are grateful to M.I. Alfonso, L. Allcock, B. Artigues, J. Bohn, J. González Jiménez, A. Lörz, R. León, P. López, L. Marquard, C. Orejas, S. Rossi, J.Ragua Gil, M. Schrödl, N. Teixido, O. Ziemers for their unceasing help in quick-sorting polychaetes from the trawl catches while still on the working deck. J.M. Gili kindly offered to share his laboratory, provided us with valuable scientific discussions and, not at last, supported us by excellent coffee and cookie provisions. M. Rauschert provided nice photographs of some living polychaete specimens.

2.3.8 Amphipoda: Weddell Sea - Western Antarctic - Magellan Region

(A.N. Loerz, M. Rauschert, O. Ziemer)

Objectives

Amphipoda play an essential role in the foodweb of the Antarctic zoobenthos. They are the most favoured food of many fish and are the third most common prey item of small penguin species after krill and fish. The composition of the amphipod fauna in the shelf areas (about 300 – 800 m) of the Weddell Sea is quite homogenous, but differs substantially from that of the shallow areas. The latter is rather comparable to the shallow-water fauna at the Antarctic Peninsula and the South Shetland Islands.

To increase our knowledge of the amphipod fauna narrow meshed nets (0.5 and 1 mm) were used on the EBS and the Rauschert dredge –as during EASZ I and II– to catch small species. These small animals are not caught with the normal gear since they escape through the meshes or are simply overlooked. To study the relationships in selected amphipod families material of several species was frozen and also preserved in 96 % ethanol at minus 20°C.

Goals of the present study:

- Biodiversity: Studies are focused on taxonomy, geographical distribution and habitats. Interspecific symbiotic ways of life were considered in particular (commensalism with sponges, gorgonians and ascidians).
- Life cycles: In comparison with former cruises the life cycles of amphipods were investigated, studying the fertility of large and small species and comparing the amount and relative size of eggs.
- Molecular biology: The evolutionary links and relationships of amphipods from the eastern Antarctic, western Antarctic and the Magellan region will be investigated using molecular techniques, using selected members of the two abundant families Lysianassidae s.l. and Eusiridae s.l. To identify trophic relationships, we studied mouthparts, stomach contents as well as stable isotopes.
- Photographic inventory of zoobenthos

Work at sea

Gammaridean Amphipoda, Cumacea and Leptostraca were collected at 43 stations using the AGT (5 x), D (18 x, of these 9 x together with the AGT or EBS), EBS (7 x), GSN (13 x) and baited traps. It turned out to be very inefficient to combine the Dredge with other gear types, because the narrow meshed net of the drege was clogged immediately with stirred-up clay. The traps were not very useful for catching amphipods because the crustaceans were nearly all eaten by the fish. Due to lack of time the animals could only partly be sorted and only in a few cases be determined to species level. Sponges and ascidians were sampled and searched for amphipods. Macrophotographs were taken of amphipods and other benthic animals in good condition for the species determination list of the AWI.

Preliminary results

Biodiversity

Faunistics. Successful dredge samples (10) and EBS trawls (5) allowed collecting of a high number of small amphipods usually in good condition. The faunal composition of the dredge and EBS catches was so diverse that an analysis can only be provided later. A preliminary list of amphipod species is given in table 20. The following families (groups) were found: Acanthonotozomellidae, Ampeliscidae, Corophiidae s.l., Dexaminidae, Epimeriidae, Eusiridae s.l., Gammaridae s.l., Lysianassidae s.l., Melitidae, Melphidippidae, Oedicerotidae, Phoxocephalidae, Podoceridae, Sebidae, Stegocephalidae, Stenothoidae, Stilipedidae, Caprellidea, Hyperiidea. More than 500,000 specimens were collected. Up to now only 156 spp. of gammaridean amphipods, Caprellidea and Hyperiidea are distinguished. Of these 39 are not yet described: 1 Leucothoidae, 1 Lilljeborgiidae, 5 Lysianassidae s.l., 1 Melitidae, 1 Podoceridae, 1 Stegocephalidae, 21 Stenothoidae, 1 Synopiidae, 1 Urothoidae. It will be necessary to create new genera for some of the species.

Besides the well known carnivorous Lysianassidae, two genera of Eusiridae were caught in the baited traps: *Eusirus* cf. *antarcticus* and *Oradarea tridentata.* It was presumed before that *Oradarea tridentata* is herbivorous.

Zoogeography. The amphipod fauna on the Hilltop at the stations 111-1 to –30 (depths of 65 - 80 m) differs considerably from the fauna living on the deeper slope areas. The families Eusiridae and Stenothoidae are more abundant on the Hilltop than Lysianassidae. Additionally genera occur which are usually quite common in the shallow-water areas of the west Antarctic/South Shetland Islands: *Oradarea, Paramoera, Prostebbingia*, *Schraderia* and several species of Stenothoidae, some of which are not yet described. For example *Antatelson walkeri* (Stenothoidae) was also caught at the Hilltop, but referring to the list of distribution this species should only occur in the west Antarctic.

At TVG station 111-18 a large number of Stenothoidae were found. 304 individuals were sampled from this catch, while other families were represented only by 1-12 individuals.

Habitats/symbioses. A few species of particular genera of stenothoids were again found associated with Gorgonaria (*Primnoella* sp.). In two cases not only stenothoids were associated with the gorgonians, but in the lower parts corophiids had built tubes. In April /May the marsupia of adult females of the commensal species living in sponges (*Colomastix* cf. *fissilingua, Leucothoe* sp. and Stegocephalidae gen. sp.) were mostly filled. *Ascidia challengeri* (Ascidiacea) was caught at station 65-1 using the GSN at 600m depth, with commensal amphipods (families Stegocephalidae and Stenothoidae) living in its peribranchial space. They were also carrying eggs . At other stations *Leucothoe spinicarpa* (Leucothoidae) as well as one species of Lysianassidae were caught living in ascidians.

Life cycles

Many egg carrying amphipods were recognized in all hauls. More than 50% of the free living species had their marsupia filled with eggs. Subsequent studies will provide exact data. During EASIZ II freshly released juvenile *Waldeckia obesa* (Lysianassidae s.l.) were caught in March, however this very abundant species was rather unfrequent on this cruise. Juvenile *Paraceradocus gibber* (Gammaridae s.l.) which had just left the marsupium were often found in the samples. The number of eggs correlated with the size of the species. Individuals of three to five mm body length often only have 1-4 eggs (which seem huge in relation to the body size of the animal); for example *Monoculodes scabriculosus* of the family Oedicerotidae is about 2 cm long and carries 39 eggs on average. The biochemists (Weber et al., this volume) will analyse the lipid contents of berried females and their eggs. *Liljeborgia georgiana* (Liljeborgiidae) of about the same body size was carrying 21 rather well developed embryos. Many females of this species had released their young and only empty marsupia remained which were losing their spicules.

Molecular biology

Since DNA cannot be sequenced on board, this work will mainly be undertaken in the laboratories of the University of Hamburg.

Photographic inventory of zoobenthos

About 1300 colour macrophotographs of live specimens of zoobenthos (more than 300 species of numerous taxonomic groups) have been taken systematically to record colours and forms.

Table 20 Preliminary list of amphipod species collected by BPN, D, EBS, GSN, GKG and TVG

	Genus	Species	E-Ant	W-Ant	Mag	ANT XVII/3 Station, Gear	Sp. n.
Acanthonotozomellidae	Acanthonotozomopsis	pushkinii (Bushueva, 1978)	X			56/111-9, 111-16	
Ampeliscidae	Ampelisca	richardsoni	X	X		56/85, 119, 135, 136 GSN 5, 7, 8	
Ampeliscidae	Byblis	sp.	X			56/109, 138 GSN; D5	
Amphilochidae	Amphilochella	cf. simplicarpa Schellenberg, 1926	X			56/111-9, -16, -29, -30 D 1-4	
Amphilochidae	gen.	sp. 2	X			56/138 D5	
Amphilochidae	gen.	sp. St.111	X			56/111-9, -16, -29, -30 D 1-4	
Caprellida	Dodecasella	elegans K. BARNARD, 1932	X	X		56/138 D5	
Caprellida	gen.	sp.	X			56/111-29 D4	
Colomastigidae	ColomastiX	fissilingua SCHELLENBERG, 1926	X	X	X	56/136 GSN 8	
Colomastigidae	ColomastiX	sp.n.	X			56/119 GSN 5	X
Corophiidae s.l.	gen.	sp.	X			56/119 GSN 5	X
Corophiidae s.l.	Haplocheira	sp. (plumosa?)	X	X		56/111-9 D1	
Corophiidae s.l.	Kuphocheira	setimana K. BARNARD, 1932	X	X		56/111-9 D1	
DeXaminidae	Polycheria	cf. antarctica (Stebbing, 1875)	X			56/111-29 D4	
DeXaminidae	Polycheria	cf. nuda Holman u. Watling, 1983	X	X		56/111-9 D1	
DeXaminidae	Polycheria	sp. n.	X			56/124 GSN 6	X
DeXaminidae	Lepechinella	drygalskii Schellenberg, 1926				56/138 D5	
DeXaminidae	Polycheria	antarctica (STEBBING, 1875)	X	X		56/136 GSN 8	

	Genus	Species	E-Ant	W-Ant	Mag	ANT XVII/3 Station, Gear	Sp. n.
Epimeriidae	Epimeria	georgiana Schellenberg, 1931	X	X		56/135, 136 GSN 7, 8	
Epimeriidae	Epimeria	macrodonta Walker, 1906	X	X		56/85, 136 GSN	
Epimeriidae	Epimeria	robusta K.H.Barnard, 1930	X			56/85, 102, 109	
Epimeriidae	Epimeria	rubrieques De Broyer & Klages, 1991	X			56/65-1 GSN 1	
Epimeriidae	Epimeriella	cf. walkeri	X			56/136 GSN 8	?
Epimeriidae	Epimeriella	walkeri K.H.Barnard,1930	X	X		56/109, 135 GSN	
Epimeriidae	Epimeriella	cf. 2 walkeri	X			56/85 GSN 2	?
Epimeriidae	gen.	sp. 1	X			56/136 GSN 8	
Epimeriidae	gen.	sp. 2	X			56/59/5 GKG	
Eusiridae s.l.	Atyloella	magellanica (STEBBING, 1888)	X	X	X	56/111-9 D1	
Eusiridae s.l.	Atyloella	quadridens (K. BARNARD, 1930)	X	X		56/111-9 D1	
Eusiridae s.l.	Atylopsis	cf. megalops Nicholls, 1938	X			56/111-16 D1	?
Eusiridae s.l.	Atylopsis	*fragilis* RAUSCHERT, 1989	X	X		56/56/111-9 D1; 138 D5	X
Eusiridae s.l.	Atylopsis	megalops (NICHOLLS, 1938)	X	X	X	56/119 GSN 5	
Eusiridae s.l.	Eusirus	antarcticus THOMSON, 1880	X	X	X	56/111-9, 119, 136 D1, GSN 5	
Eusiridae s.l.	Eusirus	perdentatus CHEVREUX, 1912	X	X		56/102, 109, 119, 135 GSN	
Eusiridae s.l.	Liouvillea	oculata CHEVREUX, 1912	X	X		56/111-9, -16, -29, -30; 119 D 1-4; GSN 5	
Eusiridae s.l.	Oradarea	sp.	X	X		56/111-9, 111-16, -29, -30	
Eusiridae s.l.	Oradarea	sp.	X			56/138 D 5	
Eusiridae s.l.	Oradarea	sp.	X			56/112 MG	
Eusiridae s.l.	Oradarea	tridentata K. BARNARD, 1932	X	X		56/85, 109 GSN	
Eusiridae s.l.	Oradarea	walkeri Shoemaker, 1930	X	X		56/138 D5; EBS2	
Eusiridae s.l.	Paramoera	hurleyi THURSTON1974	X	X		56/111 D 1	
Eusiridae s.l.	Paramoera	sp. (cf. fissicauda)	X			56/102, 119	
Eusiridae s.l.	Prostebbingia	gracilis (CHEVREUX, 1912)	X	X	X	56/109 GSN4, 111-9 D1	
Eusiridae s.l.	Rhachotropis	antarctica BARNARD, 1932	X	X	X	56/85, 109, 119, 135, 136	
Eusiridae s.l.	Schraderia	gracilis PFEFFER, 1888	X	X		56/111-9 D1, 119 GSN5	
Gammarida: Ceradocus group	Maera	sp. n.	X			56/138 EBS2	X
Gammaridae *s.l.*	Paraceradocus	gibber ANDRES, 1984	X	X		56/85, 111-5, 136 GSN	
Gammaridae s.l.	Paraceradocus	miersii (PFEFFER, 1888)	X	X		56/138 D5	
Iphimediidae	Echiniphimedia	echinata?	X			56/102, 109, 119 GSN 3	
Iphimediidae	Echiniphimedia	hodgsoni	X			56/102, 109, 135 GSN	
Iphimediidae	gen.	sp. 56/	X			56/136 GSN 8	
Iphimediidae	Gnathiphimedia	cf. sexdentata (Schellenberg, 1926)	X			56/119 GSN 5	
Iphimediidae	Gnathiphimedia	macrops K.H. Barnard, 1932	X			56/102 GSN 3	
Iphimediidae	Gnathiphimedia	mandibularis K.H.Barnard, 1930	X	X		56/109 GSN 4	
Iphimediidae	Gnathiphimedia	sexdentata (Schellenberg, 1926)	X	X		56/59/4, 65, 102, 109, 136 GKG, GSN	

	Genus	Species	E-Ant	W-Ant	Mag	ANT XVII/3 Station, Gear	Sp. n.
Iphimediidae	Gnathiphimedia	sp. weiß	X			56/102 GSN 3	
Iphimediidae	Gnathiphimedia	sp.2 cf. sexdentata	X			56/109 GSN 4	
Ischyroceridae	gen.	sp. 2	X			56/138 D5; EBS2	
Ischyroceridae	gen.	sp. 56/1	X			56/135, 136 GSN 7, 8	
Ischyroceridae	gen.	sp. 56/2	X			56/138 D5	
Ischyroceridae	Jassa	sp A (grey)	X	X		56/119, 136 GSN 5, 8	
Ischyroceridae	Pseudericthonius	gaussi Schellenberg, 1926	X			56/136 GSN 8	
Ischyroceridae	Pseudericthonius	sp.	X			56/111-29 D3	?
Ischyroceridae	Ventojassa	georgiana (SCHELLENBERG, 1931)	X	X	X	56/111-9 D1	
Leucothoidae	Leucothoe	sp. n.	X			56/119 GSN 5	X
Leucothoidae	Leucothoe	spinicarpa (ABILDGAARD, 1789)	X	X	X	56/109, 119, 124, 136 GSN 4, 5, 8	
Liljeborgiidae	Liljeborgia	georgiana Schellenberg, 1931				56/119, 136 GSN 5, 8	
Liljeborgiidae	Liljeborgia	sp.n.	X			56/138 D5	X
Lysianassidae	gen.	sp.	X			56/109, 135 GSN 4, 7	
Lysianassidae s.l.	gen.	sp. 56/14	X			56/135 GSN 7	
Lysianassidae s.l.	gen.	sp. 56/15	X			56/135 GSN 7	
Lysianassidae s.l.	gen.	sp. 56/16	X			56/138 D 5	
Lysianassidae s.l.	gen.	sp.56/1	X			56/102 GSN 3	X
Lysianassidae s.l.	gen.	sp.56/10	X			56/136 GSN 8	
Lysianassidae s.l.	gen.	sp.56/11	X			56/136 GSN 8	
Lysianassidae s.l.	gen.	sp.56/12	X			56/124 GSN 6	
Lysianassidae s.l.	gen.	sp.56/13	X			56/119 GSN 5	
Lysianassidae s.l.	gen.	sp.56/2	X			56/102 GSN 4	
Lysianassidae s.l.	gen.	sp.56/3	X			56/102 GSN 4	
Lysianassidae s.l.	gen.	sp.56/4	X			56/119 GSN 5	
Lysianassidae s.l.	gen.	sp.56/5	X			56/119 GSN 5	
Lysianassidae s.l.	gen.	sp.56/6	X			56/119 GSN 5	
Lysianassidae s.l.	gen.	sp.56/7	X			56/119 GSN 5	
Lysianassidae s.l.	gen.	sp.56/8	X			56/119 GSN 5	
Lysianassidae s.l.	gen.	sp.56/9	X			56/119 GSN 5	
Lysianassidae s.l.	gen. nov.	sp.n. (Claude)	X			56/138 D5	X
Lysianassidae s.l.	gen.(Drummondia?)	sp. 56/	X			56/138 D 5	X
Lysianassidae s.l.	Hippomedon	sp.	X			56/102, 135,136 GSN 4, 7	
Lysianassidae s.l.	Hirondellea	cf. antarctica (Schellenberg, 1926)	X			56/119 GSN 5	

	Genus	Species	E-Ant	W-Ant	Mag	ANT XVII/3 Station, Gear	Sp. n.
Lysianassidae s.l.	Hirondellea	sp. n.	X			56/119 GSN 5	X
Lysianassidae s.l.	Lepidepecreum	sp.	X			56/109 GSN 4	
Lysianassidae s.l.	Orchomenella	cf. acanthura (Schellenberg, 1931)	X			56/136 GSN 8	
Lysianassidae s.l.	Pachychelium	cf.2 antarcticum, Schellenberg, 1926	X			56/102, 136 GSN 3, 8	
Lysianassidae s.l.	Stomacontion	sp. n.	X			56/119 GSN 5	X
Lysianassidae s.l.	Uristes	gigas Dana, 1849	X	X	X	56/109 GSN 4	
Lysianassidae s.l.	Waldeckia	obesa (Chevreux, 1905)	X	X		56/109 GSN 4	
Melitidae	gen. nov. (Antamelita)	sp.n.	X			56/102,109 GSN	X
Melphidippidae	Melphidippa	antarctica Schellenberg, 1926	X	X		56/138 D 5, EBS 2	
Oedicerotidae	gen.	sp.	X			56/138 D5	
Oedicerotidae	Monucolodes	sp.	X			56/102, 109, 136 GSN 3, 4, 8	
Pardaliscidae	Pardalisca	cf. cuspidata Kroyer, 1842	X			56/59-4 GKG	
Phoxocephalidae	gen.	sp. 1	X			56/59/5 GKG	
Phoxocephalidae	gen.	sp. 2	X			56/59/4 GKG, 119 GSN 5	
Phoxocephalidae	gen.	sp. 3	X			56/59/4 GKG; 56/109 GSN4	
Phoxocephalidae	gen.	sp. 4	X			56/119, 136 GSN 5, 8	
Pleustidae	Parepimeria	minor Watling & Holman, 1980	X			56/138 D5	
Podoceridae	NeoXenodice	sp.n. (cf. hoshiaii Takeuchi u. Takeda, 1992)	X			56/138 EBS 2, D5	X
Podoceridae	Podocerus	septemcarinatus Schellenberg, 1926	X	X		56/138 D5	
Podoceridae	Pseudodulichia	sp.	X			56/138 D5	
Sebidae	Seba	dubia SCHELLENBERG, 1926	X	X		56/111-9 D1	
Stegocephalidae	gen.	sp.	X			56/85 GSN2	
Stegocephalidae	gen.	sp.	X			56/119, 136 GSN5, 8	
Stegocephalidae	gen.	sp.	X			56/102 GSN 3	X
Stegocephalidae	gen.	sp.	X			56/65 GSN 1	
Stegocephalidae	gen.	sp. 56/	X			56/136 GSN 8	
Stegocephalidae	Parandania	boecki (Stebbing, 1888)	X			56/ 56, 57 Bongo	
Stenothoidae	Antatelson	walkeri (CHILTON, 1912)	X	X		56/111-9, -16, -30	
Stenothoidae	gen.	sp.	X			56/111-5 TVG	X
Stenothoidae	gen.	sp.	X			56/138 GSN 8	X
Stenothoidae	gen.	sp. 2	X			56/111-9 D1	X
Stenothoidae	gen.	sp. n.	X			56/111-5 TVG	X
Stenothoidae	gen.	sp.n. 3	X			56/111-9 D1	X
Stenothoidae	gen.	sp.n. 4	X			56/111-9 D1	X
Stenothoidae	gen.	sp.n. 6	X			56/111-9 D1	X
Stenothoidae	gen. nov. 2	sp.n.2	X			56/111-5 TVG	X
Stenothoidae	Metopoides	sp.n. 2 (ascidian)	X			56/65-1 GSN1	X
Stenothoidae	Metopoides	sp.n. 3	X			56/111-9 D1	X

	Genus	Species	E-Ant	W-Ant	Mag	ANT XVII/3 Station, Gear	Sp. n.
Stenothoidae	Metopoides	sp.n. 3 (sponge)	X			56/111-9 D1	X
Stenothoidae	Probolisca?	sp.n.	X	X		56/65-1 GSN	X
Stenothoidae	Scaphodactylus	sp.n. 1a	X			56/59/4 GKG	X
Stenothoidae	Thaumatelson	herdmani WALKER, 1906	X	X	X	56/59 GKG	
Stenothoidae	Torometopa	sp.n. 3	X			56/135 GSN 7	X
Stenothoidae	Torometopa	sp.n. 56/a	X			56/135 GSN 7	X
Stenothoidae	Torometopa	tigris or sirenkoi	X			56/111-16, 111-29	X
Stilipedidae	gen.	sp. 1	X			56/59-4 GKG; 119	
Synopiidae	Syrrhoe	psychrophila Monod, 1926	X	X		56/138 D5; EBS2	
Synopiidae	Syrrhoites	cf. anaticauda K.H.Barnard, 1930 (sp.n.)	X			56/138 D5; EBS	X
Vibiliidae	Vibilia	antarctica Stebbing, 1888	X			56/ 56 Bongo	

2.3.9 **Crinoidea and Holothuroidea** (J.M. Bohn)

Objectives

- Biodiversity of Antarctic Crinoidea and Holothuroidea in the Weddell Sea and at the Antarctic Peninsula. Up to now, about 29 Crinoidea (20 Comatulida, 8 Hyocrinida and 1 Bourgueticrinida) are known from Antarctic waters (Marr, 1963; Speel and Dearborn, 1983; Mironov and Sorokina, 1998). But there are still many areas that have been sampled only occasionally (e.g. the Weddell Sea). Weddell Sea Holothuroidea, on the other hand are quite well known since the investigations of Gutt (1988, 1990a, 1990b) who found 33 species. An area where the holothurian fauna is not so well known is the Antarctic Peninsula. The aim of this study was to investigate the crinoid and holothurian fauna of the Weddell Sea and the Antarctic Peninsula to provide a basis for biogeographical comparisons between adjacent areas (i.e. Antarctica, Magellan region, South Atlantic Ocean).

- Phylogeny of Antarctic Crinoidea. A high degree of endemism is characteristic of Antarctic comatulids. Several groups show significant radiation in Antarctic waters (e.g. Notocrinidae, Isometrinae, Heliometrinae). The origin and the evolution of these groups should be investigated with modern methods such as histological, ultrastructural and molecular approaches.

- Ontogeny of Antarctic Comatulida. Comatulid crinoids usually have a free swimming doliolaria larva which settles after a short pelagic period. After settling a complicated metamorphosis starts, which leads via a cystidum to the stalked pentacrinus larva. During metamorphosis the larval nervous system is reduced and no traces of it can be found in early cystidians (Jangoux and Lahaye, 1990). Older pentacrinus larvae already possess the adult nervous system (Grimmer, Holland, and Kubota, 1984) but what happens in between these two stages is still unknown. Does the adult nervous system develop out of remains of the larval system or does it develop de novo? To get an answer to these questions different developmental stages of crinoids should be sampled and fixed for ultrastructural and immuno-cytochemical investigations. Because 14 out of 20 known Antarctic Comatulida are brooders (Holland, 1991), it should be easy to obtain different developmental stages of larval crinoids together with adult specimens.

Work at Sea

To collect the crinoid and holothurian specimens, different kinds of gear have been used (Tab. 1). The samples were taken in the eastern Weddell Sea and at the Antarctic Peninsula at depths from 70-850 m. The crinoids and holothurians of each catch were sorted to species level and mainly fixed in 4% formalin-seawater. For molecular analyses specimens of each species were fixed in 96% Ethanol. To document coloration, photos of living specimens were taken.

Crinoid larvae at different growth stages (freshly settled cystidians to old pentacrinus) have been collected. To investigate the developing nervous system the larvae have partly been fixed in glutaraldehyde for ultrastructural research, partly fixed in 4% formalin-seawater and partly frozen in liquid Nitrogen for immunocytochemistry purposes.

Preliminary results

Investigating the crinoid and holothurian fauna of the Weddell Sea and the Antarctic Peninsula produced three preliminary results.

- The most dominant Crinoid of the Weddell Sea and the Antarctic Peninsula shelf region is *Promachocrinus kerguelensis,* followed by *Notocrinus virilis, Notocrinus mortenseni* and *Anthometra adriani.* Other crinoids have only been collected occasionally (four species).

- The crinoid larvae that were collected during the cruise at five different stations (Tab. 1) are of different developmental stages, from newly settled cystidians to old pentacrinus larvae. Many of these seem to be *Notocrinus* sp.. But it is not only both *Notocrinus* species that seem to reproduce in late summer or autumn because many *Promachocrinus kerguelensis*, *Anthometra adriani* and other Antedonidae (e.g. brooding *Isometra* species) investigated also had ripe and thick gonads or larvae in their brood pouches.

- About 30 holothurian species have been collected during the cruise. Within these are two Apodida that are probably new to science (*Taeniogyrus* sp. I, *Myriotrochus* sp. I). *Taeniogyrus* sp. I occured at three stations (Tab. 1) at depths from 621-858 m in the Weddell Sea and at the Antarctic Peninsula, whereas *Myriotrochus* sp. I has only been found in three hauls at the Antarctic Peninsula (Table 21). This species seems to have a wider depth range as it occurred from 94-896 m.

Table 21 Preliminary number of species of crinoids and holothurians at each station and presence or absence of crinoid larvae, *Taeniogyrus* sp. I and *Myriotrochus* sp. I. AGT: Agassiz trawl, D: small dredge, EBS: epibenthic sledge, GSN: bottom trawl, GKG: giant box corer, MG: multi grab, TVG: TV-grab, x: present, -: absent.

Station	59-4	65-1	85-1	86-1	89-1	97-1	102-	109-	110-	111-	111-	111-
Gear	GKG	GSN	GSN	GKG	GKG	EBS	1	1	6	6	16	18
							GSN	GSN	TVG	TVG	D	TVG
Crinoidea	-	5	4	-	1	1	5	5	1	-	-	-
Larvae	-	-	-	-	-	-	-	-	-	-	-	-
Holothuroidea	1	16	14	1	-	2	17	10	-	1	2	1
Taeniogyrus	-	-	-	-	-	x	-	-	-	-	-	-
Myriotrochus	-	-	-	-	-	-	-	-	-	-	-	-

Station	111-	113-	119-	122-	124-	135-	136-	138-	149-	155-	155-	155-	155-	158-
Gear	29	1	1	1	1	1	1	1	1	1	6	7	8	1
	D	MG	GSN	TVG	GSN	GSN	GSN	D	AGT	D	D	TVG	TVG	AGT
Crinoid.	-	-	4	-	4	3	3	3	2	-	-	-	-	-
Larvae	-	-	-	-	-	-	-	x	x	-	-	-	-	-
Holothur.	3	1	15	5	12	9	10	3	13	5	9	2	6	14
Taeniog.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myriotr.	-	-	-	-	-	-	-	-	x	-	-	-	-	x

Station	159-	163-	164-1	165-	166-	173-	174-	177-1	178-2	180-2	183-1	184-
Gear	1	1	AGT	1	1	1	1	GSN	GSN	EBS	GSN	1
	AGT	D		AGT	GSN	GSN	EBS					GSN
Crinoid.	-	2	-	2	5	3	1	3	2	3	3	2
Larvae	-	x	-	-	-	-	-	-	-	x	x	-
Holothur.	4	-	3	5	6	-	2	1	1	-	1	1
Taeniog.	-	-	x	x	-	-	-	-	-	-	-	-
Myriotr.	-	-	-	-	-	-	x	-	-	-	-	-

2.3.10 Quantitative Zoobenthos Studies (D. Gerdes, T. Janssens, A. Dewicke)

Objectives

- Macrobenthos

During EASIZ II we started collecting quantitative multibox corer samples around the tip of the Antarctic Peninsula. During this expedition we worked up 4 stations off Potter Cove in the Bransfield Strait covering water depths between 212 and 829 m and one depth profile (120 to 2000 m) with 5 multibox corer stations in the Drake Passage. These data provided the first quantitative information about the meio- and macrobenthos communities around the tip of the Antarctic Peninsula. This database, however, is by far too small and does not allow the determination of links between the fauna of this area and the high Antarctic SE Weddell Sea shelf nor to the adjacent Magellan areas north of the Drake Passage, which were intensively studied from 1994 to 96.
Our intention for this cruise therefore was to enlarge our quantitative data set for the Bransfield Strait and the southern slope of the Drake Passage, thus getting better information about benthic community structure, as well as to increase our knowledge of the taxonomic inventory of most benthos groups.

- Meiobenthos

The Meiofauna in Magellan and high Antarctic sublittoral biotopes has been studied in detail. However, the latitudinal gradient between the two continents has not been considered so far. Antarctica is the most isolated of all continents, hence an interesting region for studying the biogeographical establishment of benthic populations. Our focus is on the biogeography of the marine free-living nematode populations.

Table 22 Multibox corer and Multicorer stations in the Bransfield Strait and the southern slope of the Drake Passage.

Date	Station	Lat. (S), Long. (W)	Depth	MG No.	No. of cores 1)	Remarks
24.04.00	148-3	62°42.77' 56°52.69'	229	MG 11	8/0	Bransfield Strait
27.04.00	160-2	63°24.88' 59°26.94'	934	MG 12	5/2/1	Bransfield Strait
27.04.00	161-2	63°35.85' 59°32.85'	647	MG 13	6/2/1	Bransfield Strait
27.04.00	162-2	63°37.18' 59°33.82'	291	MG 14	6/2/1	Bransfield Strait
29.04.00	169	62°56.67' 60°25.20'	604	MG 15	6/2/1	Bransfield Strait
01.05.00	176-2	62°55.70' 60°27.10'	475	MG 16	6/2/1	Bransfield Strait
01.05.00	177-3	62°49.97' 60°50.40'	203	MG 17	7/2	Bransfield Strait
02.05.00	178-1	61°59.41' 60°21.61'	832	MG 18	5/2	Drake Passage
02.05.00	179	61°59.92' 60°16.99'	388	MG 19	7/2	Drake Passage
02.05.00	180-1	62°06.72' 60°21.74'	206	MG 20	6/2	Drake Passage
05.05.00	190-2	62°18.40' 58°34.00'	187	MG 21	7/2	Bransfield Strait
05.05.00	190-3	62°18.60' 58°33.00'	293	MG 22	7/2	Bransfield Strait
24.04.00	148-1	62°42.80‘ 56°52.50‘	234	MUC	Meio	Bransfield Strait
24.04.00	148-1	62°42.80‘ 56°52.60‘	229	MUC	Meio	Bransfield Strait
24.04.00	148-1	62°42.80‘ 56°52.80‘	227	MUC	Meio	Bransfield Strait

1) used for macrobenthos/meiobenthos/sedimentology

Work at sea

The samples collected for zoobenthic analysis are listed in Table 22. One additional multicorer was taken at station 56-4 (40°56,40‘S 9°53,50‘E) for geological research from which three cores could be used for meiobenthic community analysis. These samples will be analysed and studied by Dr. A. Vanreusel in the framework of a European biodiversity project.

Preliminary results

Nine MG stations in the Bransfield Strait at water depths between 187 and 934 m yielded a total of 79 cores for meio- and macrobenthos analyses and sedimentology. In the Drake Passage 3 additional drops at depths between 206 and 832 m provided another 24 cores.

Detailed analyses of the quantitative samples have to be presented later after sorting of the samples and breakdown of the taxonomic groups in the home laboratories. However, at a first glance from our work at sea based on rough insights into the samples and the UW-video material, the benthic fauna along the eastern Bransfield Strait slope appeared diverse but different from the SE Weddell Sea shelf fauna. At shallower sites the epifauna, which normally appears less developed around the Peninsula as compared to the SE Weddell Sea shelf, was also rich, but taxa such as sponges or crinoids were almost absent and replaced by a diverse and dense bryozoan/ascidean/echinoderm community, while the endofauna was dominated by polychaetes. On the fluffy and soft fine sand sediments at the deeper stations, which were partly oxygen undersaturated and H_2S rich, the fauna was impoverished and polychaetes were the main faunal taxon . At the shallower stations (< 100m) around Deception Island the fauna on the dark volcanic ash sediment was impoverished, too, with echinoderms being dominant. With increasing depth, crustaceans, especially amphipods and isopods, and brittle stars became more abundant whereas polychaetes seemed to be not as abundant on these coarse sand bottoms.

The fauna of the southern slope of the Drake Passage differed from that of the Bransfield Strait. It seemed to be less diverse but with high abundances of fewer taxa and, surprisingly, taxa like crinoids, occurring only ocasionally in the Bransfield Strait (and on the northern slope of the Drake Passage, were quite abundant at the Drake Passage stations.

2.3.11 Biodiversity of Macrozoobenthic Communities in the Eastern Weddell Sea and at the Antarctic Peninsula (B. Sirenko, I. Smirnov, W. Arntz)

Objectives

During the expedition ANT XIII/3 (EASIZ I) in 1996, 706 species of free living invertebrates were identified on board "Polarstern". A careful examination of the collected subsamples and remains by Russian taxonomists increased the list of species to about 1000. Presently more than 1200 species of invertebrates are known from the Weddell Sea if data on sponges, amphipods and cephalopods published by West European taxonomists are added to the list. There are large gaps in the inventory with respect to several large groups of invertebrates such as polychaetes, isopods, holothurians and nemerteans. Another interesting approach applied during ANT XVII/3 was to compare the species composition of trawl catches taken in areas disturbed by icebergs as compared to undisturbed areas.

The principal goals of investigation were

- to estimate the number of species of all groups of animals in each bottom trawl (GSN) catch;
- to define peculiarities in distribution of taxonomic biodiversity in different regions of the Weddell Sea and at the Antarctic Peninsula;
- to determine relative abundance of major taxa from trawl and dredge catches;
- to collect further material for species identification in St.Petersburg.

Work at sea

Immediately after hauling the trawl on deck digital photos were taken by an Olympus-Camedia C-2000 Z camera, more than 100 of which were stored on the computer. Before collecting any material from the catch a 5 liter subsample was taken from each trawl catch (8 GSN). After picking material by hand from the catch on deck we washed and sieved most of the remains on a set of sieves with 10x10, 5x5 and 1x1 mm mesh size. The material retained by the three sieves was sorted on board into 42 groups of animals (Table 23). After sorting, the preliminary number of species for most groups of invertebrates was counted .

Table 23 Number of invertebrate species per GSN catch

Station	65-1	85-1	102-1	109-1	119-1	124-1	135-1	136-1
Depth [m]	648	318	312	311	237	269	251	260
Porifera	19	32	26	20	23	17	12	16
Hydrozoa	14	11	12	8	10	8	8	6
Scyphozoa	-	1	1	-	-	-	-	-
Actiniaria	3	6	3	6	6	4	6	6
Scleractinia	1	2	1	2	1	-	1	-
Gorgonaria	5	9	12	9	8	11	12	8
Alcyonaria	3	2	1	3	2	1	-	1
Pennatularia	-	1	-	-	1	-	-	-
Brachiopoda	1	1	1	1	1	-	1	1
Bryozoa	26	30	35	31	27	28	16	19
Plathelminthes	-	1	-	-	-	-	-	-
Nemertini	1	1	3	2	2	-	1	2
Nematoda	-	-	-	-	-	-	-	-
Kamptozoa	-	-	-	-	-	-	-	-
Priapulida	-	-	-	-	-	-	-	1
Sipunculida		1	2	1	2	1	1	1
Echiurida	-	1	-	-	-	-	-	-
Hirudinea	-	2	-	-	-	-	-	-
Polychaeta	16	24	21	18	17	17	11	12
Polyplacophora	2	2	1	2	2	2	2	2
Aplacophora	1	3	2	-	3	2	2	2
Prosobranchia	8	14	12	11	15	7	8	27
Opisthobranchia	1	3	3	5	3	2	1	4
Bivalvia	10	11	10	6	9	11	11	13
Scaphopoda	-	-	-	-	-	-	-	-
Cephalopoda	2	4	5	2	4	3	1	3
Pycnogonida	10	9	11	10	6	5	5	9
Cirripedia	1	1	-	1	-	-	1	1
Natantia	3	2	2	2	3	2	2	1
Reptantia	-	-	-	-	-	-	-	-
Mysidacea	2	1	-	-	-	-	-	-
Amphipoda	5	15	33	23	36	12	13	30
Cumacea	-	4	4	1	-	1	-	2
Tanaidacea	-	1	1	-	-	-	-	-
Isopoda	3	6	5	4	4	3	3	8
Pterobranchia	2	4	5	4	3	5	6	4
Crinoidea	5	4	5	5	4	4	3	3
Holothuroidea	16	14	17	10	15	12	9	10
Echinoidea	4	3	4	3	2	3	2	2
Asteroidea	18	20	26	16	23	14	10	10
Ophiuroidea	15	20	16	16	14	10	8	10
Ascidiacea	11	22	26	11	13	9	11	9
Total	208	288	306	233	259	194	167	223

Preliminary species numbers per trawl catch for several other groups of animals were received from our colleagues on board "Polarstern":

Actiniaria, Gorgonaria, Alcyonaria, Pennatularia - Pablo López
Scleractinia, Asteroidea - Lucie Marquardt
Bryozoa - Beate Bader
Polychaeta - Stefano Piraino, Américo Montiel
Opisthobranchia - Michael Schrödl
Cephalopoda - Louise Allcock

Amphipoda	- Martin Rauschert
Natantia	- Roxana León
Crinoidea, Holothuroidea	- Jens Bohn
Pterobranchia	- Helmut Goerke

We thank these colleagues very much for these data. In those cases where the species number provided by them differed from our counts, we used the higher estimate of the two. Identified and counted material was fixed in 75% alcohol (bryozoans, molluscs, echinoderms, brachiopods and alcyonarians) or in 4% buffered formaldehyde (other groups). Most of the collected material will be distributed among the scientists of the Zoological Institute, St. Petersburg, and several other institutions of Russia and Ukraine for exact identification.
Besides the trawl catches material from other gear (Rauschert's dredge, GKG and TVG) was washed, sieved, sorted and fixed for future identification in the above-mentioned institutions. We are very grateful to Martin Rauschert, Juanita Ragua-Gil, Thiery Janssens and Beate Bader for this additional material.

Preliminary results

The comparison of dominant groups of animals in each trawl catch showed the similarity of some catches and differences in others (Table 24). The six first trawl catches showed the same dominant group (Porifera) and a very similar composition of the subdominant groups (Bryozoa, Holothuroidea, Pterobranchia, Ascidiacea, Crinoidea). The dominant group of sponges contributed 80-95% of the catch volume. Four of six trawl catches (Stns. 65-1, 85-1, 102-1 and 109-1) contained large sponges whereas the other two contained middle sized sponges. The first four trawls were taken in undisturbed areas. Two trawl catches (Stns. 85-1 and 102-1) had a greater species diversity within the eight trawls. Trawl St. 65-1 had a low species diversity because it was taken at greater depth (648 m) than the others (237-318 m). According to our data the highest species diversity in the eastern Weddell Sea occurs at depths of 212-504 m (Sirenko et al., 1997). The trawl catch from St. 109-1 which showed a lower biodiversity was processed less minutely than others. Two trawls (St. 119-1 and 124-1) were apparently taken in old scour areas because the sponges had a medium size and were less diverse. The two last trawls (Stns. 135-1 and 136-1) were taken evidently in disturbed areas because the sponges and other dominant species in the catch were small (Table 24). The higher species biodiversity of the last trawl catch (St. 136-1) can be explained by the great volume of sandy mud in it. This catch was washed less in the trawl during the heaving process. Washing and sieving all the remains of this trawl on deck we collected a lot of small specimens of molluscs, crustaceans and polychaetes most of which in other trawl catches were probably washed in the sea. If we exclude the small animals in all trawl catches we get a more realistic picture of comparative biodiversity for all stations. Again Stns. 135-1 and 136-1 reveal the lowest biodiversity which is characteristic for a disturbed area.
The comparison of species richness between the six GSN catches (Stns. 65-1, 85-1, 109-1, 119-1, 124-1) from undisturbed or old scour areas in the Weddell Sea and the five trawl (GSN) catches (Stns. 166-1, 173-1, 177-1, 183-1, 184-1) taken near the Antarctic Peninsula shows big differences. Although the trawl catches were taken from the same depth (approximately 200-600 m) the medium species richness in the Weddell Sea (248 species) was more than twice the medium species richness off the Antarctic Peninsula (105 species). Moreover the sponges often did not dominate in the trawl catches taken in the latter area whereas other dominant groups of invertebrates characteristic of soft bottoms (Polychaeta, Echinoidea Irregularia and the cnidarian Anthomastus) appeared there. Apparently one of the reasons for this difference is the predominance of soft sediments (silt, clay) near the Antarctic Peninsula opposed to gravelly dropstone-rich muddy sand in the eastern Weddell Sea.

Table 24 Dominant and subdominant groups of invertebrate species in trawl catches (GSN)

Station	Depth [m]	Dominant and subdominant groups of invertebrates
65-1	648	Porifera (>80%)+Holothuroidea+Bryozoa+Crinoidea
85-1	318	Porifera (>90%)+Bryozoa+Holothuroidea+Pterobranchia
102-1	312	Porifera (>90%)+Pterobranchia+Bryozoa+Holothuroidea
109-1	311	Porifera (>95%)+Pterobranchia+Bryozoa+Holothuroidea
119-1	237	Porifera (>90%)+Ascidiacea+Gorgonaria+Bryozoa+Holothur.
124-1	269	Porifera (>95%)+Bryozoa+Ascidiacea+Holothuroidea
135-1	251	Crinoidea (>70%)+Ascidiacea+Bryozoa+ Pterobranch.+Holothur.
136-1	260	Crinoidea+Polychaeta+Bryozoa+Holothuroidea+Porifera

Perspectives

Obviously the material from various "Polarstern" cruises combined with the careful examination of larger samples by specialists and published results from the literature enable us to approach the total number of species in the Atlantic sector of the high Antarctic, which might then be compared with other well-investigated regions to clarify the question of latitudinal gradients. This would mean an important step from sample diversity to regional diversity. On the next cruise, an attempt should be made to arrive at species-area curves by checking how species accumulate with increasing numbers of trawls.

We are very grateful to all those who participated in sampling and processing of materials. In particular we thank Chief Engineer Volker Schulz and his specialists for skilled assistance . This work was supported by the Alfred Wegener Institute and the Russian Federal Programme "Study of Antarctic biota, Project N 16".

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2.3.12 Zooplankton (F. Pages, S. Grabbert, A. Cornils)

Objectives

- Horizontal sampling of zooplankton in order to characterize the populations living near the bottom and to investigate bentho-pelagic coupling.
- Vertical and oblique sampling in different water masses for collecting selected copepod species to carry out molecular genetic studies on phylogenetic relationships and to identify populations.
- To collect planktonic cnidarians for complementing the comparatively well known fauna of medusae and siphonophores from the Weddell Sea.

Work at Sea

Four types of plankton nets were used during the cruise. The Multinet (0.25 m^2 opening) was equipped with five nets (mesh-size 100 µm) and was used to sample discrete depth ranges in the top 1000 m, or from the bottom to the sea surface at shallower waters. The depth ranges were chosen according to the temperature and salinity profiles at each station. The Bongo net (60 cm mouth diameter, mesh-size 100 µm) collected samples to get biomass for molecular genetic studies. Both the SHHN (small horizontal hauling net, diameter 60 cm, mesh-size 236 µm) and the LHHN (large horizontal hauling net, mouth diameter 115 cm, mesh-size 500 µm) were hauled near the bottom.

In total 62 hauls, namely 32 Multinet, 15 Bongo (vertical and oblique hauls), 11 SHHN and 4 LHHN were carried out. The samples were taken in the eastern Weddell Sea (Atka Bay, Auståsen, Hilltop and Kapp Norvegia) and off the Antarctic Peninsula, especially in the Bransfield Strait and the Drake Passage. Many samples were taken according to positions of Multicorer and Multigrab stations to fit with the benthopelagic coupling. Most of the sampling was done at night.

Preliminary results

During the first half of the cruise, off Kapp Norvegia, Hilltop and Auståsen, zooplankton communities were dominated by copepods and ctenophores. It is interesting to note the high abundance of ctenophores in comparison with the cruise ANT X/3 carried out in autumn 1992 in the eastern Weddell Sea, when gelatinous zooplankton was composed mainly by medusae and siphonophores, both sparse this year. Ctenophores were distributed along the whole water column being more abundant in the upper layers where *Callianira antarctica* and its predator *Beroe* spp. were the most common species.

Off the Antarctic Peninsula, copepods and *Salpa thompsoni* were the most conspicuous organisms. Both stages of *S. thompsoni* occurred in most of the samples and depth ranges. The population reproduced sexually and asexually over the sampling period. This species was distributed from the surface to just above the bottom. The horizontal hauls showed that at night this salp (Fig. 57) was the most abundant macroplanktonic organism above the bottom. The high abundance of salps was corroborated by its occurrence in the bottom trawl catches and fish traps deposited on the seabed, as well as by many specimens found stranded on the beach near Jubany station, at King George island.

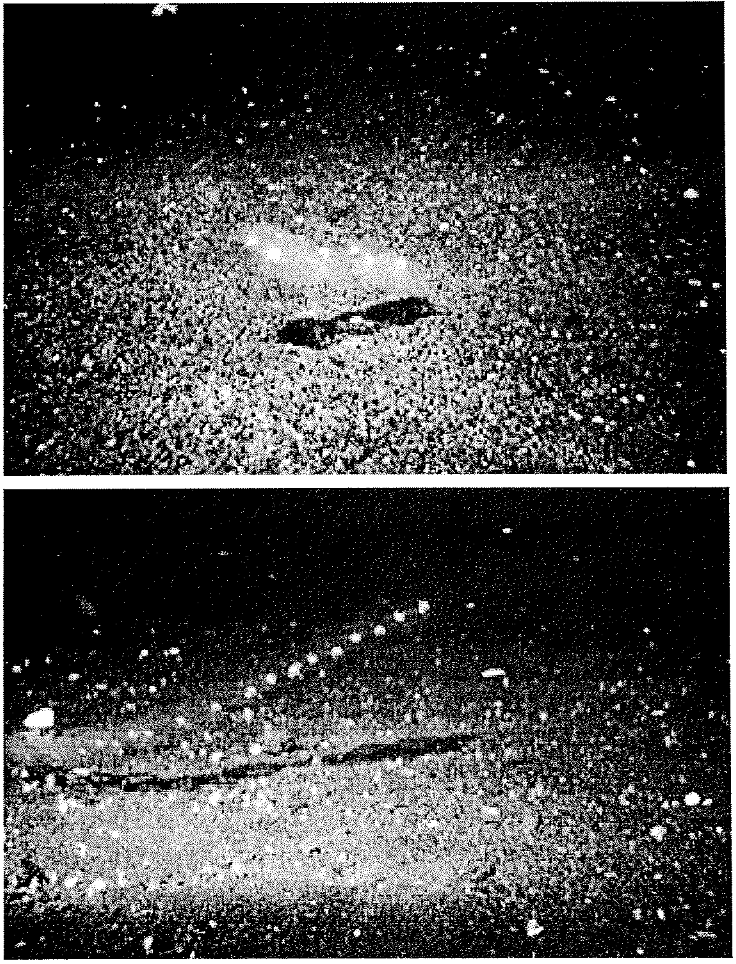


Fig. 57 Colonies of *Salpa thompsoni* off the Antarctic Peninsula were abundant just above the bottom.

Cnidarians were sparse but important from a qualitative point of view, particularly hydromedusae. Some specimens of rare species (*Leuckartiara brownei*, *Zanclonia weldoni*) as well as a new narcomedusan (*Pegantha* sp.) and several stages of a new leptomedusan were collected in the eastern Weddell Sea. The rest of zooplankton taxa did not show remarkable differences in comparison with summer, excepting the relatively high abundance of polychaete larvae, possibly of benthic species. On the other hand, a few decapod larvae were collected near the bottom.

Molecular genetics

A very extensive collection of subsequent samples in different areas of the eastern Weddell Sea and at the Peninsula has been taken. So there are good possibilities to study the molecular genetic differences of common species (*Calanus acutus*, *C. propinquus*, *Microcalanus pygmaeus*, *Metridia gerlachei*, *Oithona similis*) within a wide geographical distance. Furthermore the vertical distribution of the populations, which is given by the samples of the Multi-closing net, allows a comparison of the populations of the same species that occur in different layers.

To get fresh material for further molecular analysis in the laboratory about 1200 specimens of big sized copepods were immediately sorted, identified and frozen at -80 °C after recovery of the nets.

Likewise, many specimens belonging to different species and stages were transported alive into cool containers onboard *Polarstern* to do crossing experiments at the AWI laboratories.

2.3.13 Pelagic Microbial Biodiversity (C. Pedrós-Alió , J.-M. Gasol)

Objectives

In the past few years, we have been carrying out a survey of the molecular diversity of bacterial, archaeal and picoeukaryotic communities in Antarctic waters. In particular, transects have been studied across the Polar Front in the Drake Passage and the Scotia-Weddell Seas, and from the ice edge to open waters. In this cruise the goal was to sample a transect from Cape Town to Atka Bay (Transect 1) and another one from the eastern to the western Weddell Sea (Transect 2) in order to compare microbial diversity across fronts, at different depths and with samples from previous years.

Work at sea

Most samples were taken with the continuous pump from the ship and teflon-lined tubing. Depth profiles were taken from the CTD-Rosette. Along Transect 1 aliquots were prefiltered through 5 µm, 2 µm and GF/A filters before collection of biomass on Sterivex 0.2 µm pore size filtering units. One aliquot was filtered without prefiltration. These samples will be used to determine the identity of microorganisms in different size classes (sizes in Table 25). All other samples were prefiltered though 5 µm filters. All prefilters and Sterivex units were soaked in lysis buffer and frozen for later analysis. For each sample and size fraction, aliquots were also filtered to determine chlorophyll a concentration (on board) and preserved for cell counts by flow cytometry (back in Barcelona). Stations sampled and the type of diversity samples obtained are shown in Table 25.

Water from most of the surface samples was also filtered on GF/F filters and frozen in liquid nitrogen for determination of particulate methylated sulfur compounds (DMSO in the table) back in Barcelona.

Preliminary results

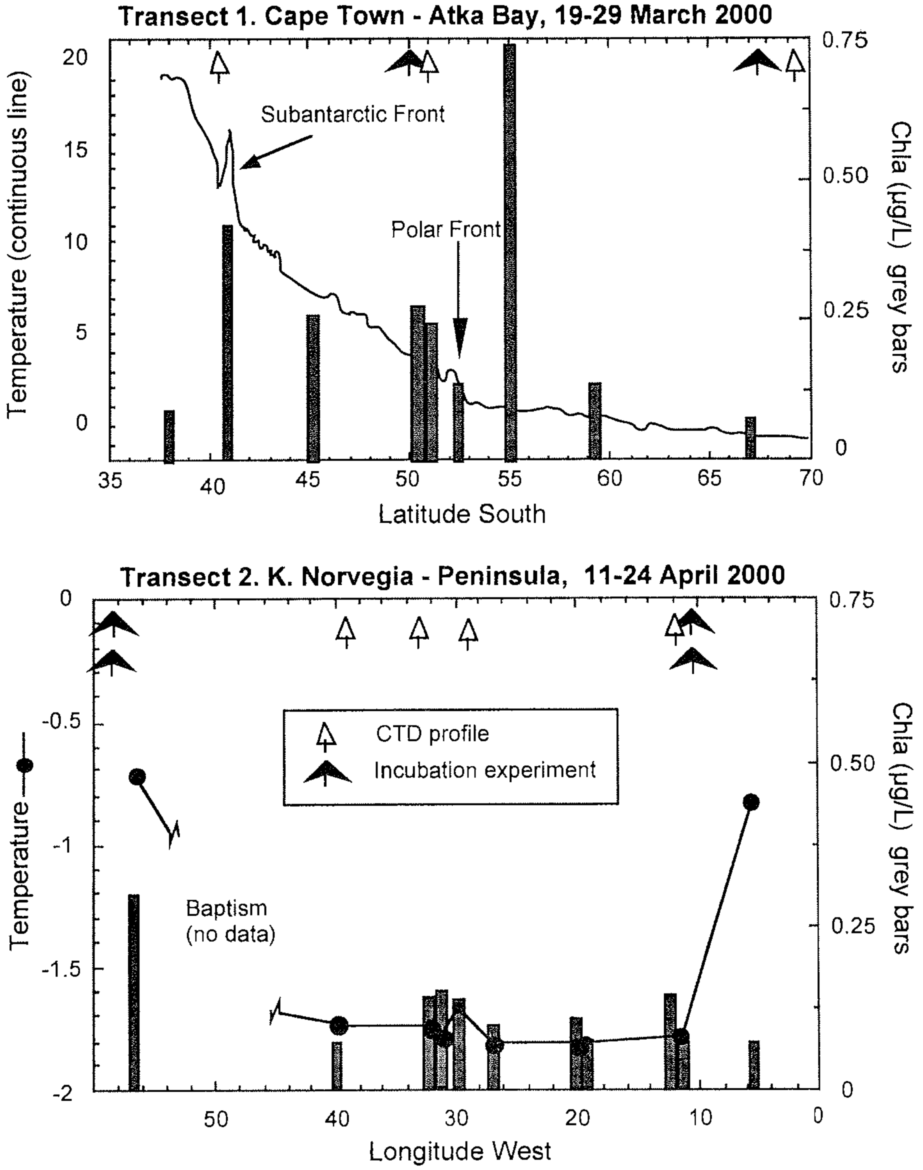
Temperature and chlorophyll a concentrations along the two transects are presented in Fig. 58. The figure also shows the positions where experiments for bacterial growth were carried out (see water column section). All other information will be retrieved in the laboratory in Barcelona.

DNA will be extracted from the filters and preserved as a library of microbial diversity. Different samples will be analyzed in the following way: the SSU rRNA genes will be amplified by polymerase chain reaction with primers for bacteria, Archaea and Eukarya. The resultant collection of genes will be then analyzed by denaturing gradient gel electrophoresis (DGGE). This technique provides a fingerprint of each microbial community that can be compared quantitatively to those of other samples. Additionally, the most relevant bands in the DDGE gel will be cut and sequenced to determine the identity of the organisms that originally had those genes. Other analyses will be carried out as required for particular purposes. Further details about this approach and techniques can be found in Pedrós-Alió (1993) and Massana et al. (2000).

Table 25 Stations where samples for microbial diversity and particulate DMSO were taken.

Station	Date	Lat		Long		Diversity[a]	DMSO
C1	19 March					Sizes	+
C3	21 March	41	11.45	9	46.84	Profile	+
56-3 (C2)	21 March	40	57.35	9	52.87	+	
C4	22 March	45	7.32	7	55.24	Sizes	+
C5	23 March	49	7.95	6	5.2	Sizes	+
C6	24 March	52	22.57	4	23.6	Profile	+
57-1	24 March	51	9.45	5	2.32	+	
C7	25 March	55	7.90	2	53.3	Sizes	+
C8	26 March	59	18.90	0	23.9	Sizes	+
C9	28 March	67	1.27	-5	28.4	Sizes	+
98	3 April	71	10.88	-12	27.56	Profile	
111-5 (C10)	5 April	71	7.49	-11	27.6	Profile	+
C11	13 April	70	40.89	-19	20.99	+	+
C12	14 April	68	56.90	-20	14.64	+	+
C13	15 April	68	41.87	-26	57.9	+	+
139	16 April	68	56.67	-30	1	Profile	+
C14	17 April	69	4.82	-31	22.3	+	+
143-4	18 April	68	40.94	-32	29.02	Profile	+
146	20 April	66	44.79	-40	4.18	Profile	+
148	24 April	62	42.78	-56	52.96	+	+
C15	26 April	62	52.91	-57	38.45	+	+
172-2	29 April	62	56.28	-60	26.59	Profile	

[a] "Sizes" indicates that surface samples were prefiltered through several pore size filters; "Profile" that a vertical profile of 5 depths down to either bottom or 1000 m was sampled. + surface samples without size fractionation.


Transect 1. Cape Town - Atka Bay, 19-29 March 2000

Transect 2. K. Norvegia - Peninsula, 11-24 April 2000

Fig. 58 Temperature and chlorophyll a concentrations along the two transects and the positions where experiments for bacterial growth were carried out.

2.3.14 Bird Observations during the Cruise (O.Krüger, C. Pedrós-Alió)

This section deals with the birds seen during the entire cruise. Since both observers were occupied with other work, no systematic observation was possible and effort varied considerably over the cruise. However, the attempt was made to make recordings on a daily basis at least. Only those birds positively identified were included and both Tuck and Heinzel (1984) and Harrison (1991) were used for identification. In total 43 bird species from 11 families were recorded. In the following, we emphasize major transitions of the avifauna along the cruise.

From Cape Town to Atka Bay, truly coastal species were dominant close to the shore, such as Cape Gannet, Kelp and Hartlaub`s Gull. In open waters the Procellariformes became the dominant group and were largely represented by the White-chinned Petrel, with rare observations of Great-winged, Brown and Soft-plumaged Petrels. The Albatross species already present were Black-browed, Yellow-nosed and White-capped Albatross. South of 40°S Wandering Albatross was also seen, followed further south by Sooty Albatross, Grey-headed Albatross and finally Light-mantled Sooty Albatross which was observed until the pack ice edge was reached at about 67°S. Due to the late time of this cruise, no Shearwaters except for the Great Shearwater were seen. Bouvet Island proved to be very diverse with eleven species recorded. Due to the absence of a clear Antarctic Convergence, there was also no sudden shift in the bird fauna except for the gradual transitions previously described. Closer to the pack ice, different Procellariform species became increasingly dominant, first the Cape Petrel, followed by Southern Fulmar and Antarctic Petrel and finally the Snow Petrel.

In the Eastern Weddell Sea, the abundance of penguins was lower compared to reports of earlier EASIZ cruises. Only single or groups up to five Emperor Penguins were observed and Adelie Penguins were virtually absent except larger groups of up to 50 individuals during two days in the eastern part of the passage from the Eastern Weddell sea to the Antarctic Peninsula. In general, the avifauna in autumn was poorer in species and abundance compared to previous summer cruises.

At the Antarctic Peninsula, both species richness and abundance were higher. While Cape, Antarctic and Snow Petrel were still dominant, Kelp Gulls were seen again and there were regular sightings of Yellow-billed Sheathbill and Antarctic Tern. Chin-strap Penguins, quite abundant on former cruises, were virtually absent except a major colony on Deception Island.

In the southern parts of the Drake Passage, only Cape Petrel and Southern Fulmar were regularly recorded, whereas both species of Giant Petrel were rare. Close to Tierra del Fuego, several species of Albatross were seen again, i.e. Wandering, Black-browed and Grey-headed Albatross. New species not seen before included Royal Albatross and Magellan Diving Petrel. The ratio between adult and juvenile birds was extremely biased towards juveniles in many Petrel and Albatross species.

Table 26 Species list and status of birds identified during the cruise. Location abbreviations are: CAP = Cape Town-Atka Bay Passage, EWS = Eastern Weddell Sea, AP = Antarctic Peninsula, PPP = Peninsula-Punta Arenas Passage; status abbreviations are: va = very abundant (many records every day), c = common (at least one record every day or some larger groups), r = rare (recorded one or a few times).

Family	Common name	Scientific name	CAP	EWS	AP	PPP
Spheniscidae	Emperor Penguin	Aptenodytes forsteri		c		
	Gentoo Penguin	Pygoscelis papua			r	
	Adelie Penguin	Pygoscelis adeliae		c	r	
	Chin-strap Penguin	Pygoscelis antartica			r	
	Macaroni Penguin	Eudyptes chrysolophus	r			
	Jackass Penguin	Spheniscus demersus	r			
Diomedeidae	Wandering Albatross	Diomedea exulans	r			r

	Royal Albatross	D. epomorpha				r
	Black-browed Alb.	D.melanophrys	c			c
	Yellow-nosed Alb.	D. chlororhynchos	r			
	White-capped Alb.	D. cauta	r			
	Grey-headed Alb.	D. chrysostoma	r			c
	Sooty Albatross	Phoebetria fusca	r			
	Light-mantled S. Alb.	P. palpebrata	c			
Procellariidae	Southern Giant Petrel	Macronectes giganteus		c	r	r
	Northern Giant Petrel	M. halli	c	r	c	c
	Southern Fulmar	Fulmarus glacialoides	r	c	c	c
	Antarctic Petrel	Thalassoica antarctica	r	c	c	c
	Cape Petrel	Daption capense	c	r	va	va
	Snow Petrel	Pagodroma nivea		va	c	
	Great-winged Petrel	Pterodroma macroptera	r			
	Schlegel`s Petrel	P. incerta	r			
	Soft-plumaged Petrel	P. mollis	r			
	Kerguelen Petrel	P. brevirostris	c			
	Blue Petrel	Halobaena cerulea	r			r
	Dove Prion	Pachyptila desolata	c			
	White-chinned Petrel	Procellaria aequinoctialis	c		r	c
	Brown Petrel	P. cinerea	r			
	Great Shearwater	Puffinus gravis	r			
Oceanitidae	Wilson`s Storm Petrel	Oceanites oceanicus	r			
	Black-bellied Storm Petrel	Fregetta tropica	r			
Pelecanoididae	Magellan Diving Petrel	Pelecanoides magellani				r
Sulidae	Cape Gannet	Sula capensis	r			
Phalacrocoracidae	Cape Cormorant	Phalacrocorax capensis	r			
	White-breasted Corm.	Phalacrocorax carbo	r			
	Imperial Shag	P. orax atriceps			c	
Chionidae	Yellow-billed Sheathbill	Chionis alba			r	
Stercorariidae	South Polar Skua	Catharacta maccormicki		r		
	Antarctic Skua	Catharacta antarctica	r			
Laridae	Kelp Gull	Larus dominicanus	c		va	r
	Hartlaub`s Gull	Larus hartlaubii	r			
Sternidae	Greater Crested Tern	Sterna bergii	r			
	Antarctic Tern	Sterna vittata			r	

2.3.15 Parasitological Survey in Antarctic Fish and Invertebrates

(B. Mehlhorn, H. Mehlhorn)

Objectives

Parasites are widespread within the marine food chain, which in the Antarctic leads via fish to the final predators whales, seals, penguins and flying birds, and have adapted their life cycles to a specific follow-up of different hosts. Among the latter various invertebrates and invertebrate-engorging fish are used as intermediate hosts, while predator fishes and warm-blooded animals may function as final hosts harbouring the mature sexual stages of the parasitic life cycle. Generally it is suggested that all types of parasites (protozoans, helminths, arthropods) should occur throughout the whole year within the different links of the food chain. This might be expected especially in the Antarctic, where the water temperatures undergo much lower changes throughout the year when compared to the North

Sea or Mediterranean Sea, or fresh water biotopes. Thus the present investigation was undertaken to survey the occurrence of parasites in invertebrates, fish and some warm-blooded predators with a special focus on the search for protozoans, which cover up to 50% of the parasites in fresh water ponds and are also very common e.g. in animals of the North Sea or the Australian Sea.

Work at Sea

On board the research vessel the following investigations/preparations were done:

- The organs (skin, eyes, gills, mouth, stomach, intestine, mesenterial system, kidneys, liver, muscles, blood) of 152 fishes belonging to 25 genera and 33 species and including Teleostei and Selachii were squeezed and examined lightmicroscopically for the presence of parasites. The fishes originated from bottom trawls taken at Kapp Norvegia and at different sites of the Bransfield Strait and Drake Passage (depths 300-800 m). The observed parasites were documented on micrographs and videotapes and finally fixed for transmission (TEM) and scanning (SEM) electron microscopy.
- Whole specimens of invertebrate animals, which could function as intermediate hosts, were exposed to through-shining light (dark background) under a stereo microscope. Due to this method eventually contained parasites became visible, even if they were of the same colour as the surrounding host tissues. The findings were documented in the same way as in the fish preparations. Specimens of the following groups were investigated: polychaetes, amphipods, copepods, decapods, isopods, pantopods, asteroids, crinoids, gastropods, and cephalopods.
- Fresh, still warm feces of 15 elephant seals and 5 gentoo penguins (*Pygoscelis papua*) were collected on the 4th and 5th May 2000 at Jubany Station and deep frozen (-20°C) in order to analyze the parasitic contents at home. This investigation will give some hints – for sound results the number of samples is much too small – whether adult worms or other infectious stages were present and actively propagating also in autumn.

Preliminary results

The examination of several hundreds of tissue samples revealed some surprising results:

- Protozoan parasites were completely absent. Although the examination of blood smears and of histologic sections will be done at home, there is only little hope to find any stage, since the methods used on board are in general sufficient to determine their existence.

- All investigated fishes except for the specimens of *Gymnoscopelus nicholsi* were heavily infected (often simultaneously) by several species of parasites. These parasites belonged to the following groups:
    - Digenea: no larvae were found, only a few, singly situated adult flukes occurred, which may probably belong to two new species.
    - Cestodes: exclusively larval stages were observed in the Teleostei being situated in separate capsules or free in the tissues. These larvae belonged to the order Pseudophyllidae and the family Proteocephalidae and perhaps represent new species (Fig. 59, 60). The few specimens of rays made available to us contained single, short, adult tapeworms and large numbers of apparently ingested larval stages, that might grow to adults, if *Raja* or *Bathyraja* were the appropriate hosts.
    - Nematodes: exclusively larvae occurred: besides defined species of the genera *Phocanema* and *Contracaecum* there were seen other species which need exact determination at home (Fig. 61, 62).
    - Acanthocephala: exclusively the larval stages of the so-called cystacanths were seen in different Teleostei (e.g. *Trematomus nicolai, Lepidonotothen larseni* or *Chaenocephalus aceratus*).

- Hirudinea: two not yet determined species were found in the mouth and on the skin of *Chaenocephalus aceratus;* a third species belonging to the Pharyngobdellidae occurred on several other fish species.
- Copepoda: giant, 5-7 cm sized parasitic copepods stretched through the body wall into the body cavity of *Macrourus whitsoni* (Fig. 63), while specimens of a small, about 0.8-1.3 cm long species were extremely numerous in the mouth, on the gills and between the fins of several fish species (e.g. *Chionodraco rastrospinosus*).

- The endoparasites were mainly found in the liver, in the stomach wall, in the mesenterial system and in the body cavity being situated in cysts, in capsules or migrating free in the body cavity.
- Some of the teleostean fish species – ice fish as well as red-blooded fish – were extremely high parasitized. Up to 100 worms – up to 5 cm in length – were rather common in most of the investigated specimens of *Chaenocephalus aceratus, Lepidonotothen larseni, Chionodraco rastrospinosus* (Fig. 61). They started movements immediately after the death of the fish and thus may leave the body cavity and enter the muscles eventually being used for human consumption.

Fig. 59 Scanning electron micrograph of the anterior pole of a plerocercoid larvae of a tapeworm found in a cyst in the body cavity of *Chaenocephalus aceratus.* x50

- The nematode larvae and the pseudophyllidean plerocercoids are apparently not host specific, since they were found in most of the teleostean fish species in the same state of development, but not in the few individuals of rays studied and not in 30 specimens of *Gymnoscopelus nicholsi.* This broad ranging host spectrum may have its reason in the close systematic relations of Antarctic teleostean fish and/or the broad range of fish species engorged by seals and penguins - there was enough time for adaptation during the millions of years of Antarctic isolation.
- In and/or on invertebrates the following parasites were found:

polychaetes: adult and larval nematodes, polychaetes,
amphipods: copepods, decapods,
isopods: procercoids of tapeworms, nematode larvae, copepods,
asteroids: larval and adult nematodes,
crinoids: Myzostomida,
pantopods: leeches (Hirudinea),
cephalopods: nematode larvae in 1 of 3 examined species, copepods.

Whether these observed parasites belong as life cycle stages to any of the parasites seen in fish, will be evaluated in detailed morphological analyses at home.

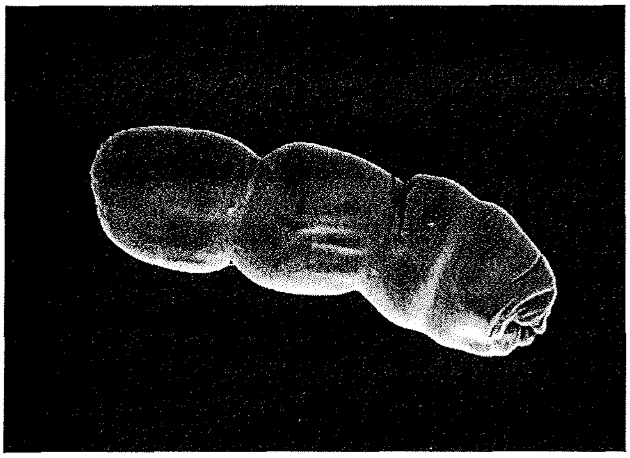


Fig. 60 Scanning electron micrograph of a tapeworm larva found free in the body cavity of *Chaenocephalus aceratus*; note the proglottid-like infoldings.

Fig. 61 Macroscopic aspect of a view into the body cavity of a *Chaenocephalus aceratus* fish showing larvae of *Phocanema decipiens* (long dark worms), *Contracaecum sp.* (clear white nematodes), cysts of larval tapeworms (single arrow heads) and cystacanths of Acanthocephala (double arrow heads).

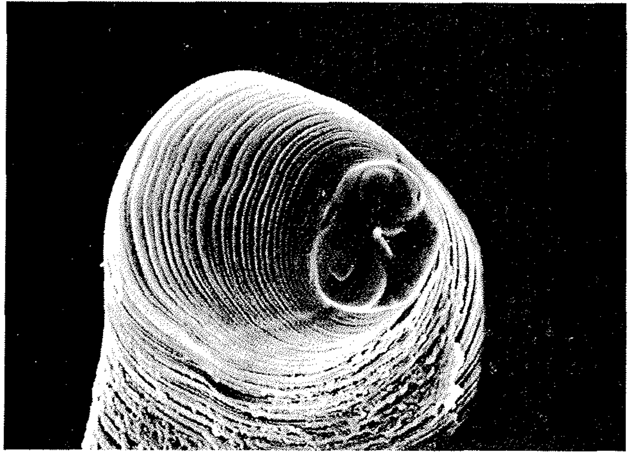


Fig. 62 Scanning electron micrograph of the anterior pole of a *Phocanema*-larva taken from *Chaenocephalus aceratus*. x40

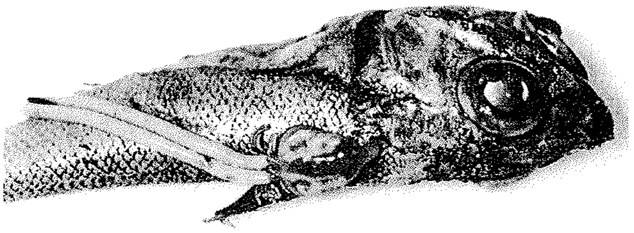


Fig. 63 Macroscopic photo of a large copepod on a *Macrourus whitsoni* fish. x1

Conclusions

- The obvious absence of protozoan parasites needs confirmation by studies including more fish specimens, but may also be due to an autumn effect that induced a reduced propagation. On the other hand, if the general absence or limited presence of a few species becomes confirmed, the reasons may be seen in the constant deep water temperatures or in the lack of specific intermediate hosts.
- The nearly exclusive occurrence - at least in the teleostean fish species - of larval worms and the lack of adult stages might also indicate an autumn effect leading to a reduction of sexual stages and an increase of larval stages inside intermediate hosts, as was noted here in so many cases of tremendous infections. The planned investigations of feces of elephants seals and penguins to check the excretion rate of worm eggs (indicating the existence and activity of adult fertile worms) will contribute to these questions.

- The observed worm stages belong to rather few species that occur in nearly all teleostean fish studied here and have their final hosts in rather few warm-blooded host types. This apparent broad spectrum of fish may be due to a reduced host specificity of the parasites or expression of the close systematic relations of the Antarctic teleostean fish species.
- In any way the observed masses of parasites must have an enormous impact on the regulation of Antarctic animal populations, since the factor disease will considerably shorten the individual life span of heavily infected hosts. Furthermore they become an easy prey to predators.
- Since some of the highly parasitized fish species are used for human consumption, precautions such as shock-frosting or well–cooking have to be considered in order to avoid human infections and diseases.

2.4 Ecophysiology and Adaptive Strategies

2.4.1 Temperature Physiology of Antarctic Invertebrates (F.J. Sartoris, O. Krüger, B. Klein)

Objectives

Recently we have proposed that the biogeography of marine crustaceans in cold oceans is related to the combined effects of extracellular magnesium ($[Mg^{2+}]_e$) and low temperature. Activity levels in decapod crustaceans are related to $[Mg^{2+}]_e$ while $[Mg^{2+}]_e$ increases with falling temperatures in most crustaceans and, in addition, the anaesthetic potency of magnesium increases with decreasing temperature. However, the highly active cephalopod molluscs do not regulate $[Mg^{2+}]_e$ at all. The haemolymph of cephalopods is characterised by elevated K^+-levels while the potassium concentrations are highest in the more active species like squid and cuttlefish. One could hypothesize that magnesium excretion in cephalopods has never developed to the extent required for an effective reduction of extracellular levels and that cephalopod molluscs have overcome this constraint by slightly increasing the extracellular potassium concentration ($[K^+]_e$). This hypothesis is strengthened by the work of Branisteanu et al., 1976 who found that under conditions of magnesium anaesthesia a small increase in $[K^+]_e$ facilitates transmitter release at the neuromuscular junction.

Up to now no experiments have been carried out related to the effects of extracellular magnesium and potassium on the activity levels of Antarctic crustaceans. During this cruise measurements of spontaneous activity of the isopod *Glyptonotus antarcticus* were performed to test the hypothesis that the activity level of Antarctic crustaceans is a function of $[Mg^{2+}]_e$. In addition we wanted to test the hypothesis that elevation of extracellular K^+ prevents the muscle from the narcotizing effect of increased magnesium concentrations. Since information on magensium concentration of Antarctic crustaceans is limited to two species we also wanted to collect available crustacean species and determine the extracellular magnesium concentration.

Work at Sea

We obtained 16 *Glyptonotus antarcticus* (Crustacea, Isopoda) from various bottom trawls in the eastern Weddell Sea. They were initially kept separate at –0.2 ± 0.5 °C in normal sea water containing approximately 53 mmol Mg^{2+}/l and 10 mmol K^+/l and were given several days to acclimatise. During that period, two died. On the first experimental day, each of the 14 *Glyptonotus* was transferred into a plastic dish of the dimensions 0.6 times 0.4 m which contained normal sea water with a temperature of 2.4 ± 0.2 °C. The higher temperature served as an additional stimulus. The bottom of the dish was marked in 25 cm^2 quadrants and the animal was allowed to move around for ten minutes. The number of quadrants entered was counted and the ten minute session was filmed on video. After the experiment, the isopods were transferred back to the aquarium.

After one day of acclimatisation, the 14 individuals were transferred into a different aquarium which contained normal sea water plus 50 mmol Mg^{2+}/l and were kept at –0.2 ± 0.5 °C for 24 h. Afterwards, they were tested as described above. After this experimental day, 10 mmol K^+/l was added and they were kept for another 24 h and tested afterwards. Following this experimental day, they were given three days in normal sea water to recover and were once again tested under control conditions. This was done to exclude any effect of decreasing condition on the outcome of the experiment. As a final experiment, we increased the Potassium concentration on its own by 10 mmol/l and tested all *Glyptonotus* five days after they had done the second control test.

During the experiments, five *Glyptonotus* died and were completely excluded from the analysis so that sample size equalled nine. After all experimental tests, body length of the nine individuals was measured to the nearest mm in order to control the effects of body size. We compared the walking speed over the ten minute test interval between the five treatments and analysed differences by a Kruskal-Wallis-test and t-test for paired samples at a p-level of 0.05.

Preliminary results

Under control conditions, walking speed fluctuated greatly between 0.8 and 7.9 m/10 min. There was no significant association between body length and walking speed (r = 0.548, df = 7, P = 0.126). Increasing the Magnesium concentration significantly reduced the walking speed (Fig. 64, t = 3.698, df= 8, P = 0.006) by 55 %. An increase of the Potassium concentration strengthened the effect (control versus + 50 mmol/ Mg^{2+} and + 10 mmol K^+: t = 4.225, df = 8, P = 0.003) so that walking speed was only 11 % of the control value. There was also a significant difference between + 50 mmol/l Mg^{2+} and + 50 mmol/l Mg^{2+} and + 10 mmol/l K^+ (t = 3.557, df = 8, P = 0.007). This reduction in walking speed was not caused by a decreasing overall body condition, since there was no significant difference between the two controls (t = 0.522, df = 8, P = 0.616). The second control exhibited a walking speed of 90.3 % compared to the first control. Just increasing the Potassium concentration by 10 mmol/l also had a significant effect on the walking speed compared to the second control (t = 3.728, df = 8, P = 0.006) which was only 1.7 % of the second control. Overall, differences between the five treatments were highly significant (H = 25.586, k = 4, n = 45, P = 0.0001).

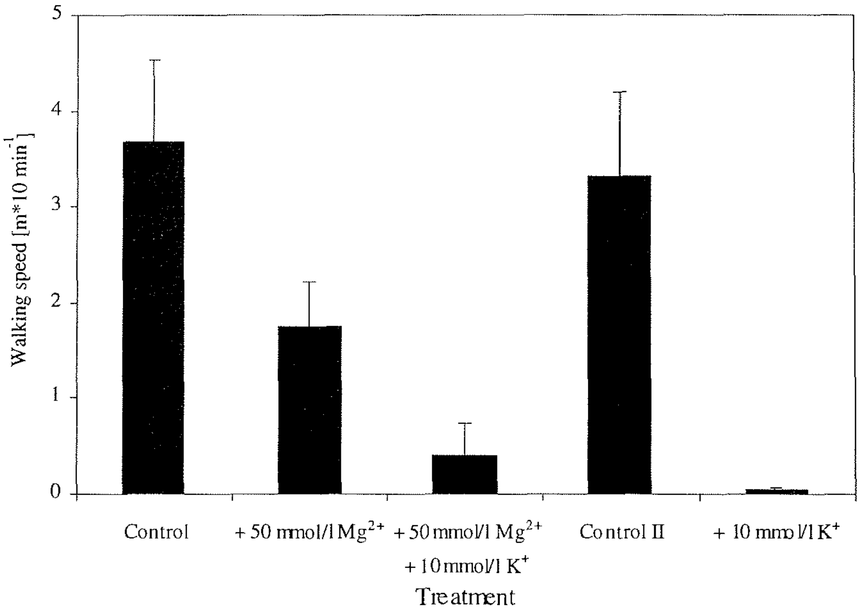


Fig. 64 Mean walking speed (+ s.e.) of the nine *Glyptonotus antarcticus* under different ion concentrations in sea water. Control conditions were approximately 53 mmol/l Mg^{2+} and 10 mmol/l K^+.

The increase of magnesium up to a level usually found in reptant decapod crustaceans had a pronounced effect on spontaneous activity of the Antarctic isopod. This was characterized by increasing periods of inactivity and a decrease in walking distance. This results strengthens our hypothesis that the synergistic effects of magnesium and temperature sets the limits for the scope for activity in crustaceans. The increase of K^+, however, did not abolish the anaesthetic effect of magnesium but acted as a potent anaesthetic as well. The original hypothesis concerning the effects of K^+ could thus not be verified.

From a total of 39 specimens of 6 crustacean species samples were taken for ion analysis: *Serolis trilubiluides*; *Serolella bouveri*; *Eusirus sp.*; *Paraceradocus mirii*; *Epimeria sp.*; *Glyptonotus antarcticus.*

2.4.2 Respiration Rate of Antarctic Amphipods (O. Heilmayer, A.N. Lörz, F. Sartoris, T. Brey)

Objectives

Oxygen consumption, i.e. the metabolic rate is often used as a proxy for the sum of all active processes of an organism (basic metabolism, gonadic and somatic growth). Determining oxygen consumption is the easiest and often the only way to estimate the metabolic rates of an organism.

To validate respiration measurements we will analyse ETS (activity of the electron transport system). The ETS assay measures the potential respiration that could be supported by the present enzymatic 'machinery' and is specific for organisms and populations. If the ratio between ETS enzyme activity and actual respiration rate (measured as oxygen consumption), i.e. the R:ETS ratio, is known for a certain organism, ETS can provide ecologically meaningful estimates of in situ respiration rates independent of short-term variations in individual condition (e.g. caused by sampling stress) which may affect respiration measurements.

Work at sea

The oxygen uptake of the amphipod *Eusirus perdentatus* was measured in filtered (0.2µm) seawater. *E. perdentatus* was the most abundant larger (>2cm) amphipod species in the bottom trawls of the Bransfield Street. Oxygen concentration was determined in a flow–through experimental set-up and continuously measured with optical micro optodes, which are linked to a MOPS -Array (© COMTE GmbH, Hannover). After each experiment, animals were frozen at - 80°C for weighting and determination of electron-transport-system (ETS) activity.

For further analyses of ETS activity 30 animals were immediately frozen after the haul. Another 15 amphipods are carried alive to Bremerhaven, where we intend to measure the mitochondrial respiration rate.

Preliminary results

All specimens used for the experiments showed a relaxed behaviour under experimental conditions. The oxygen content stabilised after a short acclimation period at 90%. As for now there is only one estimation of respiration rate for *Eusirus* spec. from Ivleva (1980), but no further physiological data.

2.4.3 Respiration of Meiofauna under varying Food and Temperature Conditions (T. Janssens, A. Dewicke)

Objectives

The seasonal nature of food supply is of major importance for the Antarctic meiobenthos although the combined influence of low temperatures remains poorly understood.The aim was to investigate the separate and combined effects of both factors on the metabolic rate (measured as oxygen uptake) of marine free-living nematodes in an experimental way.

Work at sea

The sea bottom was sampled at Atka Bay (stations 58-1 and 58-3), and 18 sediment cores (31 cm^2) were incubated according to different treatments: two food supply conditions (0 mg orgC/core and 10.5 mg orgC/core) and two temperatures (-1°C & 4°C). Nematodes from the upper two cm were extracted from the sediment by decantation over a 38µm sieve and subsequently picked out under a binocular microscope. Several attempts were made to measure the oxygen uptake (in 1ml of 0,22 µm filtered seawater) of up to five hundred nematodes from the different treatments at both incubation temperatures. Unfortunately, it was concluded that the equipment (Strathkelvin Instruments, Polarographic oxygen electrodes) was not sensitive enough to measure the respiration rates. The putative very low rates of the nematodes could not be distinguished from the oxygen consumption by the electrodes. Thus, this technique was not the appropriate one under these conditions.

2.4.4 Growth performance and Fecundity of Nototheniοids (J. González, B. Artigues, A. Schroeder, K. Mintenbeck & R. Knust)

Introduction

Antarctic fish are small and have apparently seasonal and slow growth. Jugding from the growth parameters K (growth coefficient) and W_∞ (infinite weight) of the von Bertalanffy equation, Weddell Sea species seemingly grow slower than Subantarctic fish, and exceptionally slow growth is observed in *Trematomus* sp.
Antarctic fish have annual reproductive cycles and require special adaptations. Adult fish must allocate enough energy for egg production and spawning. Time of spawning, egg incubation time and larval hatch must be matched to assure the presence of the pelagic larvae during the short phase of high primary production.
The typical Antarctic fish reproductive pattern includes high age at first maturity (5-9 y), low fecundity, and large and yolky eggs.

Objectives

Determination of the Notothenioidei life history in the eastern Weddell Sea and at the Antarctic Peninsula. This includes studies on reproduction looking at maturation processes and fecundity, age determination and growth using direct methods.

Work at sea

Fish were collected from GSN and AGT hauls. In abundant species about 5 individuals per 0.5 cm length class were analysed, in less abundant species the whole catch was used. For each specimen total length and weight, visceral weight, sex, maturity stages, gonad weight and repletion index was determined and the sagittal otoliths were sampled. Maturity stages were determined according to a 5 stage scale (Kock & Kellerman, 1991), gonads in stages 3 and 4 were collected and preserved in buffered formalin.

Preliminary results

A total of 1396 otoliths were extracted from four families of the perciform suborder Notothenioidei (Table 27) and dry-preserved for future determination of the annual and daily rings. This material will serve for age and growth studies comparing Weddell sea fish with those from the Antarctic Peninsula area.

Table 27 Distribution of collected otoliths among taxa.

ARTEDIDRACONIDAE	N	CHANNICHTHYIDAE	N
Artedidraco orianae	33	*Chaenocephalus aceratus*	36
Artedidraco shackletoni	13	*Champsocephalus gunnari*	61
Artedidraco skottsbergi	7		
Chinodraco rastrospinosus	130	NOTOTHENIIDAE	
Chionobathyscus dewitti	60	*Aethotaxis mytopterix*	11
Chionodraco hamatus	16	*Dissostichus mawsoni*	4
Chionodraco myersi	7	*Gobionotothen gibberifrons*	51
Chionodraco wilsoni	9	*Lepidonotothen kempi*	31
Cryodraco antarcticus	44	*Lepidonotothen larseni*	56
Neopagetopsis ionah	3	*Lepidonotothen nudifrons*	61
Pagetopsis macropterus	2	*Notothenia coriceps*	1
Pagetopsis maculatus	9	*Pleuragramma antarcticum*	21
Pseudochaenichthys georgianus	6	*Trematomus bernachii*	5
		Trematomus eulepidotus	239
BATHYDRACONIDAE		*Trematomus hansoni*	32
Cygnodraco mawsoni	11	*Trematomus lepidorhinus*	103
Gymnodraco acuticeps	8	*Trematomus nicolai*	16
Prionodraco evansii	27	*Trematomus pennelli*	174
		Trematomus scotti	109

During the present cruise 108 ovaries in resting and developing maturity stages were collected from 19 fish species (1 Artedidraconidae, 7 Channichthyidae, 9 Nototheniidae, 2 Bathydraconidae), with the aim to improve the knowledge on the spawning period and the reproductive strategies of Antartic fish. Although the first objetive was to study the Nothotheniidae, all species in an maturity stage useful for fecundity studies were included.

In the Weddell Sea, only 1.7% of the ovaries taken were in the gravid stage, whereas 25.5% were found in a developing stage. At the Antarctic Peninsula, these values were 3.4% and 13.3%, respectively (Table 28).

Weddell Sea Maturity
FEMALES

	1	2	3	4	5	n
AKAR NUD	0.0	100.0	0.0	0.0	0.0	1
ARTE LOE	0.0	50.0	41.7	0.0	8.3	12
ARTE ORI	0.0	58.1	25.8	9.7	6.5	31
ARTE SHA	0.0	63.6	27.3	0.0	9.1	11
ARTE SKO	13.0	65.2	17.4	0.0	4.3	23
BATH MAR	0.0	100.0	0.0	0.0	0.0	6
CRYO ANT	17.6	41.2	11.8	0.0	29.4	17
CYGN MAW	10.0	50.0	10.0	0.0	30.0	10
CHAE WIL	0.0	42.9	14.3	0.0	42.9	7
CHIO HAM	12.5	37.5	25.0	0.0	25.0	8
CHIO MYE	0.0	14.3	71.4	0.0	14.3	7
DACO HUN	0.0	100.0	0.0	0.0	0.0	2
GYMN ACU	0.0	50.0	50.0	0.0	0.0	2
HIST VEL	33.3	33.3	0.0	0.0	33.3	3
PAGE MAC	0.0	0.0	50.0	50.0	0.0	8
POGO MAC	0.0	100.0	0.0	0.0	0.0	1
POGO MAR	0.0	33.3	33.3	0.0	33.3	3
PRIO EVA	0.0	42.9	38.1	0.0	19.0	21
RACO GLA	0.0	50.0	0.0	0.0	50.0	4
TREM BER	0.0	100.0	0.0	0.0	0.0	2
TREM EUL	11.2	52.6	29.3	0.0	6.9	116
TREM HAN	5.0	50.0	35.0	0.0	10.0	20
TREM LEP	61.7	38.3	0.0	0.0	0.0	47
TREM NIC	10.0	50.0	10.0	20.0	10.0	10
TREM PEN	21.7	53.9	9.6	0.0	14.8	115
TREM SCO	6.3	18.8	75.0	0.0	0.0	32
TREMATOZ	0.0	100.0	0.0	0.0	0.0	1
Total	**15.4**	**48.8**	**23.5**	**1.7**	**10.6**	**520**

Peninsula Antarctica Maturity
FEMALES

	1	2	3	4	5	n
AETH MIT	75.0	0.0	25.0	0.0	0.0	4
ANTI ROS	33.3	66.7	0.0	0.0	0.0	3
CRYO ANT	14.3	85.7	0.0	0.0	0.0	7
CHAE ACE	61.5	38.5	0.0	0.0	0.0	13
CHAM GUN	12.8	51.3	23.1	2.6	10.3	39
CHIO DEW	83.3	16.7	0.0	0.0	0.0	30
CHIO RAS	49.3	39.1	0.0	4.3	7.2	69
GOBI GIB	3.0	57.6	39.4	0.0	0.0	33
GYMN ACU	25.0	75.0	0.0	0.0	0.0	4
LEPI KEM	75.0	25.0	0.0	0.0	0.0	20
LEPI LAR	43.1	25.5	31.4	0.0	0.0	51
LEPI NUD	33.3	41.0	2.6	20.5	2.6	39
MACR WHI	100.0	0.0	0.0	0.0	0.0	8
NEOP ION	0.0	0.0	100.0	0.0	0.0	2
NOTO COR	0.0	0.0	100.0	0.0	0.0	1
PLEU ANT	7.7	76.9	0.0	0.0	15.4	13
PSEU GEO	0.0	100.0	0.0	0.0	0.0	3
TREM EUL	75.0	25.0	0.0	0.0	0.0	4
TREM HAN	16.7	33.3	16.7	0.0	33.3	6
TREM SCO	0.0	25.0	75.0	0.0	0.0	4
Total	**40.2**	**39.1**	**13.3**	**3.4**	**4.0**	**353**

1 = Immature
2 = Resting
3 = Developing
4 = Gravid
5 = Spent

Table 28 Maturity stages of Notothenioid fish in the Weddell Sea and at the Antarctic Peninsula.

The gonads collected in this cruise will provide useful information for fecundity studies. We will measure the size of oocytes from several parts of each gonad and determine their degree of development in order to evaluate the exact maturity stages. In combination with length and weight, these data will provide the basis for an estimation of the length at sexual maturity and the gonad maturation cycle.

2.4.5 Ecology and Trophic Position of Antarctic Asteroids (L. Marquardt, O. Heilmayer, A. Cornils, T. Brey)

Objectives

Asteroids are prominent members of the Antarctic benthos, however their significance in the energy flow through the benthic community is yet unknown. To get an idea of the contribution of asteroids to the energy transfer in the system, mass specific respiration rates can be used to estimate production and consumption via empirical relations. Further information on trophic position will be derived from stomach content analysis and by analysis of stable isotope ratios ($^{14/15}N$, $^{12/13}C$).

Work at Sea

Quantitative samples of asteroids from 14 bottom trawls, 4 Agassiz trawls, 4 dredges, 2 epibenthic sledges, 1 multi grab, 2 giant box corers and 1 TV grab were taken from the shelf/ slope of the eastern Weddell Sea, the Bransfield Strait and west of Deception Island. The samples were preserved in 4% formalin, 70% ethanol or frozen at –29°C for taxonomy, biomass, size frequency distribution, stable isotope analysis ($^{14/15}N$, $^{12/13}C$), ETS (activity of the electron transport system) and stomach content analysis. Live specimens were kept in aquaria in a cooling container at 0°C for respiration experiments. Those specimens were chosen that had survived the catch without being obviously damaged and that stayed alive in good condition in the aquaria. The respiration experiments were carried out with filtered seawater (55µm) in a closed but intermittently opened (whenever oxygen saturation was below 70-75%) system. Oxygen saturation was determined by micro optodes (Holst et al. 1997). Constant mixing in the respiration system (chambers and tubes) was assured by using peristaltic and Eheim pumps which caused a circulating flow. An additional empty chamber (containing only water) was used in every run as a blind.

Preliminary results

Altogether 2879 asteroids (Weddell Sea: 909, Peninsula region: 1970) were collected from 27 catches. Not all specimens have been determined yet, but the diversity in the Weddell Sea was higher than in the Bransfield Strait and west of Deception Island. In the Weddell Sea *Acodontaster conspicuus* is the dominant species. In the Bransfield Strait and west of Deception Island three dominant species were found, *Henricia sp. 2*, *Diplasterias sp.* and *Labidiaster annulatus.*

Surprisingly, breeding individuals of 4 species were found, mostly in the Bransfield Strait and West of Deception Island. *Diplasterias sp.* and *Henricia sp.2* showed the highest number of breeding specimens. The development stage of the brood varied distinctly. Approximately 30% had ≥1 brood sacs on the aboral side of their arms, about 40% carried eggs (visibly bigger than the eggs in the brood sacs) under their mouth using their ambulacral feet, and about 30% of the specimens carried a nearly fully developed brood.

First stomach investigations showed that one specimen of *Lophaster sp.* had ingested a complete *Diplasterias sp.* (Asteroidea). Five individuals of a smaller species (*Asteroidea sp.*) contained sediment and salps in their stomach.

From 29 individuals belonging to 9 species (eg. *Labidiaster annulatus*, *Porania antarctica*, *Acodontaster conspicuus*) the respiration rate was measured. The animals were transferred from the aquaria to the respiration chambers without problems. After an initial time of acclimatisation in the chambers the experiment was started. These data are not yet analysed.

2.5 Chemical Ecology and Marine Chemistry

2.5.1 Chemical Ecology in Antarctic Waters (F.J. Sartoris, B. Klein, O. Krüger)

Objectives

Marine organisms, especially invertebrates such as sponges, soft corals, and molluscs, produce many secondary metabolites which are unprecedented within the terrestrial habitat. Secondary metabolites are not required for primary metabolic processes like respiration, energy turnover or photosynthesis. They evolved for specific purposes such as attraction of members of the same species as well as toxins to repel predators. In the field of natural product research marine organisms in tropical waters have received much more attention than Antarctic organisms. However, the Antarctic seafloor is covered with a dynamic and highly interactive community of corals, snails, tunicates, sponges and molluscs. Many of these organisms are immobile and use chemical defence mechanisms for antifouling or against predators. During this cruise animals were to be collected from many phyla to allow for the screening of potentially interesting natural products on a broad base.

Work at Sea

60 specimens from different phyla including Porifera, Bryozoa, Isopoda, Polychaeta, Holothuroideas, Asteriodea, Crinoidea, Nemertinea, and Cephalopoda were collected and frozen at - 50 °C. The planned experimental work could not be performed due to the lack of potential predator organisms in good condition.

2.5.2 Structure and Function of Marine Natural Products in Benthic Invertebrates (W. Drebing, H. Goerke, A. Müller, K. Weber)

Objectives

Chemical screening for natural products on board

Investigations were conducted to obtain preliminary results on the occurrence, chemical structure and levels of natural products in seawater and Antarctic invertebrates. Feedback from chemical results was scheduled to improve sampling and to support biological experiments. Detection and identification were performed on trace levels using grams to kilograms of seawater and milligrams to grams of invertebrate tissue.

Molecular biomarkers in sea water as indicators for food

In Antarctica downward transport of particulate matter in the sea is only high during a short period after the spring bloom. Nevertheless, in most areas benthic animals - considered to depend on this flux - persist in high densities throughout the year. A possible explanation for this paradox may be a constant food supply via strong bottom currents, which remobilize deposited but not yet degraded organic material from the sea floor. Food, either dissolved, colloidal or particulate, consists of natural products of which biomarkers indicate sources and quality. We therefore investigated natural products in autumnal seawater. Large scale screening of surface water along the ship's route was intended to give information on biomarker sources. Vertical screening in water of the eastern Weddell Sea and the western Bransfield Strait should exhibit downward transport of biomarkers and indicate excess organic matter near the bottom. Water above sediments and porewater was investigated to explore degradation processes at the sediment/water interface.

Influence of taxa, specimen dissection and environment

The principle objective of the investigations was to search, identify and quantify chemical compounds of biological significance in selected benthic invertebrates. Chemical structures of metabolites exhibit how invertebrates carry out organic synthesis determined by the genetic code and in response to the Antarctic environment. Distribution within animals and occurrence in the same species of different sea areas may allow for conclusions on ecological and/or biochemical functions. A few investigations were also extended to bacteria associated with invertebrates, since evidence emerges which suggests that some species carry out biosynthetic steps formerly ascribed to their hosts.

Work at sea

Sampling

Locations and details of water sampling are given in Table 29. Overall, 35 surface samples were taken along the ship's route. Sampling was started near the Subtropical Front and continued while crossing the Polar Front and reaching the Antarctic Coastal Current near the Neumayer Station. Sampling was performed within the autumnal marginal ice zone from Kapp Norvegia to the tip of the Antarctic Peninsula. Water was also sampled within an ice free area of the Bransfield Strait from NE of Trinity Island to SW of Livingston Island and finally in the western Drake Passage. Five vertical concentration gradients including four depths were measured near Kapp Norvegia. In the Bransfield Strait four vertical stations were chosen. Vertical sampling in each area was accomplished within few days for quasi-synoptical comparisons. Bottom water was taken near the tip of the Antarctic Peninsula. Pore water was obtained from surface sediment, when possible. Water sampling was supported by oceanographic measurements (Polarstern and CTD data). Brown ice was collected inmidst of pancake ice in the Weddell Sea. Green ice was sampled in the northeastern Bransfield Strait, when various of green icebergs came in sight for 1-2 days. Animal sampling was carried out in the northeastern Weddell Sea near Auståsen and Kapp Norvegia as well as in different areas of the Bransfield Strait and Drake Passage. Results are summarized in Table 2. Overall 429 animal samples representing 149 species and/or phenotypes and including 81 specific tissues were obtained in 12 sea areas; the same species from different stations can be compared in 24 cases. Gorgonacea, Bryozoa, Porifera and Polychaeta were mostly collected. Appreciable modifications in sampling had to be made in comparison to the scheduled program. Autumnal weather and ice conditions prevented launching of preferred gears. Live animals, collected by traps and scheduled for a variety of biological experiments on board, were only obtained towards the end of the expedition; therefore, respective investigations had to be shifted to the home laboratory.

Sampling methods

20 l seawater were sampled in the open ocean, 1 to 2 l near the ocean bottom and 10 to 100 ml from sediment pores. Surface water was collected during steaming by a magnetically driven rotary pump (Klaus pump) and delivered by the ship's V4A-clean-water-system designed for trace organic analyses. Deep water was taken from 12 l 'Go-Flow' PVC-bottles within a Rosette water sampler (General Oceanics); sampling depths were selected from continuous CTD data (help of the oceanographic group is acknowledged). Bottom water was taken 50 to 5 cm above the sediment surface from multicorer tubes immediately after sampling using all glass piston pipettes. Porewater was sampled after centrifuging surface layers, which were taken from surface sediments in corers (Beckmann Centrifuge type GPR; 3800 rpm, 30 minutes, 5°C). Autumnal brown ice was collected in midst of fresh pancake ice; green ice was broken off from a growler by ship impact. Floating 20 to 50 kg ice chunks were taken on board and broken into smaller pieces. Resulting samples of few kilograms were rinsed with running seawater from the ship's clean-water-system in a plastic trough. Finally, 5kg brown ice as well as 5

and 20 kg green ice were allowed to melt within 24 h at room temperature in 30 l aquaria from acrylic glass tightly covered with aluminium foil.

Table 29 Samples for natural product analyses in benthic invertebrates.

Taxon	Samples	Species or phenotypes	Dissected tissues	Regional comparisons	Samples / region
Porifera	32	13		3	5/A, 4/B1, 3/B2, 4/C2, 12/D, 2/E
Hexacorallia	6	2			3/E, 1/H2
Alcyonacea	29	7	13	1	10/B1, 2/F, 17/H2
Gorgonacea	156	49		9	43/A, 62/B1, 2/B2, 15/D, 20/E, 10/H1,
Pennatulacea	14	4	10	1	1/A, 11/B1, 2/H1
Nematoda	6	4			6/G1
Amphipoda	9	3	2		2/E, 7/F
Isopoda	11	3	8		1/F, 1/G2, 4/H2
Nemertini	4	4			1/B1, 2/D, 1/G1
Bryozoa	32	14			11/A, 3/B1, 5/C1, 13/D, 2/G1
Polyplacophora	1	1			1/A
Aplacophora	3	1		1	2/A, 1/B2
Prosobranchia	8	5		1	4/A, 1/B1, 1/G1, 2/H2
Nudibranchia	23	5	36	3	11/A, 9/B1, 2/E, 1/G1
Sipunculida	1	1			
Echiurida	3	2			1/B1, 2/H2
Polychaeta	30	10	3	1	5/A, 2/B1, 4/E, 2/G1, 5/J
Holothuroidea	4	2	2		3/F
Asteroidea	13	5			6/A, 1/F
Ophiuroidea	5	4			1/B1, 4/E
Pterobranchia	28	5		2	2/A, 4/B1, 1/H1, 3/J
Ascidiacea	12	3	3	2	2/B1, 8/C2, 2/J

NE Weddell Sea
A: Auståsen, shelf (250-270m)
B1: Kapp Norvegia, shelf (100-340m)
B2: Kapp Norvegia, slope (440-615m)
Drake Passage
H1: Southern shelf (204-374m)
H2: Southern slope (804m)

Bransfield Strait
C1: Ant. Peninsula, NE margin, shelf (218m)
C2: Ant. Peninsula, NE margin, slope (911-1100m)
D: Trinity Peninsula, shelf (95m)
E: Western Central Basin, slope (666-858m)
F: Deception Island, shelf (45-379m)
G1: Livingston Island, shelf (202m)
G2: Livingston Island, slope (484m)
J: King George Island, shelf (100-372m)

Animals were taken by forceps from bottom trawls and put into fresh local surface water. Before processing they were kept in an aquarium container at 1°C during some days for observation of behaviour and photographic documentation. They were maintained in 1 to 30 l aquaria connected to a 500 l circulation system, the water of which was continuously filtered through charcoal and partly renewed every few days. Dead animals from trawls were processed as soon as possible after collection. Animal dissections were performed under the microscope after narcotizing specimens with CO_2. Samples from milligrams to a few hundred grams wet weight scheduled to be analyzed for natural products in the home laboratory were shock frozen in liquid nitrogen and stored evacuated and wrapped in polyethylene foil at -80°C until further processing. Large animals, which could not be processed in conventionally sized Dewar flasks were frozen and stored at -30°. Isopods and amphipods, caught with traps towards the end of the expedition, were taken alive on board to the home institution, where feeding experiments with tissues containing identified and quantified natural products will be carried out. Sea water agar was inoculated with bacteria from the surface and dissection tract of invertebrate species. Reference material from the hosts was deep frozen and stored at -80°C under sterile conditions for DNA sequencing of non cultivatable species as well as for natural product analyses. Support for classification of sampled taxa by colleagues during the cruise is acknowledged (in particular M. Schrödl for nudibranchs, B. Bader for bryozoans, M. Rauschert for amphipods, B. Sirenko for pterobranchs and C. Pedrós-Alió for microbiological work).

Chemical analyses

Experimental conditions for evaluation of analytical results are described below. Summing up, n-hexane was taken for concentrating trace organic compounds from seawater by liquid-liquid distribution, supercritical carbon dioxide was used for tissue extraction. High resolution separation of natural product mixtures by capillary gas chromatography (GC) followed including cold split injection of large volumes of raw extracts and splitless flash evaporation of volatiles. Low resolution mass spectrometry (MS) was selected for detection of individual components. In order to obtain fast results and to gain highest analytical sensitivity neither elaborated liquid/liquid partitioning and liquid chromatographic separation nor derivatization and selective chemical work-up were generally used on board. Only from some animal extracts saponification of triglycerides and subsequent methylation of free fatty acids were performed preceding GC-MS. Contaminants could be neglected in tissue analyses, but might have interfered in seawater analyses where concentrations are some orders of magnitude lower. Sampling near the ship was especially susceptible to contamination. Ubiquitous natural chemicals like saturated fatty acids, cholesterol, squalene, crude oil derived n-alkanes and high volatiles such as lower alkanals were difficult to control. Contamination by anthropogenic chemicals, like phthalates (e.g. di-n-butylphthalate and di-2-ethylhexylphthalate), antioxidants (e.g. 4-methyl-2,6-di-tert-butylphenol) and other technical products (e.g. alkylnitrates, organophosphates, nitrophenols) could be easily realized by GC-MS identification.

Extraction

Extraction of water was performed in glass bottles and separatory funnels with 10 to 100 ml n-hexane by shaking for 20 minutes yielding extracts with 80-90% solvent recovery on an average. The solvent was purified immediately before use by fractionating spinning-band distillation and adsorptive filtration using basic Al_2O_3 (activity Super I, ICN). Consecutive 2-3 extractions using n-hexane were chosen for bottom and pore water. Resulting organic emulsions were separated from clear water and broken by centrifuging in PET bottles (Beckmann Centrifuge Type GPR; 3800 rpm, 15 minutes, 5°C). For extraction of tissues 0.1-0.5 ml samples were frozen in liquid nitrogen, ground with 2 g of clean quartz sand and 7 g of Na_2SO_4 resulting in a dry powder, which was extracted with supercritical CO_2 supported by 0.5 ml n-hexane/acetone (1/1 v/v) as modifier. SFE conditions: Suprex Prepmaster, 80 °C, 300 atm, 20 min stationary time, 10 min flushing time with 2 ml CO_2/min, dissolution from the restriction trap with 4 ml n-hexane/acetone (1/1 v/v). Saponification of extracted lipids was accomplished with methanolic NaOH (100°C, 30 min) followed by derivatization of fatty acids with methanolic HCl (80 °C, 10 min) and separation of neutral compounds. Secondary natural product levels of less than 100ppb and sterol levels of less than few ppm were not investigated.

Gaschromatographic separation and mass spectrometric identification (GC-MS)

Extracted compounds were concentrated by solvent evaporation using an appropriately dimensioned Vigreux column for fractionating. 20 l seawater extracts were finally calibrated in a gentle stream of purified argon to 1 ml from which 50 µl were taken for GC separation corresponding to 1 l seawater. From extracts of bottom and pore water 50 µl aliquots roughly corresponding to 10-100 ml water were injected. Supercritical fluid extracts were likewise calibrated to 0.5 ml, from which 10 µl were used and diluted with 40 µl n-hexane to yield 50 µl injection volume corresponding to 2 to 10 mg tissue. Internal deuterated and external conventional hydrocarbon standards were used for the detection of the relative gaschromatographic retention (retention index) and rough quantifications of natural products. Recorded sterols were used to check for proper analyses, especially if only few milligrams of tissues had to be processed. Remaining sample volumes were protected with argon, sealed in glass ampoules and stored at -30°C for deeper analyses and verifications of uncertain chemical structures in the home laboratory. GC injection: Gerstel KAS 3; 40 °C, 50 µl n-hexanic extract/50sec, 1 min open split, purge gas helium with 20 ml/min, splitless injection after 1 min by flash heating 10 °C/sec from 40-300 °C. GC separation: Bruker GC module; 30 m x 0.3 mm fused silica, 0.25 µm film, DB-5 stationary phase, carrier gas helium, stopped flow during injection, constant pressure with an average flow of 1.2 ml/min during separation, temperature program 6 °C/min from 40-325 °C after injection. MS conditions: Bruker 640M mass spectrometer; ionization EI+, 70 eV; nominal mass resolution; scan range 41-450 mu; scan cycle time 0.8 sec. Data acquisition: PC Dolch Pac 586, operating system OS/2, software Bruker Labstar. Data processing: PC Compaq Armada 3500, operating system Windows 95, software Bruker DataAnalysis, MS data base NIST 98. Data output: HP Deskjet 895Cxi colour printer. Reproducible tuning of the purge and carrier gas flow for proper injection of the 50µl samples after changing and repositioning the injection glass liner - generally necessary after 30-40 injections because of contamination - was the most time consuming technical problem. A not reparable failure of the GC-MS power supply system during the expedition could be overcome by provisional hardware arrangement from the ship's stock. Help by the ship's electricians and 'email' advice from Bruker-Daltonik, Bremen, is acknowledged.

Preliminary results

Chemical screening for natural products on board

100 invertebrate samples and 100 sea water samples were extracted and chemically screened for natural products by GC-MS on board. 100 tests were conducted to check the analytical performance. Retention time precision during one hour separation was approximately 1 sec. Dynamic range of GC-MS analyses covered 2-3 orders of magnitude in most cases. Overall 1 million low resolution mass spectra were acquired during 300 h GC time resulting in 1 gigabyte GC-MS data. Detection limits for natural products accounted 1 ppt for sea water and 10 ppb for tissue approximately. Acquired compounds extended in polarity from hydrocarbons to hydroxy carbonic acids and monoglycerides. Analyzed molecular weights ranged from 100 to 600 mu with highest sensitivity in the mid-mass region. Thermally unstable, ionic and highly polar compounds such as phospholipids could not be detected. Chemical identifications were mainly based on direct comparisons and analogies with chromatographic and mass spectroscopic properties of reference compounds. However, general rules in organic chemistry and consistencies of biochemical pathways supported structure elucidations substantially. Most of the natural products occurring in sea water and benthic invertebrates could be identified 3 h after sampling allowing feedback from results to work on board.

Sterols

Main sterols identified during the expedition included phyto- and zoosterols: 24-norcholesta-5,22-dien-3β-ol, cholesta-5,22E-dien-3β-ol (dehydrocholesterol), cholest-5-en-3β-ol (cholesterol), cholesta-5,24-dien-3β-ol (desmosterol), 24R/S-methylcholesta-5,22E-dien-3β-ol (brassica/crinosterol), 24-methylcholesta-

5,24(28)-dien-3β-ol (methylencholesterol), 24R/S-ethylcholesta-5-en-3β-ol (γ-sitosterol/clionasterol), 24-ethylcholesta-5,24(28)Z-dien-3β-ol (isofucosterol) and 24-propylcholesta-5,24(28)-dien-3β-ol. Hence, diversity of carbon skeletons was rather conventional and novel structures were not discovered (see e.g. Fig. 65).

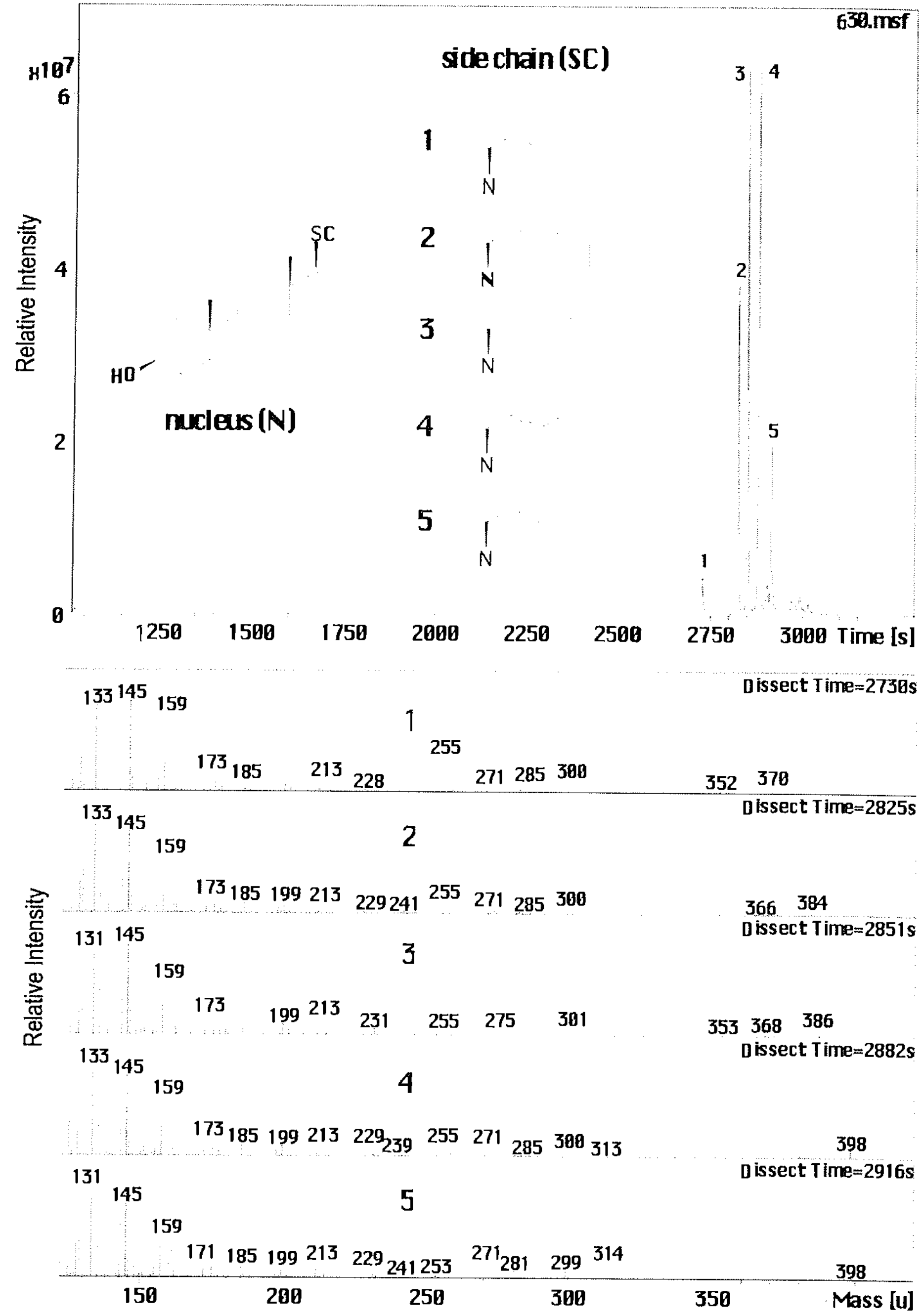


Fig. 65 Gas chromatogram (total ion content, TIC) of an *Isosecuriflustra thysanica* extract and mass spectra (upper mass range) of the main TIC peaks.

Concentration patterns changed only a little between similar samples; exceptional compositions and special features are given below. The major sterol corresponded to roughly 100 ppm in animals (wet weight basis) and was only slightly above the detection limit of 1 ppt in water (weight basis) on an average.

Sesquiterpenes and diterpenes

Sesquiterpene hydrocarbons and oxygenated derivatives were mostly found as mixtures and in traces. High levels of individual sesquiterpenes, free or chemically bound, were only sometimes observed. Open chain Z-7,11-dimethyl-3-methylene-1,6-dodecatriene (Z-β-farnesene), tricyclic (1R,2S,4R,11R)-1,3,3,11-tetramethyl-tricyclo[5,4,0,$0^{2,4}$]-undec-7-en (β-gurjunene) and (1S,2R,3R,11R)-3,3,7,11-tetramethyl-tricyclo[6,3,0,$0^{2,4}$]-undec-7-en (ledene) could be preliminarily identified as main free compounds. Z-β-farnesene predominated in different taxa (see below, e.g. Fig. 69). High levels of bound sesquiterpenes, probably monoglycerides and respective acetate derivatives, were only detected in one species. In this case large amounts of animals were collected and will be further investigated in the home laboratory. From diterpenoids glyceryl labda-8-en-15-oate including acetate derivatives and/or glyceryl esters with halimane skeleton (rearranged labdane) were present in one taxon. Among acyclic isoprenoid hydrocarbons (all-E)-2,6,10,15,19,23-hexamethyl-2,6,10,14,18,22-tetracosahexaene (squalene) and meso-2,6,10,14-tetramethylpentadecane (pristane) were also found. Squalene is a well-known biosynthetic intermediate for cyclic triterpenes including sterols and occurs ubiquitously. Only traces were found in investigated benthic animals and surface water. Pristane is derived from (2E,7R,11R)-3,7,11,15-tetramethyl-2-hexadecen-1-ol (phytol) by various oxidation and decarboxylation processes. It is only slowly metabolized and bioaccumulated by some marine animals. Like squalene, pristane was not abundant in benthos. Phytane, a derivative from phytol in reductive environments, was not present anywhere.

Free and bound carboxylic acids

Saturated and unsaturated fatty acids were mainly observed after saponification of triglycerides. Small amounts of free saturated fatty acids in untreated tissue might originate from lipase action during work-up. Traces in water appeared nearly identical in many samples (concentration pattern: palmitic acid/C16:0 > myristic acid/C14:0 > stearic acid/C18:0), but results are doubtful because of possible contamination on board. Monounsaturated fatty acids (mainly oleic acid/ C18:1ω9 and vaccenic acid/C18:1ω7) were present in all extracts with variable concentrations; incomplete gaschromatographic separation was improved after methylation. Among free polyunsaturated acids (PUFAs) all-Z-3,6,9,12,15-eicosapentaenoic acid (EPA/ C20:5 ω3) was most frequently found; all-Z-3,6,9,12,15,18-docosahexaenoic acid (DHA/ C22:6 ω3) and all-Z-5,8,11,14-eicosatetraenoic acid (arachidonic acid/ C20:4 ω6) could only be detected in few animal samples. Unusual C24:6ω3-fatty acid was preliminary identified in one species after saponification. Sources of PUFAs are a permanent topic because of their role as diet supplement for human health. Fatty acid amides (concentration pattern: C14:0 = C16:1 = C16:0 = C18:0 < C18:1) were surprisingly measurable by GC-MS in green ice, which was sampled with high contamination risk from surface water close to the ship. From gaschromatographic behaviour (unusual high retention) some doubts on the identification of amides remained. Occurrence of short chain β-hydroxy fatty acids (concentration pattern: C6:0β-OH < C8:0β-OH = C12:1β-OH < C10:0β-OH) and dimeric condensation products in deep water was exceptional. α-Hydroxy fatty acids supposed to be chemically labile in the free state could be detected unexpectedly in two animal samples (C8:0α-OH and concentration pattern: C14:1α-OH = C16:1α-OH). α-Chloroheptanoic and α-chlorooctanoic acids were the only halogenated natural products identified during this expedition. A series of aromatic compounds, similar to salicylic acid, were found in adhesive material from eggs of a sea star. However, results were only obtained once and may be accidental and not representative.

Wax esters and fatty alcohols

Not yet hydrolyzed wax esters were frequently observed in water and animals. Components with a chain length from C32 to C36 were most abundant, but individuals and patterns changed appreciably between samples. Free long chain alcohols could neither be detected in water nor in animals in significant amounts. This was also true for phytol, derived from chlorophylls. Saponification of extracts from some egg samples exhibited fatty alcohols.

Aliphatic aldehydes and ketones

Short chain n-alkanals were detected in surface water and ice. The compounds may originate from abiotic cleavage of unsaturated fatty acids like oleic acid by ozonolysis or from degrading metabolism of fatty acids. Mid and long chain n-alkanals, n-alkenals and n-alkenols occurred frequently in animals in high levels (Fig. 66). Individual double bond isomers were generally present in large excess. Since positions of double bonds were not proven they are not specified in this report. The geologically reactive species may derive from fatty acids and fatty alcohols by redox processes but also from plasmalogens by saponifications. During methylation of fatty acids aldehydes were partly converted to dimethylacetals and analyzed in this form. Chain lengths from 16 to 20 carbons predominated in n-alka/enales. However, there was no strict preference of even numbered carbon chains or other correlation to conventional acetogenines. Unconventional alkanals, like n-C15-, i-C15-, i-C16- and ai-C17-al, were also measured. Methylketones were detected in animals sporadically. This compound class is well-known to occur in sedimentary materials. In agreement with odd/even predominance it is supposed to arise from β-oxidation of fatty acids and consecutive decarboxylation or by microbial oxidation of n-alkanes. However, detected methylketones exhibited neither uneven carbon chains and only two carbon chain lengths (C16:0, C18:0). In some samples the mid-chain ketone 9-heptadecanone was identified. The biosynthetic origin and significance of this compound are obscure.

Aliphatic hydrocarbons

Homologous n-alkanes from fossil sources were found with roughly the same pattern in some samples. Distributions of individual compounds were smooth and unimodal with carbon ranges from C21 to C39 approximately. Maxima positions were at C27. No preference of odd/even carbon numbers was observed. Individual n-pentadecane was only found once in significant levels. Identical patterns of even chain n-alk-1-enes (C12-C28; maximum C16 and C18) were measured in such diverse samples as bottom water, brown ice and maintenance water of benthic invertebrates. Lower amounts of even carbon chain n-alkanes, additional n-alkenes, i-alkenes and alkylcyclohexanes were also present. Moreover, unsaturated hydrocarbons diminished with increasing molecular weight and were substituted by even chain alcohols (C18-C36; maximum C32, C34). Common biological precursors may be derived from further studies of these product patterns. Pyrolytic formation of alkenes during injection of raw extracts for gaschromatographic analyses is less probable, since it was never observed analyzing long chain alcohols and wax esters. All-Z-3,6,9,12,15,18-heneicosahexaene (HEH) was one of the main products in surface water, but was not significantly present in animals. It is supposed to be derived from algal DHA by decarboxylation. On the other hand, a respective decarboxylation product from EPA, which occurred most frequently among PUFAs, was not detectable. This observation excludes abiotic degradation of PUFAs and suggests specific biosynthesis of HEH.

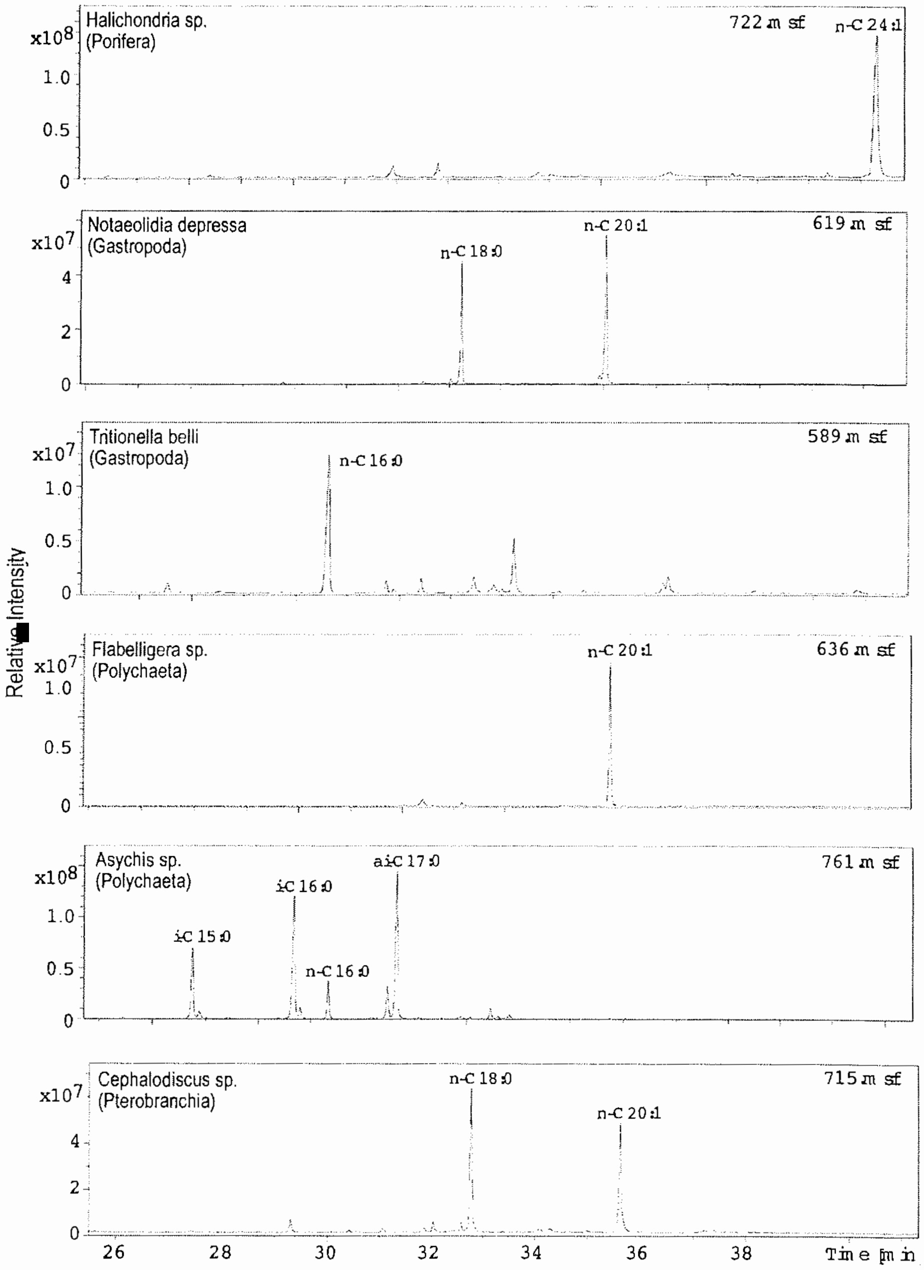


Fig. 66 Gas chromatogram (total ion content, TIC) of invertebrate extracts exhibiting specific n-alka/enales of different chain length.

Molecular biomarkers in sea water as indicators for food

General conclusions on the autumnal food supply for dense benthic communities on the eastern Weddell Sea shelf cannot yet be given unambiguously since only few stations in a short time span were sampled. Moreover, particle and current measurements were not available. Measured residues from zooplankton assemblages indicated by wax esters and pristane probably have highest nutritional potential for bottom living animals. Both molecular species are rather persistent in the water column and were found to be enriched in frontal areas as well as in coastal and marginal ice zones during the cruise. In accordance with results from water analyses wax esters were also found in many benthic animals (see below). Occasional presence of high levels of EPA in surface water and short chain β-hydroxy carbonic acids in deep water may point to bacterial contributions to food. Enhanced palmitoleic acid throughout the water column may also be indicative for bacterial sources. Not yet degraded phytoplankton products like phytosterols or other algal biomarkers were neither found at the sea surface nor at the sea floor significantly. Sampling and chemical analyses of 'marine snow' in the shelf area will give more information on this subject.

Sources in surface water

Preliminary results show that the distribution of natural products in surface water is influenced by biological processes and reflects seasonal impact. Very few phytosterols originating from diatoms, photosynthetic dinoflagellates or other phytoplankton species were found. Neither phytol, which is derived from chlorophyll and could easily be measured in spring surface water, nor n-heptadecane, indicative of blue-green algae, were detected. n-Pentadecane, preferably synthesized by brown algae, was only present near the Subtropical Front, where sampling was started. Accordingly no recent photoproduction took place within autumnal Antarctic waters. Fig. 67 shows the distribution of some natural products in surface water between Cape Town and Antarctica. Zooplankton derived wax esters were high near 50°S indicating the presence of a productive Polar Front, though conductivity and temperature did not show pronounced gradients because of rough sea conditions which had preceded sampling. Cholesterol dominated a few instances. Since phytosterols did not occur simultaneously it must have derived from zooplankton species. EPA, generally hypothesized to originate from phytoplankton and to be a trigger for zooplankton growth, was very high south of the Polar Frontal Zone. A similar but more moderate distribution pattern was observed for palmitoleic acid. Both fatty acids may also originate from cold adapted bacteria. Within the Antarctic Circumpolar Current C18:1 fatty acids and short chain saturated aldehydes (concentration pattern: $C8:0 = C10:0 < C9:0$) were enhanced. The Coastal Antarctic Current and the marginal ice zone within the Weddell Sea was dominated by wax esters again derived from copepods and euphausiids. Pristane exhibited highest levels in Atka Bay and near Kapp Norvegia, but was also slightly higher within the Polar Front. Herbivorous zooplankton species have biochemical mechanisms to concentrate and store this compound for regulation of buoyancy. Natural product levels within the ice covered Weddell Sea were very low and represented winter conditions. Neither wax esters nor pristane were found in surface water of the Bransfield Strait. HEH dominated in this sea area. It was also preferably found in surface water north of the Polar Front and within the Drake Passage. Contrary to spring, DHA could only be detected in trace levels in autumn.

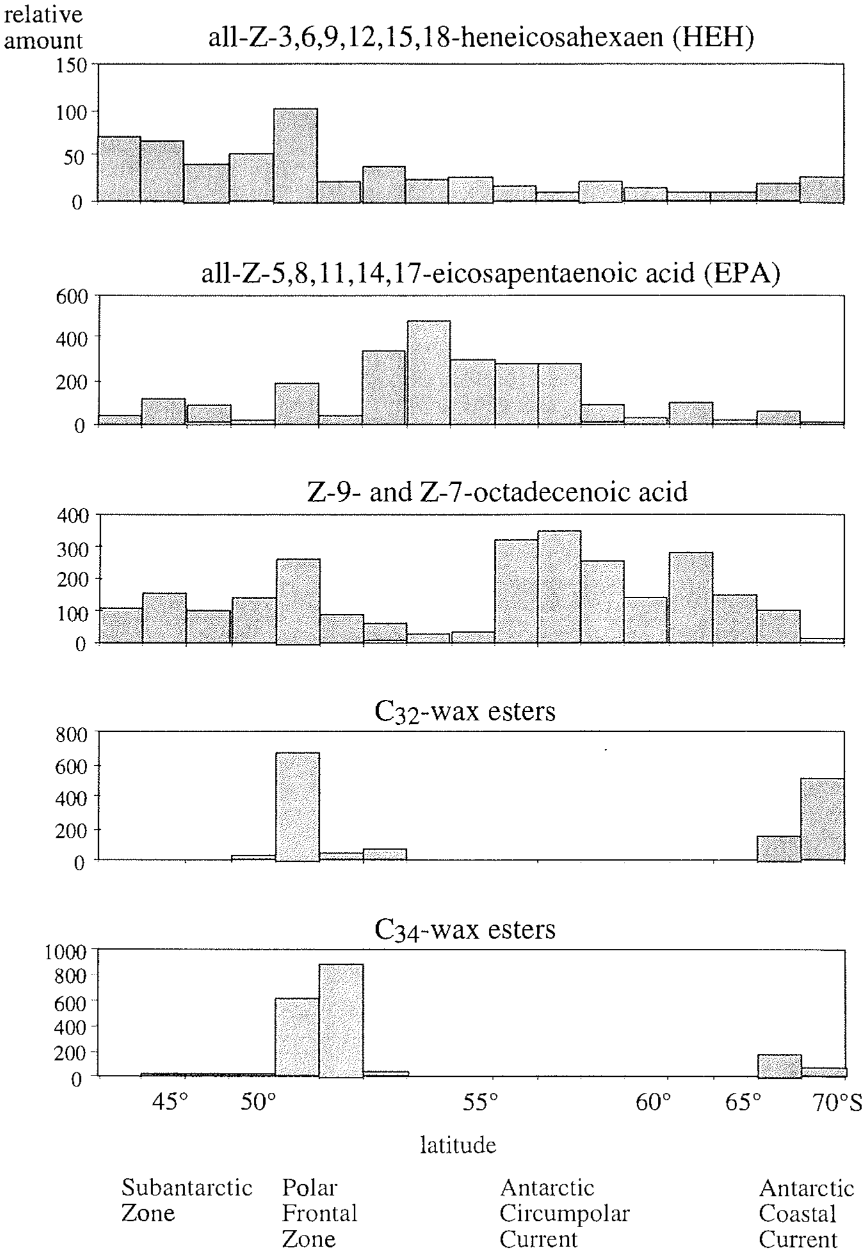


Fig. 67 Distribution of some natural products in ocean surface water between Cape Town and Antarctica.

Vertical concentration gradients in deep water

As with surface water there was no simple correlation in vertical concentration gradients of natural products and oceanographic parameters. Higher concentrations of natural products were generally found in Weddell Sea shelf water compared with the Bransfield Strait. However, variability in space and time was large (Fig. 68). Zooplankton wax esters were prominent in all depths, but low near the bottom in most cases. Concentration patterns of individual wax esters changed from station to station. Pristane was also found in deep water, but occurred in much higher concentrations at the surface. Squalene was higher in deep water. However, samplers for deep water were susceptible of contamination; therefore, analyses of squalene in water must be carefully evaluated in each case. HEH, EPA and DHA decreased continuously with increasing depth below the detection limit. Small amounts of homologous n-alkanes were sporadically found at different depths, but never near the sea surface. In some cases fatty acid levels were enhanced near the bottom. In autumnal deep water of the western Bransfield Strait wax esters occurred only in low levels; HEH, phytosterols and n-alkanes could not be detected at all. Near the bottom of Orleans Canyon β-hydroxy-alka/enoics and dimeric derivatives were found. β-Hydroxycarbonic acids are used in chemotaxonomy of bacteria. It is therefore speculated that the detected products originate from bacterial lipids, though alkyl chains from 8 to 10 carbons have not yet been reported in any taxa.

Processes at the bottom

In two of three bottom water samples taken near the tip of the Antarctic Peninsula, series of homologous n-alkanes of similar intensity occurred indicating seeps of fossil hydrocarbons at the sea floor. However, short chain n-alkanals (concentration pattern: C8:0<C9:0<C10:0), conventional saturated fatty acids (concentration pattern: C16:0>C14:0>C18:0) and cholesterol were also present suggesting possible contamination of the samples. One bottom water sample contained large amounts of unsaturated hydrocarbons, including even carbon chain n-alk-1-enes as main products, but also individual 9-heptadecanone. Nearly identical compound patterns were found in brown ice and in maintenance water of gorgonians and nudibranchs (see below). Since olefinic compounds are rather unstable in the geosphere the identified compounds may represent early stages of biomass degradation. In living organisms only individual n-alk-1-enes are generally described, like isomeric heptadecenes in algae, cyanobacteria and bacteria. Mid-chain ketones exhibiting carbon chain length of C27 to C31 are known as wax constituents from terrestrial plants which biosynthesize these compounds from hydrocarbons with strong odd/even preference. In insects, specific molecular species of this type are used as sexual pheromones. Mid-chain ketones have not yet been reported to occur in marine organisms. Collected porewater from sediments was badly contaminated with technical chemicals; hence, detailed analyses were not conducted.

Natural products in brown ice and green ice

Natural products in a sample of brown ice were roughly the same as observed in bottom water (see above). In addition HEH, saturated fatty acids (concentration pattern: C14:0 > C16:1 = C16:0) and 24-methylcholesta-5,22-dien-3β-ol were detected. Surprisingly, neither stearic acid, oleic acid and PUFAs nor specific algal biomarkers were found. Average concentrations of detected compounds in brown ice were two orders of magnitude higher compared to water. There was no similarity in natural products from the brown ice sample and a surface water sample taken nearby. Both results indicate that turnover of natural products in water and ice is widely decoupled. As with brown ice, there was no similarity of natural products in green ice and adjacent surface water. Average concentrations in green ice were only one order of magnitude higher. None of the identified products in green ice absorbs visible light. Fatty acid amides (concentration pattern: C14:0 = C16:1 = C16:0 = C18:0 < C18:1) were found as major compounds in addition to fatty acids (concentration pattern: C14:0 = C15:0 = C16:1 = C18:1 = C18:0 < C16:0) and homologous n-alkanes, which may derive from bacterial contributions. Mixtures of fatty acid amides are used as chemicals for many technical applications. The main compound, however, is physiologically active and known as 'sleeping lipid'.

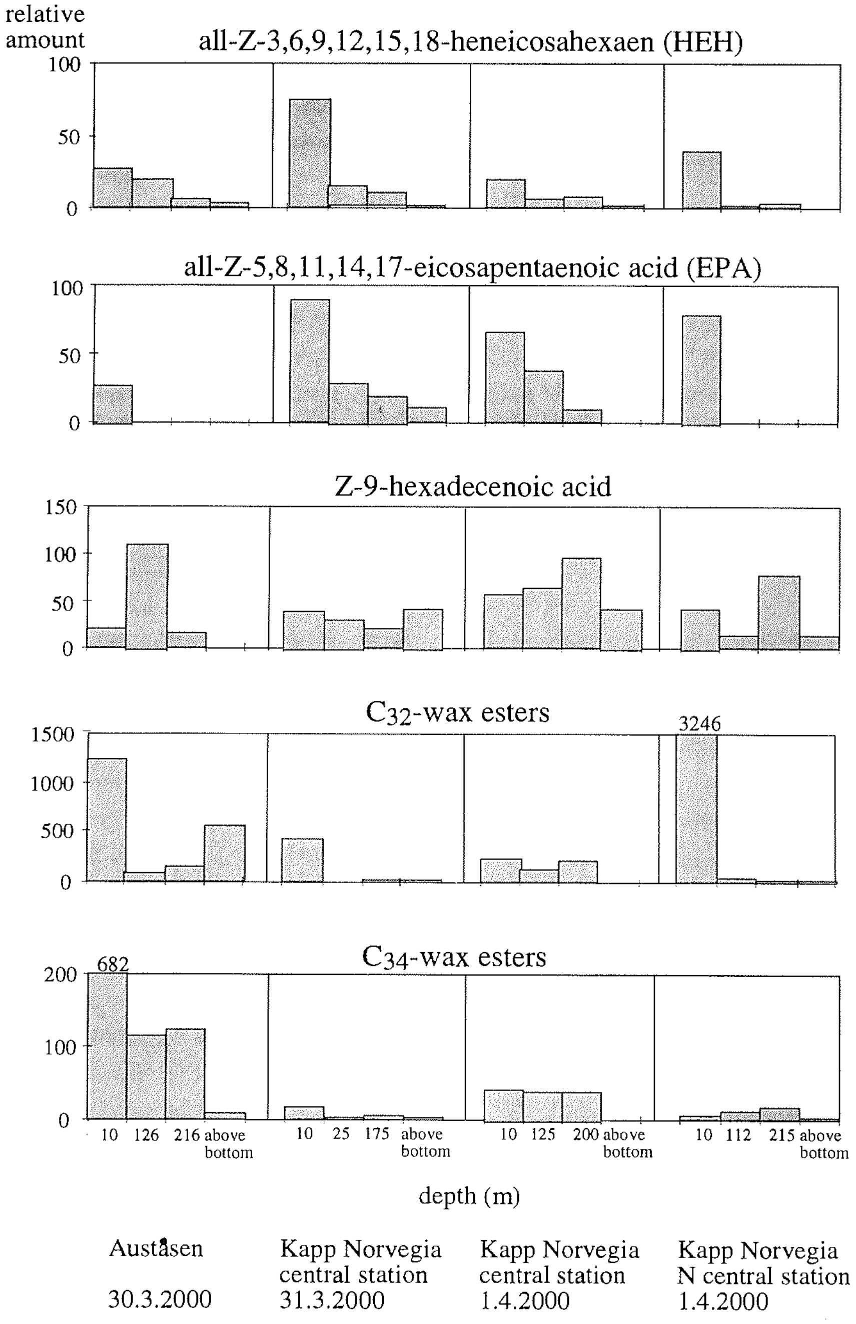


Fig. 68 Vertical distribution of some natural products in shelf water off Auståsen and Kapp Norvegia, Weddell Sea.

Anthropogenic phthalates were also present in the samples and exhibit contamination during uptake of ice from the sea and/or work-up and make analytical results doubtful. Chemical analyses of green ice have to be repeated in the home lab using more rigorous trace analytic techniques than was possible on board.

Influence of taxa, specimen dissection and environment

Most benthic invertebrates contained mixtures of natural products in trace levels. Compounds exceeding sterols in concentration were only occasionally found. Nevertheless, results - as far as investigated - were similar, if the same species from different stations were compared. Though metabolites were sometimes identical in different taxa particular concentration patterns were observed. Predominance of individual n-alkanals in pterobranchs, n-alkenals in sponges, PUFAs in gorgonians and terpenes in nudibranchs were exceptional and exhibited that biosynthesis proceeds very selectively. Preference of carbon lengths, double bond numbers and positions as well as functional group modifications point to biochemical performances of individual invertebrates that modulate the common acetate metabolism. Taxa specific cyclases are responsible for ring closures of acyclic isoprenoid precursors to individual terpenoid ring systems. The observed chemical diversity may be the molecular expression of biological specialization. However, specific impacts of natural products in benthic invertebrates on biological functions have still to be proven.

Sponges

4 species were investigated. *Halichondria* sp. contained n-tetracosenal as the main compound exceeding the main sterol. The position of the double bond is not indicated and remains to be detected. The same compound was observed in *Stylocordyla borealis,* but in lower levels and with preferred occurrence in the apical part of animals. In *S. borealis,* sterols with saturated nuclei were observed, which were otherwise found in Antarctic hexactinellids; cholestan-3β-ol dominated in the stalk. Scheduled analyses of phospholipid derived fatty acids in the home laboratory will supplement results for sterols. In an orange coloured species only cholestan-3β-ol occurred in addition to unsaturated sterols. Few n-docosenal and n-tetracosenal were identified in this species. An abundant yellow sponge, not yet further determined, contained moderate amounts of free C26:3-fatty acid. Very long chain fatty acids are generally abundant in sponges and may be helpful in the chemotaxonomic characterization of Antarctic species. However, more target analyses in sponge lipids must be performed to decide whether fatty acids are genetically or environmentally determined. No other peculiarities were observed.

Octocorals

From octocorals 11 gorgonacean species and 2 alcyonacean species were investigated on board. Wax esters, aldehydes and ketones as well as polyunsaturated fatty acids and sesquiterpenes were found in these animals. In about one half of the investigated octocorals not yet hydrolyzed wax esters were present, which are supposed to deliver energy over extended periods of time. No pristane, co-occurring with wax esters in the water column, could be detected in the animals. Individual n-alkanals (C16:0) or n-alkanal mixtures (C15:0, C16:0, C18:0) were repeatedly observed. N-alkenals (C20:1), n-alkadienols (C16:2) and methylketones (C16:0 and C18:0) were occasionally found. Compounds of these structural types exhibit diverse ecological functions in insects. Specific occurrence in marine invertebrates indicates biological functions, too. Among PUFAs arachidonic acid occurred in *Fannyella rossii* and in a not yet identified gorgonacean species in levels far exceeding sterols, but was surprisingly not found in *Fannyella spinosa* exhibiting the same sterol pattern as *F. rossii.* EPA was present in *Amphilaphis grandiflora, Dasystenella acanthina, Ainigmaptilon antarcticus*, 3 *Thouarella* and 1 Primnoidae species. Arachidonic acid, EPA and DHA are precursors of prostaglindine type compounds which are highly active in biological processes like cell communication. Among sesquiterpenes open chain Z-β-farnesene and tricyclic β-gurjunene could be preliminarily identified in *A. grandiflora* and *D. acanthina.* Terpenes are well known for biological functions in different taxa. In *A. antarcticus* some oxygenated derivatives in addition to a bouquet of different sesquiterpene hydrocarbons occurred. In a *Thouarella* species small amounts of a dioxygenated sesquiterpene were detected, which was also found in the bryozoan *Systenopora contracta.* In maintenance water of a Primnoidae species, the same compound mixture was observed as in maintenance water of nudibranchs and in bottom water (see above). In an alcyonacean species Z-β-farnesene (main compound), n-hexadecanal and EPA were found (Fig. 69), a not yet identified acetate derivative of medium molecular weight ($350\ \mathrm{mu} < M < 400\ \mathrm{mu}$) occurred in another one. The pennatulacean *Umbellula* sp. (Fig. 70) contained n-alka/enals (concentration pattern: C16:0 > C18:0 > C20:1) in slightly lower levels than sterols as well as traces of sesquiterpene hydrocarbons and free saturated fatty acids. Partitioning between animal sections was different for individual compounds. After saponification, normal saturated and unsaturated fatty acids (C16:0 to C24:6ω3) derived from triglyzerides and alcohols derived from wax esters (concentration pattern: C20:1 = C22:1) showed off. Free fatty alcohols were not observed contrary to results from spring collections. Saponification of eggs from *Umbellula* sp. yielded fatty acids and fatty alcohols far in excess of sterols indicating large amounts of triglyceride and wax ester depots in the reproductive cells.

Bryozoans

11 colonies were investigated, 8 of which were of the flustrid type. Flustridae were preferred in this study, because representatives from the North Sea had been proven to contain brominated alkaloids, the biological functions of which still have to be explored. However, alkaloids did not occur in Antarctic bryozoans. In *Isosecuriflustra angusta* and *I. thysanica* from different stations nothing but conventional sterols were found (Fig. 65). Some other species contained relative large amounts of C29- and C30-sterols. In an orange coloured bryozoan, not yet taxonomically characterized, fungal ergosterol was present in addition to cholesterol as the main sterol. In *Reteporella hippocrepis* conventional free fatty acids dominated; moderate levels of odd chain as well as C20:1-, C20:2- and C20:5-fatty acids were included. In a not yet characterized brown-orange coloured species appreciable amounts of α-hydroxy-myristoleic acid (C14:1α-OH) and α-hydroxypalmitoleic acid (C16:1α-OH) were detected. α-Hydroxy fatty acids are components of cerebrosides in plants and animals but are also present in bacterial

lipopolysaccherides. A large amount of this species was collected for structure verification and functional investigations in the home laboratory. In *Systenopora contracta* a dioxygenated sesquiterpene was detected, which was also found in a gorgonacean. Otherwise only small amounts of 2,6,6-trimethyl-2-cyclohexene-1,4-dion, possibly resulting from carotenoid degradation, were detected.

Polychaetes

3 species were investigated. A *Flabelligera* sp., not carrying epiphytic hydroid polyps contrary to a dead specimen, contained moderate amounts of n-eicosenal. In two maldanid species cholesterol dominated among sterols by far; isofucosterol was also relatively high. In *Isocyrrus yungi*, a mixture of n-, i- and ai-alkanals occurred (mainly n-C16:0, i-C16:0, ai-C17:0). Among short chain fatty acids α-hydroxyoctanoic (C8:0α-OH), α-chloroheptanoic (C7:0α-Cl) and α-chlorooctanoic acid (C8:0α-Cl) were exceptional. Enhanced acidity of α-chlorinated acids compared to nonchlorinated ones may be used for chemical defence. *Asychis* sp. though nearly identical in neutral compound patterns with *I. yungi*, was devoid of chlorinated and nonchlorinated carbonic acids. Neither short chain wax esters nor fatty alcohols were found in maldanid polychaetes as was observed in spring collections.

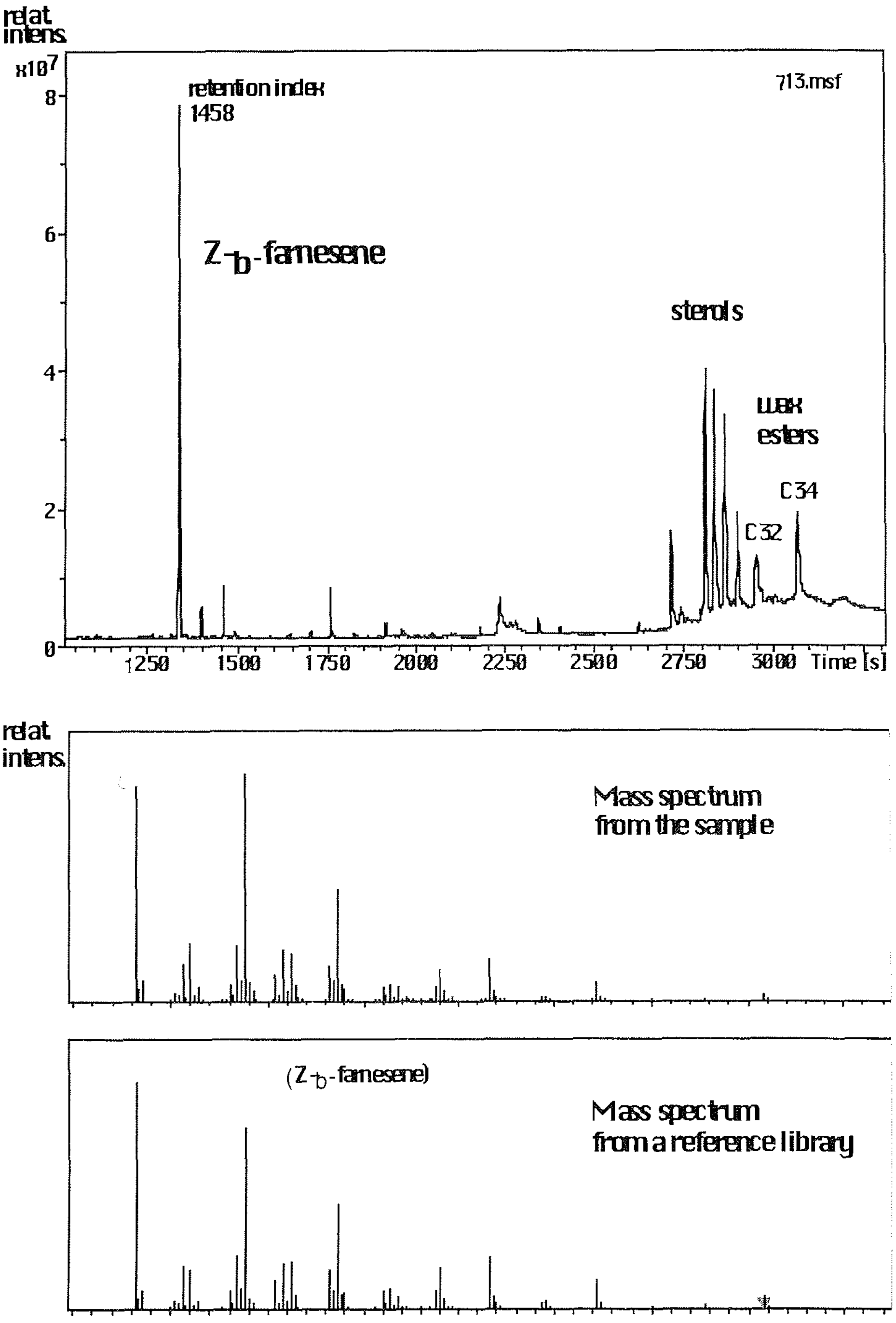
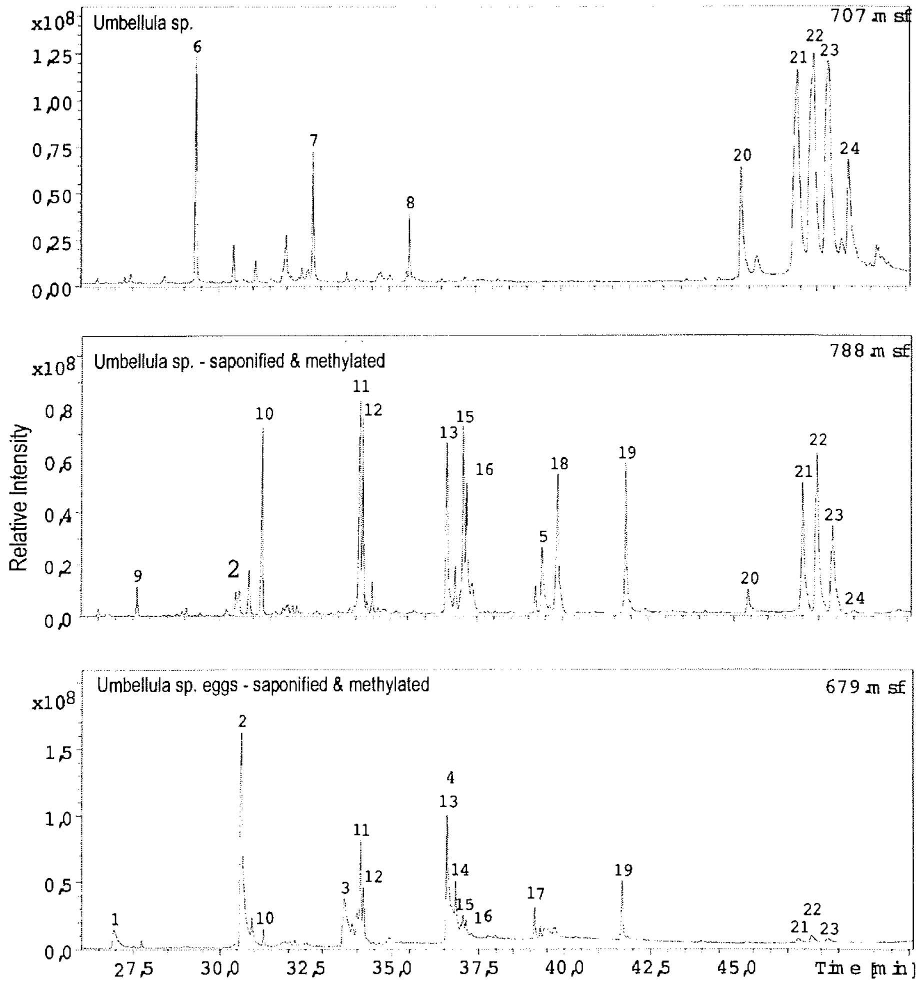


Fig. 69 Gas chromatogram (total ion content, TIC) of an alcyonacean extract, mass spectrum from the main TIC peak and most similar mass spectrum from a reference library.



n-alka/enoles
1 C14:0
2 C16:0
3 C18:1
4 C20:1
5 C22:1

sterols
20 24-norcholesta-5,22E-dien-3_b-ol
21 cholesta-5,22E-dien-3_b-ol
22 cholest-5-en-3_b-ol
23 24-methylcholesta-5,22E-dien-3_b-ol
24 24-methylcholesta-5,24(28)-dien-3_b-ol

n-alka/enales
6 C16:0
7 C18:0
8 C20:1

n-fatty acid methylesters
9 C14:0
10 C16:0
11 C18:1
12 C18:1
13 C20:5
14 C20:4
15 C20:1
16 C20:1
17 C22:6
18 C22:1
19 C24:x

Fig. 70 Gas chromatogram (total ion content, TIC) of differently processed *Umbellula* sp. extracts. Numbers indicate main TIC peaks.

Nudibranchs

Various tissues were analyzed in the Antarctic nudibranchs *Notaeolidia depressa, Tritonia* sp. and *Tritoniella* sp. Qualitatively similar results were obtained from analyses of cerata and foot of *N. depressa* exhibiting n-hexadecanal, n-octadecanal, n-octadecenal and 2 isomers of n-eicosenal as main natural products. A twofold enrichment for these compounds was observed in the cerata, if sterols were taken as reference. Though enrichment is not high, it may be an indication for the function of these compounds as defensive agents in Aeolidacea. *Tritonia* sp. and *Tritoniella* sp. contained nearly identical compounds. Leden was tentatively identified as the main sesquiterpen hydrocarbon in both species. In the mantle of *Tritonia* sp. sesquiterpenes, n-hexadecanal, n-octadecanal and arachidonic acid were present; in *Tritoniella* sp. arachidonic acid was absent and alka/enals dominated over sesquiterpenes. However, midgut glands of Tritoniidae showed identical compound patterns. We conclude from these observations that *Tritoniella* sp. and *Tritonia* sp. enrich the aforementioned compounds by food to protect themselves from predators and feed occasionally on the same items. In addition maintenance water of *N. depressa* and *Austrodoris kerguelenensis* were extracted to check for animal exsudations. Both investigations showed similar results to what is described from maintenance water of a gorgonacean species and a bottom water sample (see above). For *A. kerguelenensis* a mixture of diterpenoic acid monoglycerides and monoacetate derivatives were additionally found. The compounds are known to occur in the mantle of this species in high concentrations and are supposed to be biosynthesized ‘de novo’ as feeding deterrents. Elimination of the glycerides into water by *A. kerguelenensis* could not be proven unambiguously.

Crustaceans

Shrimps and attached eggs exhibited a simple sterol mixture of cholesterol and desmosterol. More bound PUFAs (mainly EPA) than bound saturated fatty acids (mainly C16:0) were found in reproductive organs compared to the adjacent body. In eggs of *Monoculodes cf. cabriculosus* (Amphipoda) equal amounts of C16:0-, C18:1(2x)- and C20:5-FA showed off after saponification. Among investigated samples no compounds could be detected, which may protect eggs of crustaceans during breeding.

Seastars

In adhesive material of solasterid eggs n-octadecanal was found as the main compound. Occurrence of Δ-7-sterols was characteristic of seastar tissue. Cholest-7en-3β-ol (lathosterol), 4α-methylcholest-7-en-3β-ol (lophenol) and 4α-methylcholesta-7,24-dien-3β-ol were identified. Saponification of adhesive material yielded conventional mixtures of fatty acids with palmitic acid predominating. In addition, a complex mixture of oxygenated aromatic compounds was found. The main product was structurally similar to salicylic acid, which is known to be biosynthesized through the shikimic acid pathway by plants. This compound is antibiotic and blocks eicosanoid biosynthesis. Nothing is known on their significance for solasterid eggs. Saponification of eggs yielded mainly EPA, but also n-C14:0-, ai-C15:0-fatty acid and DHA in relatively high yield. n-Octadecanal was also identified among saponification products - masked as dimethylacetal after work-up - and might be used for protection.

Pterobranchs

4 species were analyzed and their coenoecia as well. In individuals n-hexadecanal, n-heptadecanal, n-octadecanal, n-octadecenal and n-eicosenal were detected in different patterns with n-octadecanal as the main compound. Ratios between alka/enals and sterols varied appreciably, in some samples n-octadecanal clearly exceeded sterols in concentrations. Pterobranchs contained few conventional fatty

acids, but some species would be an excellent source of different PUFAs (arachidonic acid, EPA and DHA). Neither any of these metabolites nor other products were found in the coenoecia.

2.5.3 Persistent, Bioaccumulative, Toxic Chemicals in the Antarctic Ecosystem (W. Drebing, H. Goerke, A. Müller, K. Weber)

Objectives

Persistent organic pollutants (POPs) are introduced to Antarctica by global atmospheric transport and bioaccumulated in Antarctic animals. The contamination of the Antarctic ecosystem by POPs was to be evaluated and a scientific basis set for future circumantarctic monitoring of POPs and for identification of local anthropogenic impacts as well. Levels in animals from medium trophic levels were preferentially investigated during this expedition.

Work at sea

Altogether 50 samples from the Weddell Sea, Bransfield Strait and Drake Passage were collected and prepared for POP analyses. Fish and invertebrate specimens were taken from bottom and Agassiz trawls with steel forceps to prevent contamination as far as possible. Immediately after sampling, specimens were wrapped in n-hexane washed aluminium foil, sealed in polyethylene bags, deep-frozen and kept at –30°C until further processing in the home laboratory. Animal dissections and chemical analyses were not performed on board because of severe contamination risks.

The following species were collected: *Terebella ehlersi, Pista mirabilis, Eunoa* spec. (Polychaeta), *Eusirus perdentatus, Notocrangon antarcticus, Chorismus antarcticus* (Crustacea), *Pareledone polymorpha, Pareledone* sp., Teuthoidea (Cephalopoda), *Bathyraja maccaini, Pleuragramma antarcticum, Trematomus eulepidotus, Cryodraco antarcticus, Macrourus whitsoni* (Pisces).

Perspectives from the collections

Polychaetes, crustaceans and fish represent taxa with different capacities to metabolize POPs in the northern hemisphere. Now, the collected samples allow to perform respective investigations in Antarctic species, which have contamination levels 2 to 3 orders of magnitude lower and are probably not yet influenced by enzyme induction. Pelagic and benthic cephalopods, pelagic, benthic and even deep-sea fish can be analysed to investigate the fate of pollutants during vertical transport in the water column. The geographical influence on POP levels can be considered, since animals from the Weddell Sea, Bransfield Strait and Drake Passage were sampled quasi synoptically. Residue levels in Antarctic fish of different size will be evaluated in order to obtain information on the parameter age. Including earlier residue analyses in top predators such as penguins and seals, representatives of the entire Antarctic food web are now under investigation. Collected results will characterize the contamination of Antarctic animals of different trophic levels with POPs and the trend of residue patterns in the Antarctic ecosystem.

2.6 Other Investigations

2.6.1 Study of the Winter Antarctic Marginal Ice Zone (M. Doble, M. Coon & O. Peppe)

Objectives

This cruise represents the field programme for the three-year project "Short Timescale Motion of Pancake Ice", or STiMPI. The project began in May 1999, and is a collaboration between the Scott Polar Research Institute (SPRI) Sea Ice Group, in Cambridge, and the Marine Technology Division of the Centre for Coastal and Marine Science, based at the Dunstaffnage Marine Laboratory in Oban. The aim of the study is to investigate the processes involved in the formation and deformation of the winter Antarctic marginal ice zone (MIZ), using an array of six innovative drifting buoys. The buoys are designed to mimic the characteristics of young pancake ice and transmit GPS location, sea surface temperature, meteorological observations and wave spectra back to the UK. New satellite data-transmission technology allows motion at 20-minute intervals to be resolved.

The formation of Antarctic sea ice in winter is one of the largest seasonal events on the planet, yet the processes by which it forms – especially in the ice edge region – are not well understood. The high turbulence levels of the Southern Ocean do not allow forming ice to congeal into a coherent ice sheet, but instead as a suspension of unconsolidated crystals known as frazil ice. Cyclic compression by the wave field causes the frazil crystals to clump together into small cakes which are known as pancake ice. Only at a considerable distance from the ice edge is the ocean swell damped enough to allow the pancakes to freeze together to form an ice sheet and the familiar pack ice. The importance of this pancake-frazil formation lies in the fact that most of the sea ice growth occurs at the "open water" rate. The amount of heat lost from the ocean and the amount of salt injected to surface waters is thus much greater than would be achieved by sheet ice growth.

Work at sea

The first month of the cruise was spent assembling the buoys, completing the electronic control boards and finalising the microprocessor control code. Though the systems were less complete than we might have wished when we borded, it was at least a very efficient use of cruise time for us. A differential global positioning system (DGPS) antenna was installed on the east stairway at Neumayer base, to provide the precise position reference required by the short time-interval fixes from the buoy array.

The buoys were completed and tested just in time for deployment at the ice edge, on April 17th. Figure 1 shows one of the buoys, floating away from the ship having just been released down the stern ramp.

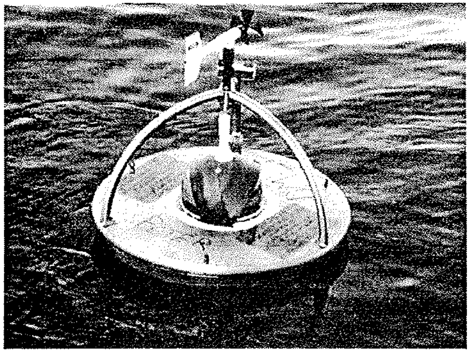


Fig. 71 The STiMPI buoy, released at station 5. The tripod carries a wind sensor, GPS antenna and satellite aerial. A standard MetOcean SVP-B drifter sits in the middle of the hull, as an autonomous backup system.

Helicopter reconnaissance flights and passive microwave (SSM/I) satellite images were used to determine the extent of the pancake zone in the ice edge area and choose the best location for the array. The area between 20°W and 30°W, which had originally been chosen for the array, proved unsuitable as the latitudinal width of the pancake zone was not sufficient to allow the array to be placed on the 100km+ scale intended. Satellite images suggested that this zone was wider west of 30°W, and this was found to be the case. Five buoys were deployed in a rectangular array – a buoy at each corner and one in the middle – between 30°W and 35°W, from April 17th to April 19th. Array size was approximately 80km x 110km, with the larger dimension parallel to the ice edge. The sixth buoy was placed a further 300km along the ice edge on April 20th, to verify that the main array was moving in a manner consistent with the larger MIZ on this scale.

Weather conditions during the buoy deployments proved ideal. Storm-force winds ceased on April 15th, the subsequent period of calm continuing for the whole deployment process. This not only made working conditions on deck very pleasant, but allowed the ice cover in the area of the array to be synoptically characterised - since advection and freezing/melting of ice during that time was minimal.

Frazil and pancake ice were sampled at each deployment station. Smaller pancakes were lifted on board, using the AWI ice basket, for measuring, sectioning and salinity/temperature analysis. Frazil ice was collected from the ship's 'mummy chair' for salinity and volume analysis. 36 pancakes and 70 frazil samples were tested. These measurements are important primarily to understand the character of the ice cover to which the buoy array responds. Knowledge of the pancake size distribution from the ice edge to consolidated pack is important both for studies of waves in the MIZ and for understanding the dynamics of the observed motion. Properties of the pancakes themselves are necessary to understand mechanical behaviour in response to incident wavefields, the response of various satellite sensors to observed ground-truth, and determination of input properties to models; such as drag coefficent, turning angle and rheology.
CTD casts to 200m were performed at each station and photography transects were flown using Polarstern's helicopters and the specialised SPRI aerial camera. The buoys were also overflown several hours after deployment, to verify that they were moving with the pancakes, rather than through them. No wakes were caused by any of the buoys, and we can therefore be reasonably confident that they are responding as planned.

The ROV of the Starmans group was deployed at three locations, to examine the pancake ice from below. Surprising forms of pancakes were observed at the first station, with deep 'roots' extending below the layer of frazil ice. A side view this type is shown on deck, in Figure 2, below. Frazil was not observed to be deeper than the pancakes at any station, though the low swell regime and lack of active ice production may account for this.

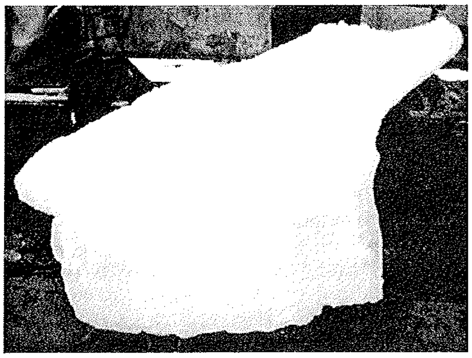


Fig. 72 Side view of a pancake with a deep columnar ice root, on Polarstern's aft deck.

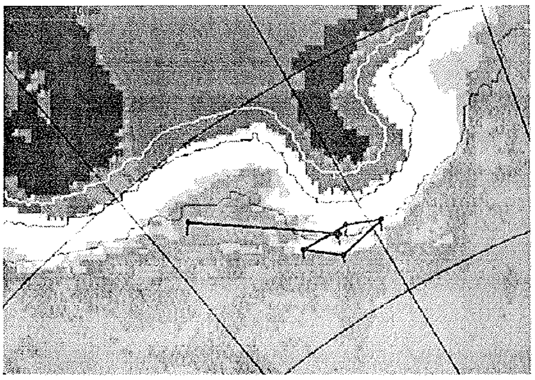


Fig. 73 SSM/I image for May 4th, from Leif Toudal at the Danish Technical University, showing the buoy array position and deformation since deployment. The outer, light, contour shows the 15% ice concentration line.

Preliminary Results

All the buoys were still transmitting at the end of the cruise and were seen to move with the ice edge, as it responded to the passage of low-pressure systems across the Weddell Sea. The deployment area developed into a large embayment, which had closed to encircle the array by May 6th. The array location is marked on Figure 3, which also shows the ice concentration, derived from SSM/I satellite data. The region proved to be an extremely dynamic area, with the buoys regularly moving over more than 10nm per day. Environmental data from the array was not analysed on board, beyond the verification of continued operation of all sensors, but this will form the main task in the coming months.

Analysis of the pancake and frazil data on board enabled us to develop a theory for the formation of the previously-undescribed pancake morphologies seen, and it is suggested that a newer layer of frazil ice is built on top of an existing platform by rafting of frazil slush. This contrasts with the accepted method of building pancakes, from the side and downwards. Preliminary calculations indicate that this method allows double the pancake thickness to be produced, when compared to conventional methods over the same time period, with the increased heat and salt fluxes that this implies.

3. ANNEXES

3.1 Abbreviations of Gears and Investigation Areas

Gears

Abbreviation	Gear
AGT	Agassiz trawl
BO	Bongo net
BIOROSI	Bio Rosette
BPN	Bentho-pelagic trawl
CTD	Conductivity-Temperature-Depth data logger
D	Rauschert's small Dredge
EBS	Epibenthic sledge
F trap	Fish trap deployment
F trap recov	Fish trap recovery
FTS	Photo sled
GKG	Giant box corer
GSN	Bottom trawl
LHHN	Large horizontal hauling net
MG	Multigrab
MN	Multinet
MO	Mooring deployment
M recov	Mooring recovery
MUC	Multicorer
PSN	Pelagic fish trawl
SHHN	Small horizontal hauling net
ROV	Remotely operated vehicle
TVG	TV grab

Investigation Areas

Abbreviation	Area
AB	Atka Bay
ADB	Admiralty Bay
AUS	Austasen
BFS	Bransfield Strait
CB	Charcot Bay
CG	Charcot Gulf
DI	Drescher Inlet
DP	Drake Passage
HB	Halley Bay
KG	King George Island
KN	Kapp Norvegia
N/KN	north of KN
P	Peninsula
PF	Polar Front
S/KN	south of KN
VK	Vestkapp
W/D	west of Deception Island
WSD	Weddell Sea, deep sea region

3.2 Station List

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
21.03.	PF	56-1	6:38		40° 56.35'	009° 53.55'	4613	MN (1000m)
			7:30	at depth	40° 56.36'	009° 53.36'	4610	
			8:05		40° 56.40'	009° 53.20'	4608	
			8:40		40° 56.50'	009° 53.40'	4608	MN (1000m)
			9:12	at depth	40° 56.65'	009° 53.60'	4613	
			9:45		40° 56.85'	009° 54.00'	4613	
	"	56-2	10:23		40° 57.15'	009° 54.10'	4616	BO
			10:35		40° 56.40'	009° 53.40'	4608	
	"	56-3	10:58		40° 56.40'	009° 53.20'	4613	CTD (1053m)
			11:47		40° 57.40'	009° 52.90'	4612	
	"	56-4	12:10		40° 56.50'	009° 53.30'	4609	MUC
			14:02	on grnd	40° 56.40'	009° 53.50'	4613	
			15:53		40° 56.20'	009° 54.70'	4626	
24.03.	"	57-1	4:57		51° 09.35'	005° 02.30'	4009	CTD (1000m)
			5:22	at depth	51° 09.35'	005° 02.30'	4009	
			5:46		51° 09.76'	005° 02.66'	4001	
	"	57-2	5:58		51° 09.92'	005° 02.74'	4004	MN (1000m)
			6:01	stop	51° 09.92'	005° 02.74'	4004	
			6:13		51° 10.04'	005° 02.85'	4012	
			6:57	at depth	51° 10.04'	005° 02.85'	4012	
			7:38		51° 10.83'	005° 04.32'	3981	
	"	57-3	8:04		51° 10.95'	005° 05.05'	3963	MN (1000m)
			9:20		51° 11.00'	005° 06.40'	3944	
29.03.	AB	58-1	12:35		70° 29.30'	007° 41.80'	311	GKG
			12:45	on grnd	70° 29.40'	007° 41.70'	312	
			12:55		70° 29.40'	007° 41.70'	310	
	"	58-2	13:17		70° 29.40'	007° 41.60'	312	GKG
			13:25	on grnd	70° 29.40'	007° 41.50'	312	
			13:35		70° 29.40'	007° 41.50'	312	
	"	58-3	13:57	repetition	70° 29.50'	007° 41.70'	302	GKG
			14:07	on grnd	70° 29.50'	007° 41.40'	301	
			14:14		70° 29.50'	007° 41.30'	305	
	"	59-1	16:19		70° 40.19'	007° 39.96'	99	GKG
			16:23	on grnd	70° 40.19'	007° 39.96'	110	
			16:29		70° 40.22'	007° 40.04'	99	
	"	59-2	16:48		70° 40.23'	007° 40.03'	99	GKG
			16:52	on grnd	70° 40.23'	007° 40.03'	99	
			16:59		70° 40.27'	007° 40.05'	100	
	"	59-3	17:12		70° 40.22'	007° 40.06'	99	GKG
			17:16	on grnd	70° 40.22'	007° 40.06'	110	
			17:23		70° 40.25'	007° 40.05'	99	
	"	59-4	17:38		70° 40.25'	007° 40.07'	100	GKG
			17:42	on grnd	70° 40.25'	007° 40.07'	100	
			17:49		70° 40.23'	007° 40.06'	100	
	"	59-5	18:18		70° 40.20'	007° 40.20'	99	FTS
			19:00	heave	70° 40.30'	007° 40.30'	101	
			19:02		70° 40.03'	007° 40.03'	101	
	"	59-6	20:30		70° 40.50'	007° 41.20'	132	MN
			20:36	at depth	70° 40.50'	007° 41.20'	132	
			20:42		70° 40.50'	007° 41.10'	136	
	"	59-7	21:45		70° 40.50'	007° 41.30'	140	SHHN
			22:11		70° 40.40'	007° 40.90'	109	
	"	59-8	22:46		70° 40.50'	007° 41.30'	136	SHHN
			23:16		70° 40.40'	007° 41.10'	113	
	"	59-9	23:49		70° 40.50'	007° 41.20'	122	BO
			0:25		70° 40.50'	007° 41.30'	130	
30.03.	"	59-10	0:35		70° 40.40'	007° 41.30'	126	BO

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			0:57		70° 40.40'	007° 41.40'	130	
	"	59-11	1:03		70° 40.50'	007° 41.30'	137	BO
			1:20		70° 40.50'	007° 41.40'	140	
	"	59-12	1:40		70° 40.40'	007° 41.00'	117	ROV
			2:00	on grnd	70° 40.40'	007° 41.10'	118	
			2:06	traverse	70° 40.40'	007° 41.20'	120	
			3:14	heave	70° 40.30'	007° 40.60'	97	
			3:21		70° 40.30'	007° 40.60'	97	
	AUS	60-1	14:43		70° 53.40'	010° 33.00'	235	MO (M9)
			15:15	release	70° 53.56'	010° 33.77'	235	
	"	60-2	15:36		70° 54.00'	010° 33.50'	250	CTD
			15:53		70° 54.00'	010° 34.00'	260	
	KN	61-1	23:58		71° 10.70'	012° 40.50'	347	ROV
			1:03		71° 10.80'	012° 42.00'	340	
31.03.	"	62-1	3:33		71° 10.50'	012° 29.30'	326	ROV
			4:28		71° 10.63'	012° 30.41'	319	
	"	63-1	6:33		71° 10.47'	012° 27.22'	332	MO (M10)
			7:08	release	71° 10.54'	012° 27.72'	337	
	"	63-2	7:23		71° 10.57'	012° 27.95'	333	CTD
			7:59	stop	71° 10.61'	012° 28.22'	328	
	"	63-3	8:27		71° 10.60'	012° 25.90'	328	CTD
			9:03		71° 10.60'	012° 26.90'	330	
	"	64-1	12:52		71° 20.30'	013° 00.50'	248	CTD
			13:07		71° 20.35'	013° 01.00'	253	
	"	64-2	13:45		71° 20.50'	013° 03.20'	254	MO (M11)
			14:17	release	71° 20.59'	013° 04.00'	260	
	"	65-1	18:24		71° 19.90'	013° 56.10'	629	GSN
			19:09	on grnd	71° 17.60'	013° 48.00'	615	
			19:36	off grnd	71° 16.67'	013° 45.79'	648	
			20:22	on board	71° 15.70'	013° 41.00'	621	
01.04.	"	66-1	1:45		71° 12.60'	012° 41.60'	370	CTD
			2:15		71° 12.90'	012° 44.40'	364	
	"	67-1	3:25		71° 12.80'	012° 35.00'	397	CTD
			4:00		71° 13.00'	012° 37.80'	407	
	"	68-1	8:17		71° 12.20'	012° 27.00'	310	CTD
			8:38		71° 12.10'	012° 27.80'	311	
	"	69-1	9:16		71° 12.60'	012° 22.20'	310	CTD
			9:32		71° 12.60'	012° 23.10'	306	
	"	70-1	10:11		71° 12.60'	012° 16.40'	326	CTD
			10:28		71° 12.60'	012° 17.30'	325	
	"	71-1	11:11		71° 10.60'	012° 16.20'	327	CTD
			11:28		71° 10.60'	012° 17.50'	330	
	"	72-1	12:02		71° 10.50'	012° 22.00'	343	CTD
			12:20		71° 10.50'	012° 23.10'	344	
	"	73-1	12:50		71° 10.60'	012° 29.30'	326	CTD
			13:07		71° 10.70'	012° 30.70'	322	
	"	74-1	13:26		71° 10.70'	012° 34.20'	342	CTD
			13:56		71° 10.60'	012° 34.80'	353	
	"	75-1	14:30		71° 10.50'	012° 40.50'	348	CTD
			14:50		71° 10.50'	012° 41.50'	350	
	"	75-2	15:03	repetition	71° 10.60'	012° 42.10'	353	CTD
			15:20		71° 10.70'	012° 43.00'	334	
	"	76-1	16:03		71° 08.59'	012° 40.73'	401	CTD
			16:25		71° 08.78'	012° 41.57'	393	
	"	77-1	17:08		71° 08.40'	012° 33.77'	421	CTD
			17:29		71° 08.49'	012° 34.62'	408	
	"	78-1	18:08		71° 08.50'	012° 27.70'	413	CTD
			18:31		71° 08.60'	012° 28.60'	405	
	"	79-1	19:03		71° 08.59'	012° 20.64'	456	CTD
			19:26		71° 08.58'	012° 21.35'	451	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			20:19		71° 08.50'	012° 16.00'	465	
	"	81-1	21:27		71° 12.40'	012° 20.20'	319	ROV
			23:06		71° 12.50'	012° 23.80'	310	
	"	82-1	23:56		71° 14.80'	012° 32.10'	364	FTS
			0:11	at depth	71° 14.80'	012° 32.10'	364	
			0:49		71° 14.90'	012° 33.30'	385	
02.04.	"	83-1	1:12		71° 14.80'	012° 29.60'	313	FTS
			1:27	at depth	71° 14.80'	012° 29.60'	313	
			2:08		71° 14.74'	012° 31.03'	342	
	"	84-1	3:24		71° 14.10'	012° 27.08'	248	ROV
			4:41	heave	71° 14.16'	012° 28.94'	263	
			4:51		71° 14.19'	012° 29.20'	271	
	"	85-1	9:02		71° 07.30'	012° 09.70'	856	GSN
			10:00	on grnd	71° 11.30'	012° 15.40'	309	
			10:30	off grnd	71° 12.19'	012° 19.01'	318	
			11:09	on board	71° 12.60'	012° 16.80'	326	
	"	86-1	13:14		71° 12.60'	012° 15.50'	328	GKG
			13:27		71° 12.80'	012° 16.40'	301	
	"	87-1	14:04		71° 12.50'	012° 21.70'	309	GKG
			14:21		71° 12.60'	012° 22.60'	310	
	"	88-1	14:47		71° 12.40'	012° 26.80'	317	GKG
			15:05		71° 12.50'	012° 27.80'	305	
	"	89-1	15:31		71° 12.50'	012° 33.40'	377	GKG
			15:51		71° 12.70'	012° 34.40'	391	
	"	90-1	16:26		71° 12.45'	012° 39.50'	380	MG
			16:39	at depth	71° 12.56'	012° 39.76'	378	
			16:52		71° 12.58'	012° 39.92'	382	
	"	91-1	17:35		71° 10.62'	012° 39.57'	349	GKG
			17:52		71° 10.68'	012° 39.72'	344	
	"	91-2	18:11		71° 10.70'	012° 39.60'	345	GKG
			18:20		71° 10.70'	012° 39.60'	345	
			18:29		71° 10.83'	012° 40.06'	344	
	"	92-1	19:12		71° 10.55'	012° 33.79'	341	GKG
			19:19	on grnd	71° 10.55'	012° 33.79'	341	
			19:38		71° 10.61'	012° 34.57'	345	
	"	93-1	20:20		71° 10.50'	012° 30.80'	321	CTD
			20:37		71° 10.60'	012° 31.40'	325	
	"	93-2	20:50		71° 10.80'	012° 32.00'	332	MN
			21:01	at depth	71° 10.80'	012° 32.00'	332	
			21:14		71° 10.80'	012° 32.80'	340	
	"	93-3	21:31		71° 10.90'	012° 33.60'	345	MN
			21:44	at depth	71° 10.90'	012° 33.60'	345	
			21:58		71° 11.10'	012° 34.80'	356	
	"	93-4	22:09		71° 11.20'	012° 35.30'	346	BO
			22:18	at depth	71° 11.20'	012° 35.30'	346	
			22:27		71° 11.40'	012° 36.00'	365	
	"	94-1	23:19		71° 07.30'	012° 38.90'	456	FTS
			0:15		71° 07.50'	012° 40.10'	435	
03.04.	"	95-1	0:52		71° 05.80'	012° 44.50'	786	CTD
			1:26		71° 05.90'	012° 45.40'	762	
	"	95-2	1:34		71° 05.90'	012° 45.60'	752	MN
			1:27		71° 06.20'	012° 47.30'	675	
	"	95-3	2:40		71° 06.20'	012° 47.30'	665	BO
			3:00		71° 06.30'	012° 47.80'	613	
	"	96-1	3:23		71° 05.60'	012° 50.10'	1052	CTD
			4:04		71° 05.79'	012° 51.64'	1001	
	"	96-2	4:17		71° 05.82'	012° 52.02'	987	MN
			4:44	at depth	71° 05.82'	012° 52.02'	987	
			5:14		71° 06.21'	012° 53.29'	888	
	"	97-1	6:19		71° 06.34'	012° 51.56'	729	EBS

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			7:10	heave	71° 06.24'	012° 49.92'	743	
			7:50	on board	71° 06.26'	012° 49.57'	712	
	"	98-1	9:00		71° 10.90'	012° 27.60'	325	CTD
			9:14		71° 10.90'	012° 27.80'	324	
	"	98-2	9:32		71° 10.90'	012° 28.00'	327	MG
			9:39	on grnd	71° 10.90'	012° 28.00'	324	
			9:44	on grnd	71° 10.90'	012° 28.10'	325	
			9:52	on board	71° 10.90'	012° 28.20'	326	
	"	99-1	10:42		71° 08.60'	012° 39.80'	400	GKG
			10:49	on grnd	71° 08.60'	012° 39.80'	400	
			10:58		71° 08.60'	012° 39.80'	396	
	"	100-1	11:36		71° 08.50'	012° 33.90'	409	GKG
			11:44	on grnd	71° 08.50'	012° 34.00'	410	
			11:54		71° 08.50'	012° 34.10'	404	
	"	100-2	12:12	repetition	71° 08.60'	012° 33.40'	403	GKG
			12:20	on grnd	71° 08.60'	012° 33.60'	403	
			12:35		71° 08.60'	012° 33.60'	407	
	"	101-1	13:02		71° 08.30'	012° 27.80'	437	GKG
			13:09	on grnd	71° 08.30'	012° 28.00'	438	
			13:20		71° 08.40'	012° 28.20'	429	
	"	101-2	13:27	repetition	71° 08.40'	012° 28.22'	430	GKG
			13:37	on grnd	71° 08.40'	012° 28.20'	433	
			13:49		71° 08.40'	012° 28.40'	433	
	"	102-1	14:41		71° 13.20'	012° 27.90'	260	GSN
			15:37	on grnd	71° 11.90'	012° 21.70'	323	
			15:56	off grnd	71° 11.44'	012° 19.20'	312	
			16:28	on board	71° 11.20'	012° 16.40'	310	
	"	103-1	17:21		71° 08.66'	012° 21.23'	439	GKG
			17:30	on grnd	71° 08.71'	012° 21.31'	434	
			17:45		71° 08.80'	012° 21.37'	424	
	"	104-1	18:08		71° 10.40'	012° 21.10'	353	GKG
			18:16	on grnd	71° 10.40'	012° 21.20'	353	
			18:24		71° 10.40'	012° 21.20'	343	
	"	105-1	19:03		71° 10.56'	012° 15.01'	330	GKG
			19:11	on grnd	71° 10.57'	012° 15.03'	331	
			19:19		71° 10.57'	012° 15.05'	330	
	"	106-1	20:14		71° 10.80'	012° 27.50'	326	CTD
			20:32		71° 10.80'	012° 27.60'	328	
04.04.	"	107-1	0:19		71° 08.70'	012° 32.20'	396	ROV
			1:38		71° 08.80'	012° 32.10'	396	
	"	108-1	7:14		71° 08.67'	012° 14.63'	442	MG
			7:32	on grnd	71° 08.64'	012° 14.75'	441	
			7:44		71° 08.53'	012° 14.80'	452	
	"	109-1	9:40		71° 09.60'	012° 12.00'	337	GSN
			10:20	on grnd	71° 11.30'	012° 18.50'	311	
			10:40	off grnd	71° 11.90'	012° 20.70'	316	
			11:12	on board	71° 12.40'	012° 23.50'	317	
	"	110-1	13:01		71° 18.10'	012° 15.70'	182	CTD
			13:12		71° 18.00'	012° 15.20'	184	
	"	110-2	13:37		71° 18.00'	012° 15.50'	182	CTD
			13:51		71° 18.10'	012° 15.30'	183	
	"	110-3	14:55		71° 18.10'	012° 15.90'	180	MUC
			15:04		71° 18.00'	012° 15.70'	177	
	"	110-4	15:18	repetition	71° 18.00'	012° 15.60'	177	MUC
			15:27		71° 18.00'	012° 15.50'	177	
	"	110-5	15:37	repetition	71° 17.90'	012° 15.40'	178	MUC
			15:47		71° 18.00'	012° 15.30'	178	
	"	110-6	16:51		71° 18.13'	012° 16.03'	180	TVG
			17:31	on grnd	71° 18.10'	012° 15.95'	179	
			17:38		71° 18.08'	012° 15.89'	180	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			1:20		71° 07.50'	011° 27.70'	72	
	"	111-2	2:02		71° 07.50'	011° 27.50'	69	FTS
			2:32		71° 07.50'	011° 28.10'	100	
	"	111-3	2:53		71° 07.50'	011° 28.20'	110	ROV
			3:50		71° 07.50'	011° 27.60'	67	
	"	111-4	4:23		71° 07.54'	011° 27.94'	101	FTS
			4:44		71° 07.53'	011° 27.60'	68	
	"	111-5	8:43		71° 07.50'	011° 28.40'	112	TVG
			8:46	on board	71° 07.50'	011° 28.40'	112	
			9:15	repetition	71° 07.50'	011° 27.80'	66	
			9:21	on grnd	71° 07.50'	011° 27.70'	66	
			9:31	on board	71° 07.50'	011° 27.70'	65	
	"	111-6	9:42		71° 07.50'	011° 27.90'	65	TVG
			9:50	on grnd	71° 07.50'	011° 27.80'	65	
			9:58		71° 07.50'	011° 27.70'	68	
	"	111-7	10:12		71° 07.50'	011° 27.80'	70	TVG
			10:19	on grnd	71° 07.50'	011° 27.70'	67	
			10:28		71° 07.50'	011° 27.80'	68	
	"	111-8	10:53		71° 07.50'	011° 27.60'	74	CTD
			11:03		71° 07.50'	011° 27.50'	93	
	"	111-9	11:18		71° 07.50'	011° 27.80'	62	D
			11:35		71° 07.50'	011° 27.10'	145	
	"	111-10	12:42		71° 07.10'	011° 28.00'	100	SHHN
			13:05		71° 07.30'	011° 27.60'	100	
	"	111-11	13:13		71° 07.30'	011° 27.70'	99	LHHN
			13:38		71° 07.30'	011° 27.40'	117	
	"	111-12	14:06		71° 07.30'	011° 27.30'	127	MN
			14:17		71° 07.40'	011° 27.20'	133	
	"	111-13	15:03		71° 07.20'	011° 28.00'	107	SHHN
			15:20		71° 07.30'	011° 27.60'	109	
	"	111-14	15:35		71° 07.20'	011° 27.80'	103	LHHN
			15:55		71° 07.30'	011° 27.60'	112	
	"	111-15	16:13		71° 07.31'	011° 27.52'	112	MN
			16:19	at depth	71° 07.31'	011° 27.52'	112	
			16:24		71° 07.34'	011° 27.42'	116	
	"	111-16	16:56		71° 07.45'	011° 27.64'	77	D
			17:00	at depth	71° 07.45'	011° 27.64'	80	
			17:11		71° 07.50'	011° 27.95'	83	
	"	111-17	17:41		71° 07.50'	011° 27.92'	75	TVG
			17:55	on grnd	71° 07.52'	011° 27.87'	78	
			18:01		71° 07.56'	011° 27.93'	105	
	"	111-18	18:23		71° 07.50'	011° 28.00'	106	TVG
			18:29	on grnd	71° 07.50'	011° 28.00'	105	
			18:37		71° 07.50'	011° 28.02'	93	
	"	111-19	19:17		71° 07.45'	011° 28.42'	113	TVG
			19:30	on grnd	71° 07.48'	011° 28.30'	112	
			19:40		71° 07.47'	011° 28.29'	113	
	"	111-20	20:19		71° 07.90'	011° 28.90'	120	CTD
			20:30	frozen	71° 07.80'	011° 28.90'	122	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			20:52		71° 07.80'	011° 28.90'	120	
	"	111-21	21:24		71° 07.50'	011° 27.90'	102	CTD
			21:31		71° 07.50'	011° 28.00'	104	
	"	111-22	21:57		71° 07.50'	011° 27.70'	66	CTD
			22:04		71° 07.50'	011° 27.70'	64	
	"	111-23	22:28		71° 07.40'	011° 27.30'	117	CTD
			22:36		71° 07.40'	011° 27.20'	124	
	"	111-24	23:04		71° 07.40'	011° 26.90'	151	CTD
			23:13	on board	71° 07.40'	011° 26.90'	150	
			23:16	repetition	71° 07.40'	011° 26.90'	149	CTD
			23:24		71° 07.40'	011° 26.90'	151	
06.04.	"	111-25	1:17		71° 07.40'	011° 27.00'	140	ROV
			1:45	stopped	71° 07.30'	011° 27.00'	143	
	"	111-26	2:13		71° 07.50'	011° 27.60'	74	FTS
			2:28		71° 07.30'	011° 26.90'	150	
	"	111-27	4:38		71° 07.24'	011° 27.66'	108	SHHN
			4:43	stopped	71° 07.25'	011° 27.66'	109	
	"	111-28	5:04		71° 07.28'	011° 27.52'	117	MN
			5:11	at depth	71° 07.28'	011° 27.52'	117	
			5:18		71° 07.27'	011° 27.47'	122	
	"	111-29	7:06		71° 07.61'	011° 27.52'	67	D
			7:26		71° 07.51'	011° 27.46'	105	
	"	111-30	7:46		71° 07.51'	011° 27.59'	73	D
			8:21		71° 07.40'	011° 27.10'	137	
	"	112-1	12:25		71° 06.10'	012° 43.00'	570	MFG
			12:35	on grnd	71° 06.10'	012° 43.10'	576	
			12:50		71° 06.00'	012° 43.20'	587	
	AUS	113-1	18:36		70° 49.93'	010° 36.76'	275	MG
			18:52	on grnd	70° 49.91'	010° 36.77'	275	
			18:59		70° 49.84'	010° 36.71'	279	
07.04.	"	114-1	6:28		70° 46.18'	010° 43.17'	740	MG
			6:52	on grnd	70° 46.19'	010° 43.22'	741	
			7:10		70° 46.19'	010° 43.38'	743	
	"	115-1	8:15		70° 48.10'	010° 41.80'	499	GKG
			8:24	on grnd	70° 48.10'	010° 42.20'	500	
			8:34		70° 48.10'	010° 42.70'	502	
	"	116-1	9:10		70° 49.70'	010° 38.00'	316	GKG
			9:17	on grnd	70° 49.70'	010° 38.30'	316	
			9:25		70° 49.60'	010° 38.40'	322	
	"	117-1	9:57		70° 51.50'	010° 36.10'	234	GKG
			10:02	on grnd	70° 51.50'	010° 36.50'	239	
			10:08	on board	70° 51.50'	010° 36.50'	244	
			10:10	repetition	70° 51.50'	010° 37.30'	246	GKG
			10:15	on grnd	70° 51.50'	010° 37.60'	247	
			10:24	on board	70° 51.50'	010° 38.20'	257	
			11:00	repetition	70° 51.70'	010° 36.00'	229	GKG
			11:06	on grnd	70° 51.70'	010° 36.00'	229	
			11:11	on board	70° 51.70'	010° 36.00'	229	
	"	118-1	12:07		70° 53.40'	010° 33.50'	223	GKG
			12:13	on grnd	70° 53.40'	010° 33.60'	235	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
	"	119-1	13:49		70° 48.40'	010° 42.30'	469	GSN
			14:37	on grnd	70° 50.40'	010° 35.20'	266	
			14:53	off grnd	70° 51.20'	010° 35.10'	226	
			15:30	on board	70° 50.90'	010° 33.80'	226	
08.04.	"	120-1	10:28		70° 50.30'	010° 35.10'	271	MG
			10:59	on grnd	70° 50.30'	010° 35.00'	270	
			11:06		70° 50.40'	010° 35.20'	270	
	"	121-1	14:25		70° 53.60'	010° 34.20'	248	MG
			15:04	on grnd	70° 53.70'	010° 34.10'	249	
			15:12		70° 53.70'	010° 34.10'	248	
09.04.	"	122-1	9:19		70° 50.40'	010° 35.40'	269	TVG
			9:41	on board	70° 50.50'	010° 35.30'	267	
			9:59	repetition	70° 50.70'	010° 35.00'	234	
			10:10	on grnd	70° 50.70'	010° 35.10'	235	
			10:23	on board	70° 50.70'	010° 34.90'	233	
	"	122-2	10:51		70° 50.70'	010° 34.00'	233	TVG
			11:14	on grnd	70° 50.70'	010° 35.00'	233	
			11:31		70° 50.80'	010° 35.10'	233	
	"	122-3	11:51		70° 50.80'	010° 35.70'	229	CTD
			12:03		70° 50.80'	010° 35.90'	245	
	"	122-4	12:35		70° 50.80'	010° 36.80'	247	CTD
			12:48		70° 50.80'	010° 37.10'	254	
	"	123-1	13:53		70° 53.50'	010° 34.30'	233	M recov
			14:37	on board	70° 53.90'	010° 34.00'	252	
	"	124-1	15:38		70° 53.70'	010° 40.60'	305	GSN
			16:35	on grnd	70° 50.60'	010° 35.40'	247	
			16:47	off grnd	70° 50.20'	010° 34.89'	269	
			17:17	on board	70° 49.20'	010° 33.40'	278	
	"	125-1	18:37		70° 45.97'	010° 33.95'	328	FTS
			18:46	on grnd	70° 45.97'	010° 33.95'	312	
			19:29		70° 45.90'	010° 33.77'	315	
	"	126-1	20:41		70° 50.00'	010° 34.50'	280	ROV
			21:54		70° 50.20'	010° 34.50'	278	
	"	127-1	23:32		70° 52.30'	010° 31.40'	245	ROV
			0:53		70° 52.30'	010° 30.90'	245	
10.04.	"	128-1	1:31		70° 53.60'	010° 33.90'	234	CTD
			1:44		70° 53.60'	010° 33.60'	233	
	"	129-1	2:22		70° 51.50'	010° 35.40'	222	CTD
			2:35		70° 51.40'	010° 35.20'	221	
	"	130-1	3:04		70° 49.80'	010° 37.70'	301	CTD
			3:19		70° 49.70'	010° 37.60'	303	
	"	131-1	3:49		70° 48.00'	010° 40.40'	498	CTD
			4:13		70° 48.00'	010° 40.25'	495	
	"	132-1	5:25		70° 55.20'	010° 30.69'	236	CTD
			5:39		70° 55.20'	010° 30.68'	237	
	"	133-1	6:03		70° 56.99'	010° 28.16'	249	CTD
			6:18		70° 56.99'	010° 28.14'	250	
	"	133-2	6:43		70° 56.99'	010° 28.14'	250	GKG
			6:49	on grnd	70° 56.99'	010° 28.14'	250	
			6:54		70° 56.99'	010° 28.14'	250	
	"	134-1	7:28		70° 55.24'	010° 30.79'	249	GKG
			7:33	on grnd	70° 55.24'	010° 30.79'	249	
			7:38		70° 55.25'	010° 30.76'	249	
	"	135-1	9:03		70° 47.20'	010° 32.90'	280	GSN
			9:50	on grnd	70° 50.20'	010° 34.70'	274	
			10:33	off grnd	70° 50.30'	010° 34.70'	273	
			10:56	on board	70° 51.10'	010° 35.30'	228	
	"	135-2	11:36		70° 50.50'	010° 34.90'	252	BO
			11:56		70° 50.50'	010° 35.00'	254	
	"	135-3	11:58	repetition	70° 50.50'	010° 35.00'	254	BO

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
	"	135-4	12:19		70° 50.50'	010° 35.00'	242	BO
			12:33		70° 50.50'	010° 35.10'	244	
	"	135-5	12:40		70° 50.50'	010° 35.10'	244	BO
			12:52		70° 50.50'	010° 35.20'	244	
	"	135-6	13:35		70° 50.10'	010° 34.50'	257	MG
			13:59	on grnd	70° 50.20'	010° 34.50'	266	
			14:07		70° 50.20'	010° 34.50'	263	
	"	136-1	15:35		70° 48.20'	010° 33.28'	255	GSN
			16:10	on grnd	70° 50.20'	010° 35.40'	271	
			16:23	off grnd	70° 50.80'	010° 36.20'	251	
			16:58	on board	70° 51.70'	010° 38.80'	253	
	"	137-1	18:00		70° 50.19'	010° 34.68'	276	MG
			18:12	on grnd	70° 50.20'	010° 34.70'	276	
			18:21		70° 50.30'	010° 34.90'	276	
11.04.	N/KN	138-1	7:18		71° 08.45'	013° 12.85'	793	EBS / D
			8:10	on grnd	71° 08.90'	013° 12.80'	765	
			8:19	heave	71° 08.80'	013° 13.20'	840	
			9:03	on board	71° 08.80'	013° 17.50'	1140	
16.04.	WSD	139-1	8:10		68° 56.70'	030° 00.20'	4630	CTD
			8:52		68° 56.70'	030° 00.70'	4615	
	"	139-2	9:22		68° 56.90'	030° 00.10'	4630	ROV
			9:31	on board	68° 56.90'	030° 00.10'	4630	
			9:44		68° 57.00'	030° 00.30'	4614	
			10:19	on board	68° 57.10'	030° 00.40'	4614	
	"	139-3	10:40		68° 57.20'	030° 00.30'	4614	PC-ice-catching
			10:44	on board	68° 57.20'	030° 00.30'	4614	
			10:50		68° 57.20'	030° 00.30'	4614	PC-ice-catching
			10:57	on board	68° 57.20'	030° 00.30'	4614	
	"	140-1	15:33		68° 53.70'	030° 15.00'	4628	Bug-CTD
			15:55		68° 53.80'	030° 15.00'	4627	
	"	140-2	16:18		68° 53.61'	030° 14.55'	4631	ice-catching
			16:31		68° 53.61'	030° 14.56'	4630	
			16:35		68° 53.61'	030° 14.48'	4631	PC-ice-catching
			16:38		68° 53.61'	030° 14.48'	4631	
			16:48		68° 53.63'	030° 14.90'	4629	PC-ice-catching
			16:58		68° 53.63'	030° 14.90'	4629	
17.04.	"	141-1	8:13		68° 38.10'	030° 00.40'	4675	CTD
			8:23		68° 38.10'	030° 00.40'	4671	
	"	141-2	8:57	release	68° 39.90'	030° 00.20'	4691	PC-Buoy No.1
	"	141-3	9:17		68° 40.30'	030° 00.50'	4691	Frazile-ice-catching
			9:32		68° 40.30'	030° 00.50'	4691	
	"	141-4	9:36		68° 40.30'	030° 00.60'	4691	PC-ice-catching
			10:04		68° 40.30'	030° 00.60'	4691	
	"	142-1	16:43	release	69° 04.92'	032° 09.39'	4558	PC-Buoy No.2
	"	142-2	17:01		69° 04.99'	032° 09.05'	4553	CTD
			17:12		69° 04.99'	032° 08.98'	4557	
	"	142-3	17:33		69° 05.04'	032° 08.67'	4554	PC-ice-catching
			17:59		69° 05.04'	032° 08.67'	4554	
	"	143-1	22:44		68° 41.00'	032° 29.60'	4558	BO
			0:01		68° 41.30'	032° 30.00'	4558	
18.04.	"	143-2	0:03		68° 41.30'	032° 30.00'	4558	BO

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
	"	143-3	1:02		68° 41.50'	032° 30.20'	4552	MN
			2:14		68° 41.80'	032° 30.40'	4560	
	"	143-4	8:31		68° 40.95'	032° 29.04'	4556	CTD
			9:13		68° 40.50'	032° 29.30'	4544	
	"	143-5	9:42	release	68° 40.80'	032° 29.80'	4544	PC-Buoy No.3
	"	143-6	9:55		68° 40.80'	032° 30.10'	4543	Frazile-ice-catching
			10:28		68° 40.80'	032° 30.10'	4543	
	"	143-7	10:48		68° 40.70'	032° 30.90'	4542	PC-ice-catching
			11:11		68° 40.70'	032° 30.90'	4542	
	"	144-1	14:39	release	68° 17.90'	032° 47.20'	4526	PC-Buoy No.4
	"	144-2	15:10		68° 17.70'	032° 47.00'	4527	CTD
			15:21		68° 17.80'	032° 46.80'	4526	
	"	144-3	15:40		68° 17.90'	032° 46.50'	4528	Frazile-ice-catching
			16:00		68° 17.90'	032° 46.50'	4528	
	"	144-4	16:34		68° 18.30'	032° 46.30'	4527	Pancake Lifter
			16:50		68° 18.30'	032° 46.30'	4527	
	"	144-5	17:27		68° 18.35'	032° 46.40'	4528	ROV
			18:24		68° 18.31'	032° 46.28'	4528	
19.04.	"	145-1	9:37		68° 36.85'	034° 37.08'	4451	CTD
			9:46		68° 36.80'	034° 37.96'	4453	
	"	145-2	10:18	release	68° 36.50'	034° 38.50'	4431	PC-Buoy No.5
	"	145-3	10:43		68° 36.20'	034° 38.90'	4423	ice-drilling
			11:04		68° 36.20'	034° 38.90'	4423	
	"	145-4	11:16		68° 35.90'	034° 39.40'	4415	Frazile-ice-catching
			11:36		68° 35.90'	034° 39.40'	4415	
	"	145-5	11:58		68° 35.80'	034° 39.90'	4410	PC-ice-catching
			12:20		68° 35.80'	034° 39.90'	4410	
20.04.	"	146-1	11:47		66° 44.80'	040° 04.20'	4581	CTD
			12:29		66° 44.40'	040° 03.00'	4586	
	"	146-2	12:54		66° 44.10'	040° 02.90'	4584	PC-Buoy No.6
	"	146-3	13:10		66° 44.10'	040° 03.10'	4577	Frazile-ice-catching
			13:30		66° 44.10'	040° 03.10'	4577	
	"	146-4	13:37		66° 44.10'	040° 02.70'	4581	PC-ice-catching
			14:17		66° 44.10'	040° 02.70'	4581	
	"	146-5	15:07		66° 44.20'	040° 02.10'	4587	ROV
			15:58		66° 44.20'	040° 02.60'	4587	
23.04.	P	147-1	18:15		62° 34.60'	054° 15.10'	296	MUC
			18:32	failed	62° 34.50'	054° 15.00'	307	
	"	147-2	18:43		62° 34.60'	054° 15.40'	303	MUC
			19:01	failed	62° 34.50'	054° 15.20'	305	
24.04.	BFS	148-1	13:13		62° 42.80'	056° 52.50'	234	MUC
			13:27		62° 42.80'	056° 52.60'	232	
	"	148-2	13:44		62° 42.80'	056° 52.70'	229	MUC
			13:58		62° 42.80'	056° 52.60'	231	
	"	148-3	14:10		62° 42.80'	056° 52.80'	218	MG
			14:26	on grnd	62° 42.80'	056° 52.80'	218	
			14:31		62° 42.80'	056° 52.80'	224	
	"	148-4	14:47		62° 42.80'	056° 52.80'	227	MUC

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
	"	148-5	15:34		62° 42.50'	056° 54.70'	211	green-ice-catching
			15:50		62° 42.50'	056° 54.70'	211	
	"	149-1	18:06		62° 29.20'	056° 53.40'	922	AGT / D
			18:45	on grnd	62° 30.00'	056° 55.80'	911	
			18:52	heave	62° 30.10'	056° 56.10'	909	
			19:39	on board	62° 30.00'	056° 56.20'	907	
	"	150-1	20:19		62° 29.96'	056° 56.65'	897	D
			20:47	on grnd	62° 29.97'	056° 57.08'	880	
			21:00	trawling	62° 30.04'	056° 57.51'	869	
			21:10	heave	62° 30.08'	056° 57.74'	863	
			21:46	on board	62° 30.23'	056° 58.46'	850	
	"	151-1	22:49		62° 29.62'	057° 13.10'	1097	CTD
			23:26		62° 29.60'	057° 13.22'	1102	
	"	151-2	23:34		62° 29.56'	057° 13.17'	1100	MN
			0:09	at depth	62° 29.56'	057° 13.17'	1100	
			0:42		62° 29.50'	057° 12.90'	1097	
25.04.	"	151-3	0:51		62° 29.50'	057° 12.90'	1098	MN
			1:25	at depth	62° 29.50'	057° 12.90'	1098	
			1:59		62° 29.40'	057° 12.80'	1098	
	"	151-4	2:14		62° 29.40'	057° 12.80'	1097	BO
			2:20	stop	62° 29.50'	057° 12.90'	1097	
	"	152-1	3:44		62° 38.20'	057° 05.00'	378	CTD
			3:57		62° 38.20'	057° 05.00'	372	
	"	152-2	4:06		62° 38.20'	057° 05.00'	375	MN
			4:37		62° 38.40'	057° 05.20'	372	
	"	152-3	4:47		62° 38.40'	057° 05.00'	354	MN
			5:15		62° 38.60'	057° 05.40'	378	
	"	152-4	5:36		62° 38.70'	057° 05.50'	379	MN
			6:06		62° 38.80'	057° 05.80'	385	
	"	152-5	6:17		62° 38.90'	057° 05.70'	376	CTD
			6:37		62° 38.90'	057° 05.70'	368	
	"	153-1	10:35		62° 54.60'	057° 29.41'	397	F trap
			10:39	lower	62° 54.59'	057° 29.46'	399	
			10:56	release	62° 54.56'	057° 29.36'	410	
	"	154-1	14:02		63° 04.60'	057° 30.50'	94	ROV
			14:15	stop	63° 04.60'	057° 30.50'	94	
			14:54	repetition	63° 04.00'	057° 31.00'	108	
			16:06		63° 03.60'	057° 31.90'	108	
	"	155-1	17:14		63° 05.00'	057° 30.80'	97	D
			17:49		63° 04.50'	057° 31.20'	98	
	"	155-2	17:56		63° 04.90'	057° 31.30'	94	CTD
			18:06		63° 04.90'	057° 31.50'	95	
	"	155-3	18:19		63° 04.90'	057° 31.60'	97	MN
			18:29		63° 04.90'	057° 31.90'	95	
	"	155-4	18:37		63° 04.90'	057° 31.90'	96	MN
			18:47		63° 04.90'	057° 32.20'	98	
	"	155-5	19:02		63° 04.90'	057° 32.50'	93	MN
			19:11		63° 04.80'	057° 32.90'	95	
	"	155-6	19:24		63° 04.80'	057° 33.30'	97	D
			20:02		63° 04.80'	057° 33.90'	93	
	"	155-7	20:56		63° 04.92'	057° 31.91'	96	TVG
			21:15		63° 04.85'	057° 31.92'	96	
	"	155-8	21:44		63° 04.88'	057° 32.02'	97	TVG
			22:02		63° 04.85'	057° 32.04'	97	
26.04.	"	156-1	2:00		62° 38.30'	057° 35.90'	872	CTD
			2:30		62° 38.10'	057° 36.40'	892	
	"	156-2	2:42		62° 38.10'	057° 36.50'	920	MN
			3:37		62° 37.80'	057° 36.90'	994	
	"	156-3	3:48		62° 37.80'	057° 36.90'	995	MN
			5:01		62° 37.80'	057° 37.50'	1017	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			12:38	on board	62° 54.60'	057° 29.50'	405	
	"	158-1	14:28		63° 05.20'	057° 30.80'	98	AGT /D
			14:42	on grnd	63° 04.70'	057° 31.60'	94	
			14:57	off grnd	63° 04.50'	057° 32.00'	95	
			15:04	on board	63° 04.30'	057° 32.30'	99	
	"	159-1	17:13		62° 55.00'	057° 40.40'	205	AGT /D
			17:25	on grnd	62° 55.00'	057° 39.50'	218	
			17:35	heave	62° 55.20'	057° 39.20'	214	
			17:59	on board	62° 55.30'	057° 39.30'	212	
27.04.	CB	160-1	12:05		63° 25.30'	059° 28.00'	933	CTD
			12:49		63° 25.10'	059° 27.60'	941	
	"	160-2	13:01		63° 25.00'	059° 27.30'	948	MG
			13:38	on grnd	63° 24.80'	059° 26.90'	934	
			13:54		63° 24.80'	059° 26.70'	907	
	CG	161-1	16:05		63° 36.00'	059° 32.90'	605	CTD
			16:32		63° 36.10'	059° 32.80'	606	
	"	161-2	16:44		63° 36.00'	059° 32.70'	615	MG
			17:06	on grnd	63° 35.90'	059° 32.00'	646	
			17:25		63° 35.80'	059° 33.00'	654	
	"	162-1	18:17		63° 36.90'	059° 34.40'	415	CTD
			18:39		63° 36.90'	059° 34.20'	387	
	"	162-2	18:52		63° 36.80'	059° 34.30'	461	MG
			19:23	on grnd	63° 37.20'	059° 33.80'	290	
			19:31		63° 37.20'	059° 33.70'	293	
	"	162-3	19:55		63° 37.20'	059° 34.30'	388	D
			20:16	on grnd	63° 37.24'	059° 34.66'	356	
			20:35	heave	63° 37.14'	059° 34.40'	343	
			20:55	on board	63° 37.07'	059° 34.67'	419	
28.04.	BFS	163-1	1:24		63° 07.60'	059° 25.00'	774	CTD
			1:58		63° 07.50'	059° 25.00'	787	
	"	163-2	2:12		63° 07.40'	059° 25.20'	785	BO
			3:06		63° 06.20'	059° 27.60'	803	
	"	163-3	3:39		63° 07.40'	059° 25.20'	786	MN
			4:40		63° 07.30'	059° 26.20'	786	
	"	163-4	4:48		63° 07.30'	059° 26.40'	782	MN
			5:47		63° 07.10'	059° 27.30'	799	
	"	163-5	10:23		63° 07.52'	059° 25.43'	782	GKG
			10:38	on grnd	63° 07.52'	059° 25.43'	782	
			10:57		63° 07.61'	059° 25.20'	788	
	"	164-1	12:00		63° 06.00'	059° 35.20'	857	AGT /D
			12:37	on grnd	63° 04.90'	059° 32.90'	858	
			13:03	off grnd	63° 04.70'	059° 32.70'	859	
			13:23	on board	63° 04.60'	059° 32.20'	855	
	"	165-1	16:14		63° 00.90'	059° 09.50'	689	AGT /D
			16:42	on grnd	63° 00.80'	059° 06.90'	621	
			17:08	off grnd	63° 00.50'	059° 06.60'	618	
			17:23	on board	63° 00.50'	059° 06.70'	631	
	"	166-1	18:38		63° 04.50'	059° 12.80'	667	GSN
			19:18	on grnd	63° 02.30'	059° 10.40'	666	
			19:50	off grnd	63° 01.20'	059° 09.20'	673	
			20:27	on board	63° 00.80'	059° 07.20'	627	
29.04.	"	167-1	0:02		62° 58.40'	059° 56.20'	1019	GKG
			0:22	on grnd	62° 58.40'	059° 56.10'	1020	
			0:48		62° 58.20'	059° 56.10'	1026	
	"	167-2	1:02		62° 58.10'	059° 56.10'	1028	CTD
			1:46		62° 57.80'	059° 55.90'	1028	
	"	168-1	3:18		62° 56.10'	060° 21.20'	872	CTD
			3:56		62° 56.00'	060° 21.30'	869	
	"	169-1	11:40		62° 56.61'	060° 24.83'	639	MG
			12:03	on grnd	62° 56.70'	060° 25.20'	607	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
	"	170-1	12:50		62° 55.80'	060° 27.00'	472	F trap
			13:16	release	62° 55.83'	060° 26.88'	475	
	"	171-1	15:07		63° 00.20'	060° 31.30'	40	ROV
			15:31		63° 00.10'	060° 31.10'	36	
	"	171-2	17:14		63° 00.10'	060° 31.10'	36	ROV
			18:37		63° 00.00'	060° 29.60'	184	
	"	171-3	18:50		63° 00.10'	060° 30.70'	45	D
			19:13		63° 00.10'	060° 31.00'	48	
	"	171-4	20:16		63° 00.07'	060° 31.27'	35	ROV
			22:00		63° 00.01'	060° 30.97'	37	
	"	172-1	23:35		62° 55.89'	060° 26.35'	499	CTD
			23:59		62° 55.93'	060° 26.30'	499	
30.04.	"	172-2	0:12		62° 56.00'	060° 26.40'	497	MN
			0:30	at depth	62° 56.00'	060° 26.40'	497	
			0:52		62° 56.20'	060° 26.60'	488	
	"	172-3	1:05		62° 56.30'	060° 26.60'	491	CTD
			1:30		62° 56.30'	060° 26.50'	471	
	"	172-4	2:04		62° 56.70'	060° 25.30'	609	CTD
			2:27		62° 56.80'	060° 25.40'	608	
	"	172-5	2:36		62° 56.80'	060° 25.50'	607	MN
			2:57	at depth	62° 56.80'	060° 25.50'	607	
			3:27		62° 57.10'	060° 25.80'	580	
	"	172-6	4:05		62° 57.20'	060° 23.20'	778	SHHN
			5:22		62° 57.10'	060° 23.30'	769	
	W/D	173-1	16:15		63° 00.50'	061° 13.27'	311	GSN
			16:46	on grnd	63° 01.20'	061° 08.70'	352	
			17:07	off grnd	63° 01.70'	061° 82.90'	379	
			17:34	on board	63° 02.50'	061° 04.70'	485	
	"	174-1	18:28		63° 00.90'	061° 09.70'	308	EBS / D
			18:52	on grnd	63° 01.10'	061° 09.10'	311	
			19:03	heave	63° 01.30'	061° 08.60'	365	
			19:21	on board	63° 01.30'	061° 08.30'	367	
	"	175-1	19:40		63° 01.10'	061° 08.40'	346	EBS
			19:56	on grnd	63° 01.00'	061° 08.80'	305	
			20:09	heave	63° 00.88'	061° 09.34'	304	
			20:25	on board	63° 00.82'	061° 09.41'	303	
01.05.	"	176-1	12:03		62° 55.70'	060° 26.50'	493	F trap recov
			12:29		62° 55.70'	060° 27.00'	484	
	"	176-2	13:16		62° 55.70'	060° 27.00'	484	MG
			13:34	on grnd	62° 55.70'	060° 27.10'	486	
			13:46		62° 55.70'	060° 27.20'	491	
	"	177-1	17:49		62° 49.30'	060° 46.80'	202	GSN
			18:08	on grnd	62° 49.50'	060° 49.30'	202	
			18:34	off grnd	62° 50.40'	060° 51.60'	200	
			18:58	on board	62° 50.80'	060° 53.10'	205	
	"	177-2	19:57		62° 49.20'	060° 49.50'	202	EBS / D
			20:17	on grnd	62° 50.13'	060° 50.39'	204	
			20:28	heave	62° 50.16'	060° 50.53'	206	
			20:44	on board	62° 50.15'	060° 50.53'	205	
	"	177-3	21:09		62° 49.98'	060° 50.40'	204	MG
			21:22	on grnd	62° 49.98'	060° 50.40'	196	
			21:27		62° 49.99'	060° 50.51'	203	
02.05.	"	178-1	13:30		61° 59.60'	060° 21.30'	753	MG
			14:03	on grnd	61° 59.40'	060° 21.60'	835	
			14:26		61° 59.30'	060° 22.00'	892	
	"	178-2	15:29		62° 00.40'	060° 21.90'	577	GSN
			16:26	on grnd	61° 58.50'	060° 18.70'	804	
			17:04	off grnd	61° 57.30'	060° 16.70'	930	
			17:55	on board	61° 56.80'	060° 16.70'	1054	
	"	179-1	18:51		61° 59.80'	060° 17.20'	388	MG

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			19:18		62° 00.00'	060° 16.90'	389	
	"	180-1	20:54		62° 06.70'	060° 21.68'	207	MG
			21:07	on grnd	62° 06.70'	060° 21.68'	203	
			21:14		62° 06.74'	060° 21.83'	206	
	"	180-2	21:51		62° 06.84'	060° 22.07'	206	EBS / D
			22:08	on grnd	62° 07.20'	060° 22.80'	200	
			22:18	heave	62° 07.40'	060° 23.00'	201	
			22:27	off grnd	62° 07.40'	060° 23.10'	201	
			22:35	on board	62° 07.40'	060° 23.12'	199	
	"	180-3	23:22		62° 06.76'	060° 22.01'	204	MN
			23:31	at depth	62° 06.76'	060° 22.01'	194	
			23:46		62° 06.86'	060° 22.09'	206	
03.05.	"	180-4	0:30		62° 06.90'	060° 22.10'	207	SHHN
			1:05		62° 07.30'	060° 21.90'	207	
	"	180-5	1:25		62° 07.00'	060° 21.70'	203	CTD
			1:40		62° 07.00'	060° 21.50'	203	
	"	181-1	2:43		62° 00.10'	060° 17.40'	385	CTD
			3:06		62° 00.20'	060° 17.20'	390	
	"	181-2	3:13		62° 00.30'	060° 17.20'	389	MN
			3:27	at depth	62° 00.30'	060° 17.20'	389	
			3:46		62° 00.50'	060° 17.10'	387	
	"	181-3	4:19		62° 00.60'	060° 16.80'	387	SHHN
			5:06		62° 00.90'	060° 16.70'	304	
	"	182-1	5:46		61° 57.70'	060° 16.70'	831	CTD
			6:21		61° 57.80'	060° 16.60'	790	
	"	182-2	6:30		61° 57.90'	060° 16.80'	774	MN
			7:20		61° 58.20'	060° 16.70'	624	
		182-3	7:47		61° 58.50'	060° 18.60'	819	LHHN
			8:28		61° 58.47'	060° 19.05'	836	
	"	183-1	12:19		62° 05.50'	060° 18.70'	236	GSN
			12:43	on grnd	62° 06.70'	060° 21.70'	204	
			13:08	off grnd	62° 07.60'	060° 23.50'	200	
			13:27	on board	62° 08.30'	060° 24.90'	199	
	"	184-1	17:33		61° 59.70'	060° 16.90'	391	GSN
			18:04	on grnd	62° 00.90'	060° 20.70'	374	
			18:30	off grnd	62° 01.90'	060° 22.90'	338	
			18:59	on board	62° 02.70'	060° 25.00'	297	
	"	184-2	19:42		61° 59.80'	060° 18.00'	389	EBS
			20:05	on grnd	62° 00.09'	060° 19.33'	399	
			20:15	heave	62° 00.26'	060° 19.54'	391	
			20:23	off grnd	62° 00.26'	060° 19.54'	391	
			20:36	on board	62° 00.22'	060° 19.75'	399	
	ADB	185-1	17:41		62° 10.99'	058° 20.90'	400	F trap No.1
			18:04	release	62° 10.87'	058° 21.00'	402	
04.05.	"	186-1	19:06		62° 11.00'	058° 25.10'	203	F trap No.2
			19:21	release	62° 11.02'	058° 25.13'	202	
05.05.	KG	187-1	3:32		62° 18.80'	058° 34.90'	310	CTD
			3:57		62° 18.70'	058° 34.70'	286	
	"	187-2	4:14		62° 18.80'	058° 34.50'	305	MN
			4:38		62° 18.70'	058° 34.30'	302	
	"	188-1	4:59		62° 18.70'	058° 34.70'	255	SHHN
			5:44		62° 18.80'	058° 34.90'	288	
	"	188-2	5:55		62° 18.70'	058° 34.60'	263	SHHN
			6:37		62° 18.70'	058° 34.60'	278	
	"	188-3	6:51		62° 18.60'	058° 34.40'	254	SHHN
			7:28		62° 18.60'	058° 34.20'	255	
	"	188-4	7:35		62° 18.60'	058° 34.30'	245	LHHN
			8:11		62° 18.55'	058° 34.13'	236	
	"	189-1	8:24		62° 18.48'	058° 34.14'	205	CTD
			8:45		62° 18.47'	058° 34.11'	205	

Date	Area	Stat.	Time (UTC)	Action	Lat. (°S)	Long. (°W)	Depth (m)	Operation
			9:00	at depth	62° 18.45'	058° 34.09'	205	
			9:13		62° 18.45'	058° 34.04'	203	
	"	189-3	9:36		62° 18.49'	058° 34.11'	209	BO
			9:39	stop	62° 18.49'	058° 34.11'	209	
			10:10	repetition	62° 18.56'	058° 33.51'	293	
			10:26		62° 18.77'	058° 32.53'	453	
	"	190-1	14:29		62° 17.30'	058° 31.10'	99	D
			14:58		62° 17.40'	058° 31.50'	99	
	"	190-2	15:39		62° 18.40'	058° 34.20'	190	MG
			15:53	on grnd	62° 18.40'	058° 34.00'	184	
			15:58		62° 18.40'	058° 34.00'	185	
	"	190-3	16:58		62° 18.60'	058° 38.70'	300	MG
			17:12	on grnd	62° 18.60'	058° 33.70'	306	
			17:19		62° 18.60'	058° 33.60'	303	
	"	191-1	18:51		62° 10.80'	058° 20.60'	379	F trap recov
			19:15	1st on brd	62° 10.80'	058° 21.00'	372	
	"	192-1	19:41		62° 10.90'	058° 24.70'	371	F trap recov
			20:03	2nd on brd	62° 10.80'	058° 25.10'	270	
	"	193-1	21:45		62° 18.48'	058° 32.42'	406	AGT / D
			22:06	on grnd	62° 18.73'	058° 33.57'	353	
			22:30	off grnd	62° 18.90'	058° 33.90'	378	
			22:42	on board	62° 18.92'	058° 33.98'	373	
06.05.	"	194-1	0:02		62° 18.43'	058° 32.33'	394	FTS
			1:08		62° 18.50'	058° 32.70'	369	
	"	195-1	12:08		62° 16.80'	058° 46.40'	512	F trap No.1
			12:29	release	62° 16.76'	058° 46.39'	512	
	"	196-1	13:00		62° 15.80'	058° 48.80'	497	F trap No.2
			13:22	release	62° 15.70'	058° 48.80'	513	
	"	197-1	14:10		62° 15.60'	058° 44.20'	307	FTS
			15:16		62° 15.50'	058° 44.70'	331	
	"	198-1	12:04		62° 15.70'	058° 49.10'	424	F trap recov
			12:26	2nd on brd	62° 15.70'	058° 48.90'	504	
	"	199-1	12:56	1st on brd	62° 16.60'	058° 47.70'	485	F trap recov

3.3 Participants

EASIZ Participants

Name	First Name	Institution	Country
Alfonso	Maria Isabel	UDS	E
Allcock	Louise	NMS	UK
Arntz	Wolf	AWI	D
Artigues	Bernat	CSIC	E
Bader	Beate	IGW	D
Baumgartner	Martha	AWI	D
Bohn	Jens Michael	ZLMU	D
Brey	Thomas	AWI	D
Coon	Max	TUD	DK
Cornils	Astrid	AWI	D
Dewicke	Ann	UGZ	B
Doble	Martin	SPRI	UK
Drebing	Wolfgang	AWI	D
Gasol	Joseph	ICM	E
Gerdes	Dieter	AWI	D
Gili	Josep Maria	ICM	E
Goerke	Helmut	AWI	D
González	José	IEO	E
Grabbert	Sabine	UOL	D
Heilmayer	Olaf	AWI	D
Hoge	Ulrich	AWI	D
Hohmann	Constanze	AWI	D
Janssens	Thiery	UGZ	B
Klein	Boris	AWI	D
Knust	Rainer	AWI	D
Krüger	Oliver	AWI	D
León	Roxana Paola	UMIP	CH
López-González	Pablo	USE	E
Lörz	Anne-Nina	ZIZM	D
Marquardt	Lucie	AWI	D
Mehlhorn	Birgit	IZUD	D
Mehlhorn	Heinz	IZUD	D
Mintenbeck	Katja	AWI	D
Montiel	Américo	UMIP	CH
Müller	Annegret	AWI	D
Orejas	Covadonga	AWI	D
Pagès	Francesc	ICM	E
Palanques	Albert	ICM	E
Pedrós-Alió	Carlos	ICM	E
Peppe	Oliver	DML	UK
Piraino	Stefano	IET	I
Raguá	Juanita	AWI	D
Rauschert	Martin	ZMB	D
Rossi	Sergi	ICM	E
Sabater	Francesc	UB	E
Sartoris	Franz-Joseph	AWI	D
Schrödl	Michael	ZSM	D
Schroeder	Alexander	AWI	D
Sirenko	Boris	ZISP	RUS
Smirnov	Igor	ZISP	RUS
Starmans	Andreas	AWI	D
Suck	Inken	AWI	D
Teixidó	Nuria	AWI	D
Weber	Kurt	AWI	D
Ziemer	Ole	ZIZM	D

Helicopter Crew & Meteorologists

Name	First Name	Institution	Country
Dinkeldein	Wolfgang	HSW	D
Köhler	Herbert	DWD	D
Stich	Michael	HSW	D
Lahrmann	Uwe	HSW	D
Strüfing	Reinhard	DWD	D
Zepick	Burkhard	HSW	D

From Jubany

Name	First Name	Institution	Country
Bornemann	Horst	AWI	D
Jerí	Teresa	AWI	D
Plötz	Jochen	AWI	D
Ramdohr	Sven	AWI	D
Steinmetz	Richard	AWI	D

3.4 Participating Institutions

	Institution	Address
AWI	Alfred Wegener Institute For Polar and Marine Research	Columbusstrasse 27568 Bremerhaven Germany
CSIC	Instituto de Estudios Avanzados de las Islas Baleares	Campus Universitari 07071 Palma de Mallorca Spain
DML	Dunstaffnage Marine Laboratory	P.O. Box 3 Oban, Argyll, PA 34 4AD Scotland / U.K.
DWD	Deutscher Wetterdienst Geschäftsfeld Seeschiffahrt	P.O. Box 700421 22004 Hamburg Germany
HSW	Helicopter Service Wasserthal GmbH	Kätnerweg 43 22393 Hamburg Germany
ICM	Institut de Ciències del Mar	Plaça del Mar s/n 08039 Barcelona Spain
IEO	Instituto Español de Oceanografía	Carretera San Andrés 38120 Santa Cruz de Tenerife Spain
IET	Instituto Exp. Talassographico	Via Roma 3 74100 Tarantro Italy
IGW	Institut für Geowissenschaften an der Universität Kiel	Ludewig-Meyn-Str. 10 24118 Kiel Germany
IZUD	Institut für Zoomorphologie Universität Düsseldorf	Universitätsstrasse 1 40225 Düsseldorf Germany
NMS	National Museum of Scotland	Chambers Street Edinburgh Scotland / U.K.
SPRI	Scott Polar Research Institute	Lensfield Road Cambridge CB2 1ER U.K.
TUD	Technical University of Denmark	Anker Engelundsvej 1 2800 Lyngby Denmark
UB	Universidad de Barcelona Fac. Biología, Dep. Ecología	Av. Diagonal 645 08028 Barcelona Spain

	Institution	Address
UDS	Universidad de Sevilla Laboratorio de Biologica Marina	Avd. Reina Mercedes No. 6 41012 Sevilla Spain
UGZ	University of Gent Institute of Zoology	K.L. Ledeganckstraat 35 9000 Gent Belgium
UMIP	Universidad de Magallanes Instituto de la Patagonia	Av. Bulnes 61890 Punta Arenas Chile
UOL	Universität Oldenburg	P.O. Box 2503 26111 Oldenburg Germany
USE	Universidad de Sevilla Laboratorio de Biologá Marina	Apdo. 1095 41080 Sevilla Spain
ZISP	Zoological Institute Russian Academy of Science	Universitetskaya Emb. 1 St. Petersburg 199034 Russia
ZIZM	Zoologisches Institut und Museum der Universität Hamburg	Martin Luther King Platz 3 20146 Hamburg Germany
ZLMU	Zoologisches Institut der L.M. Universität München	Karlstr. 25 80333 München Germany
ZMB	Zoologisches Museum Berlin	Invalidenstrasse 43 10115 Berlin Germany
ZSM	Zoologische Staatssammlung München	Münchhausenstrasse 21 81245 München Germany

3.5 Ship's Crew

Name	First Name	Rank	Country
Keil	Jürgen	Master	Germany
Grundmann	Uwe	1. Offc.	Germany
Schulz	Volker	Ch. Eng.	Germany
Rodewald	Martin	1. Offc./L	Germany
Boche	Martin	2. Offc.	Germany
Peine	Lutz G.	2. Offc.	Germany
Evers	Fridtjof	Doctor	Germany
Hecht	Andreas	R. Offc.	Germany
Delff	Wolfgang	1. Eng.	Germany
Folta	Henryk	2. Eng.	Germany
Simon	Wolfgang	2. Eng.	Germany
Baier	Ulrich	Electron.	Germany
Dimmler	Werner	Electron.	Germany
Fröb	Martin	Electron.	Germany
Holtz	Hartmut	Electron.	Germany
Piskorzynski	Andreas	Electron.	Germany
Loidl	Reiner	Boatsw.	Germany
Nelsner	Winfried	Carpenter	Germany
Bäcker	Andreas	A. B.	Germany
Bindemagel	Knuth	A. B.	Germany
Bohne	Jens	A. B.	Germany
Hagemann	Manfred	A. B.	Germany
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