# The Expedition ANTARKTIS VII/4 (EPOS leg 3) and VII/5 of RV "Polarstern" in 1989

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# ANT VII/4 (EPOS leg 3)
# PUNTA ARENAS - CAPE TOWN

## January 13 - March 10, 1989

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# ANT VII/5
# Cape Town - Bremerhaven

## March 12 - April 6, 1989

FAHRTLEITER/CHIEF SCIENTIST

W. ERNST

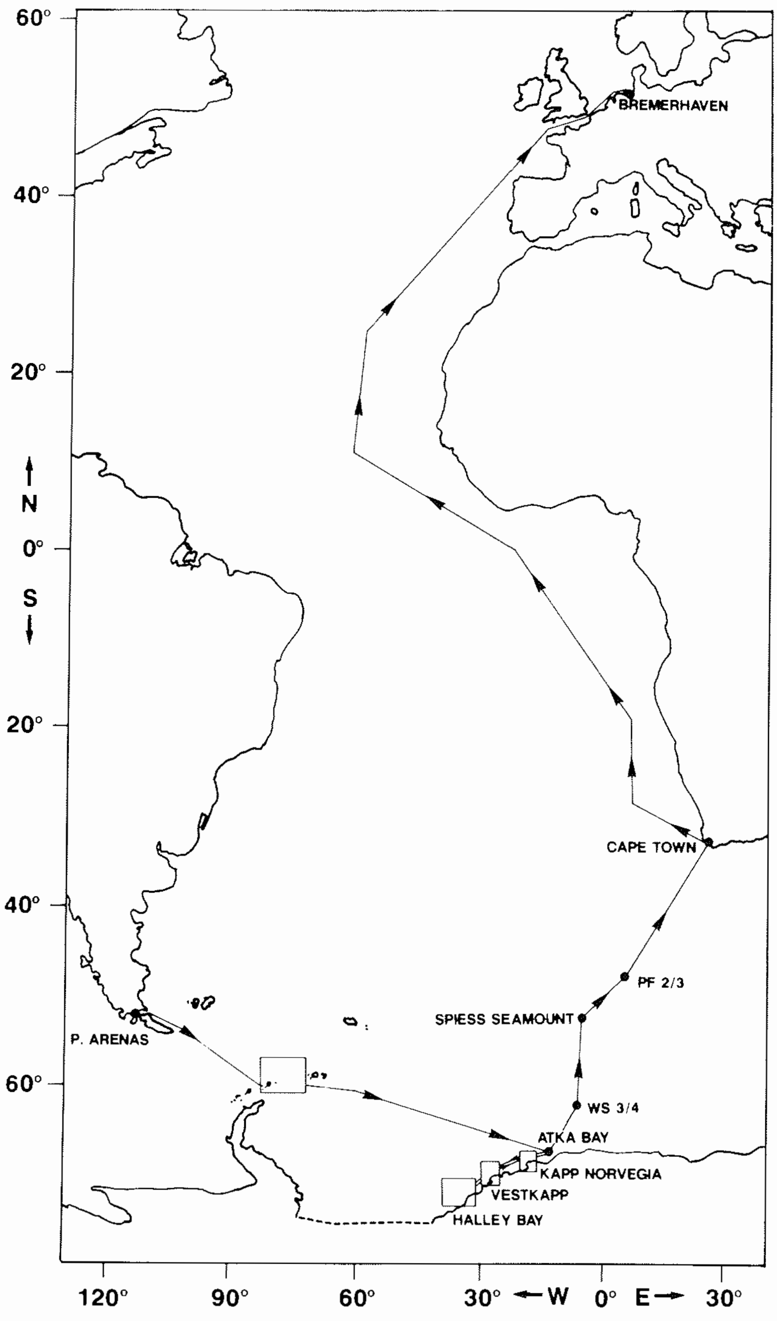


Figure 1: Itinerary FS "Polarstern" ANT VII/4 and 5

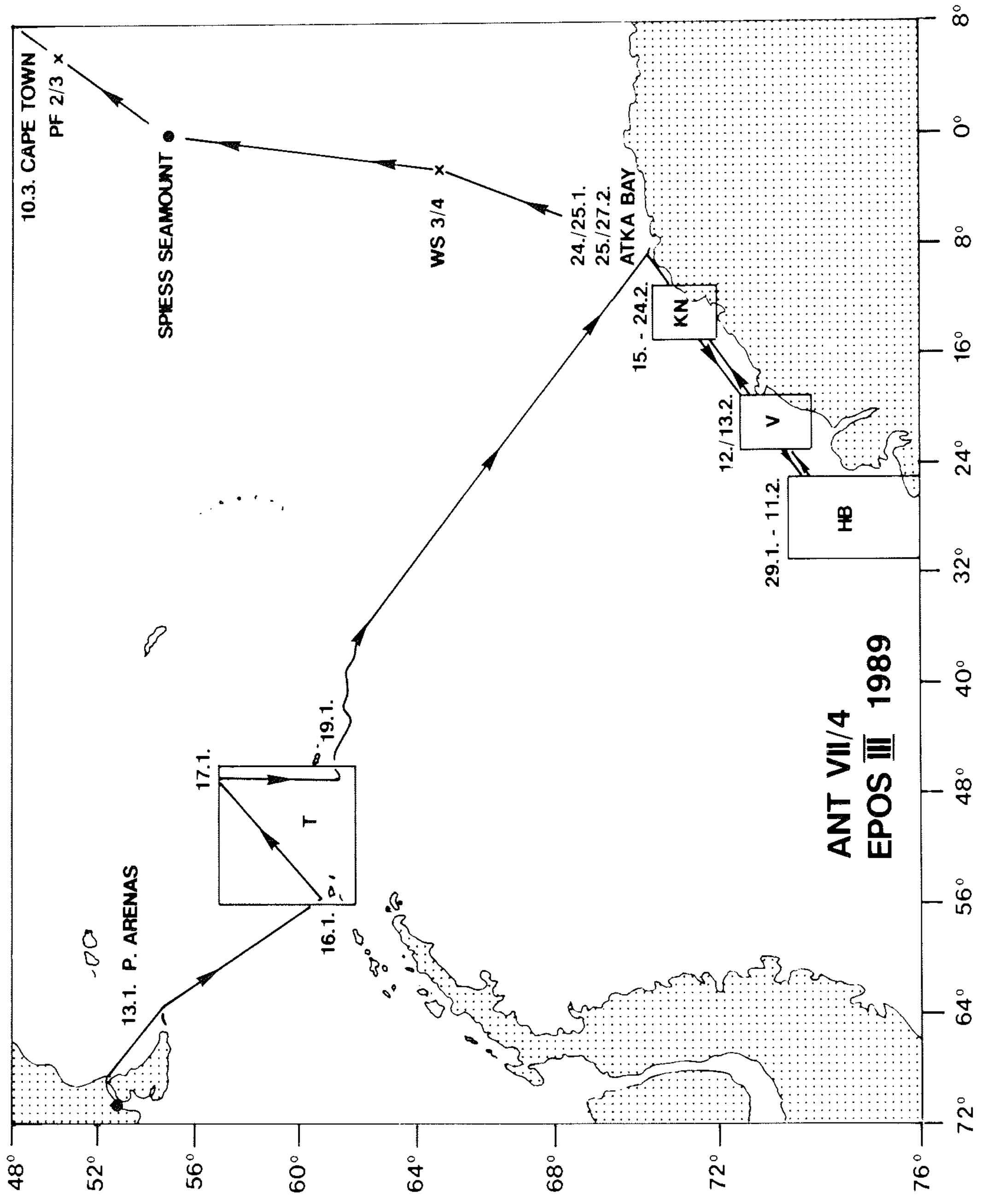


Figure 2: Itinerary of EPOS leg 3

T - Transect 47°W
KN - Kapp Norvegia
V - Vestkapp
HB - Halley Bay

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ANT VII/4 (EPOS leg 3) PUNTA ARENAS-CAPE TOWN
(January 13 - March 10, 1989)

# 1. INTRODUCTION

## 1.1 General objectives

W. Arntz, J.C. Hureau

The principal objective of EPOS leg 3, as outlined in the expedition programme, was the extension of knowledge on the high Antarctic ecosystem by means of an integrated study of benthos and fish communities in relation to biotic and abiotic environmental conditions.

This included:

- a detailed study of the macrobenthos, benthic meiofauna, pelagic and demersal fish communities related to depth, oceanographic conditions, and sediment properties;

- a study of the ecology, including bathymetric distribution, reproduction and feeding of selected groups of benthic organisms, paying special attention to amphipods, caridean shrimps, molluscs, sponges, harpacticoids, and fish. In some cases these investigations were complemented by underwater photography and observations on live material in cooled laboratory containers;

- chromosome morphology (karyology) and enzyme polymorphism studies, to provide information relevant to population dynamics, taxonomy and phylogeny of fish;

- physiological investigations on selected species to study adaptations of organisms to particular features of the high Antarctic, such as extremely low temperatures and short production periods;

- a study of the vertical distribution, and the C and N metabolism, of water column phyto- and zooplankton, bacteria and suspended matter in relation to hydrography, depth and sediment conditions at the seafloor.

During the cruise, the originally selected area of study near Vestkapp was abandoned in favour of a comparison of two transects off Halley Bay and Kapp Norvegia. Studying former underwater videos of the area, it was felt that the benthos off Vestkapp might be transitional rather than revealing typical features of either the Eastern or Southern Shelf Community described by Voss (1988). Thus the original idea of an integrated study of the (presumably) richest of the benthic communities, the Eastern Shelf Community, at a single site was replaced by a comparison of two, possibly different, communities on the southeastern Weddell Sea shelf and slope. As many samples as possible were taken from different compartments of the ecosystem (oceanographic data, water samples, plankton/fish/benthos samples of all size fractions, sediment samples), at the same time from the same stations, to be able to interrelate the various results later on. The idea of investigating a third, virtually unknown area on the Astrid Ridge had to be cancelled at an early stage due to lack of time as well as unfavourable ice and weather conditions during the central part of the cruise.

Besides the principal objectives outlined above, EPOS leg 3 had to accomplish a number of duties which were not directly connected with the ecological studies carried out in the inner Weddell Sea. They included a repetition of a transect along 47°W to continue the water column studies begun during legs 1 and 2 (this transect will be dealt with in the first part of the special cruise report), the relief of Neumayer station, retrieval and deployment of several moorings on the way to and from the Weddell Sea, and one working day each off Elephant Island and at the Spiess sea-mount near Bouvet Island. These extra duties reduced the time available for biological work in the inner Weddell Sea to about four weeks.

References

VOSS, J., I988. Zoogeography and community analysis of macrozoobenthos of the Weddell Sea (Antarctica). - (In German) - Berichte zur Polarforschung 45: I44 pp.

## 1.2 Summary review of EPOS leg 3

W. Arntz, J.C. Hureau

Many of the samples taken during the cruise need further careful analysis in the forthcoming months, and many of the results particularly from the zooplankton, benthos, and fish studies are not yet available at this time. However, the following preliminary findings can be identified at the time of writing:

- The cruise met with exceptional hydrographic and ice conditions on the entire eastern Weddell Sea shelf and slope. Off Halley Bay "Polarstern" encountered exceptionally warm surface temperatures (ab. 2°C above normal) and hardly any ice, whereas stormy conditions with subsequent mixing of surface waters down to 250 m depth prevailed off Kapp Norvegia. Even under such conditions a certain amount of warm deep water reached the shelf off Halley, demonstrating that the benthos in this area is not entirely undisturbed, whereas the surface mixing off Kapp Norvegia did not seem to have any impact on benthic life on the lower shelf and slope. Obviously, water circulation in the eastern Weddell Sea is rather variable and requires more long-term moorings to account for seasonal oscillations.

- Zoo- and ichthyoplankton samples were most effectively gathered by the new version of the rectangular midwater trawl (RMT 8+1). Off Halley, neritic fish larvae extended far into the oceanic regime which on the whole is, however, characterized by a different set of species and size spectra. A 24 hr station revealed that there is a clear diel rhythm in ichthyoplankton with densities recorded by the trawl ab. 50 % lower during the day. For the first time, a relatively large number of squid was caught both by the bottom trawl and the semipelagic trawl.

- ATP measurements in the water column showed a high plankton biomass with a slow respiration rate and high input into the food web. The abundance of flagellates in the pelagic zone off Halley Bay and Kapp Norvegia was found to be much lower than on the 47°W transect in the Scotia Arch region. Also the density of benthic flagellates on the high Antarctic shelf was found to be surprisingly low.

- Benthic meiofauna was investigated quantitatively for the first time in the high Antarctic, and sampling carried out down to 2000 m. Generally the fauna was highly diverse despite the fact that several taxa which abound in other marine areas were rare or even absent. Surprisingly, harpacticoid copepods did not reveal reproduction during summer in the field although laboratory experiments had indicated the opposite.

- Benthic macrofauna was collected quantitavely and semiquantitatively by several types of gear down to 2000 m. Although biomass decreased with depth, a considerable amount of life was found below 800 m. Faunal distribution, as also revealed by underwater photography, was very patchy, and extremely rich areas may be located close to barren grounds. Knowledge on zoogeographic and bathymetric distribution of several groups (e.g. amphipods, shrimps, molluscs, sponges, and fish) was considerably improved. Eurybathy seems to be a common feature for many taxa, whereas a clear zonation is applicable to only a few. Molluscs hardly ever use hard substrates as they do in other seas whereas brachiopods do so frequently.

- The sponge specialists take home the best collection ever obtained from high Antarctic bottoms and will thus fill a gap in Antarctic science. They also revised former statements as to regional occurrence and relative importance of this group on the eastern Weddell Sea shelf and slope. Particularly interesting are some of their findings concerning sponge associated species.

- About 2000 amphipods of 25 species, 350 molluscs of 40 species, and 50 fish of 10 species were taken back to Europe alive in cooled laboratory containers to continue life cycle and ethological studies. Experiments in situ and in aquaria revealed high feeding rates for amphipod scavengers, which stresses their role in the Antarctic food web. Caridean shrimps were found not only to have larger eggs but also eggs with a higher protein content with increasing latitude.

- The fish fauna of the Weddell Sea which had been investigated on two previous occasions was found to be even more diverse than anticipated; of 64 species encountered in total, 14 were found in the area for the first time. One Channichthyid (white-blooded icefish) was recorded from a trawl at 2000 m depth. 45 caryotypes of fish species were identified, only 7 of which were known to science, and 46 fish species were studied for enzyme polymorphism. The use of different types of commercial trawls including a semipelagic net proved to be very useful and may be partly responsible for the large number of species registered.

- For the first time, shipboard physiological investigations on Antarctic fish were done on a large number of species, especially those that cannot be obtained alive in another way. A large number of samples have been taken for ultrastructural and biochemical studies.

## 1.3 Fahrtverlauf/Itinerary of the cruise

W. Arntz, J.C. Hureau

"Polarstern" verließ Punta Arenas (Chile) am 13. Januar 1989 mit einem internationalen Forscherteam von 44 Meeresbiologen, Ozeanographen und Meteorologen aus 8 Ländern sowie 44 Besatzungsmitgliedern und 22 Gästen an Bord. Letztere setzten sich aus Personal der Stationen Georg von Neumayer und Halley Bay, dem Hubschrauberteam, einem Bautrupp und zwei Journalisten zusammen. Das Schiff überquerte die Drake-Passage bei ruhigem Wetter und nahm bis Elephant Island, das am 15. Januar erreicht wurde, nur eine Reihe von XBTs. Auf dem Schelf der Insel wurden zwei erfolgreiche Probefänge mit dem Grundschleppnetz auf 200 und 400 m Tiefe durchgeführt.

Ozeanographische und planktologische Arbeiten auf dem 47°W-Transekt begannen bei 57°S am Morgen des 17. Januar und wurden am 19. Januar bei 61°30'S abgeschlossen (Abb. 3). Der Transekt, der in der Nacht vom 17. Januar auf den 18. Januar wegen starken Winds und Seegangs unterbrochen werden mußte, umfaßte 6 CTD und 23 Planktonfänge. Auf der Höhe von Signy Island wurde ein weiterer Grundschleppnetzhol auf 230 m Tiefe genommen.

Südlich Signy fand "Polarstern" lockeres Treibeis, Nebel, Schneeschauer und zunächst noch wenig Wind vor. Am 22. Januar traf das Schiff auf offenes Wasser und steuerte die Atka-Bucht bei zunehmendem Wind und Seegang an. Vor dem Einlaufen in die Bucht, die zu diesem Zeitpunkt noch von Eis bedeckt war, wurde ein Satz beköderter Amphipodenfallen ausgebracht. "Polarstern" machte an der Eiskante am Abend des 23. Januar fest. Drift und Whiteout verhinderten an diesem und einem großen Teil des folgenden Tages jedweden Hubschrauberaustausch mit der Neumayer-Station, so daß das Überwinterungsteam, der Bautrupp und alle Lasten mit Schneefahrzeugen transportiert werden mußten.

In der Nacht des 24. Januar verließ "Polarstern" nach einem fruchtlosen Versuch, die Amphipodenfallen aufzunehmen, den Schutz des Eises in der Atka-Bucht und steuerte in stürmischem Wasser Halley Bay an. Auf dem Weg wurde eine volle Station mit ROV, CTD, RMT, zwei benthischen Multicorern für Meio- und Makrofauna und einem Grundschleppnetzhol gefahren, der über 15 t Schwämme in einer Viertelstunde erbrachte. Eine im Vorjahr ausgebrachte Verankerung wurde aufgenommen und im gleichen Gebiet wieder ausgesetzt. Da sich das Wetter besserte, machte "Polarstern" einen kurzen Abstecher ins Drescher-Inlet. Es zeigte sich, daß die nordöstliche Ecke der Schelfeiskante mit der Rampe abgebrochen war und die Container der Drescher-Station bis zu den Dächern von Schnee bedeckt waren. Am 28. Januar traf das Schiff vor Halley Bay ein, und die britischen Gäste wurden per Hubschrauber zur Station gebracht.

Das Seegebiet vor Halley war überraschenderweise mit Ausnahme einiger großer Eisberge praktisch eisfrei, und die Oberflächentemperaturen lagen um fast 2°C höher als normalerweise um diese Jahreszeit. "Polarstern" fand während der gesamten Stationszeit in diesem Gebiet wenig Wind und mildes Wetter vor. Insgesamt wurde so ein umfangreiches Programm von 17 Stationen zwischen 150 und 2000 m Tiefe mit CTD-Rosetten, Bongo-, Fransz- und Fischlarvennetzen in der Wassersäule sowie Grundschleppnetz, Agassiztrawl, Meiofaunacorer und Makrofauna-Mehrfachgreifer am Boden durchgeführt. Die Probennahme, die pro Station gewöhnlich einen Tag in Anspruch nahm, wurde durch Unterwasserphotographie an den gleichen Stellen ergänzt. In einer späteren Phase ersetzte ein hochstauendes semipelagisches Netz das Grundschleppnetz mit guten Resultaten. Zwei zusätzliche CTD-Transekte parallel bzw. senkrecht zu den biologischen Stationen wurden während der Dunkelheit durchgeführt, um die ozeanographischen Bedingungen im Untersuchungsgebiet besser zu erfassen (Abb. 5).

Die Rückreise begann am 10. Februar nach einem kurzen Treffen mit dem britischen Versorgungsschiff "Bransfield" und dem Besuch der alten und der neuen (im Bau befindlichen) Halley Bay-Station durch eine Abordnung der "Polarstern". Entlang der Eiskante auf dem Weg nach Kapp Norvegia gab es erneut loses Treibeis, aber die Schollen waren zu zerbrechlich, um die ARGOS-Bojen darauf auszusetzen; diese wurden daher in offenes Wasser ausgebracht. Am 12. und 13. Februar wurden auf Wunsch der Fisch- und Garnelenforscher einige Trawlfänge in einer Küstenpolynya vor Vestkapp gemacht (Abb. 4). Unglücklicherweise wurde das benthopelagische Netz dabei der Länge nach von Korallen aufgeschlitzt und fiel für die weitere Arbeit auf dieser Reise aus.

Als "Polarstern" die Polynya vor Vestkapp verließ, mußte sie sich mit einem schweren Sturm auseinandersetzen, der am 16. und 17. Februar Orkanstärke erreichte. Größere Schäden wurden vermieden, da das Schiff sich im Schutz der Eiskante hielt, aber die Arbeiten vor Kapp Norvegia konnten fünf Tage lang nur sehr eingeschränkt durchgeführt werden. Trotz dieser Behinderung und einer großen Zahl zerrissener Grundschleppnetze und Agassiztrawls wurde der Vergleichs-Transekt zwischen 200 und 2000 m vor Kapp Norvegia am 21. Februar einigermaßen zufriedenstellend abgeschlossen (Abb. 6).

Nach einem multinationalen Austausch mit der neuen sowjetischen Drushnaya-Station nahm "Polarstern" die nächtlichen CTD-Hols wieder auf, setzte 4 AWI-Verankerungen und weitere 3 Argosbojen in offenes Wasser aus, holte die Gerdes'schen Besiedlungssubstrate vom Meeresboden herauf und machte eine 24 Std-Station mit CTD und RMT, um tagesperiodische Veränderungen von Plankton und Fischen in der Wassersäule zu verfolgen.

Der zweite Aufenthalt vor der Neumayer-Station am 25. und 26. Februar spielte sich bei gutem Wetter ab. Allerdings konnte "Polarstern" wegen starker ablandiger Winde nicht an der Eiskante festmachen, und die Temperaturen fielen auf -20°C. Das Schiff verließ die Atka-Bucht am Abend des 25. Februar. Auch die erneute Suche nach den Amphipodenfallen blieb erfolglos. Das Wetter auf dem ersten Teil der Heimstrecke hielt sich relativ stabil, und am 28. Februar wurde eine Tiefseeverankerung aus 5000 m aufgenommen und wieder ausgesetzt. Am 3. März wurden 3 Agassiztrawls genommen und eine Reihe von Bodenaufnahmen auf der Spiesskuppe bei der Insel Bouvet gemacht. Nach der Aufnahme einer zweiten Verankerung am 5. März geriet "Polarstern" noch einmal in schweres Wetter und hohen Seegang, bevor sie ruhiges Wasser und schließlich, am 10. März, Kapstadt erreichte.

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"Polarstern" left Punta Arenas (Chile) on January 13, 1989 with an international research team of 44 marine biologists, oceanographers and meteorologists from 8 countries on board, together with 44 crew and 22 guests. The latter were Neumayer and Halley Bay Station personnel, helicopter team, construction crew, and journalists. The vessel crossed Drake Passage in calm weather conditions. Before Elephant Island, which was reached by January 15, only a series of XBT shots were done. Two successful bottom trawl trials were made on the Elephant Island shelf at 200 and 400 m depth.

Oceanographic and planktological work at the 47°W transect began at 57°S in the morning of January 17 and ended at 61°30'S on January 19 (Fig. 3). The transect, which in the night from January 17 to 18 had to be interrupted due to strong wind and swell, comprised a total of 6 CTD and 23 plankton catches. En passant, another bottom trawl haul was taken at 230 m off Signy Island.

South of Signy "Polarstern" encountered loose ice, mist, snow showers and at first, little wind. On January 22 the vessel entered open water and headed towards Atka Bay in increasing wind and swell. Before "Polarstern" entered the bay still covered by ice at that time, a set of baited amphipod traps was deployed. The vessel tied up to the ice edge in the evening of January 23. Drift and whiteout prevented all helicopter exchange with the Neumayer Station then and during large part of the following day, so the overwintering and construction teams and all supplies had to be transported by snow vehicles.

In the night of January 24, after a fruitless attempt at retrieving the amphipod traps, "Polarstern" ventured out of the calming influence of the ice into stormy open water and turned for Halley Bay. On the way one full station was run off Kapp Norvegia including ROV, CTD, RMT, two types of benthic multicorers for meio- and macrofauna, and a bottom trawl which collected more than 15 t of sponges in 15 minutes. A mooring which had been deployed a year before was retrieved and redeployed in the same area. As the weather improved, "Polarstern" made a brief digression into Drescher Inlet. It was found that the NE corner of the shelf ice had broken away, taking the ramp, and the containers of Drescher Station were buried up to their roofs. Halley Bay was reached on January 28, and our British guests were transferred to the Station.

The sea off Halley provided some surprises in that apart from a few large icebergs there was very little ice in the area, and the surface temperature exceeded the normal value for this season by almost 2°C. Furthermore, "Polarstern" encountered little wind and mild temperatures in the region for the entire transect time until February 10. At a total of 17 stations between 150 and 2000 m depth, a full programme of CTD rosette casts, water column work with Bongo, Fransz and fish larvae nets as well as benthos studies with bottom trawl, Agassiz trawl, meiofauna multicorer and multiple box corer was completed, usually dedicating one day to a station and complementing the sampling procedure with a series of sea bottom photography. In a second phase, a high-opening benthopelagic trawl replaced the bottom trawl with good results. Two additional CTD transects, one parallel to the biological stations and one perpendicular to them, were carried out during the hours of darkness to enhance our under-standing of the oceanographic conditions in the research area (Fig. 5).

The return voyage commenced on February 10 after a short meeting with the British supply vessel "Bransfield" and the visit of a small delegation both to the old Halley Bay Station and the new station under construction. Along the ice edge on the way back to Kapp Norvegia there was again some loose drifting ice, but the floes were too fragile to be used for the deployment of the ARGOS buoys which, therefore, had to be deployed into open water. On February 12 and 13, some trawling was done in a coastal polynya off Vestkapp to meet the requirements of the fish and shrimp researchers (Fig. 4); unfortunately the benthopelagic trawl was sliced open by a bank of sharp coral and could not be used any more.

As soon as "Polarstern" left the polynya off Vestkapp, it had to contend with a severe storm which reached gale force on February 16/17. Major damage was avoided as the vessel stayed in the shelter of the shelf ice, but the transect work off Kapp Norvegia was severely restricted for five days. Despite this shortcoming and many torn bottom and Agassiz trawls, the comparative transect work between 200 and 2000 m at Kapp Norvegia was satisfactorily finished on February 21 (Fig. 6).

After a multinational exchange with the new Soviet Drushnaya Station, "Polarstern" started the nightly CTD casts once again, deployed 4 AWI moorings and another 3 ARGOS buoys in open water, retrieved Gerdes´ colonization substrates, and undertook a 24 hr CTD/RMT station to follow diel changes in the water column.

The second relief of Neumayer Station, on February 25 and 26, occurred in good weather, although strong offshore winds prevented "Polarstern" from tying up to the ice shelf and the temperatures fell to -20°C. The vessel left Atka Bay in the evening of February 25. A repeated search for the baited amphipod traps was unsuccessful. The weather conditions remained fairly stable during the first part of the return, and on February 28 a deep-sea mooring of nearly 5000 m was recovered and a new system deployed. On March 3, three Agassiz trawls and a number of bottom photographs were taken on the Spiess sea-mount near Bouvet Island. After retrieval of a second mooring on March 5, "Polarstern" once again ran into heavy weather and a strong fetch before it reached calmer waters, and finally Cape Town on March 10.

## 1.4 Weather conditions

H.A. Pols

In the early morning of January 13, 1989 RV "Polarstern" left Punta Arenas and went through the Strait of Magellan into the Atlantic Ocean. Previously a cyclone had moved over the Drake Passage and its frontal system crossed Patagonia. Favoured by the orography of the Strait of Magellan wind speeds of up to Bft. 10 at times developed on the nearby pier of "Cabo Negro".

The cyclone moved eastward. To the rear of the system a ridge of high pressure had formed over the southern Pacific and southern South America. Thus the ship crossed the Drake Passage and reached Elephant Island in conditions of light to moderate north-westerly winds. During the following days a number of lows moved slowly eastwards to the north of the Weddell and Bellinghausen Seas.

Near Elephant Island helicopters could not be used because of fog which had developed in a weak pressure gradient. On January 17 a depression crossed Patagonia, moved into the southwestern Atlantic and continued to deepen into an intense low. Ahead of this low the northeast to easterly wind intensified and reached gale force during the following night. In the following days this depression became the dominant feature and moved slowly southeastward. On its way eastward "Polarstern" stayed in the vicinity of the center of this cylone. Here the weather situation was dominated by moderate to fresh winds and fog or snow at times.

On 22 January the ship crossed the belt of strong winds between the Antarctic anticylone and the above depression. As a wave depression moved towards Atka Bay, the overwinterers of the Neumayer station could not reach "Polarstern" by helicopter. Also the following day the strong easterly flow persisted. When the ship left Atka Bay, the intense depression moved eastwards and weakened. On its way towards the southeastern Weddell Sea wind force of Bft. 7 to 8 were encountered. From January 26 on weak pressure gradients caused only light winds and clear sky.

In late January, "Polarstern" reached the seaarea near the British Antarctic Station "Halley Bay". While marked low pressure systems moved across the Drake Passage to the southern Atlantic, only small-scale lows developed over the southeastern Weddell Sea. Here light to moderate, dry and cold, easterly winds were experienced off the shelf-ice. Above the relatively warm water some scattered snow-showers developed in the unstable layers of the lower atmosphere. At the end of the month fairer weather conditions returned, to the relief of many EPOS participants.

During the first days of February low pressure gradients persisted, wind force Bft. 5 was the maximum windspeed. Under these conditions no swell developed and work could be done on flat sea at times.

From February 12 the weather situation changed completely. A low tracking eastwards crossed the Antarctic Peninsula, moved to the north of the Weddell Sea and intensified. Ahead of this intense cylone a strong east to northeasterly flow developed. The storm center only moved slowly from the northern Weddell Sea to the east and other lows coming from the west were included. For several days northeast to easterly gales persisted. On its way from Halley to Kapp Norvegia "Polarstern" could only move with low speed, though only low swell developed on a short fetch. In the vicinity of Kapp Norvegia the vessel sought shelter in the lee of an iceberg, which had an extent of more than 15 km. Mean values of windspeed between Bft. 9 and 11 and also some gust up to Bft. 12 prevented work in the open sea. However, close to the ice edge and without swell, some station work could be done.

At the end of the third week of February the gale center moved slowly eastwards and weakened. Another low, which moved eastwards across the Antarctic Peninsula and northern Weddell Sea, gave snow at times, but no gales. Work could be carried out as planned. Also during the following days the relatively calm conditions continued.

At the end of February RV "Polarstern" reached Georg-von-Neumayer-Station once again. At that time to the rear of a filling depression, light to moderate southerly winds prevailed. Loading work was done without any delay, but in the late afternoon of February 25 katabatic effects intensified the south to southeasterly winds and the work had to be interupted; however, it could be continued the following day.

At the beginning of March an intense low moved to the central Weddell Sea. At triple point a secondary low developed and moved eastwards along the 60th degree of latitude. "Polarstern" made its way between these pressure systems and was not affected by the belt of strong winds associated with these lows. Afterwards the ship went northwards and a moderate westerly flow did not disturb the final work.

To the end of EPOS leg 3 a low developed near the South Sandwich Islands and moved to the east. RV "Polarstern" was north of 50° of latitude when wind force Bft. 9 and 10 and a corresponding swell affected the ship once again. At the cold front of this low a wave, which included also subtropical air, turned into a gale center. Because of this depression the windspeeds did not drop. Shortly before arrival in Cape Town light winds, sunshine and warm temperatures were encountered.

(The weather conditions during the cruise have been summarized in short form including additional information; see p. 159 in the Annex).

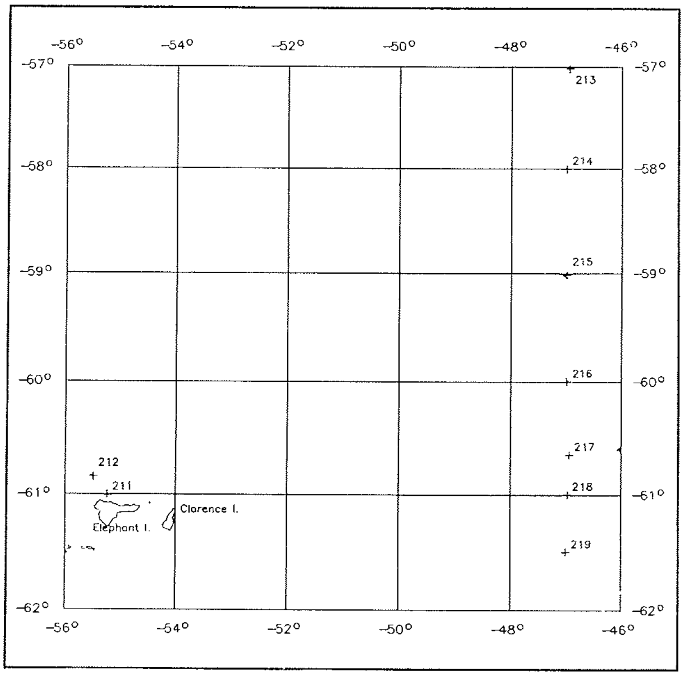



Figure 3: EPOS leg 3, station map of the 47°W transect (16 Jan. - 19 Jan.).

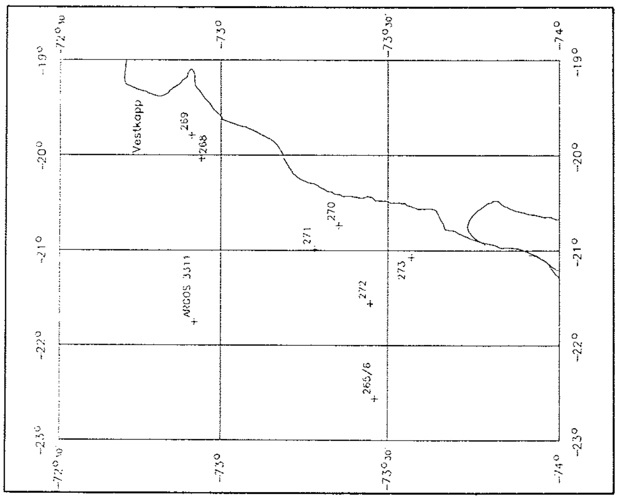



Figure 4: EPOS leg 3, station map of the Vestkapp area (12 Feb. - 13 Feb.).

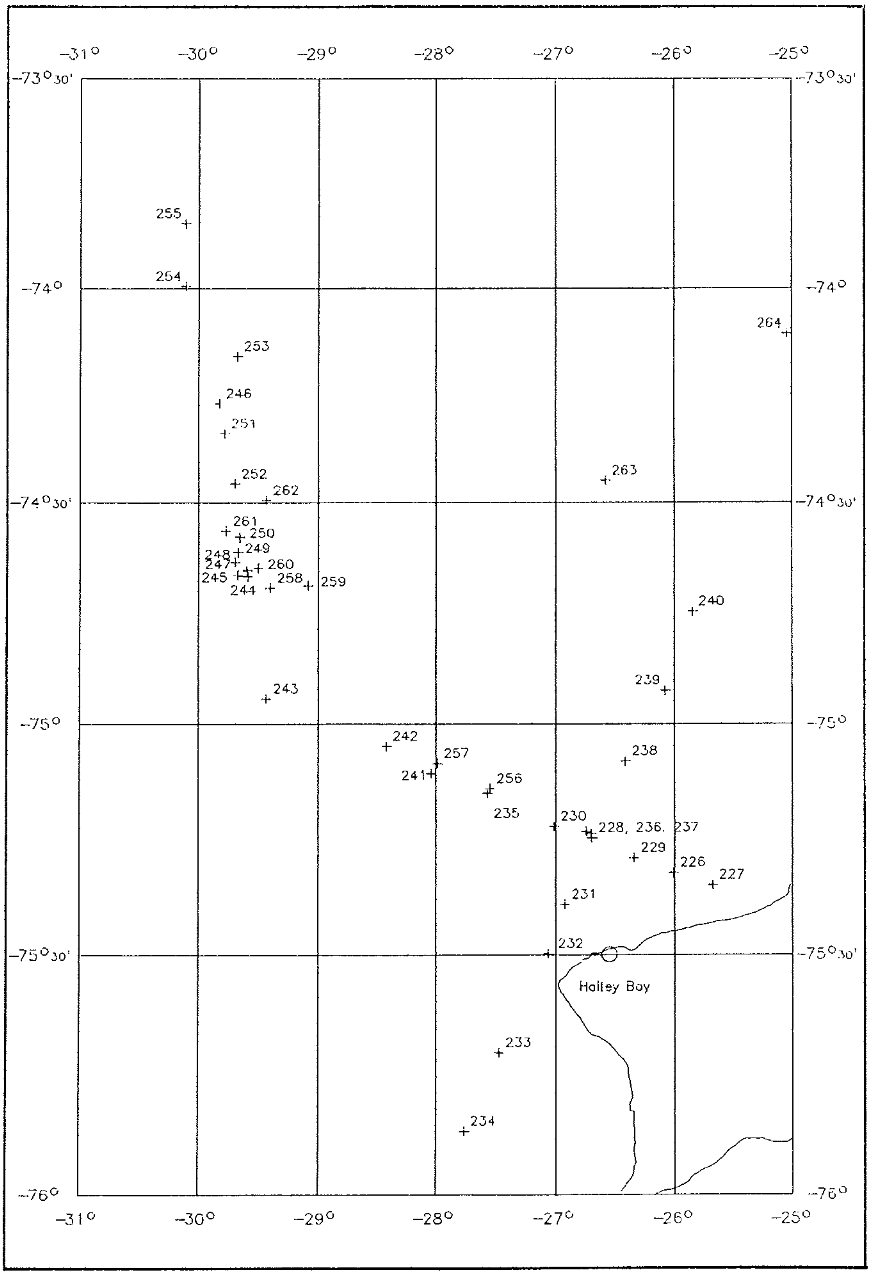



Figure 5: EPOS leg 3, station map of the Halley Bay transect (29 Jan. - 11 Feb.).

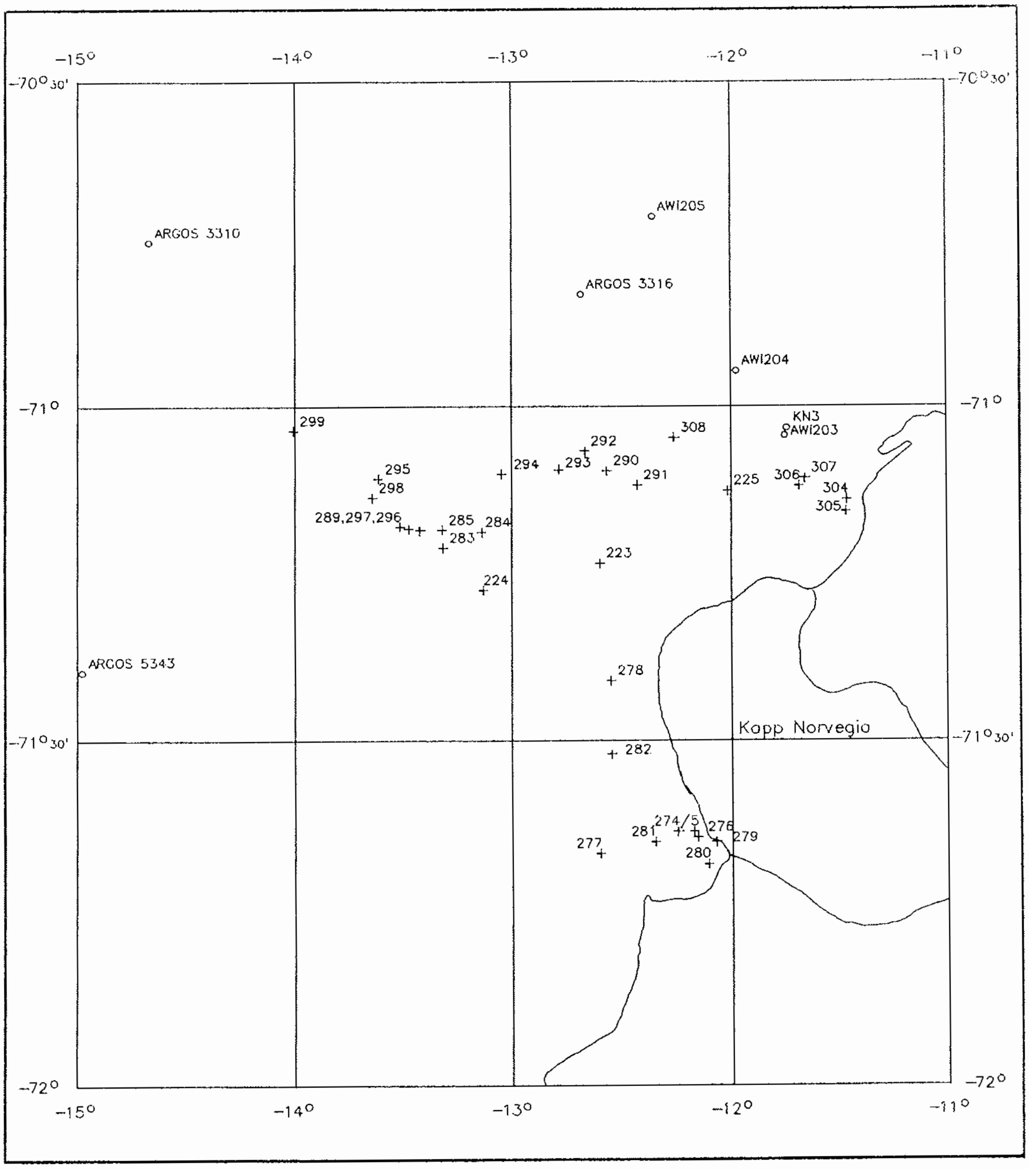



Figure 6: EPOS leg 3, station map of the Kapp Norvegia transect. (15 Feb. - 24 Feb.).

# 2. THE 47°W TRANSECT

## 2.1 OCEANOGRAPHY, SUSPENDED MATTER, AND DISTRIBUTION OF SILICATE AND AMMONIUM

A. Boldrin, D. Gouleau, S. Rabitti, G. Rohardt

Objectives

The main aim of this study was to obtain an oceanographic description of the same area in all three legs of the EPOS program, to follow the variations in oceanographic parameters from the start to the end of Antarctic summer (from October 1988 to January 1989), and to relate biological, physical and chemical characteristics of waters at the Scotia-Weddell confluence.

The program for EPOS leg 3 activity on Transect 47°W was as follows:

- collection of basic data for a general oceanographic description (temperature and salinity, dissolved oxygen and pH);
- study of vertical and horizontal distribution of suspended matter (seston dry weight and particle size distribution);
- estimation of the concentrations of particulate organic carbon and nitrogen;
- examination of the distribution of silicate and ammonium;
- estimation of phytoplankton biomass (as photosynthetic pigments);
- qualitative and quantitative description of the phytoplankton communities.

### 2.1.1 Oceanography and suspended matter

A. Boldrin, S. Rabitti, G. Rohardt

Work at sea

A Neil Brown CTD (Mark III B) was used to identify the water masses of the Scotia Sea and the Weddell Sea. Water samples were taken at 12 standard depth levels (1500, 1000, 500, 200, 100, 80, 60, 40, 30, 20, 10 m and surface) with a 24-bottle rosette (a 12 l and a 5 l bottle for each depth) at 6 stations (cf. Fig. 3). Because of very rough sea no surface samples could be taken at Station 216 and 218.

The observations are based on raw data and are not corrected for salinity.

The following analyses were performed on the sampled water:

- dissolved oxygen (samples : 61)
- pH (60)
- dry weight of seston (61)
- particle size distribution (61)
- particulate organic carbon and nitrogen (61)
- description of seston (SEM observations) (11)
- chlorophyll a and phaeopigments (43)
- phytoplankton description (10).

Dissolved oxygen measurements were made with the standard Winkler method. pH was determined using an Orion pH-meter with a Ross electrode.

Samples for seston dry weight, POC/PON and chlorophyll determination were filtered through Whatman GF/C filters (1 µm nominal pore-size) and immediately stored at -30°C for later analyses.

Electronic particle counting was done by means of a Coulter Counter Mod. TA II multichannel particle counter, using an orifice tube of 100 µm. The range examined was 2 to 40 µm, in 16 size classes. The particle size distribution of seston was determined on board, immediately after water sampling.

Samples for scanning electron microscopy were filtered through polycarbonate Nuclepore filters (0.42 µm nominal pore-size), fixed with glutaraldehyde solution (2 % v/v), and stored at -30°C.

Phytoplankton samples were fixed with buffered (hexamethylentetramin) formalin and stored for later counting.

Preliminary results

The Weddell-Scotia Confluence was found south of St. 215 as indicated by the 0.5°C isotherm (Fig. 7a). The surface temperature decreased from greater than 3°C at the northern part to less than -1°C at the southern part of the transect.

The summer water layer was nearly 40 m thick. The surface salinity (Fig. 7b) was relatively constant and low (less than 33.8 psu). From 50 to about 400 m salinity increased to 34.65 psu. The water column below 400 m was nearly homogenous.

The winter water layer which was found at St. 219 was eroded from freezing temperature up to -1.5°C but its influence extended up to St. 214. At each station the temperature minimum was found at about 100 m depth.

The distributions of dissolved oxygen (Fig. 8), pH and suspended particles (Fig. 9) follow the structure of hydrologic properties. Surface waters (down to about 200 m) showed a clear stratification in all parameters examined but at St. 215 the trend of isolines was generally deflected upward towards the surface. In the northern area the summer water layers were richer in particles than in the southern area (about 50,000 N/cm$^3$ against 30,000 N/cm$^3$ at 10 m depth); at the same time oxygen values, in percent saturation, ranged from 107 % in the north to 98 % in the southern part. The transition zone exhibited lower values both in dissolved oxygen and particle concentration. These observations lead us to suggest the existence of two areas with elevated surface productivity (higher in the northern part), separated by a third with lower productivity. In the northern part of the section, below 200 m, the waters showed low dissolved oxygen concentrations (minimum 4.03 $cm^3/l$ and 52.7 % of saturation, with a pH value of 7.94, at 500 m depth). Total particle concentration was around 2500 particles/$cm^3$, compared to a value of about 2000 N/$cm^3$ that seems to be the ground level in deep waters. Total number and volume occupied by particles decreased dramatically from the surface to deep water.

Waters in the southern area were characterized by a regular decrease of dissolved oxygen concentration with depth down to the bottom (from 8.07 to 4.91 $cm^3/l$), whereas particle concentration showed a progressive decrease from the surface down to 200 m depth (from 30,000 N/$cm^3$ to 2000) and a relative enrichment below 300 m (> 4000 N/$cm^3$).

In Fig. 10 the size spectra of suspended particles at all stations for the surface layer (down to a depth of 500 m), from north to south are reported. Noticeable are the variations of spectra at the surface from 57°S latitude (St. 213) to 61°30´S (St. 219). In the Scotia sea there was a marked peak around 16 µm, which, moving to the Weddell Sea, progressively disappeared and finally returned in the south with a diameter of about 8 µm. These different peaks probably correspond to different phytoplankton populations.

Below the surface, particle size spectra showed a general increase in coarser fractions (> 20 µm).

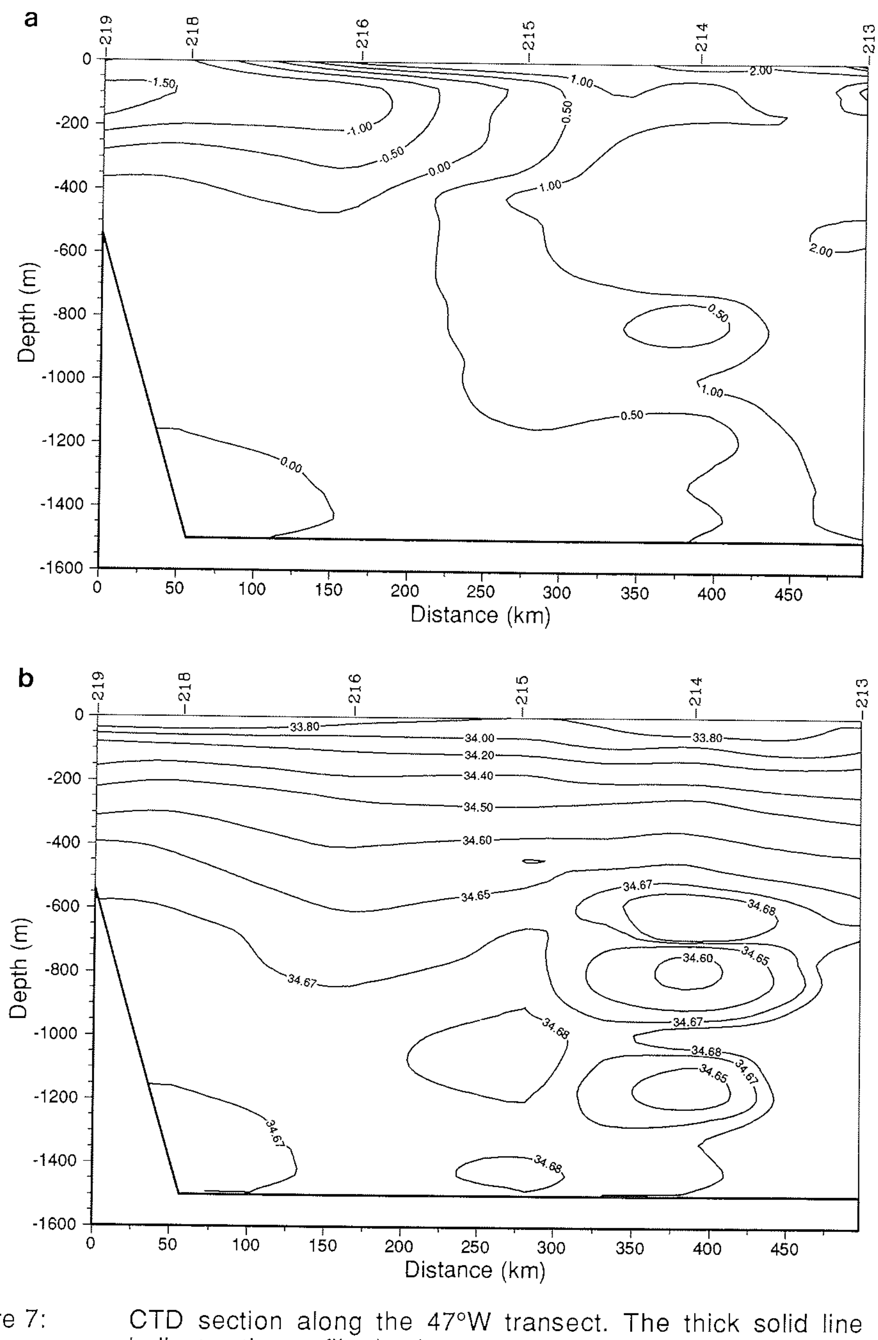



Figure 7: CTD section along the 47°W transect. The thick solid line indicates the profile depth.

(a) Potential temperature (in °C).

(b) Salinity (in psu).

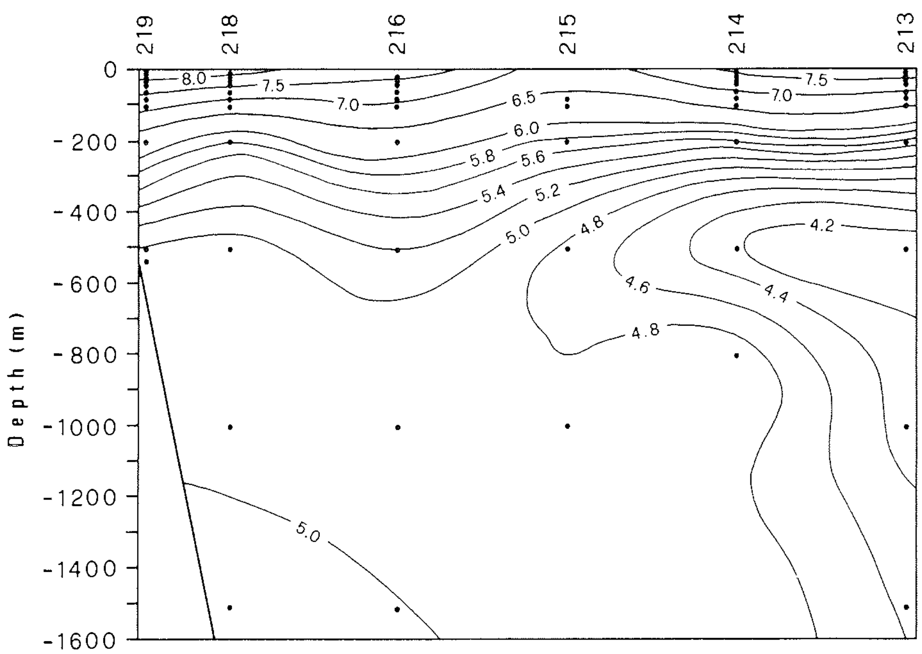



Figure 8: Distribution of dissolved oxygen content in cm$^3$ l$^{-1}$ on the 47°W transect.

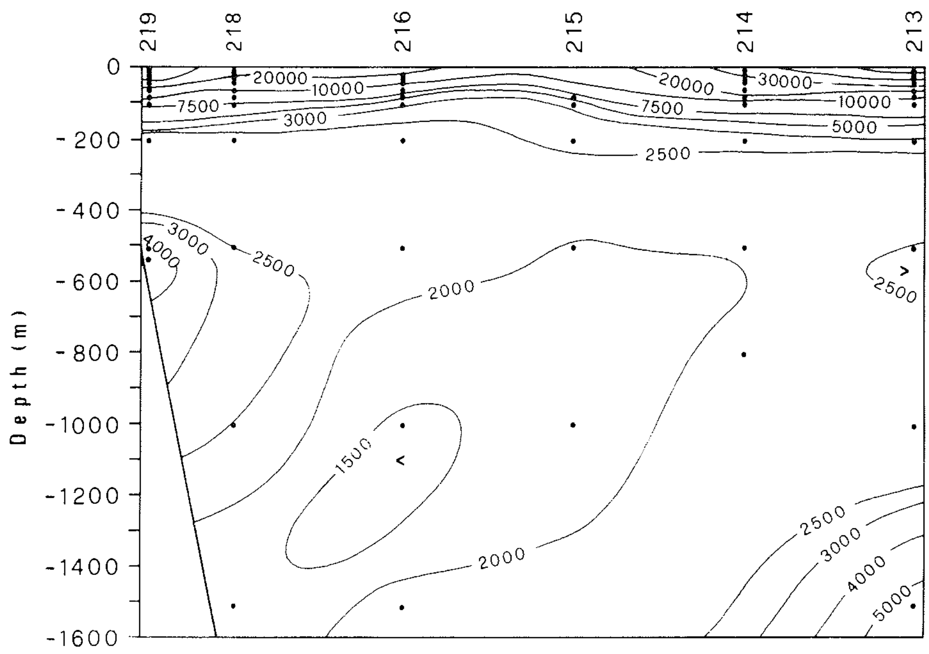



Figure 9: Distribution of suspended solid particles in cm$^3$ l$^{-1}$ on the 47°W transect.

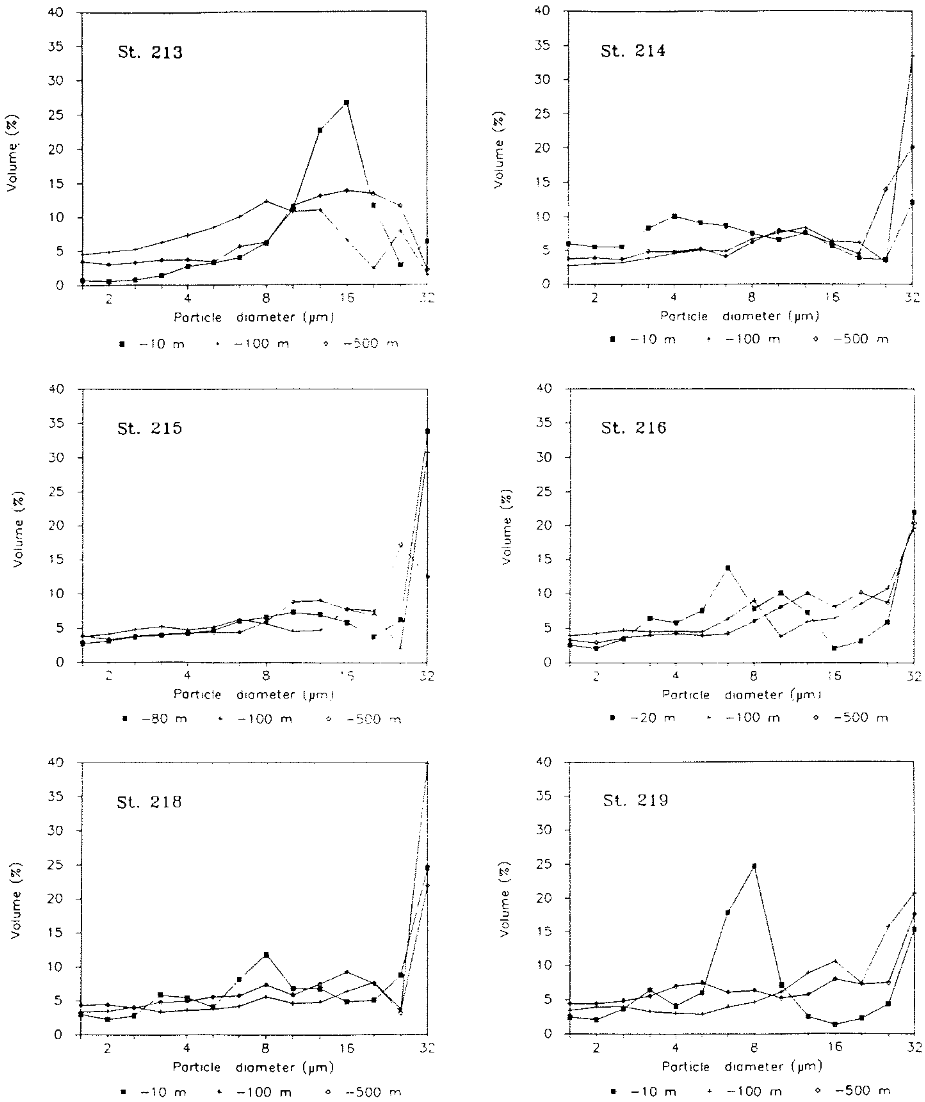



Figure 10: Relative percentage of volume occupied by solid particles at Stations 213 to 216, 218 and 219 at three different depths.

## 2.1.2 Distribution of silicate and ammonium
D. Gouleau

### Work at Sea

From six CTD casts between surface and a maximum depth of 1500 m, silicate and ammonium concentrations were determined from 62 samples of sea water.

For silicate, the method by MULLIN and RILEY (1955) adapted by STRICKLAND (1952) for Technicon auto-analyser was used; for ammonium, the method by KOROLEFF (1969), indo-phenol blue measured by manual colorimetry, at 630 nm.

### Preliminary results

The description of results is based on two depth intervals. The first ranged from surface to max. 1500 m, the second from surface to the 300 m layer. Their distribution is illustrated in the Figures 11 to 14.

#### Silicate

- Total water column (-1500 m)

  The Scotia Sea had a low silicate concentration 15 µM at the surface. From the surface down to 300 m depth, there was a strong gradient in the silicate concentration from 15 µM to 80 µM. Deeper, the concentration increased slightly from 80 µM at 300 m to 100 µM at the 1500 m depth (Fig. 11).

  Opposite to this, the Weddell Sea water body had a high silicate concentration of 78 µM , and presented a strong increase towards 120 µM at 500 m depth.

- Subsurface water body (0 to 200 m)

  The Scotia Sea extended at the surface towards the 59°S parallel, with a concentration of 50 µM $Si.Si(OH)_4$ (Fig. 12).

  The subsurface water body of the Weddell Sea had a higher silicate concentration, 70 µM at the surface and100 µM $Si.Si(OH)_4$ at 200 m depth.

#### Ammonium

The distribution of the ammonium was restricted to the superficial 200 m layer (Fig. 13).

In the surface and subsurface water, it was possible to separate three water bodies (Fig. 14):

- Scotia Sea water with a weak concentration of ammonium: 0.5 to 0.02 µM;
- Weddell Sea water with ammonium concentrationa between 0.2 and 0.3 µM;
- Scotia-Weddell Confluence water, marked by higher ammonium concentrations of 0.3 to 1.1 µM, in the upper 100 m.

Discussion and conclusion

The silicate and ammonium removal in the photosynthetic layer (0 to 100 m) due to phytoplankton activity results in a lower concentration of silicate and ammonium in the Scotia Sea water body than in that of the Weddell Sea.

The Weddell-Scotia Confluence is not well defined by the silicate concentration. Nevertheless, one can separate Weddell Sea from Scotia Sea water by their different silicate gradients.

In contrast, a high ammonium concentration distinguished the Weddell-Scotia Confluence very well. This is due to zooplankton excretion concentrated in this front.

These results must be compared to the data obtained by EPOS leg 1 and 2, taking into account particularly the ammonium concentration.

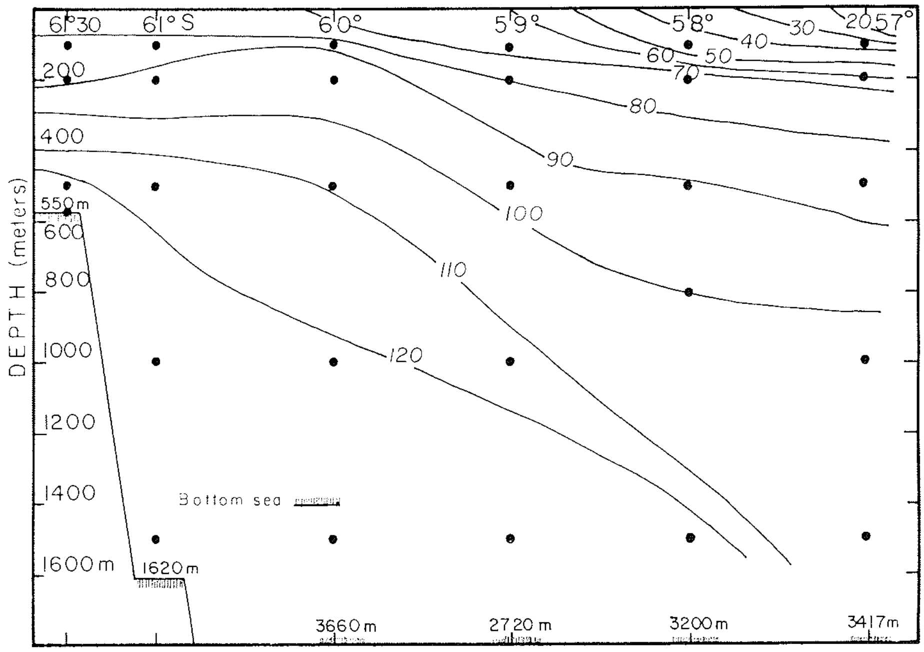



Figure 11: 47°W section, silicate distribution in μM Si.Si $(OH)_4$, from depths of 0 to 1500 meters.

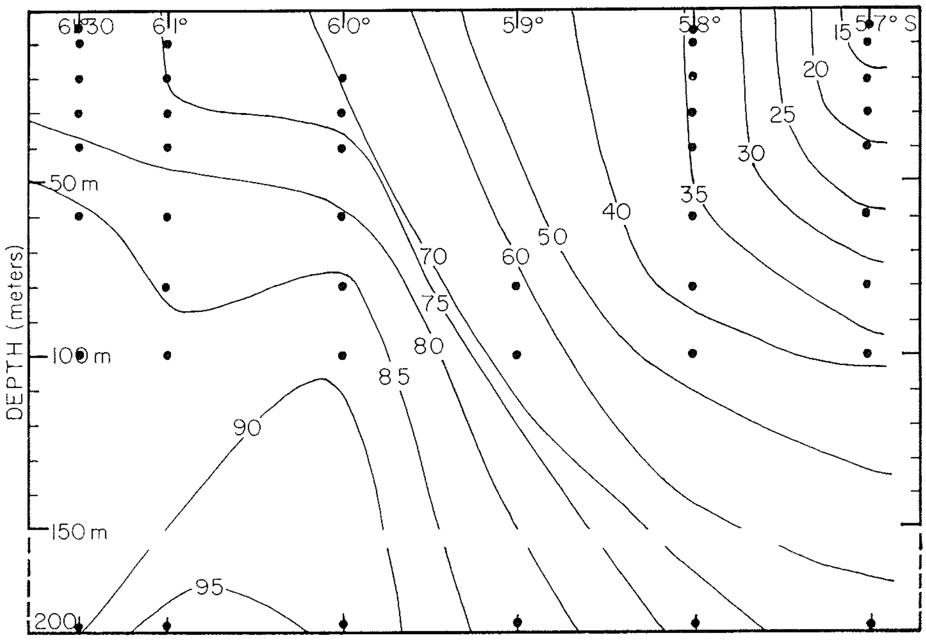



Figure 12: 47°W section, silicate distribution in μM Si.Si $(OH)_4$, from depths of 0 to 200 meters.

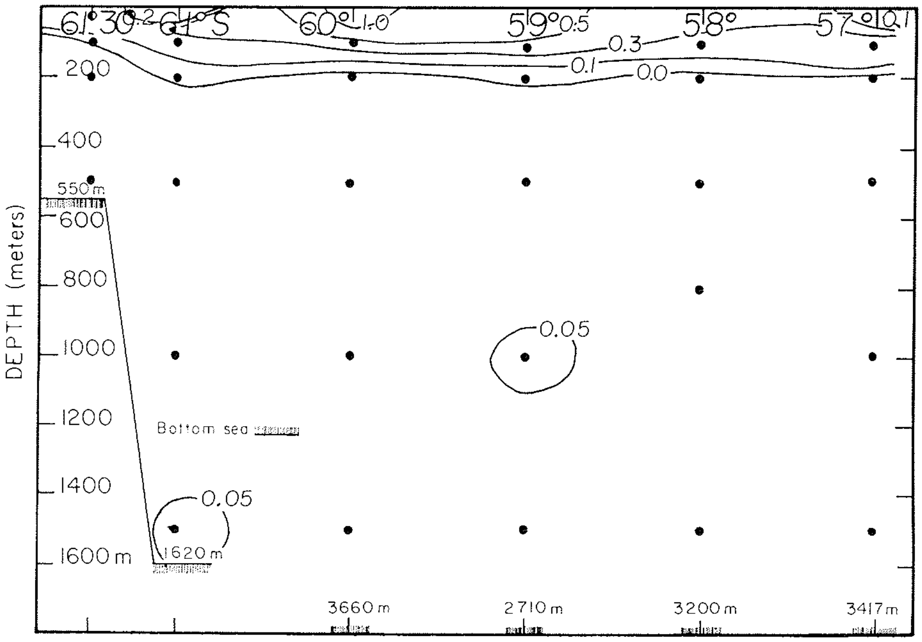



Figure 13: 47°W section, ammonium distribution in μM N.$NH_4$, from depths of 0 to 1500 meters.

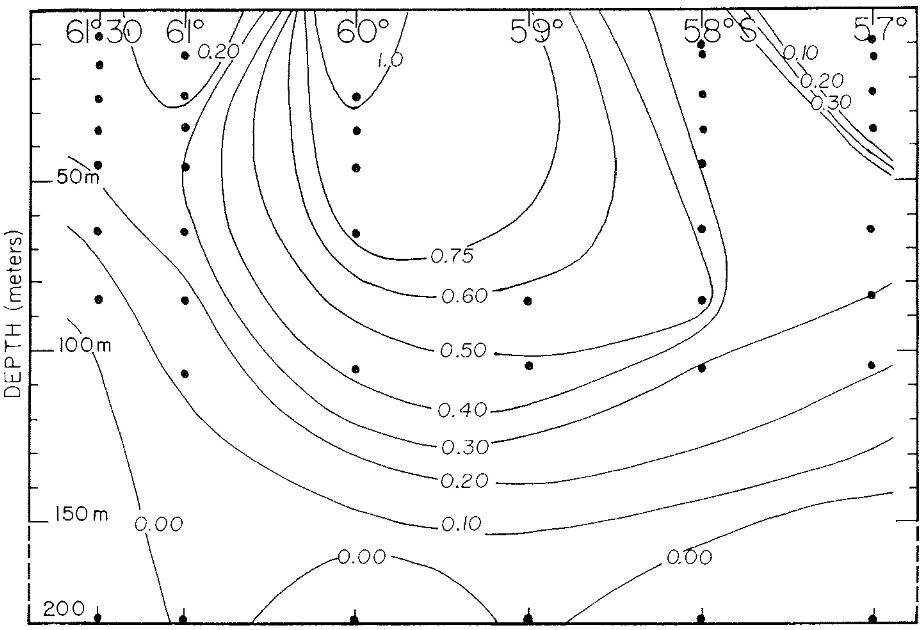



Figure 14: 47°W section, ammonium distribution in μM N.$NH_4$, from depths of 0 to 200 meters.

## 2.2 Mircoorganisms in a N-S transect across the Weddell-Scotia confluence zone

R.P.M. Bak, J.H. Vosjan, G. Nieuwland

Objectives

For reasons of comparison with observations made in the same area during leg 1 and 2 of the EPOS programme, we studied a transect along the 47°W from 57°S to 61°30'S. In this transect water samples were taken at 6 stations with a rosette sampler, from surface to 1500 m at about 12 different depths. Various parameters were measured by a multidisciplinary team of researchers. Here we report the measurements of microbial biomass and activity in the water samples, and compare these with observations made on an earlier cruise during winter time in the Bransfield Strait area.

Another objective of the present investigation was to study the densities of hetero- and autotrophic nanoplankton (< 20 µm) and of bacteria along a transect which had been covered earlier in the austral summer by EPOS leg 1 and 2.

Nanoplankton organisms are an important component in the ecological processes in the Southern Ocean (e.g. HEWES *et al.*, 1985; NÖTHIG, 1988). However, there appear to be significant changes in their relative importance in space and time.

Work at sea

Along the transect 6 stations were sampled at depths of 20, 40, and 100 m.

For the measurement of microbial biomass, we used the ATP method. A comparison of different methods made during an Antarctic winter expedition (ANT V/1) showed that they give about the same results (VOSJAN *et al.*,1987).

For estimation of respiration activity, the ETS activity measurement was used. The method gives a potential oxygen consumption rate and not the real respiration rate. It is often used for e.g. descriptive oceanographic research (PACKARD, 1985; VOSJAN & NIEUWLAND, 1987).

Seawater samples for nanoplankton and bacterial counts were fixed, stained and filtrated (techniques based on HAAS, 1982; BLOEM *et al.*, 1987 (protists), VAN DUYL and KOP ms (bacteria)). In addition samples were fixed (acid Lugol's) and counted (Utermöhl) for abundances of ciliates.

The nanoplankters, solitary flagellated cells, were counted according to size classes (20 to 10, 10 to 5, 5 to 2 and ≤ 2 µm) and gross taxonomic categories. In addition bacteria were measured/counted and a general impression was gained of the densities of larger, ciliated, protists.

Nanoplankton and bacteria were counted and measured (1000 x magnification) with a Zeiss Axiophot microscope. Ciliates were counted (100 and 400 x) with an inverted Olympic IMT-2 microscope. A model TXM Stabletop microscope table allowed counting aboard at all magnifications in all weather conditions.

Biomass was calculated using conversion factors for nanoplankton (FENCHEL, 1982; BORSHEIM & BRATBAK, 1986) and bacteria (VAN DUYL & KOP ms).

All samples were processed (preparation of microscope slides) within 45 minutes. Microscopic slides of nanoplankton were examined within 12 hours and slides of bacteria within 4 days after sampling.

Preliminary results

Preliminary results are presented in two Figures. Fig. 15 gives the isolines of ATP concentrations in ng/l over the transect and Fig. 16 gives the ETS activity at in-situ temperatures in nmol/l/h. As can be seen in the Figures the highest biomass and activity was found in the surface layers. Below 50 m depth there was a rapid decline in both. The two Figures have a great similarity, which has to be expected while the biomass is respiring.

If we analyze the horizontal distribution of these parameters we first see the highest values in the Scotia Sea area 57° and 58°S (St. 213 and 214) and also at the southernmost stations (61° and 61°30´S) the surface values were somewhat higher. Here in this Weddell Sea area the ice was melting and large amounts of ice algae seeded the upper water layers.

In the upper water layer the highest oxygen concentrations were found (see BOLDRIN *et al.*, this report), so the biomass must have consisted for the greater part of oxygen producing algae. In the deeper water layer of the 57°S and 58°S samples, in the tongue of Bransfield Strait water, a somewhat higher biomass was found, corresponding to a lower oxygen content (see BOLDRIN *et al.*, this report). Heterotrophic organisms probably consumed part of the oxygen in the water column.

While we found maximum values of about 200 ng ATP per litre during Antarctic winter off the Antarctic Peninsula and Elephant Island, the summer values recorded during EPOS leg 3 amounted to more than 1000 ng/l ATP. In the productive summer season the biomass of microorganisms is clearly higher than in winter time. Classification of waters on ground of ATP levels give a qualification of high productivity if values are higher than 500 ng/l . This means in summer these regions must be highly productive.

Nanoplankton sized protists occurred in extremely high densities, > $10^3$ cells $ml^{-1}$, at some stations (e.g. the southernmost, St. 219, Fig. 17). Generally, densities of autotrophic (pigmented) flagellates were much higher than those of heterotrophic flagellates, the exception being the northernmost station (St. 213). The vast majority of these cells was in the size class < 5 μm and a substantial part of the autotrophs < 2 μm. Such particles would not be retained very efficiently by the krill (WEBER & EL-SAYED, 1985).

Densities were highest at 20 m but still very high at 40 m (up to 6.8 x $10^3$ cells $ml^{-1}$, autotrophic + heterotrophic). At depths of 80 and 100 m the abundance of nanoplankton was generally much lower. Nevertheless at some stations (214, 218, 219) autotrophic flagellates still occurred at high densities (up to 4.8 x $10^3$ cells $ml^{-1}$).

There was a change in the composition of the nanoplankton in terms of the most abundant taxonomic groups. For example choanoflagellates occurred throughout the transect but were most abundant ( 0.8 x $10^3$ $ml^{-1}$) at the northern station (213). Densities of Prymnesiida were low at this station but these organisms were extremely common (up to 4.8 x $10^3$ $ml^{-1}$) at all other stations. Naked dinoflagellates occurred throughout the transect but were never abundant. Cryptomonads, possibly indicative of the presence of Weddell Sea water, were abundant at the three southernmost stations (216, 218, 219) with densities up to 2.3 x $10^3$ $ml^{-1}$. Prasinomonads also became more numerous at the southern end of the transect.

Bacterial numbers were highest at the southern stations with a maximum density of 1.18 x $10^6$ $ml^{-1}$. Rod-shaped cells predominated and, of course, contributed most of the carbon to the total bacterial carbon (max. 77 x $10^3$ pg $ml^{-1}$). Ciliates probably show a low abundance at all stations.

References

BLOEM, J., M.B. BAR-GILISSEN & T.E. CAPPENBERG, 1986. Fixation, counting and manipulation of heterotrophic nanoflagellates. Appl. Environm. Microbiol. 52, 1266-1272.

BORSHEIM, K.Y. & G. BRATBAK, 1987. Cell volume to cell carbon conversion factors for a bactivorous *Monas* sp. enriched from seawater. Mar. Ecol. Progr. Ser. 36, 171-175.

DUYL, F.C. VAN & A.J. KOP, in press. Seasonal patterns of bacterial production and biomass in intertidal sediments of the western Dutch Wadden Sea. Mar. Ecol. Progr. Ser.

FENCHEL, T., 1982. Ecology of heterotrophic microflagellates. II. Bioenergetics and growth. Mar. Ecol. Progr. Ser. 8, 225-231.

HAAS, L.W., 1982. Improved epifluorescence microscopy for observing planktonic micro-organisms. Ann. l'Institut Océanogr. Suppl. 58, 261-266.

HEWES, C.D., O. HOLM-HANSEN & E. SAKSHAAG, 1985. Alternative carbon pathways at lower trophic levels in the Antarctic food web. *In*: Antarctic nutrient cycles and food webs (W.R. Siegfried, P.R. Condy & R.M. Laws, eds.). Springer Verlag Berlin, pp. 278-283.

NÖTHIG, E., 1988. On the ecology of the phytoplankton in the southeastern Weddell Sea (Antarctica) in January/February 1985. Berichte Polarforsch. 53, 1-118.

PACKARD, T.T., 1985. Oxygen consumption in the ocean: Measuring and mapping with enzyme analysis.- Adv. Chem. Ser. 209, 177-209.

VOSJAN, J.H. & G. NIEUWLAND, 1987. Microbial biomass and respiratory activity in the surface waters of the East Banda Sea and northwest Arafura Sea (Indonesia) at the time of the southeast monsoon.- Limnol . Oceanogr. 32, 767-775.
VOSJAN, J.H. , G. NIEUWLAND , W. ERNST & T. BLUSZCZ, 1987. Shipboard comparison of two ATP measurement methods applied in Antarctic waters.- Neth.J.Sea Res. 21, 107-112.
WEBER, L.H. & Sz. EL-SAYED, 1985. Spatial variability of phytoplankton and the distribution and abundance of krill in the Indian sector of the Antarctic Ocean. *In*: Antarctic nutrient cycles and food webs (W.R. Siegfried, P.R. Condy & R.M. Laws, eds.). Springer Verlag Berlin, pp. 284-293.

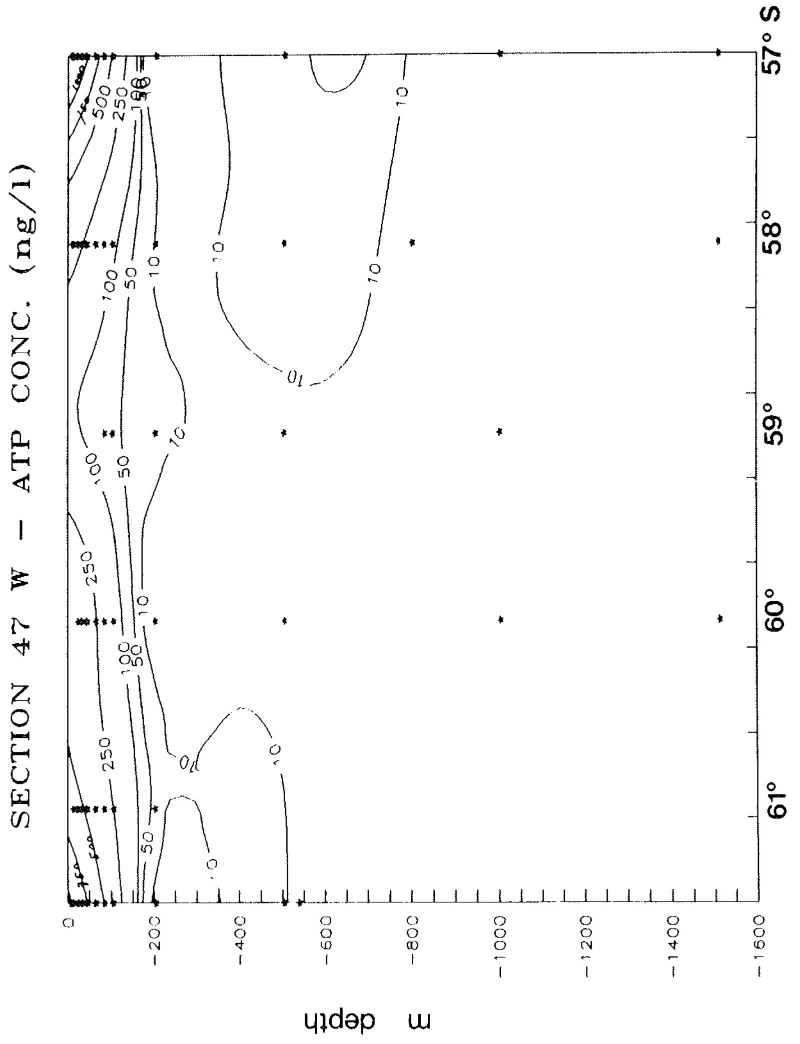



Figure 15: Isolines of ATP concentrations in ng per liter in the Weddell-Scotia Confluence zone.

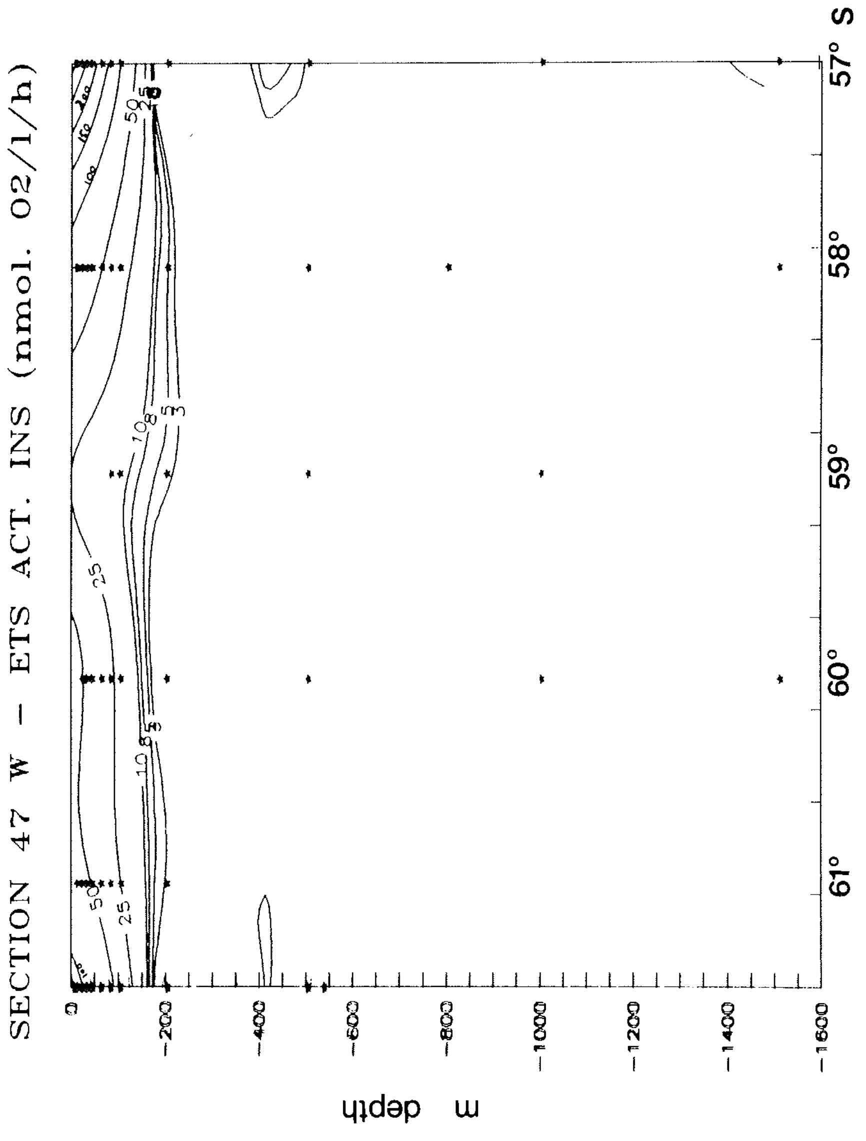



Figure 16: Isolines of the ETS activity at in-situ temperatures in nmol/l/h oxygen in the Weddell-Scotia Confluence zone.

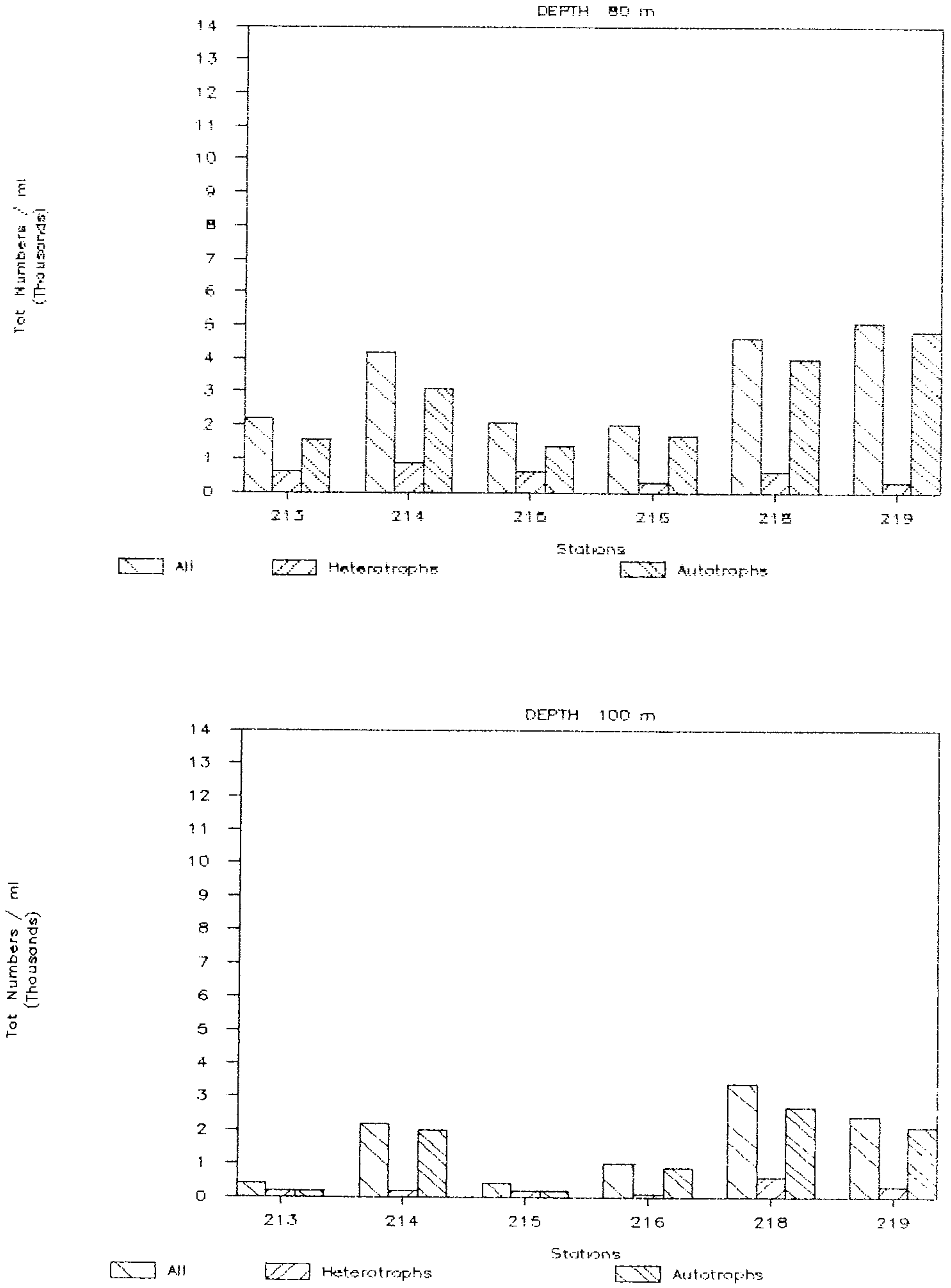



Figure 17: Numbers of flagellates per ml at 2 depths and 6 stations along the transect.

## 2.3 Spatial and temporal changes of an Antarctic zooplankton community

U. Piatkowski, M. White

### Objectives and work at sea

In all three EPOS legs during the austral spring and summer 1988/89, a sequence of six zooplankton stations was sampled along the 47°W longitude from 57°S to 61°30´S.

The samples obtained during each leg are expected to demonstrate temporal and spatial changes of the zooplankton community in relation to oceanography, nutrients, phytoplankton and microplankton at the same sampling sites. The stations along this transect cover the water masses of the Scotia Sea, the Weddell-Scotia Confluence and, in the south, the marginal ice zone of the northern Weddell Sea. Each station was accompanied by a CTD cast.

Three size classes/components of the zooplankton are to be evaluated:

1. small zooplankton, i.e. mostly the developmental stages of copepods, which were sampled by a small vertical net (Fransz net) of 50 µm mesh size in a depth range from 300 - 0 m.

2. zooplankton, i.e the copepod community, which was collected by a vertically towed multiple opening and closing net (Multi net) with a mouth opening of 0.25 $m^2$ and a mesh size of 200 µm. In order to obtain also the vertical stratification of the zooplankton, five different depth strata were sampled during each haul, i.e. 1000 to 500, 500 to 300, 300 to 150, 150 to 50, and 50 to 0 m.

3. macroplankton, i.e. large copepods, euphausiids, polychaetes etc. These organisms were sampled by a vertically towed Bongo net with 300 µm mesh size from 300 to 0 m.

During all three legs the same equipment and sampling methods were used. All samples were stored in 4% buffered Formalin-seawater solution. The evaluation of the material will be subject of subsequent analyses at Dutch and German institutes.

### Preliminary observations

The analyses of the samples of the 47°W transect are not a scientific objective of the zooplankton and micronekton group participating in EPOS leg 3. However, some first indications can be given concerning the macroplankton samples from the Bongo net:

The first two stations at the north of the transect (St. 213, 214) revealed typically oceanic species. The euphausiids occurring at these stations were *Euphausia frigida, E. triacantha* and *Thysanoessa macrura.* At the northernmost station (St. 213) heavy phytoplankton concentrations clogged the Bongo nets and only at this station large specimens of the pelagic tunicate *Salpa thompsoni,* a typical phytoplankton grazer of the Southern Ocean, were found.

The third station (St. 215) was sampled just north of the Weddell-Scotia Confluence after a heavy storm. It produced a considerable number of large adult *Euphausia superba,* the Antarctic krill.

The following two stations (St. 216, 218) yielded very poor zooplankton samples. In contrast to the previous samples there was no indication of dense phytoplankton concentrations (greenish colour of the samples). Typically oceanic forms like *Thysanoessa macrura,* the hyperiid amphipods *Primno macropa* and *Hyperiella dilatata* were encountered as well as siphonophores and chaetognaths.

The last and southernmost station of the transect (St. 219) was situated near the continental shelf region of the South Orkney Islands. It was characterized by cold Weddell Sea water (see BOLDRIN *et al.,* this volume). In contrast to the previous legs, where this station was situated at the edge of the pack ice zone, only few ice floes were encountered on this occasion. Besides some oceanic species typically neritic forms occurred at this station, e.g. mysids and gammarids. Oceanic species, which were characteristic for the Scotia Sea water, e.g. the hyperiid amphipod *Themisto gaudichaudii,* and the salp, *Salpa thompsoni,* were absent in the samples.

In summary, from the first inspection of the Bongo samples we can suggest that a slight shift from an oceanic to a mixed coldwater/neritic zooplankton community was observed along the transect.

# 3. THE HALLEY BAY - KAPP NORVEGIA COMPARISON

## 3.1 Physical oceanography

G. Rohardt, G. Ruhland, U. Schleif

The oceanographic field work concentrated on the following major topics:

- A survey of the hydrographic conditions south of the Antarctic Coastal Current Divergence off Halley Bay.
- A large scale investigation of water mass transformation along the eastern Weddell shelf area.
- Deployment of current meter moorings, inverted echo sounder and drift buoys (with ARGOS transmitting system).

### 3.1.1 A survey of the hydrographic conditions south of the Antarctic Coastal Current Divergence off Halley Bay

Objectives

1. To describe the general hydrographic condition on the shelf and from the shelf down the continental slope.
2. To identify the branches of the Antarctic Coastal Current.

Work at sea

Temperature and salinity profiles were measured with a Neill Brown CTD (Mark IIIB) at 30 stations. These stations were grouped into three sections:

A north-south section along the shelf ice edge adjacent to Halley. This section extended 136 km to the most southern station of the cruise at 75°52'S, 27°45.6'W.

A shelf section at right-angles to the coast line extending 115 km to the west.

A third section at about 29.5°W extending 130 km down the continental slope to a deepest station of 2600 m. The CTD data were corrected on board using laboratory calibration for temperature and pressure. The salinity correction was based on samples taken from the rosette. The accuracy of the salinity is about ±0.006 psu in the surface layer and ±0.003 psu in the deep water.

Preliminary results

During the summer a thin warm layer (temperature: -1.4 to 1.0°C) covered the winter water. A temperature above 0°C had never been observed in the southern Weddell shelf area. A survey of the surface temperature distribution became of special interest after observing a 30 to 45 m thick layer with a temperature above 0°C (T(max) = 1°C). A north-south transect was carried out to record the zonal gradient of the surface temperature. The isolines of the surface temperature indicated a meandering of the southern branch of the Antarctic Coastal Current (Fig. 18). The warm surface water carried by the southern branch was about 0.5°C warmer than the surface water carried with the Antarctic Coastal Current which followed the continental slope to the west.

The following water masses were found on the shelf (Fig. 19a, b): The Summer Water, warm and reduced in salinity in the top 60 m, below the Eastern Shelf Water which was cold and fresh down to the bottom except at St. 241 where a thin layer of Warm Deep Water covered the bottom. The coldest water was found in a depression close to the shelf ice (T(min) < -1.98°C). The slope of the halocline above the rise in front of the ice edge indicated the location of the Antarctic Coastal Current (Fig. 19b).

Using the bottom as the level of no motion a geostrophic velocity of > 3 cm/s was calculated. This value must be assumed 2 cm/s higher, however, according to the current meter records during the Winter Weddell Sea Project 1986 (Reports on Polar Research, 46). Adding 2 cm/s will change the northerly direction of the flow to a weak southerly flow between St. 235 and 241 (Fig. 19c). In addition this is more consistent with the extension of the Warm Deep Water on to the shelf at St. 241. The mass transport in the core of the Antarctic Coastal Current (St. 236 to 235, Fig. 19c) was less than $0.5 \times 10^6$ $m^3$/sec to the south. The transect down the continental slope (St. 243 to 255 in Fig. 20a, b) showed the transition in the water characteristics from the shallow shelf area to the deep Weddell Sea basin.

The dominant water mass in this section was the Warm Deep Water from 750 - 2100 m depth. The surface water with a temperature greater than 0°C extended to St. 251 with a break of colder water between Stations 249 to 252. This was the result of rising Winter Water due to the velocity field shown in Fig. 20c. The southern boundary of the Antarctic Coastal Current was 80 km apart from the shelf. The geostrophic velocity of the Antarctic Coastal Current was of the order of 15 cm/s assuming a bottom current of 2 cm/s. It was difficult to estimate the mass transport. If the geostrophic velocity has an error of 2 cm/s, the error of the mass transport will be $0.8 \times 10^6$ $m^3$/s. This is of the order of the geostrophic transport between St. 54 to 255. For this reason current meter records are needed to confirm the geostrophic transport derived from hydrographic measurements.

### 3.1.2 A large scale investigation of water mass transformation along the eastern Weddell Sea shelf area

Objectives

1. To describe the water mass transformation during Antarctic summer.
2. To estimate melting rates of shelf ice along the path of the Coastal Current.

3. To compare the results of the Winter Weddell Sea Project 1986 with Antarctic summer conditions along the eastern shelf area.

Work at sea

On the way from Halley Bay to the north and in the Kapp Norvegia area 19 CTD profiles were carried out. Ten stations formed a Kapp Norvegia transect extending 100 km from the shallow shelf area down the continental slope to about 2100 m depth. Five 1500 m deep profiles including St. 251 from the 29° transect and St. 297 from the Kapp Norvegia transect formed a north-south section over a distance of 700 km along the eastern Weddell Sea shelf. This section has a gap between Vestkapp and Kapp Norvegia because two stations had to be omitted due to bad weather conditions. Six CTD profiles were repeated every four hours at the same position to record the variability of the water column in relation to a biological study at this station.

Data processing on the hydrographic profiles was done as described above.

Preliminary results

The hydrographic structure of the Kapp Norvegia section was different when compared with the transect on 29°W. The calm, warm weather conditions prevailing during the observations in the Halley Bay area resulted in the formation of a distinct warm Summer Water layer at the surface. A typical Summer Water layer was not observed in the Kapp Norvegia section as a result of the storm occurring a few days before doing the transect and mixing the upper water layers. Additionally the transect was done two weeks later in the season.

A 150 to 250 m homogenous surface layer of about -1.3°C was found in the shelf area. A thin layer, the remnants of the Winter Water or cooled water from under the ice shelf covered the shelf (see Fig. 21a). Due to the influence of the strong Antarctic Coastal Current, the upper boundary of the Warm Deep Water was elevated to near the surface. This vertical front prevented the extension of the cold water off the shelf. Although the pack ice was completely melted after passing Kapp Norvegia the first time on the way to Halley Bay, a low saline layer still existed close to the ice edge ($S < 33.8$ psu, Fig. 21b). Apparently melting of shelf ice maintained the reduced saline water. To determine the exact rates of melting shelf ice, water samples were taken from the rosette to be analysed for the oxygen isotope ratio.

At this early stage it is not possible to present the final results related to the objectives of the large scale investigation mentioned above. The water samples which were taken to determine the melting rates will be analysed in Bremerhaven after the cruise. The comparison of the CTD data set from the Winter Weddell Sea Project and the summer data set from this cruise will be difficult because both data sets have to be adjusted due to the different locations of sections and profiles.

One result which is more related to the current meter programme should be mentioned: As derived from the Winter Weddell Sea Project CTD data, the calculated geostrophic velocity field of the Kapp Norvegia section indicated a northerly directed current near to the seafloor (see Fig. 21c). The mooring located to measure the countercurrent could not be recovered three years ago. For this reason the current meter array deployed north of Kapp Norvegia is of great interest to check the existence of the countercurrent with direct current measurements.

3.1.3 Deployment of moorings, inverted echo sounder and drift buoys (with ARGOS transmitting system)

Objectives

1. To identify temporal and spatial variability of the Antarctic Coastal Current.

2. To study the processes of sea ice drift in the Weddell Gyre during one year.

3. To continue the tide observations started in October 1986 during the Winter Weddell Sea Project.

4. To study the particle flux in Antarctic waters to be investigated by Dr. G. Wefer, University of Bremen.

Work at sea

Eight transmitting ARGOS buoys were deployed along the eastern Weddell Sea coast grouped in two triangular arrays. Five buoys are from the Scott Polar Research Institute, Cambridge. Three buoys are from the Institut für Meteorologie und Klimatologie, Hannover (see Table 1 where the locations and additional informations are summarized). It was planned to place the buoys on ice-floes to study the processes of the pack ice drift in the Weddell Gyre. The forces acting on the floes are derived from a current meter hanging 10 to 50 m below the buoy and the wind data from a wind sensor on top of the buoy. Additionally the buoys are equipped with air temperature, water temperature and air pressure sensors. The data are continuously transmitted via satellite together with information about the precise location of the drift buoy to a receiving centre in France.

Table 1. ARGOS buoys deployed during EPOS leg 3.

| Position | | Buoy ID | Type | Institute | Date/Time of Deployment | |
|---|---|---|---|---|---|---|
| 75°03.0'S | 28°25.0'W | 8969 | PRL | SPRI | 01 Feb.1989 | 17:00 |
| 74°16.1'S | 29°49.6'W | 5346 | PRL | SPRI | 02 Feb.1989 | 18:50 |
| 74°27.1'S | 26°35.6'W | 5341 | MO | SPRI | 11 Feb.1989 | 06:28 |
| 74°00.2'S | 25°03.3'W | 5342 | MO | SPRI | 11 Feb.1989 | 11:50 |
| 72°55.2'S | 21°45.2'W | 3311 | PRL | IMK | 12 Feb.1989 | 00:50 |
| 71°23.9'S | 14°58.7'W | 5343 | MO | SPRL | 18 Feb.1989 | 20:15 |
| 70°44.9'S | 14°40.5'W | 3310 | PRL | IMK | 18 Feb.1989 | 23:53 |
| 70°49.8'S | 12°41.0'W | 3316 | PRL | IMK | 19 Feb.1989 | 03:33 |

PRL = Polar Research Laboratory, Inc.
MO = METOCEAN Data Systems, Ltd.
SPRI = Scott Polar Research Institute, Cambridge
IMK = Institut für Meteorologie und Klimatologie, Hannover

All buoys are equipped with a current meter except buoy 8969.

This year the coastal polynya extended far to the west. No suitable floes were found, and consequently all eight buoys were deployed in open water. The southern array was set out without any problems. The northern array should have been deployed in front of Vestkapp with three buoys in a line parallel to the coast line and a 4th buoy 50 km apart from that line off the coast. After the first buoy was set a storm developed and stopped all activities for the next five days. To save ship-time the 'Polarstern' continued steaming to the second main working area off Kapp Norvegia, where the last three buoys were deployed during one night (see station map). Three days after deploying buoy 3316 it was passed by 'Polarstern', 15 nm to the south from its origin.

Four current meter rigs (two of them with additional equipment) were moored on a transect at right angles to the coast line. The locations, instruments and water depth etc. are summarized in Table 2. On the way down to Halley a sediment trap rig (KN2) was recovered (see Table 2). KN3 was deployed to continue this study for a second year. However, this time series will have a gap of about six months because the trap stopped changing the bottles due to corrosion and flooding of the electronic unit. AWI203 was equipped with a water level recorder to continue the tide observations started during October 1986 in the north eastern Weddell Sea. An inverted echo sounder was set out at the same location as the water level recorder with a quarz pressure sensor to check the accuracy of the acoustic method. After these checks inverted echo sounders should be used in the deep Weddell Sea for tide observations. These tide observations will be investigated by Dr. G. Krause from the Alfred-Wegener-Institut. The locations of the current meter rigs and the instrument depth are related to the results of the first current meter records carried out during the Winter Weddell Sea Project 1986. These observations demonstrated a nearly constant southern flow in all current meter records, however the experiment lasted only a few months. It is necessary to have records over long time periods to identify the large scale variability of the coastal current. Starting in September 1989 there will be an intensive study of the Weddell Gyre during the winter by investigating a hydrographic transect from the Antarctic peninsula to Kapp Norvegia. To provide useful background data, current meters have been deployed in the Antarctic Coastal Current during EPOS leg 3. The buoy experiment already mentioned is also included in the Winter Weddell Gyre Study.

Table 2. Mooring instruments: deployed and recovered.

| Position | Water depth (m) | Mooring No. | Type of Instr. | Depth (m) | Deployed | Recovered |
|---|---|---|---|---|---|---|
| 71°07.67'S<br>12°11.94'W | 682 | KN2 | AVTC<br>ST | 380<br>608 | 29 Feb.89<br>10:21 | 25 Jan.89<br>23:20 |
| 71°02.73'S<br>11°45.5'W | 430 | AWI203 | AVTPC<br>AVTPC<br>WLR<br>IES | 325<br>425<br>430<br>430 | 22 Feb.89<br>19:14<br><br>19:22 | |
| 71°02.04'S<br>11°44.61'W | 676 | KN3 | ST<br>AVT<br>ST<br>AVT | 276<br>286<br>613<br>671 | 22 Feb.89<br>17:56 | |
| 70°56.40'S<br>11°57.70'W | 1522 | AWI204 | AVTPC<br>AVT<br>AVT | 272<br>707<br>1517 | 22 Feb.89<br>14:42 | |
| 70°42.60'S<br>12°21.50'W | 2123 | AWI205 | AVTPC<br>AVTP<br>AVT<br>AVT | 376<br>830<br>1597<br>2118 | 22 Feb.89<br>11:23 | |
| 64°54.13'S<br>02°33.75'W | 5053 | WS3/4 | ST<br>AVTC<br>ST<br>AVTC | 360<br>380<br>4710<br>4730 | 28 Feb.89<br>15:00 | 28 Feb.89<br>8:00 |
| 50°09.44'S<br>05°44.56'E | 3757 | PF2 | ST<br>AVTC<br>ST<br>AVTC | 370<br>390<br>3410<br>3430 | | 5 Mar.89<br>6:30 |

AVT = Aanderaa current meter with thermistor
AVTP = Aanderaa current meter with thermistor and pressure sensor
AVTPC = Aanderaa current meter with thermistor, pressure, conductivity
WLR = Aanderaa water level recorder with thermistor
ST = HDW electronic sediment trap
IES = Sea data inverted echo sounder

On the way from the Neumayer Station to Cape Town two sediment trap moorings were recovered (see Table 2). WS3 was supplied with new instruments and WS4 was deployed for a 4th one year period to continue the particle flux study in the Maud Rise area. The related study in the area of the Antarctic convergence could not be continued due to bad weather conditions.

### 3.1.4 Relevance of the oceanographic field work for the biological investigations in the southeastern Weddell Sea

In the north eastern Weddell Sea the continental slope is close to the shelf ice and the area has great influence on the oceanic domain. Water masses which are formed due to interaction with the shelf ice are mixed with the water of the Antarctic Coastal Current. The wide shelf in the southern part of the Weddell Sea reduces the influence of the Warm Deep Water on the shelf water masses. The Halley Bay area is a transition zone between the shelf water masses and the oceanic water masses because one branch of the Antarctic Coastal Current follows the coast to the south and this supports the extension of the Warm Deep Water onto the shelf.

A comparison of the oceanographic conditions at Halley Bay and Kapp Norvegia based on hydrographic measurements undertaken during the cruise is difficult. This is because the weather conditions changed between collecting the two data sets making direct comparisons impractical. The calm, warm weather in the Halley area allowed the formation of a distinct surface summer water layer, whereas a strong north easterly wind occurred four days before oceanographic work at Kapp Norvegia started. As a result the surface water in the latter area was mixed down to 250 m depth.

For organisms living in the water column, the highly different mixing conditions at the two sites certainly are of great importance and may well be responsible for part of the biological differences observed. On the other hand, the situation for benthic life below 300 m depth is practically unchanged even by events like the gale off Kapp Norvegia. What may be of greater importance to the benthos is the occasional inflow of warm deep water to the shelf as was observed at St. 241 off Halley. We are, however, not able to tell from a short-term study how often and for how much time such events occur; these studies require long-term approaches and the kind of moorings we deployed in the Kapp Norvegia area.

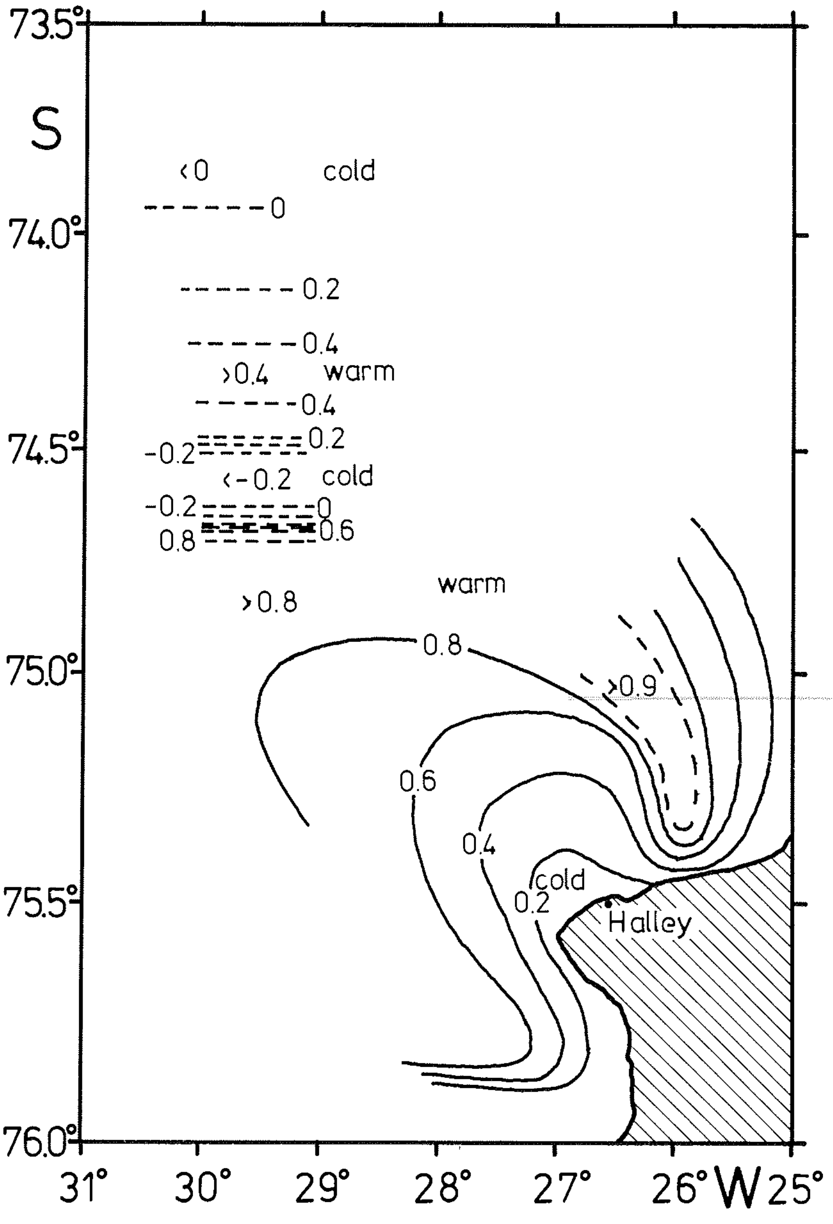



Figure 18: Sea surface temperature in the Halley Bay area derived from CTD temperature at 8 m depth (in °C). The temperature distribution in the northwestern part was derived from only one CTD transect and therefore, the isolines are denoted as straight lines.

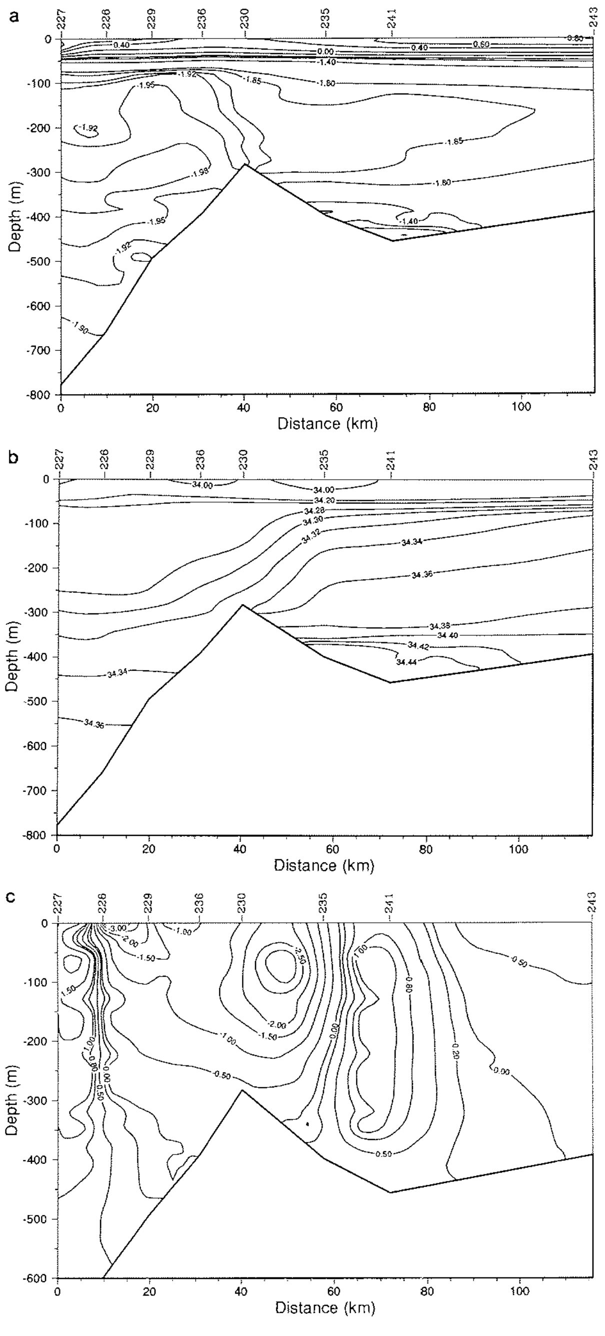



Figure 19: CTD section on the southern Weddell Sea shelf at right-angles to Halley.

a) Potential temperature (in °C)
b) Salinity (in psu)
c) Geostrophic velocity, 'minus' indicates a flow to the south.

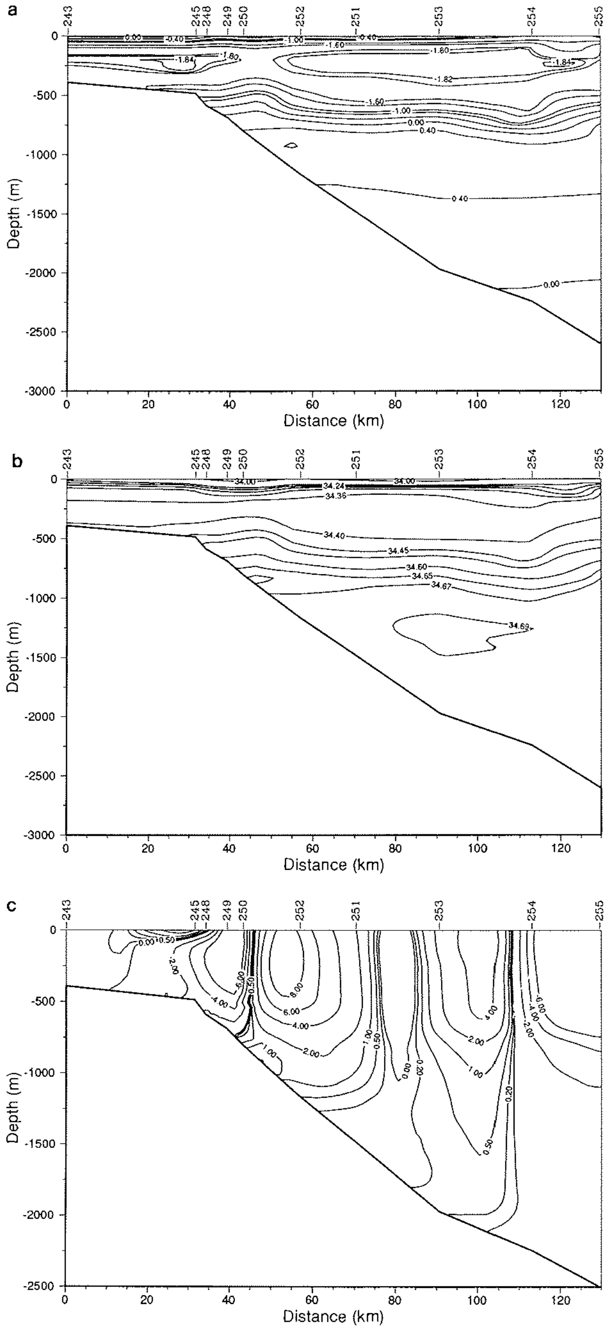



Figure 20: CTD section from the southern Weddell Sea shelf down the continental slope at 29°W.

a) Potential temperature (in °C)
b) Salinity (in psu)
c) Geostrophic velocity, 'minus' indicates a flow to the west.

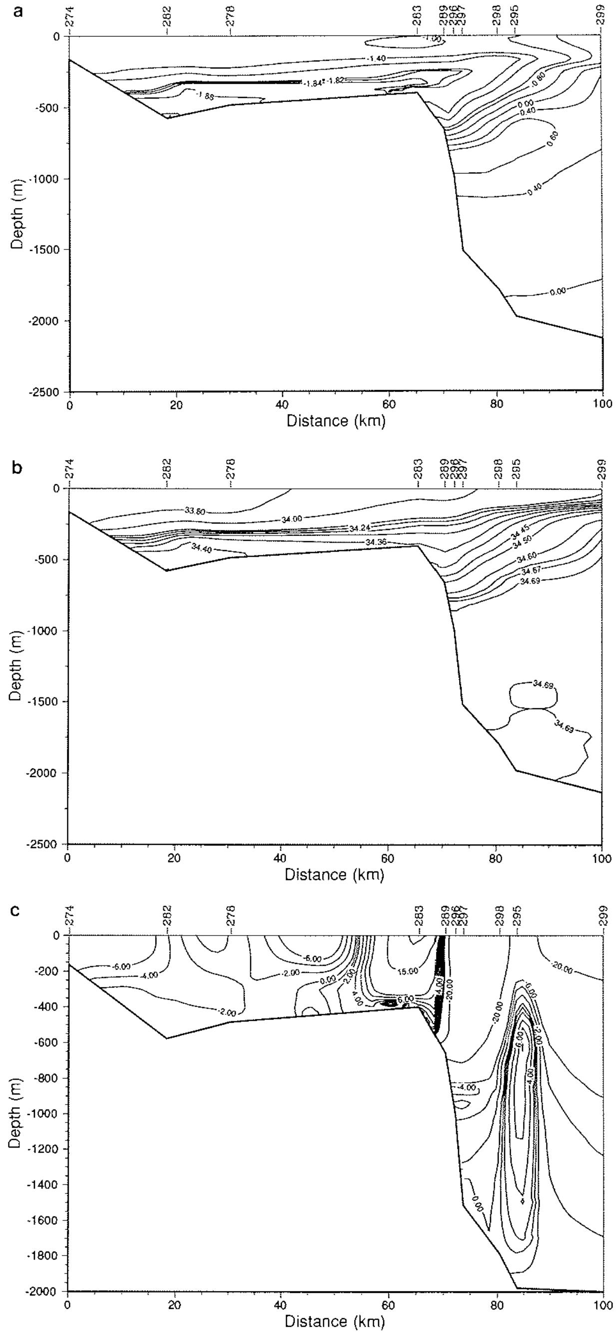



Figure 21: CTD section off Kapp Norvegia at right-angles to the coast line
a) Potential temperature (in °C)
b) Salinitiy (in psu)
c) Geostrophic velocity, 'minus' indicates a flow to the south.

## 3.2 Suspended matter, phytoplankton and nutrients

S. Rabitti, D. Gouleau, A. Boldrin

### Objectives

The main goal of our work during the EPOS leg 3 cruise was the characterization of particulate and dissolved matter in eastern Weddell Sea water in late summer conditions, to permit a definition of biological and abiotic relations among various water masses.

Especially the study of the distributions of particulate matter and biomass as photosynthetic pigments, and the related properties, has as ultimate goal the description of variations of water characteristics from the ice shelf to the oceanic domain, together with an evaluation of fluxes of matter both vertically and horizontally, and a tentative estimation of the vertical transfer of matter from the water column to the bottom (see BOLDRIN & RABITTI, Sediment physico-chemical characterization, this volume).

Among several nutrient parameters the vertical and horizontal distributions of silicate and ammonium in the water column were studied because of their importance in the metabolism of phyto- and zooplankton and zoobenthos.

### Work at sea

For sampling operations and methods see BOLDRIN *et al.*, section 47°W (this volume), with the unique exception that water samples were collected down to the bottom, and not only down to 1500 m.

Water samples were collected at 12 depths at 19 stations in the Halley Bay transect and at 10 stations in the Kapp Norvegia transect, with 3 stations in between.

At Station 308, in the Kapp Norvegia area, a time series of data was collected lasting 20 hours (from 0400 to 2400) with a 4 hours sampling interval.

Particle number and occupied volume (total and in 14 size classes ranging from 2 to 40 microns) were determined immediately after the sampling, together with dissolved oxygen analysis and pH measurements. Water samples were filtered for total suspended matter dry weight determination and carbon and nitrogen analysis along the whole water column, whereas samples for chlorophyll a and phaeopigments determination were collected in the euphotic layer (0 to 200 m). Samples for qualitative and quantitative analysis of phytoplankton were stored, and water was filtered and fixed for a morphologic description of suspended matter by means of a scanning electron microscope.

Preliminary results

## 3.2.1 Suspended matter and oxygen
S. Rabitti, A. Boldrin

### Part I: Halley Bay Transect

According to the distribution of physical properties of water (see ROHARDT *et al.*, Physical oceanography, this volume), Eastern Shelf Water, Winter Water, Modified Deep Water and Warm Deep Water are recognizable at the Halley transect.

In Fig. 22 (section 03: St. 227 to 243) and 23 (section 04: St. 243 to 255) preliminary vertical distributions of oxygen and particle contents, both in the shelf and oceanic domains, are reported.

Surface water

Considering the upper 200 m waters, three main structures (Fig. 24) are recognizable, corresponding, from left to right, to the ice shelf, the continental slope and the oceanic domain.

The highest concentrations of particles (more than 10,000 N/cc) are limited to a depth of about 80 m in the whole area and clearly indicate Summer Water. Absolute maxima were found at the surface, with values up to 70,000 N/cc in the oceanic area. The two extreme areas, shelf and oceanic, can be easily distinguished, at the surface, by the particle size distribution spectra (Fig. 25a, 25b), with main modes very different in diameter (around 7 µm for shelf waters and 3.5 µm for oceanic waters), reflecting probably different phytoplankton communities. This has to be confirmed by phytoplankton sample analyses. In the same euphotic layers oxygen values, both in the shelf and oceanic domains, are high, with a saturation higher than 90 %.

Below approximately 80 m depth, lower particle concentrations were found, in relation to the cold waters, both in the ice shelf (Eastern Shelf Water) and the oceanic area (Winter Water).

A similar trend has been observed for oxygen distribution.

Eastern shelf water

These waters were found between 100 and 400 m in section 03 (St. 227 to 229). They present an average content of dissolved oxygen of 7 to 7.5 cc/l (mean 7.48) and a mean particle concentration of 3800 N/cc, with a core lower than 2000, well defined. A representative particle size spectrum is given in Fig. 25c.

Winter water

These waters present a low temperature core (< -1.80°C) at about 200 m depth in section 04; an average content of dissolved oxygen (7 to 7.5 $cm^3/l$, mean 7.35), and a characteristic particle concentration around 5500 $N/cm^3$.

Warm deep water

Warm deep water is present below 700 m in section 04 (St. 249 to 255); it shows typical low values in oxygen concentration (< 5 $cm^3/l$, mean 4.89 with 61.36 percentage of saturation and pH 7.92). Particle concentration is low (< 4000 $N/cm^3$), with a central core lower than 2000 $N/cm^3$, well defined. A representative particle size spectrum is given in Fig. 24b.

One small core of this water body is recognizable in section 03 at the bottom of St. 235 and 241. In the deepest part of the oceanic waters (from St. 251 to St. 255) transition waters between Warm Deep Waters and Weddell Sea Bottom Waters are present, characterized by dissolved oxygen concentration values and a particle concentration slightly higher than in the overlying waters.

Part II: Kapp Norvegia Transect

Distributions of particulate matter as number of particles and oxygen content are illustrated in Fig. 26. Taking into account the distributions inferred by these properties, the first three stations close to the ice shelf (St. 274, 282 and 278) show a homogenous water column down to a depth of 200 m (Fig. 27). This structure is probably due to the effects of strong easterly winds (up to 12 Beaufort) occurring for at least three days before and during the sampling at these stations.

From St. 274 (ice shelf) to St. 278 (continental shelf) particle concentration values exhibit a decrease from more than 27,000 $N/cm^3$ to approximately 17,000, showing a vertical homogeneity.

In the surface layers of the oceanic domain, the highest concentrations of suspended matter were observed, with values around 30,000 $N/cm^3$. Particle size spectra show coarser fractions clearly prevailing both in the ice shelf and oceanic domains. Below 200 m depth, in the continental shelf and oceanic domains, a vertical differentiation was observed, both in suspended matter and in oxygen distributions. These two properties show strong gradients (in perfect agreement with temperature and salinity trends) in correspondence with the continental slope edge, clearly dividing continental and oceanic waters.

In the oceanic domain, between approximately 500 m and 2000 m depths, Warm Deep Water (temperature > 0°C) is present, showing a low particle concentration (< 4000 $N/cm^3$) and a low oxygen content (< 5.5 $cm^3/l$).

## Part III: Comparison between the two Transects

### Surface water

In the Halley Bay transect particle concentration was on average higher than off Kapp Norvegia. We found absolute maxima in both cases in oceanic water, but with 70,000 $N/cm^3$ in the Halley transect and approx. 34,000 $N/cm^3$ in the Kapp Norvegia transect. Particle size spectra are very clearly differentiated off Halley in the ice shelf surface waters and in open waters. On the other hand, off Kapp Norvegia ice shelf and open waters are more homogenous and completely different from those observed off Halley. Dissolved oxygen values are on average higher off Halley than off Kapp Norvegia.

### Shelf water

The concentration of particles is higher off Kapp Norvegia than off Halley Bay (approx. 10,000 $N/cm^3$ against 3000 $N/cm^3$).

At Kapp Norvegia oxygen concentrations are increased toward the bottom (mixing effect of the wind ?), whereas off Halley we found a well defined vertical stratification, with low values near the bottom.

### Oceanic water

In both transects Warm Deep Water is present, and it presents the same characteristics: low particle concentration (< 4000 $N/cm^3$) and low oxygen content (< 5 to 5.5 $cm^3/l$). At the bottom, transition waters showed the same relative increase both in suspended matter and in oxygen values, but it was more evident at the Halley Bay transect.

### Time station

The preliminary distributions in time of the observed properties showed variations more evident in particle concentration than in oxygen content. Around 12 noon we found a big increase in the number of suspended particles, particularly at the surface and at 80 m depth, but evident also at 200 m (Fig. 28). Variations in oxygen content are less pronounced, and at the same time, the values appear to be slightly decreasing.

This trend is consistent with the variations of total irradiance, as measured by the ship system (Kipp & Zonen solarimeter, type CM10), that reaches a maximum value of 140 $W/m^2$ at noon, but could be explained also by the intrusion of a water mass of different characteristics at this time, as suggested by the thermal structure (warmer water at about 100 m, with a little higher salinity, weaker ammonium content and a somewhat higher silicate content (cf. Fig. 33).

### 3.2.2 Nutrients

D. Gouleau

Silicate

Generally, the total distribution of silicate marks a clear difference between water bodies of the two transects (Figs. 29, 31, 33). The Halley Bay transect was characterized by a vertically increasing gradient structure towards greater depth, while the Kapp Norvegia transect was dominated by a horizontally increasing gradient structure towards the open sea. Weather conditions may be the cause of these differences, because the storm in the Kapp Norvegia area was responsible for the perturbation of the upper water layer.

On the shelf, the silicate content varied from 40 to 45 µM off Halley Bay, and from 50 - 60 µM off Kapp Norvegia. These differences in the surface may be due to the primary production activity which is higher off Halley Bay than off Kapp Norvegia.

On the slope, in both transects, the silicate content was increasing toward the deeper stations. There was a clear stratification, and the analogous values for the same depths in both transects are noticeable .

Ammonia

In both transects, ammonium is concentrated only in the upper 200 m water layer.

The Halley Bay transect was characterized by a stratification with an increasing ammonium content in the surface layer from the shelf to the slope (Fig. 30). These highest values (1.5 µM) were concentrated around the thermocline, which surfaces on the slope edge. Beneath 200 m, no ammonium was found in the water column. In the overlying bottom water of the shelf the ammonium content varied from 0.1 to 0.4 µM.

In the Kapp Norvegia transect the upper 200 m layer was completely mixed (Fig. 32). The ammonium content above the shelf varied from 0.8 to 1.15 µM. On the slope the concentration decreased to 0.3 to 0.4 µM. No ammonium was found in the deeper layer and in the overlying bottom water.

Final remark

At the Halley Bay transect stratification was perturbed due to the presence of a \`sea-mount´. Near the shelf ice melting water increased the silicate content (up to 65 µM) and decreased the ammonium content down to 0.2 µM (Figs. 29 and 30). On the slope edge Warm Deep Sea Water added silicate in the upper water layers to the concentration of 65 µM. In this way this water body also perturbed the ammonium content and created an instable situation.

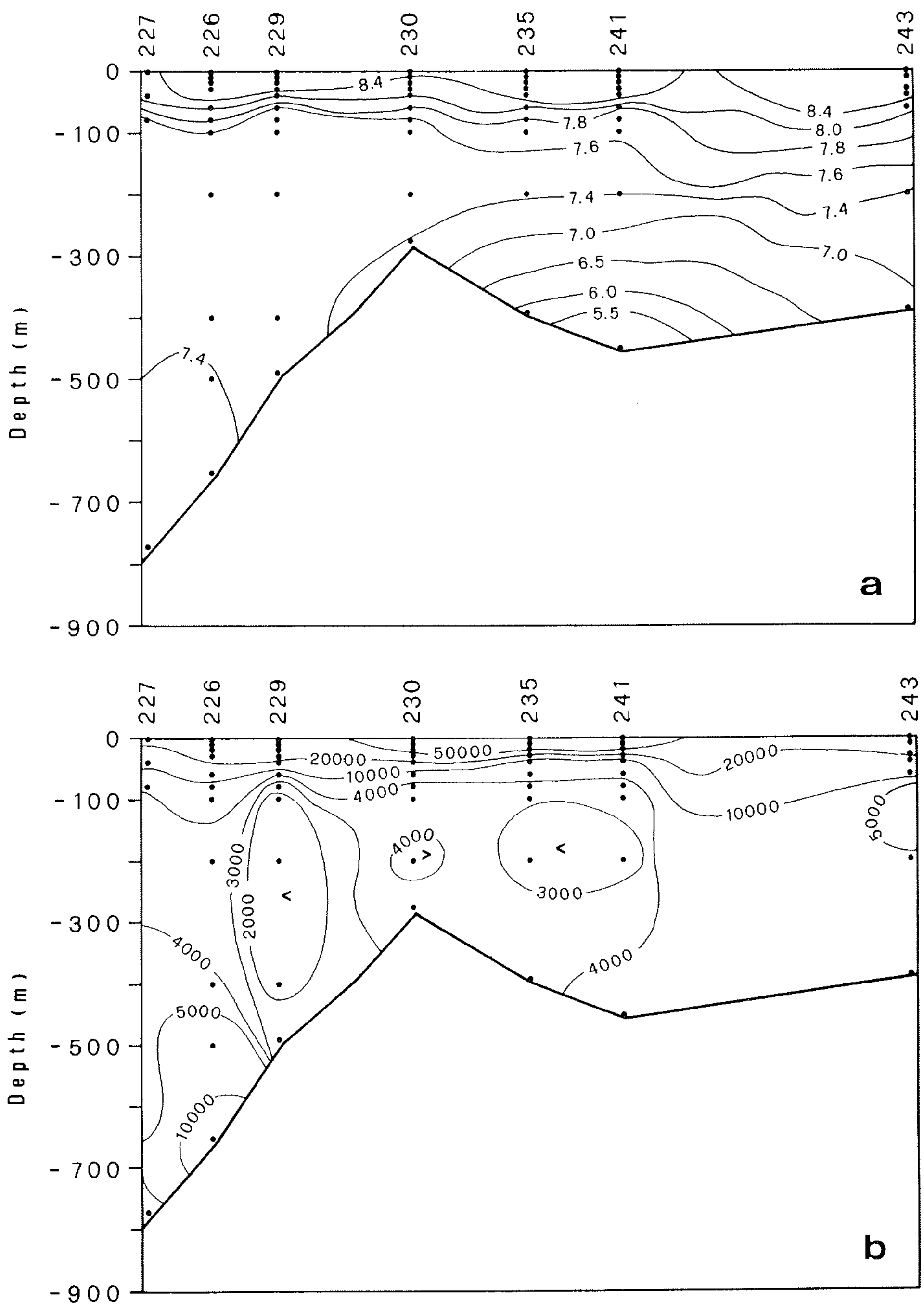



Figure 22: (a) Dissolved oxygen in $cm^3\ l^{-1}$ and
(b) particle concentration in $cm^3\ l^{-1}$ in section 03 (Halley Bay transect).

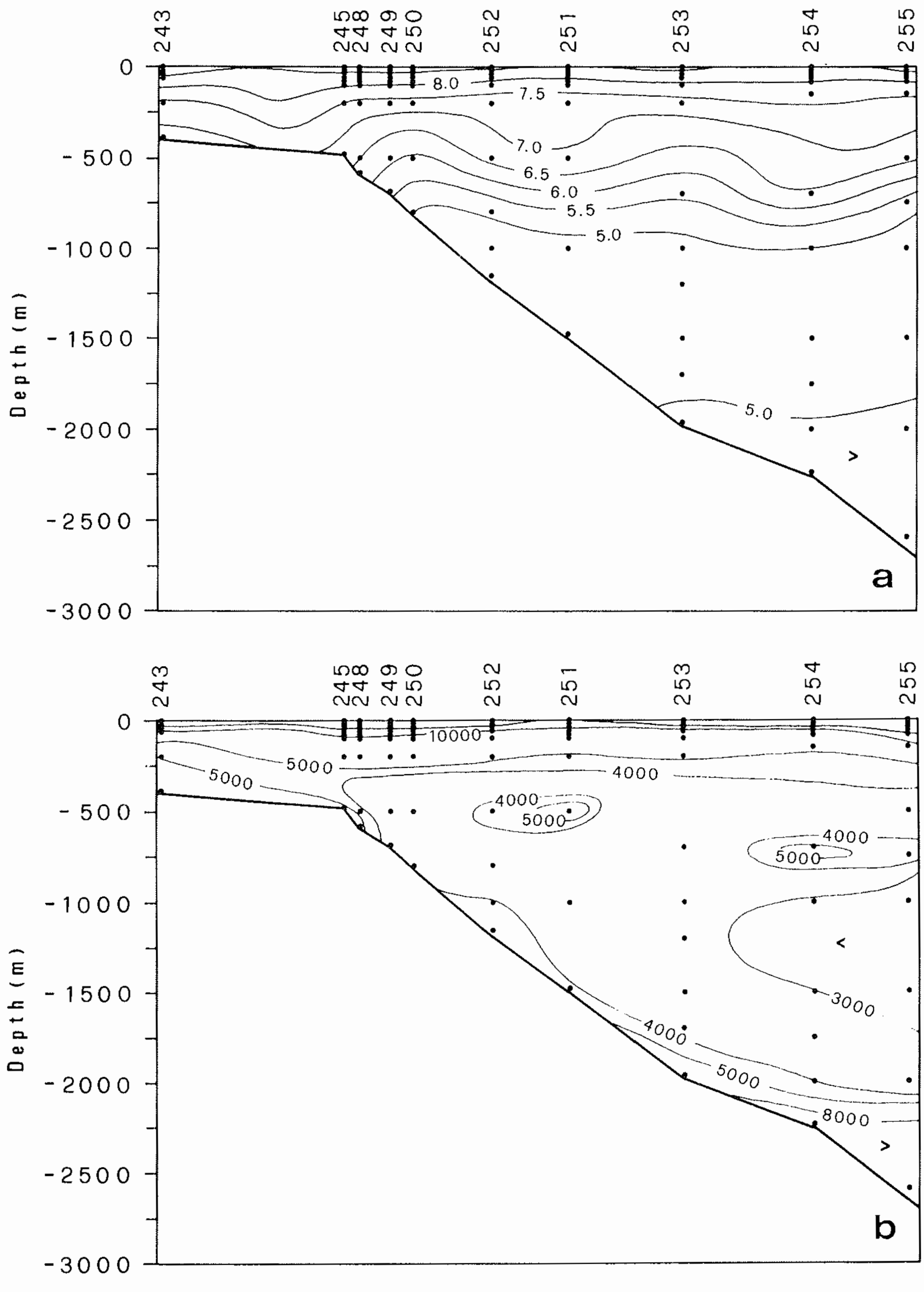



Figure 23: (a) Dissolved oxygen in $cm^3\ l^{-1}$ and
(b) particle concentration in $cm^3\ l^{-1}$ in section 04 (Halley Bay transect).

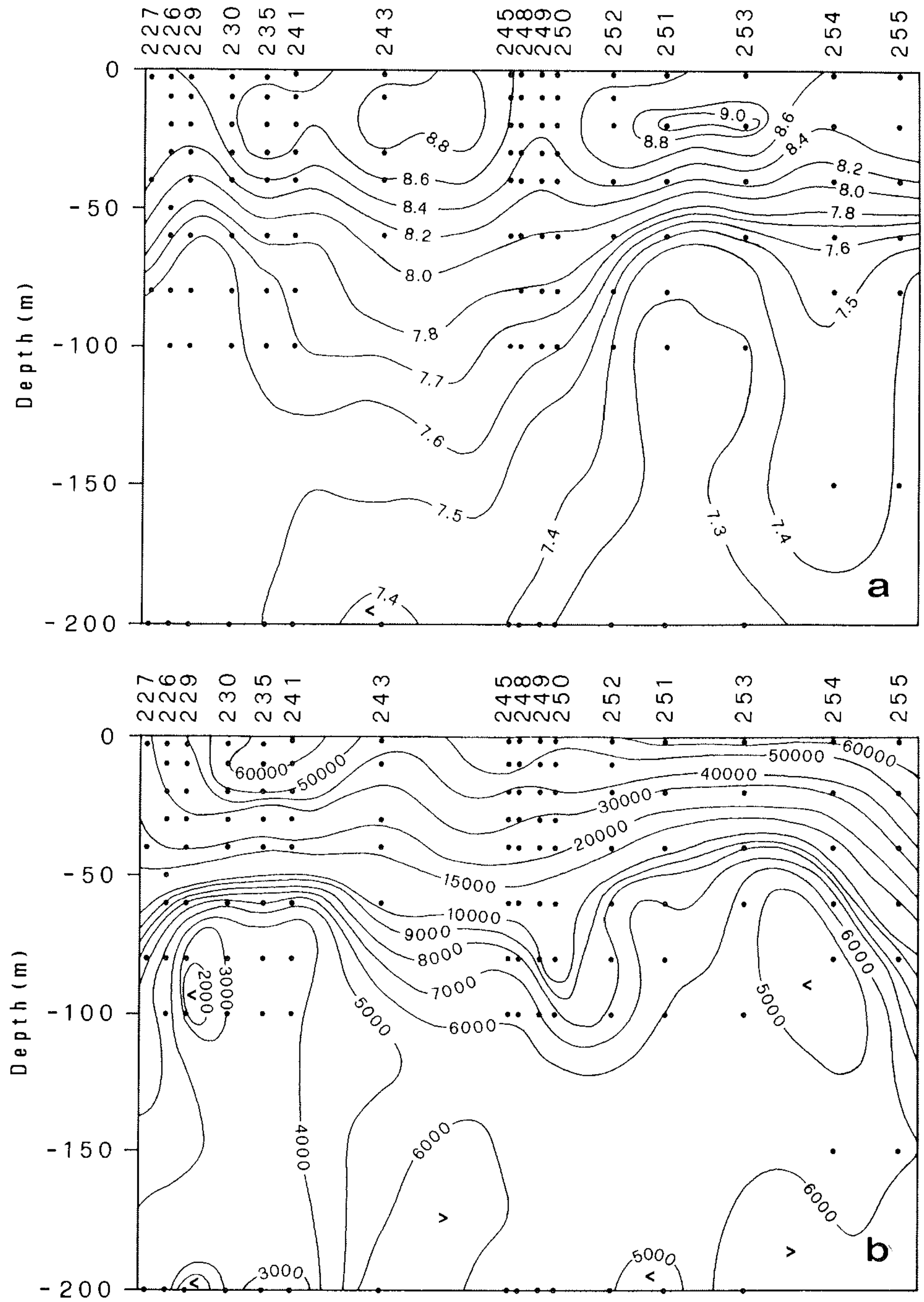



Figure 24: (a) Distribution of dissolved oxygen content in cm³ l⁻¹ and (b) particle concentration in cm³ l⁻¹ in the Halley Bay transect (sections 03 to 04) in the upper layer (0 to 200 m).

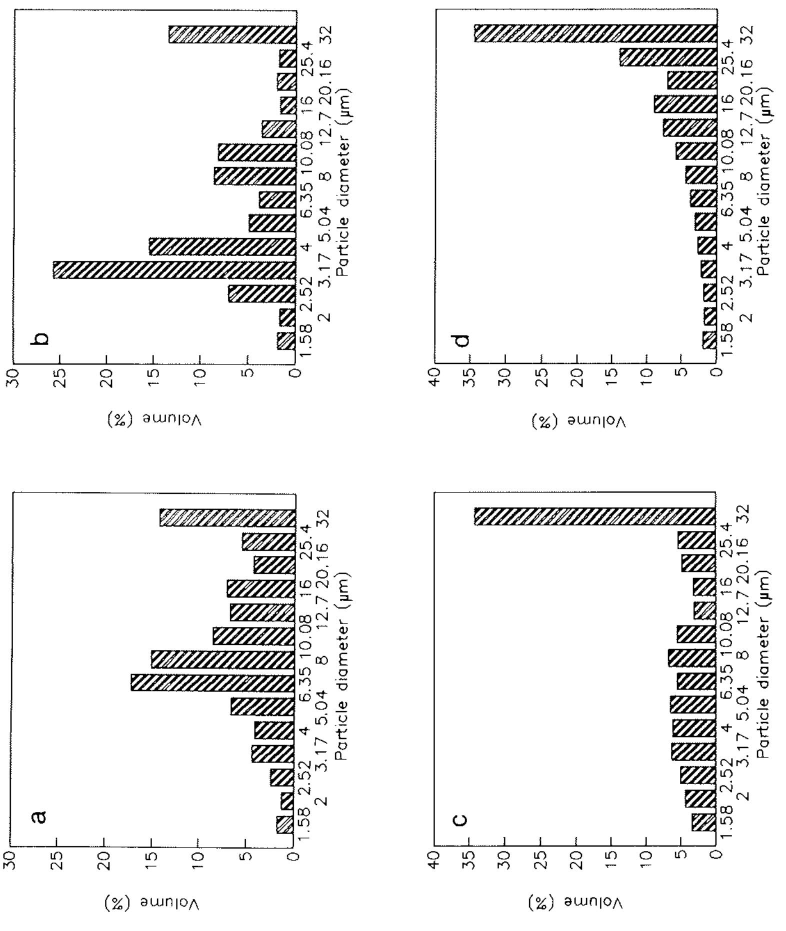



Figure 25: Particle size spectra :
(a) St. 229, depth 3 m;
(b) St. 253, depth 2 m;
(c) St. 226, depth 200 m;
(d) St. 253, depth 1500 m.

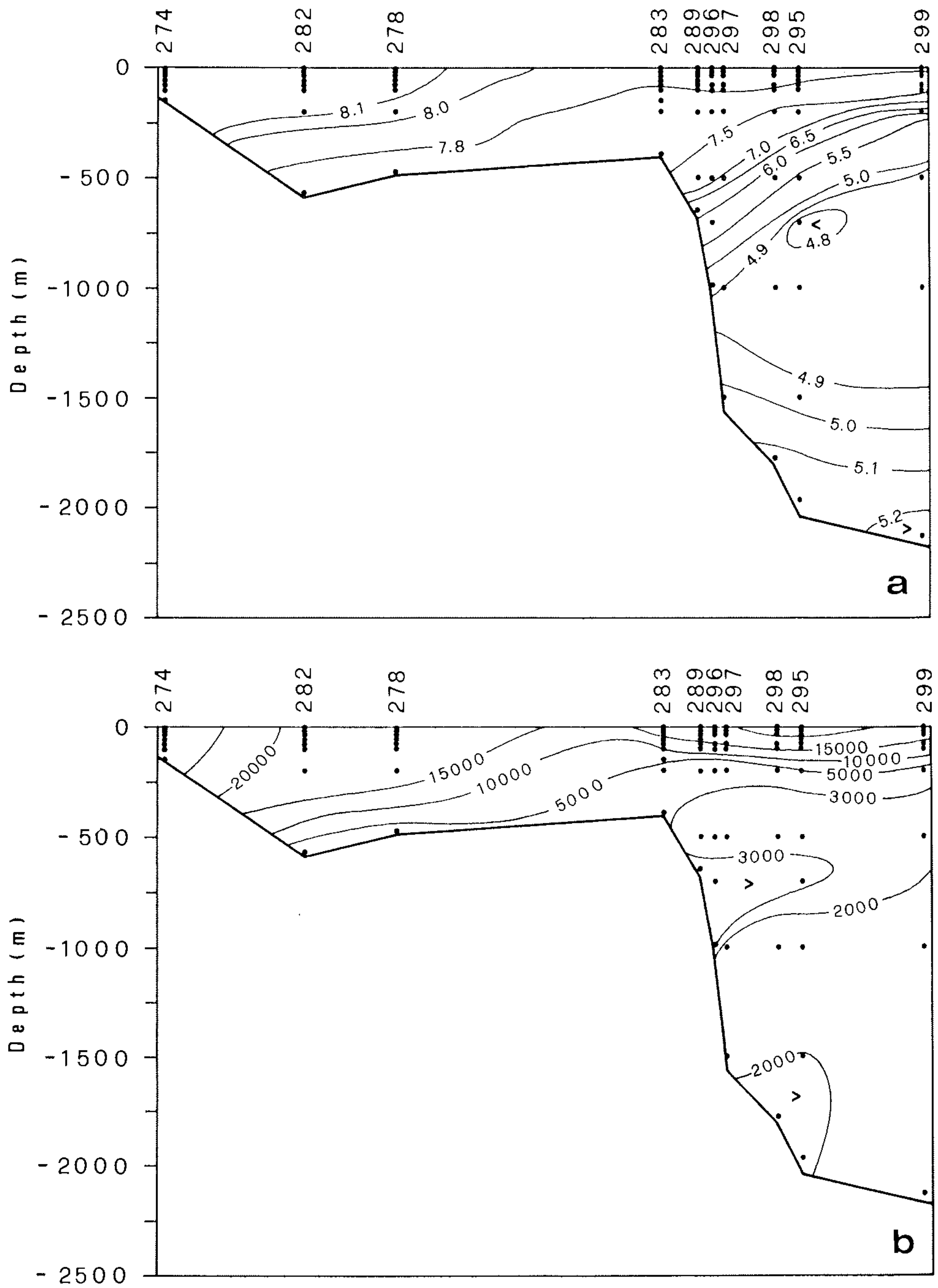



Figure 26: (a) Dissolved oxygen content in $cm^3\ l^{-1}$ and
(b) particle concentration in $cm^3\ l^{-1}$ in section 05
(Kapp Norvegia transect).

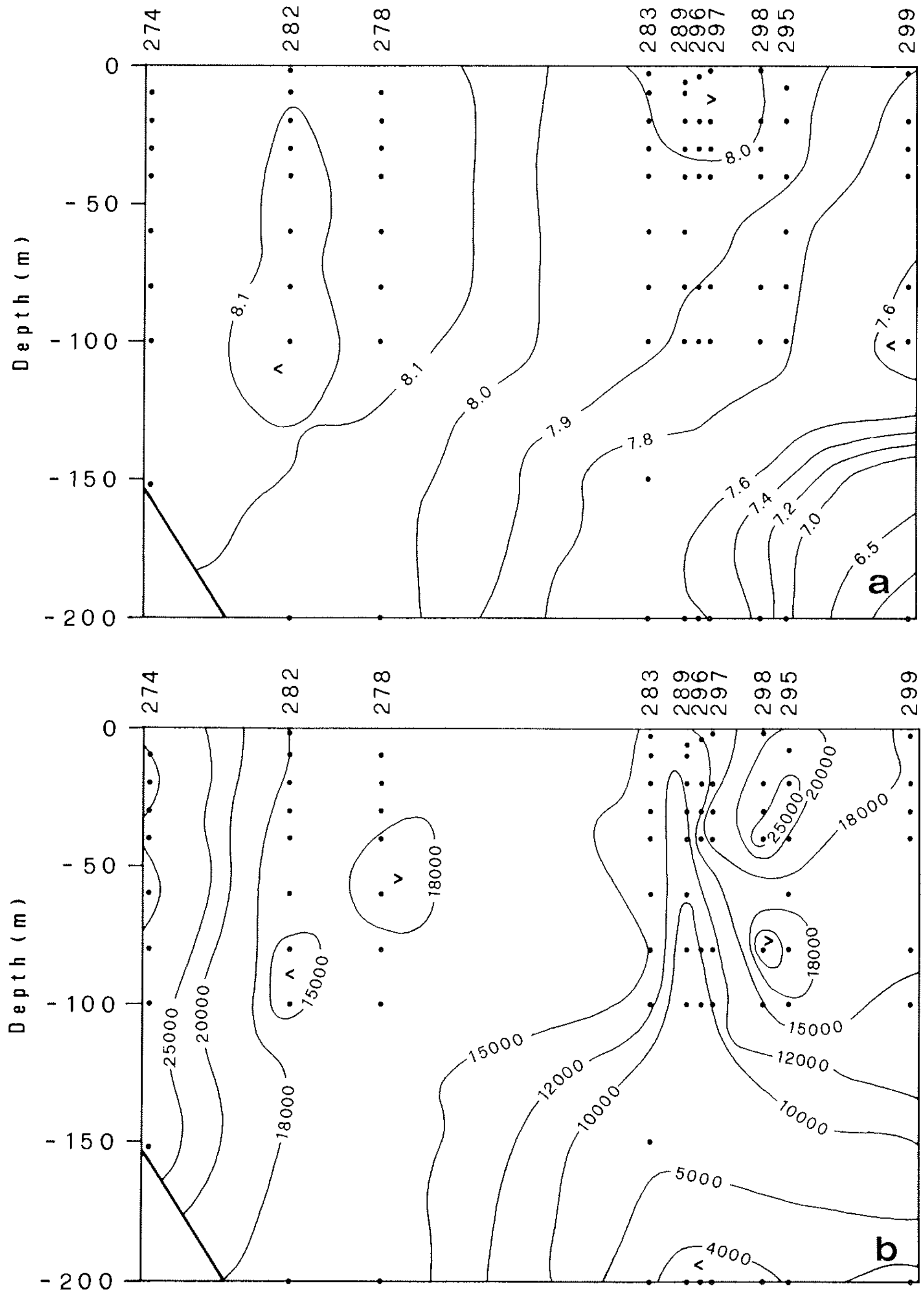



Figure 27: (a) Dissolved oxygen content in $cm^3\ l^{-1}$ and
(b) particle concentration in $cm^3\ l^{-1}$ in section 05 (Kapp Norvegia transect) in the upper layer (0 to 200 m).

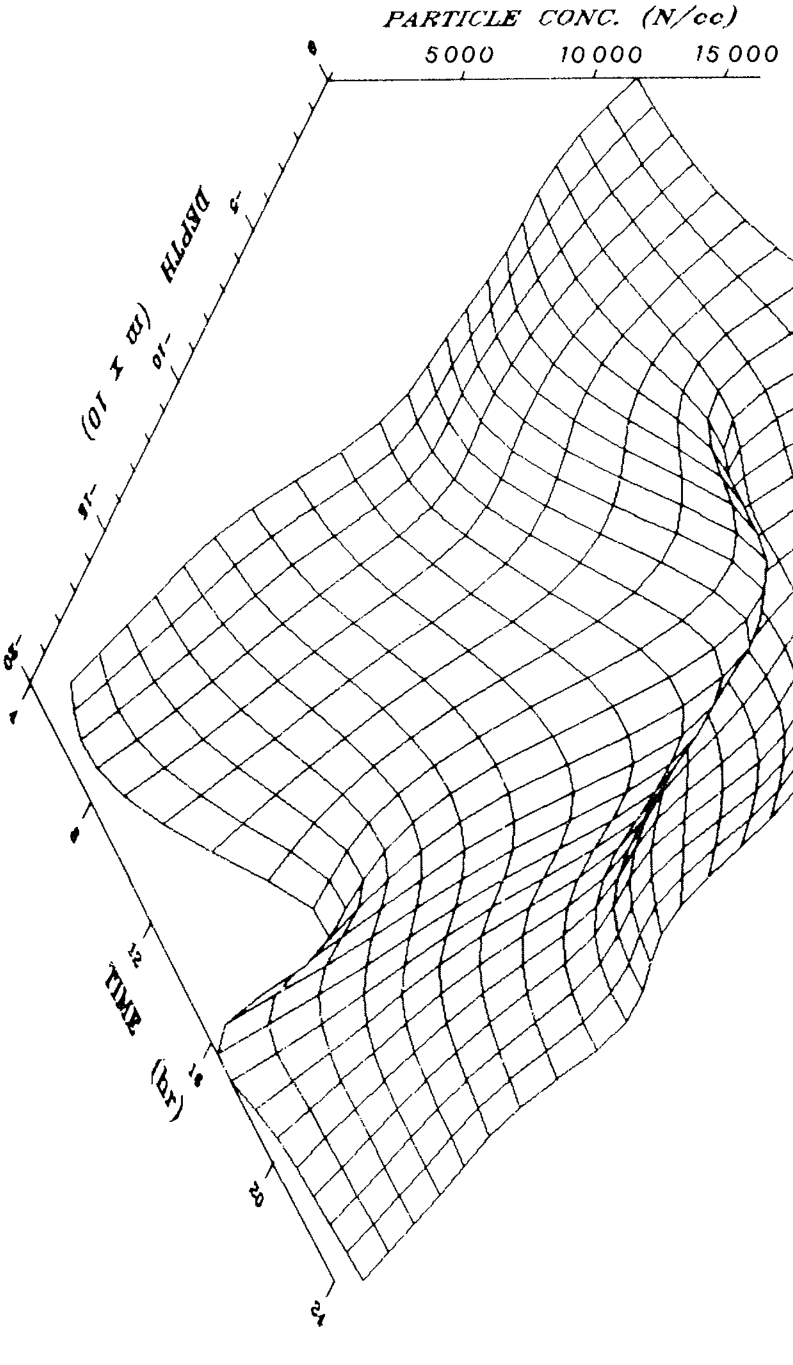



Figure 28: Particle concentration in $cm^3\ l^{-1}$ in function of depth and hour in time series of Station 308.

Si (OH)4 μM

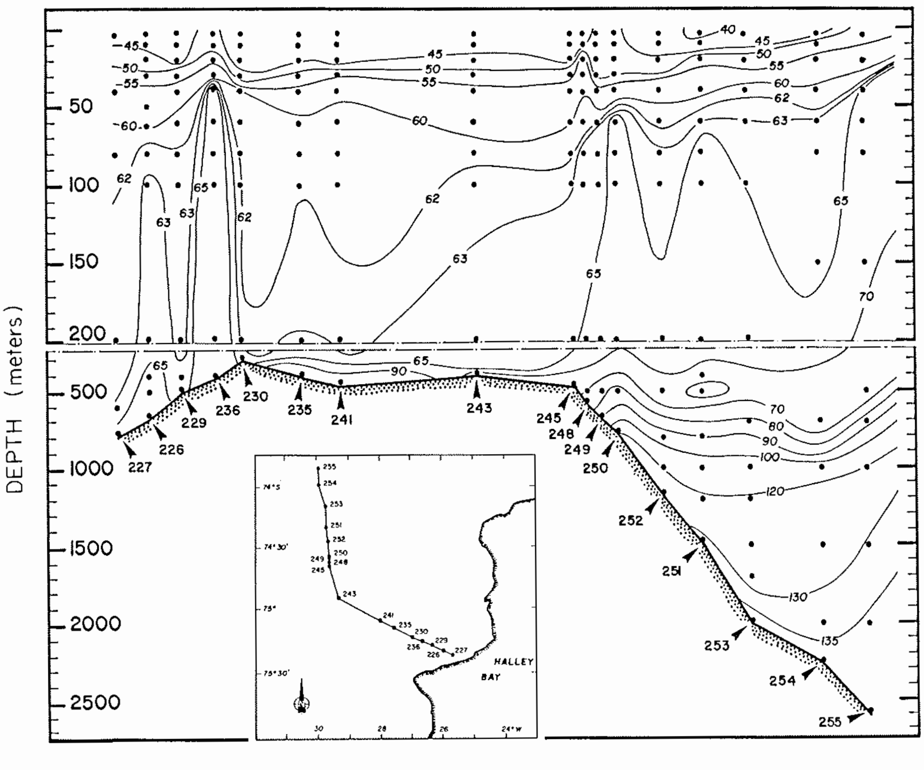



Figure 29: Silicate distribution, Halley Bay transect.

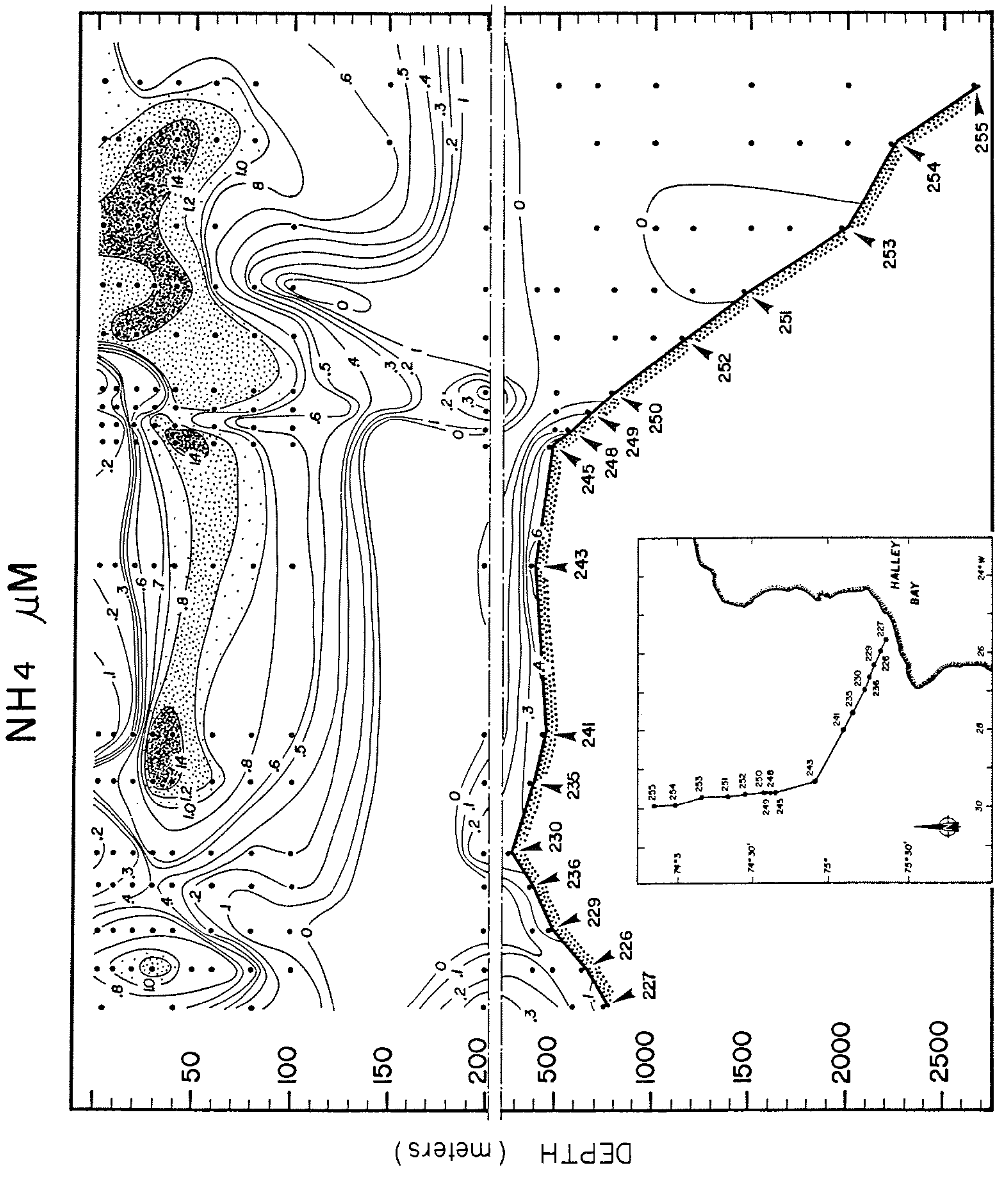



Figure 30: Ammonium distribution, Halley Bay transect.

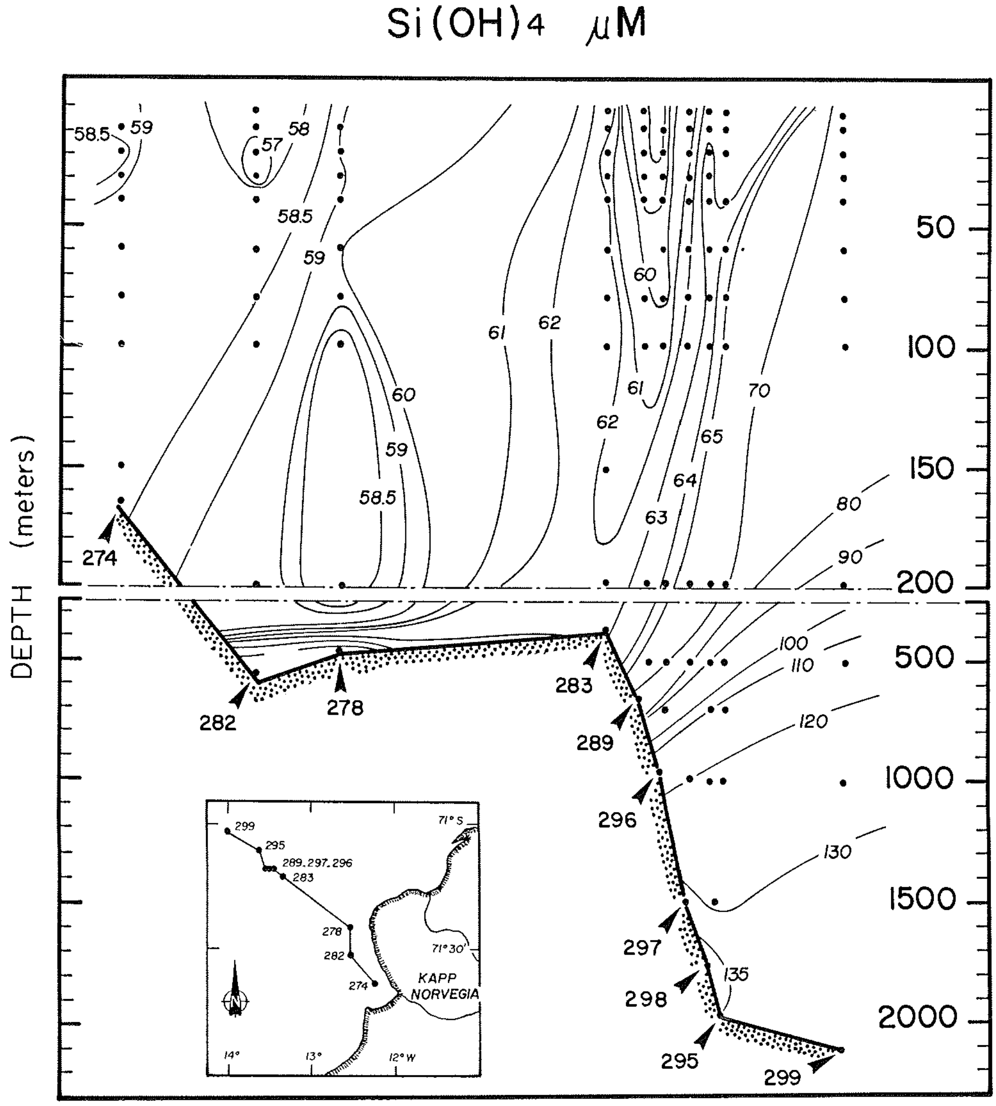



Figure 31: Silicate distribution, Kapp Norvegia transect.

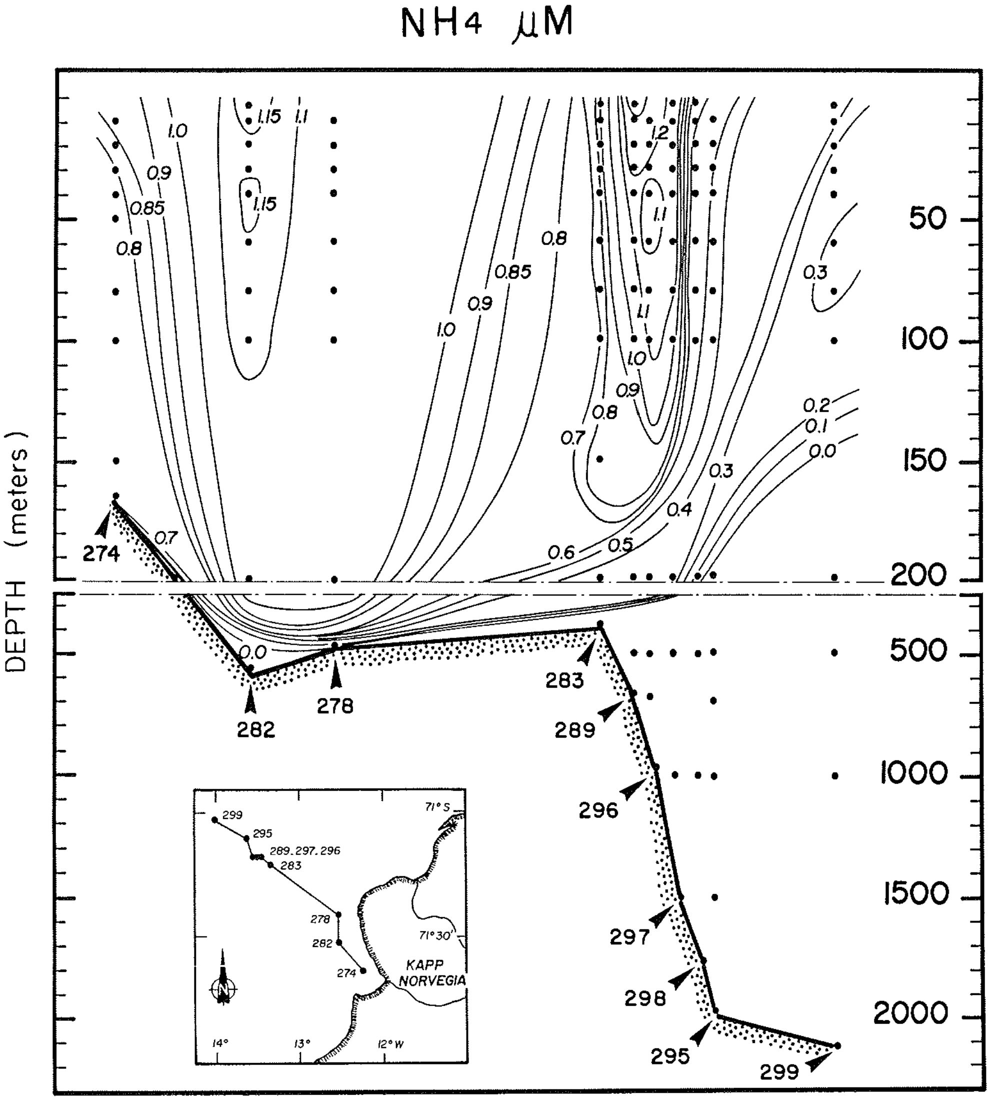



Figure 32: Ammonium distribution, Kapp Norvegia transect.

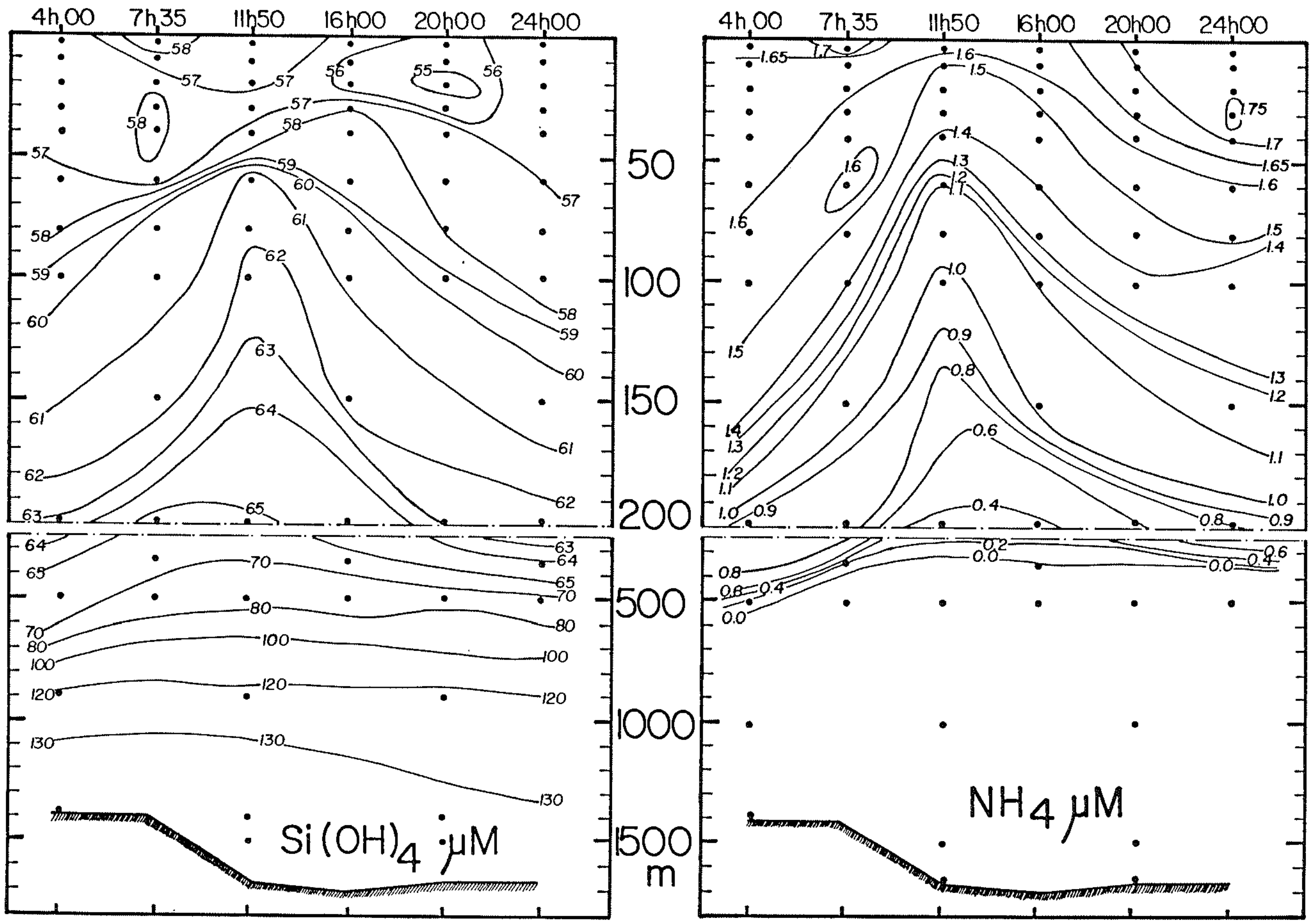



Figure 33: Ammonium and silicate distributions at the 24 hour station off Kapp Norvegia.

## 3.3 Microbial characteristics in water and sediment of the eastern Weddell Sea

J.H. Vosjan, R.P.M. Bak, G. Nieuwland

### Objectives

The energy flow in high Antarctic ecosystems is poorly known. The benthic ecosystem is primarily fed by the extremely seasonal primary production in the euphotic zone. In the water column the microbial loop is active and will remineralize part of the produced organic matter. Another part of the produced material will, during and after a phytoplankton bloom, sink out of the photic zone and give a pulse of food to the benthos. Besides this, sinking of surface water during the formation of Antarctic bottom water will cause a transport of suspended matter and of dissolved organic matter to deeper layers and the benthic system may benefit from this. With this in mind we studied the distribution of microbial biomass in the water column and in the sediment. Since microorganisms play a quantitatively large role in the degradation of organic matter, the rate of respiration in the water and sediment will also be described.

There is recent information that during certain periods of the year auto- and heterotrophic nanoplankton populations, mostly < 20 µm flagellates, dominate the pelagic system in Weddell Sea water (e.g. BECQUEVORT, 1989; BUMA *et al.*, 1989) reaching relatively high population densities (e.g. $12.6 \times 10^3$ $ml^{-1}$, BAK *et al.*, this volume). Most data have, however, been collected at the periphery of the Weddell Sea. For the Weddell Sea proper the only available data is the study of NÖTHIG (1988). The present survey was made to obtain comparable data at another point in time to observe possible variations in the reported patterns.

### Work at sea

Along the ice shelf coast of the eastern Weddell Sea 14 stations (St. 264, 265, 268, 274, 278, 282, 283, 289, 295, 296, 297, 298, 299, 308) were sampled at depths of 20, 40, 80 and 100 m. St. 308 was a time station and sampled with 4 hours interval over a 24 hour period.

Water samples were taken with a rosette sampler and sediment samples with a multicorer.

As a total microbial community measurement we used the ATP method (KARL, 1986). ATP is used as a bioindicator and multiplying the ATP content by a factor 250 gives the biomass in C (carbon) units. As a potential respiration rate measurement we used the ETS activity method (VOSJAN, 1988). We measured the temperature effect and calculated with the Arrhenius curve an activation energy of 15.5 $Kcal.mol^{-1}$. With this we calculated the ETS activity at in situ temperature from the activity at the incubation temperature of 10°C. From this the real oxygen consumption can be calculated by using a ETS-A: R ratio. This ratio we empirically estimated in other ecosystems and we used it in Antarctic waters. With the ETS: R ratio of 4 and assuming a respiratory quotient of 1, the ETS activity at in situ temperatures can be converted to the real respiration rate expressed in C-units.

The techniques used for the investigation of nanoplankton and bacterial populations were the same as those mentioned in BAK (1989). To count and measure the bacteria we additionally used techniques based on HOBBIE *et al.* (1977). Numbers of ciliates were only counted in the 20 m depth samples.

Preliminary results

Microbial biomass and activity

In the water column and in the sediment from surface to about 6 to 10 cm depth the ATP concentrations have been measured. In the water as well as in the sediment the highest biomasses are found in the upper layers. E.g. at St. 291 (see Fig. 34) in the upper 20 m of the water column about 1000 ng ATP per liter, and at the sediment surface 200 ng ATP per cubic cm are found. Per volume this is 200 times more in the sediment than in the water. The values quickly decrease with depth. At 100 m depth in the water the ATP concentration is about 20 ng per liter, and at 2 cm depth in the sediment it is about 30 ng per cc.

Over a column we can integrate the values to get information about the quantity per $m^2$. For Halley Bay, integrated over 100 m water column, the values were 42.9 $\pm$25 % mg ATP $m^{-2}$ (= 10.7 gC $m^{-2}$) and the respiratory ETS activity at in situ temperatures were 225.7 $\pm$27 % mmol $m^{-2}$ $d^{-1}$ ( = 680 mg C $m^{-2}$ $d^{-1}$). Vertical distribution of ATP and ETS-A of the Halley Bay area over the upper 250 m is given in Fig. 35. In the deeper layers below 50 m, the respiration related to the biomass increased. The same phenomenon was seen in tropical waters (VOSJAN & NIEUWLAND, 1987), and may be explained by the fact that in the photic zone more phytoplankton organisms are present, while below the photic zone heterotrophic organisms dominate.

For Kapp Norvegia the values over a column of 100 m were 25 $\pm$29 % mg $m^{-2}$ ATP (= 6.3 gC $m^{-2}$) and 165 $\pm$27 % mmol $m^{-2}$ $d^{-1}$ respiratory activity (= 495 mg C $m^{-2}$ $d^{-1}$).This seems lower than at Halley Bay but after a storm the water column was mixed to over 200 m, so the microbial biomass was diluted over a larger depth than in the Halley Bay area. Here we had calm wind conditions and the biomass mostly was in the upper 50 m.

At the sediment surface we saw very high values of ATP, about 200 times higher than in the water column, but they decrease quickly. Integrated over a few cm there are lower values than the total biomass of the water column. For Halley Bay the integrated values (over 5 cm) were 2.6 $\pm$38 % (N = 11) mg ATP $m^{-2}$ (= 0.65 gC $m^{-2}$), and there was a tendency of a decrease of ATP with increasing depth, e.g. at 2000 m depth (St. 253) the ATP content over a 5 cm column is 0.95 mg ATP $m^{-2}$ ( = 0.24 gC $m^{-2}$).

At Kapp Norvegia the ATP content was 3 $\pm$49 % (N = 6) mg $m^{-2}$ (= 0.75 gC $m^{-2}$), also with a tendency to decrease with depth. At 2000 m depth a value of 1.35 mg ATP $m^{-2}$ ( = 0.34 gC $m^{-2}$) has been found (Station 295).

Recalculating the ATP values to carbon units and also the respiratory ETS activity to real respiration in C units we can find B/R (biomass/respiration) ratios of 10 to 12 days. This means that in about 10 to 12 days an amount of organic matter equal to the biomass is respired. In tropical waters we found values of about 1 day (VOSJAN & NIEUWLAND, 1987).

In a time series water samples were taken every four hours at the same place during one day/night period. In this way the diel rhythm of ATP content in the water column was studied. This kind of studies also has been done in tropical waters with a clear 12 hours darkness/ light periodicity (VOSJAN *et al.*, in press). In Antarctic waters (Kapp Norvegia) the profiles of the biomass distribution change during the day and over the light period (about 20 hours) an increase of 3 mg ATP $m^{-2}$ (= 0.75 gC $m^{-2}$ $d^{-1}$) was found. Over the column of 100 m water a respiration rate of about 0.2 gC $m^{-2}$ $d^{-1}$ has been estimated, so the gross production must be more than 1 gC $m^{-2}$ $d^{-1}$. The exported production (new production) by sedimentation and grazing must also be added to total production. It is a percentage of the biomass. If we assume a daily export from the upper 100 m of 10 % by sedimentation and 10 % by grazing, then 20 % of the biomass, that is 0.7 gC $m^{-2}$, must be added to the production. Hence the gross production is at least 1.7 gC $m^{-2}$ $d^{-1}$. The sedimented organic matter is for the greater part mineralized in the upper layer of the sediment (see Fig. 35).

Pelagic nanoplankton and bacterial populations

Numbers of flagellates were highly variable. Total numbers varied from 0.7 to 5.5 x $10^3$ $ml^{-1}$, heterotrophs from 0.2 to 1.4 x $10^3$ $ml^{-1}$, and autotrophs from 0.2 to 4.4 x $10^3$ $ml^{-1}$. The source of the variation is not immediately clear. Although, at least at 20 m, there is the component of the daily pattern of density variation, there appears also to be a spatial component. This is evident from the relatively high densities reached at some stations at night (St. 298, 299) which were as high as mid day densities at some other stations (e.g. St. 283).

The effect of the stormy weather conditions during this part of the cruise, which resulted in a complete mixing of the upper 200 m surface layer, is obvious. Apart from St. 264, near Halley, sampled before the storm, densities are apparently not much related with depth, and the usual decrease in numbers with depth was hardly observed.

It appears that the densities were never as high as those encountered, approximately one month earlier, along the 47 degrees West transect at the northern extension of the Weddell Sea (BAK *et al.*, this volume; chapter 2.2). These low densities are probably not caused by the extensive mixing of the surface layers of the Weddell Sea in the period the observations were made. Turbulence did not result in higher numbers of flagellates at greater depths. When densities deeper in the water column are compared, e.g. at 80 m, values are still higher for the northern Weddell Sea.

Groups that have been studied in Antarctic waters such as choanoflagellates and heterotrophic dinoflagellates were generally present in our samples but not dominant. Among the autotrophs Prymnesiida appeared to be most abundant.

Numbers of bacteria were quite normal and varied from 0.5 to 1 x $10^6$ $ml^{-1}$. The related variation in biomass, 17 to 65 x $10^3$ pg C $ml^{-1}$, is much more extreme because of the changes in the relative contribution of cocci and rod-shaped cells.

During the time station numbers of flagellates increased from early in the morning to midday, decreasing again towards the end of the day. This effect was, however, only clearly discernable at 20 m depth. At other depths there was about the same range in density variation but, although highest values also occurred at midday, the diel pattern was less clear.

Bacteria probably showed no diel variation in either number or biomass.

References

BUMA, A., M. ESTRADA, J. LARSEN, U. RIEBESELL, I. SCHLOSS & H.A. THOMSEN, 1989. Unicellular organisms studied alive using photographic and video techniques. EPOS leg 2 cruise report.

BECQUEVORT, S., 1989. The microbial loop. EPOS leg 2 cruise report.

HOBBIE, J.E., R.J. DALEY & S. JASPER, 1977. Use of nucleopore filters for counting bacteria by epifluorescence microscopy. Appl. Environm. Microbiol. 33, 12225-1228.

KARL, D.M., 1986. Determination of in situ microbial biomass, viability, metabolism and growth. *In*: Bacteria in Nature.II Poindexter & Leadbetter eds. Plenum. 85-176.

NÖTHIG, E., 1988. On the ecology of the phytoplankton in the southeastern Weddell Sea (Antarctica) in January/February 1985. Berichte Polarforsch. 53, 1-118.

VOSJAN, J.H., 1988. The ATP and ETS method in the study of surface layers and deep-sea basins of East Indonesian waters. Arch. Hydrobiol. Beih. Ergebn. Limnol. 31, 221-228.

VOSJAN, J.H. & G. NIEUWLAND, 1987. Microbial biomass and respiratory activity in the surface waters of the east Banda Sea and northwest Arafura Sea (Indonesia) at the time of the southeast monsoon. Limnol. Oceanogr. 32, 221-228.

VOSJAN, J.H., G. NIEUWLAND & RUYITNO, in press. Monsoonal differences in microbial biomass, respiratory activity and bacterial numbers in the Banda Sea. Neth. J. Sea Res.

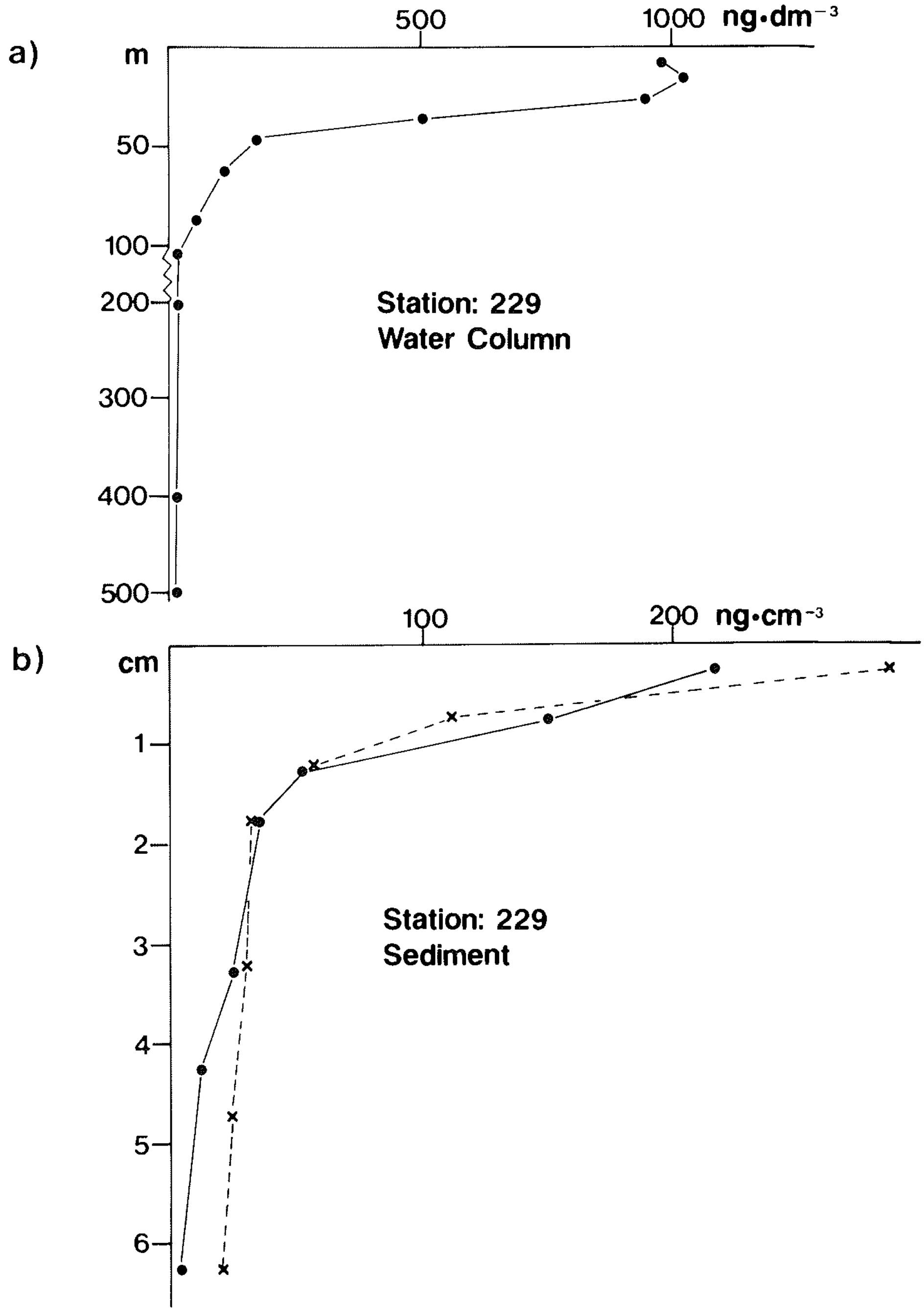



Figure 34: Vertical distribution of ATP in water and sediment (two cores) of Station 229.
(a) Depth in meters and ATP concentration in ng $dm^{-3}$.
(b) Depth in cm and ATP in ng $cm^{-3}$.

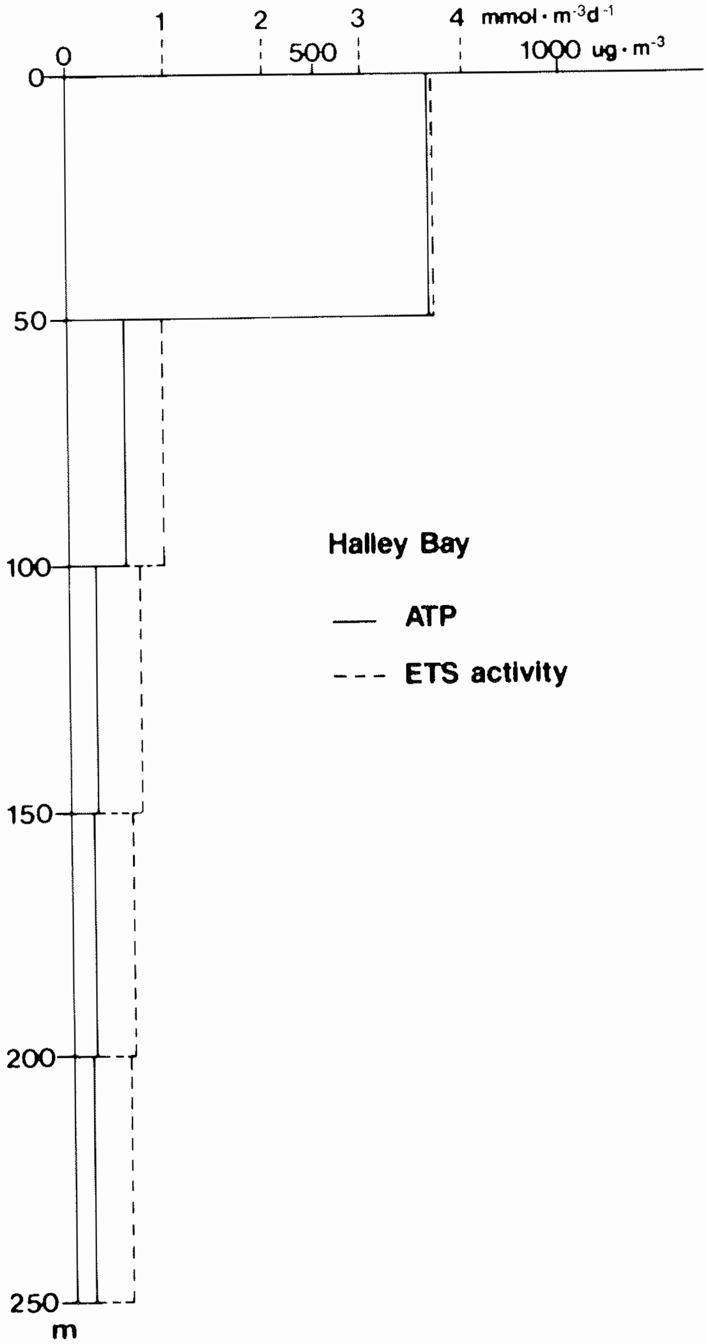



Figure 35: Vertical distribution of ATP and ETS activity at in-situ temperature. The means of the Halley Bay stations are given in µg $m^{-3}$ ATP and mmol $m^{-3}$ $d^{-1}$ ETS activity over the upper 250 m water depth.

## 3.4 Micronekton of the Weddell Sea: Distribution and abundance

U. Piatkowski, M. White, W. Dimmler

### Objectives

Recent studies on the zooplankton and micronekton distribution in the Weddell Sea have revealed three distinct communities which are closely related to bathymetric and hydrographic conditions (BOYSEN-ENNEN & PIATKOWSKI, 1988 among others). Although these communities have been described previously, their transition zones or boundary regions are not well known. A fine-scale transect or grid of sampling stations is necessary to reveal the changes in the community composition in these transition areas. Accordingly, in parallel with the hydrographic, benthic and ichthyological research during EPOS leg 3 two transects at right-angles to the coast line, one off Halley Bay, the other off Kapp Norvegia, were selected to investigate the transition zone between shelf and oceanic micronekton communities in more detail.

The pelagic communities are subject to diel changes in composition, structure and abundance. In an ideal sampling programme, this variable would be eliminated by collecting samples at the same time each day or by sampling at regular intervals throughout each 24 hour cycle. It was impractical to undertake this type of approach during of EPOS leg 3 but as means of identifying the magnitude of diel variations occurring within the pelagic community a time station was undertaken near Kapp Norvegia.

The objectives of the micronekton studies during EPOS leg 3 were:

- To describe the micronekton communities and their changes occurring in the eastern Weddell Sea, with particular attention to the transition from the neritic to the oceanic community;

- to interpret these results in relation to the physical and chemical structure of the water column, bathymetry and biotic factors, and to compare these observations with previous results from the Weddell Sea;

- to examine the changes in micronekton vertical distribution resulting from diel variations in the light environment;

- to obtain samples to study trophic interactions between the benthic and pelagic communities, particularly in relation to resource partitioning of demersal fish;

- to obtain samples of squid for life history analysis;

- to sample and maintain live micronekton organisms for investigations of behaviour and to identify species which can be readily kept.

Initial observations reported here relate only to the material from RMT8 net samples which were roughly sorted during the cruise. The RMT1 net samples require detailed laboratory treatments and will be processed in laboratories in Germany and UK before further analyses can be carried out.

Work at sea

Samples of micronekton were collected using a multiple rectangular midwater trawl (RMT8+1M) with net apertures of 1 $m^2$ (335 micron mesh) and 8 $m^2$ (4.5 mm mesh) deployed on a 18 mm coaxial conducting trawl wire. Information from the net and net commands to the net were recorded by an onboard computing system. Depth, water temperature, filtered water volume, tilt angle, time and status of the net were displayed in real time using software developed at the AWI. Altogether 30 RMT hauls were carried out (see station list).

At most locations the water column was stratified except along the Kapp Norvegia transect where the surface waters were well mixed due to a recent storm. RMT hauls were made to sample these layers as discretely as practical. The standard RMT8+1M haul sampled the upper 300 m of the water column in 300 to 200 m, 200 to 70 m and 70 to 0 m strata at the Halley Bay and Kapp Norvegia transects. Additional hauls from near the seafloor to 300 m were made at the outer 6 stations at the Halley Bay transect to obtain samples from the whole water column. A routine haul of 800 to 300 m, 300 to 100 m and 100 to 0 m was adopted at the time station to sample both the mesopelagic components and near-surface micronekton and to detect the vertical migration of the micronekton within the diel cycle. The RMT8+1M net was deployed to collect samples as an upward oblique haul. The descent rate was normally 0.4 m/sec, the ascent rate was 0.3 m/sec.

The samples were maintained in seawater at ambient temperatures before being processed in the laboratory. The approximate wet volume and major components were assessed, then the RMT8 net samples were rough sorted to extract the ichthyoplankton and squid for examination during the progress of EPOS leg 3. The remainder of each sample was fixed in buffered 4 % seawater-formaldehyde solution. In addition, length frequencies of euphausiid species were recorded from samples at the Halley Bay transect and 9 stations of this transect sorted completely during the cruise. The RMT1 samples were fixed without any preliminary processing.

In addition to the RMT sampling, 17 Bongo hauls were performed in the Halley Bay region. The Bongo nets (300 micron mesh) were hauled vertically through the upper 300 m water column directly after CTD casts. This equipment collected 34 zooplankton samples which will be evaluated in combination with the RMT samples.

Both the RMT8+1M and Bongo nets captured a large number of live micronekton specimens from which small sub-samples were separated, recorded and transferred into aquaria. These were kept in a constant temperature laboratory container (-1°C). The temperature of the seawater within the aquaria varied from -0.5° to -1.0°C. The water was exchanged approximately each third day, the animals were fed with various microalgae.

Preliminary results

Rough sorting of the RMT8 net samples yielded a total of at least 76 micronekton and ichthyoplankton species, copepods and ostracods excluded. More than 5200 larval and small juvenile fish which comprised 25 species (Table 3) were removed from the samples. Most of these were collected from the Halley Bay transect and the time station samples.

Table 3. Number and species of fish sampled using RMT8 during EPOS leg 3.

| Species* | Number of specimens |
|---|---|
| *Pleuragramma antarcticum* | 4176 |
| *Chionodraco myersi* | 307 |
| *Chionodraco hamatus* | 1 |
| *Chionodraco rastrospinosus* | 1 |
| *Chaenodraco wilsoni* | 3 |
| *Cryodraco antarcticus* | 1 |
| *Dacodraco hunteri* | 23 |
| *Pagetopsis* sp. | 206 |
| *Aethotaxis mitopteryx* | 234 |
| *Trematomus lepidorhinus* | 9 |
| *Trematomus* sp. | 3 |
| *Notolepis* sp.** | 55 |
| *Bathylagus* sp. | 59 |
| *Electrona antarctica* | 29 |
| *Gymnoscopelus opisthopterus* | 1 |
| *Gymnoscopelus braueri* | 1 |
| *Racovitzia glacialis* | 27 |
| *Akarotaxis nudiceps* | 2 |
| *Prionodraco evansi* | 19 |
| *Gerlachea australis* | 2 |
| *Bathydraco antarcticus* | 2 |
| *Bathydraconid* sp. | 1 |
| *Artedidraconid* sp. a | 2 |
| *Artedidraconid* sp. b | 1 |

* Species identifications are tentative.

** Specimens identified as *Notolepis* sp. are probably *Notolepis coatsi* since no other species of the genus *Notolepis* is reported from the Weddell Sea, however, the species can only be identified with confidence once specimens have attained a length of about 60 mm.

The Halley Bay transect

The presence of a very wide coastal polynya in February 1989 enabled sampling to be undertaken along a bathymetric transect to the 2000 m contour. Eleven stations were sampled at standard depths to 300 m and then 6 of the seaward stations were re-sampled to obtain material from the water column below the surface 300 m layer to near the seafloor.

The detailed sorting of 27 samples of the 9 standard RMT stations along the transect produced approximately 60,000 micronekton specimens of 46 species (copepods, ostracods and fish excluded). These species belonged to the following taxonomic groups: coelenterates (9 species), ctenophores (2), molluscs (6), polychaetes (5), euphausiids (3), larval decapods (3), amphipods (13), chaetognaths (4) and pelagic tunicates (1). In terms of numbers and biomass the predominant species was *Euphausia crystallorophias* (the ice-krill), with a maximum density of 6447 ind./1000 $m^3$ in the surface layer above the 400 m contour. The siphonophore *Dimophyes arctica* and the chaetognath *Eukrohnia hamata* were also very abundant with highest numbers at seaward stations (49 and 86 ind./1000 $m^3$, respectively).

A total of >4300 individual larval and juvenile fish of 19 species were collected. The identifications should be considered tentative, however, the most numerous species were readily recognizable. Members of the sub-order Notothenioidei dominated the samples with three species of channichthyids (ice-fish) and *Pleuragramma antarcticum* (Antarctic silver-side) being the most common.

Interpretation of the results must be viewed with some caution because of the lack of replicate samples but the observations suggest that there was a neritic community at the stations near to the ice-shelf dominated by large numbers of *E. crystallorophias*, a nototheniid post-larva *Aethotaxis mitopteryx*, and an ice-fish, *Dacodraco hunteri*. A more oceanic community was observed at the seaward end of the transect where the larval stages of *P. antarcticum*, two ice-fish, *Chionodraco myersi* and *Pagetopsis* sp. occurred together with typically oceanic representatives such as *Notolepis* sp., *Bathylagus* sp., myctophids, the pteropod, *Clio pyramidata*, and the chaetognath, *Sagitta marri*, which were lacking at the stations near the ice-shelf. A rich sample of *Euphausia superba,* the Antarctic krill (56 ind./1000 $m^3$, SL=36-55 mm, mature females and males) (Fig.36a) was obtained in the surface layer of the most offshore station of the transect, whereas at all other stations this species appeared only sporadically.

At most locations the water column was stratified, comprising surface summer warm water, an underlying layer of cold Antarctic shelf water and then below this a layer of water with ascending temperature (see ROHARDT *et al.*, this volume). Hauls using the multiple RMT were made to approximately sample these layers in the upper 300 m by dividing this into 300 to 200 m, 200 to 70 m and 70 to 0 m depth intervals.

Except for coelenterate and chaetognath species at the majority of stations most specimens and highest biomass values were found in the upper 70 m layer, however, at St. 252 over 2000 m, this pattern was inverted by an abundance of *P. antarcticum* in the 300 to 200 m layer.

Commonly a sharp demarcation is noted between neritic and oceanic micronekton communities at the junction of the continental shelf and slope. This was not well defined on the Halley Bay transect because, although the community became more oceanic towards the seaward end of the transect, neritic components such as the ice-fish, the ice-krill and meroplanktonic larvae like the larvae of the shrimp *Notocrangon antarcticus* and a larval stage of a benthic gastropod (Echinospira) were still a significant part of the catches. The seaward extension of this neritic community is probably a result of the wide shelf in the south-eastern Weddell Sea and this results in a poorly demarcated transition zone.

The Kapp Norvegia transect

Bad weather conditions hampered the sampling along this transect and RMT standard hauls could be conducted at only five scattered stations.

In contrast to the Halley Bay transect the upper 200 m of the water column was not stratified due to the mixing caused by a previous storm. The two nearshore stations were very poor in terms of numbers and biomass of micronekton except for the surface haul of the station above the 600 m contour where a moderate concentration of adult and juvenile *E. superba* was sampled (160 ml/1000 $m^3$, displacement volume).

The three offshore stations yielded typical oceanic zooplankton and micronekton. A vertical stratification of these communities within the upper 300 m was not as pronounced as at the offshore stations at the Halley Bay transect. The most seaward station above the 2000 m depth contour was accompanied by marked krill echoes on the 30 kz echosounder and yielded a moderate sample of juvenile *E. superba* (150 ml/1000 $m^3$) (Fig.36b) in the surface layer. The ichthyonekton exhibited a similar neritic to oceanic transition along the Kapp Norvegia transect as the Halley Bay transect. These samples were dominated in terms of numbers and biomass by *Pleuragramma antarcticum* accompanied by the larval stages of ice-fish at the stations near to the ice shelf and by oceanic representatives such as *Notolepis* sp. and *Electrona antarctica* at the seaward end of the transect.

Time Station

The time station was conducted as an experiment to examine the order of magnitude of variation in the micronekton numbers and species likely to result from factors such as net avoidance and vertical migration during the diel cycle. Such processes can radically affect the catches resulting from sampling in the water column and on the seafloor with the majority of types of nets.

The time station at 71° 00´S, 12°15´W was occupied for a 24 hr period during which 6 RMT8+1M samples were collected at 4 hr intervals accompanied by CTD casts. The physical oceanographic data collected during the experiment indicated that the water mass was essentially the same throughout the duration of the sampling. The water column had the characteristics of the Antarctic

Coastal Current flowing parallel to the continental slope. Variations in the chemical and microbiological characteristics of the water column were noticed during the experiment and are reported elsewhere (RABITTI *et al.,* this volume) but of particular interest was the marked increase in ammonium measured near the surface during the night accompanied by a decrease in ATP/ETS activity and phytoplankton abundance. This has been tentatively interpreted as being due to zooplankton activity near the surface after dark and was associated with a large catch of *E. superba* (691 ml/1000 $m^3$) in the sample during the "midnight" station. Zooplankton and ichthyoplankton were largely composed of oceanic species and the abundances were low in comparison with the numbers found along the Halley Bay transect.

Only 193 specimens of 14 ichthyoplankton species were represented in the RMT8 catches. The zooplankton was dominated by chaetognaths and gelatinous zooplankton. In addition some mysids, a mesopelagic shrimp and 8 juvenile squids of 3 species (*Galiteuthis glacialis, Alluroteuthis antarcticus, Psychroteuthis glacialis*) were captured mostly in the deeper strata. The ichthyoplankton caught at the time station exhibited a distinct diel pattern in the total numbers of specimens caught at each time interval, there being about a 50 % reduction in numbers during "daylight". (Fig.37). Mesopelagic fish were represented by three species of myctophid and a *Bathylagus* species. All of these displayed distinctive patterns of vertical distribution. They were normally found in the deepest net (800 to 300 m) except for the early larval stages of *Electrona antarctica* which were found at all levels sampled. These four species also exhibited an increase in abundance and an ascent to shallower depths at night.

The differences noted in the micronekton abundance and distribution during the time station experiment demonstrated how important such a procedure is as a control for assessing the diel variations of the biological components in the water column and indicate that conclusions based on the result of single samples should be considered with caution.

Squid

Altogether 180 specimens of 3 squid species were collected during the cruise. These were *Psychroteuthis glacialis* (n = 154), *Galiteuthis glacialis* (n = 19) and *Alluroteuthis antarcticus* (n = 7).

A bottom trawl (GSN) and semipelagic trawl (BPN) (see HUREAU *et al.*, this volume) yielded the majority of the large specimens while their early life stages were sampled by the RMT8.

It was the first time that such a large number of *P. glacialis* had been caught on a scientific cruise. Most of the specimens were juveniles, only a few adults were sampled. The dorsal mantle length (DML) of the animals collected varied from 10 to 37 cm (Fig.38). Nearly all of them were caught along the Halley Bay transect near the seafloor on the slope at a depth of 600 to 800 m.

*G. glacialis* and *A. antarcticus* are well known from Antarctic mid- and deepwater samples. However, it should be noticed that one specimen of

*G. glacialis* captured by the GSN in about 600 m depth was a very large animal with a dorsal mantle length of 41cm.

Live micronekton

In constant temperature aquaria (-0.5° to 1.0°C) we succeeded in maintaining some micronektonic organisms over periods of several days to weeks. The aim of this work was to study their behaviour and to obtain some information for future studies on living Antarctic micronekton species.

The following species could be kept alive and studied in the aquaria: *Euphausia superba* (n = 50), the hyperiid amphipod *Cyllopus lucasii* (n = 2), the polychaete *Tomopteris carpenteri* (n = 1) and the early life stages of the squids *Galiteuthis glacialis* (n = 1) and *Psychroteuthis glacialis* (n = 1). Only *E. superba* and *C. lucasii* survived several weeks, the other species died about 5 to 6 days after being captured mostly due to an inadequate supply of natural food.

In conclusion, although much work remains to be done in the home laboratories during the next months it is already evident that the results of the micronekton studies of the Weddell Sea will contribute to a better understanding of the complex Antarctic ecosystem.

References

BOYSEN-ENNEN, E. & PIATKOWSKI, U., 1988. Meso- and macrozooplankton communities in the Weddell Sea, Antarctica. Polar Biol 9, 17-35.

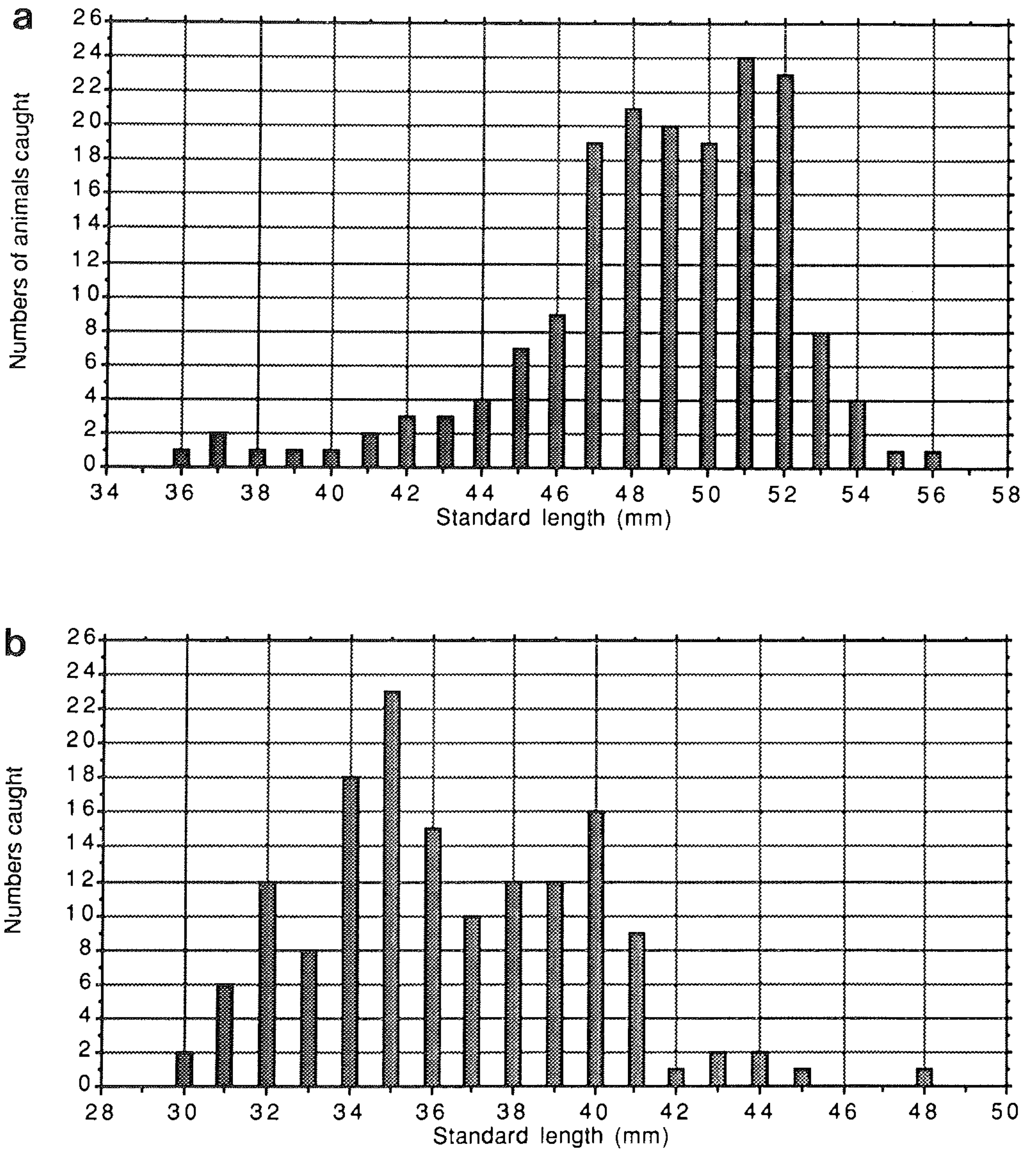



Figure 36: (a) *Euphausia superba*, size classes, Station 253, RMT8-3 (70 - 0 m), n=173.
(b) *Euphausia superba*, size classes, Station 295, RMT8-3 (70 - 0 m), n=150 (subsample) of 850 (total).

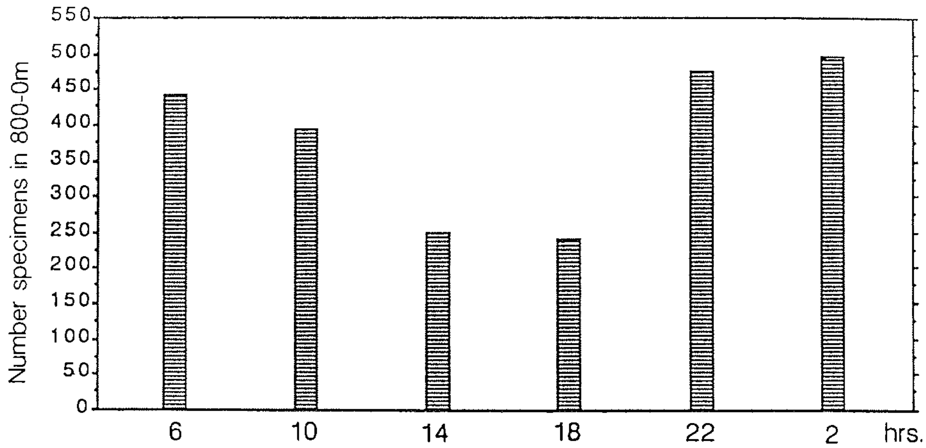



Figure 37: 24 hr time station. Number of ichthyoplankton specimens caught by RMT in the 800 - 0 m range.

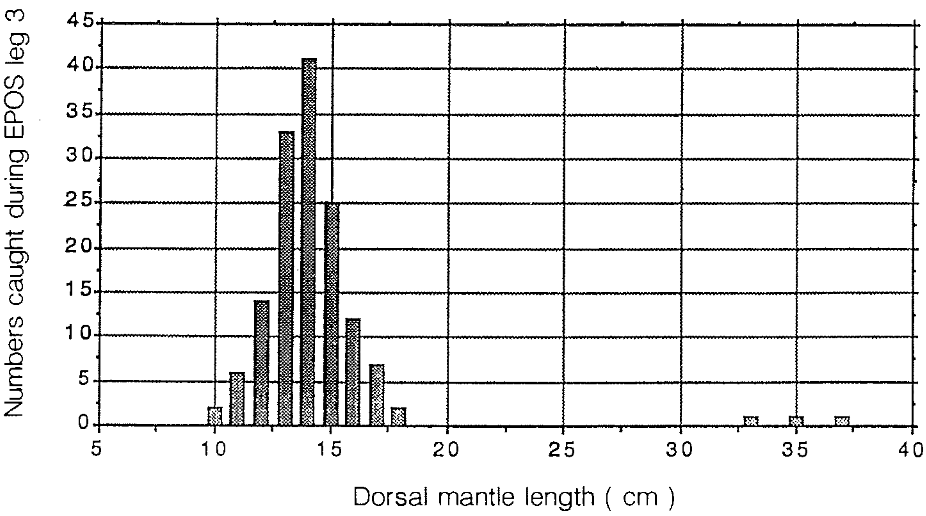



Figure 38: *Psychroteuthis glacialis*, size classes, n=154.

## 3.5 Physico-chemical characterization of sediments

A. Boldrin, S. Rabitti

### Objectives

The main aim of our work was the physico-chemical description of sea bottom sediments and their relations with overlying water characteristics (see RABITTI *et al.*, this volume) along two transects from the ice shelf to the open waters in the eastern coastal area of the Weddell Sea (Halley Bay and Kapp Norvegia areas). This characterization is finalized to the evaluation of the exchanges between water and sediment and, more in general, to the concept of a basic environmental frame for benthic meio- and macrofauna studies.

### Work at sea

Sediment and overlying water samples were collected from the Multi Corer and the Multi Box Corer at 11 stations on the Halley Bay transect and at 5 stations on the Kapp Norvegia transect (Table 4; for distribution of samples among disciplines, see MUC Annex). Eh and pH measurements were done immediately after sampling; pH was measured at the top of the core (Orion pH-meter mod.SA720), whereas for Eh, vertical profiles with steps of 1 cm were done (Schott Geräte pH-meter, mod.CG817, with a special platinum electrode made by NIOZ). Overlying water was collected in paralells by means of plastic syringes and immediately stored at -30°C for later nutrient analyses, after filtration through a Whatman GF/C 25 mm filter. Sediments were sampled at different depths (depending on the total length of the recovered core) for the following analyses to be done in the laboratory:

- grain size
- mineralogy
- organic matter content (readily oxidizable)
- carbon (total and organic)
- nitrogen
- chlorophyll a and phaeopigments
- nutrients (Si-$SiO_4$, P-$PO_4$, N-$NH_3$, N-$NO_2$, N-$NO_3$) in interstitial water.

### Preliminary results

#### Halley Bay area

The visual observations of sediment samples gave us a rough idea about the sediment distribution along the section. Near the ice shelf line (Station 226, 582 m depth) the sediment presented characteristics of a sandy pelite, with an observed flocculant layer of 0.5 to 2 cm thickness. Toward open water the bottom depth remained roughly constant (with a minimum depth of 247 m) and the sediment was initially a pelite mixed with a large amount of small gravel transported by ice and the observed flocculant layer was progressively diminishing. In the initial part of the escarpment toward the deep bottom (Stations 245, 248, 249, 250) the sandy fraction prevailed in the top layer (5 to 10 cm) of sediment, whereas below 10 cm of sediment homogenous gray clays were present, typical of pelagic sedimentation. These were the major component in the deepest samples (St. 252, 1185 m, St. 253, 1958 m).

Table 4. Samples taken from the sediment and overlying water in the southeastern Weddell Sea.

| Station No. | Depth m | Samples and measurements |
|---|---|---|
| HALLEY BAY | | |
| 226 | 582 | 1.2.3.4.5.7.8.9. |
| 229b | 502 | 1.2.3.4.5.7.8.9. |
| 230b | 271 | 2.3.4. |
| 235 | 399 | 1.2.3.4.5.7.8.9. |
| 241 | 458 | 1.2.3.4.5.7.8.9. |
| 245 | 492 | 1.2.3.4.5.7.8.9. |
| 248 | 633 | 1.2.3.4.5.6.7.8.9. |
| 249b | 681 | 1.2.3.4.5.6.7.8.9. |
| 250 | 806 | 1.2.3.4.5.6.7.8.9. |
| 252 | 1185 | 1.2.3.4.5.6.7.8.9. |
| 253 | 1958 | 1.2.3.4.5.6.7.8.9. |
| KAPP NORVEGIA | | |
| 274 | 202 | 1.2.3.5.9. |
| 277 | 405 | 1.4.5.6.7.8. |
| 278 | 555 | 5.9. |
| 294 | 1168 | 1.2.3.4.5.6.7.8. |
| 295 | 2037 | 1.2.3.4.5.6.7.8. |

Samples and measurements explanation:

1: Top layer core (1 cm 2 x 4 cm length)
(plastic syringes, stored at -30°C)
2: overlying water for nutrient analyses
(politene bottles, stored at -30°C)
3: filter (200 ml of overlying water)
(GFC filter, stored at -30°C)
4: top layer sample (0 to 1 cm)
(glass bottle, stored at -30°C)
5: samples for grain size, mineralogy, C, N
(0 to 1, 1 to 5, 5 to 10, 10 to 15, 15 to 20 cm etc.)
(politene bottles, partly stored at -30°C)
6: small samples for C, N analyses
(2, 3, 5, 7, 10, 15, 20 cm)
(politene vials, stored at -30°C)
7: vertical profile of Eh (1 cm step)
8: surface layer (1 cm) pH measurement
9: liner (PVC 5 cm diam.) from Multi-Box-Corer
(stored at - 30°C)

In Fig. 39a the bottom profile and a general description of sediments are reported. Values of pH (at top layer) and Eh (at 1, 5 and 8 cm depth) along the section are reported (Fig. 39b, c). Both show a regular trend from the ice shelf line to the slope, where there is a sharp variation, followed by a parallel increase. A consistent trend has been observed for ATP concentration values integrated over the first 5 cm of sediment (see VOSJAN *et al.*, this volume). In Fig. 40 vertical profiles for Eh and ATP measurement in the upper centimeters of the sediment are given for Stations 241 (458 m) and 252 (1185 m).

Kapp Norvegia area

The first rough description of the sediment top layer follows the trend observed on the Halley Bay transect. From the ice shelf to the oceanic domain the sequence is very similar: pelite (close to the ice shelf), sandy pelite, sands with gravel (on the continental shelf), sandy pelite again (on the continental slope) and finally clayey pelite (in the area of pelagic sedimentation). In Fig. 41 the bottom profile and a general description of the sediment top layer for the Kapp Norvegia transect is reported.

In Fig. 42, as an example, the vertical profile of measured Eh values and the preliminary textural composition of the core is given for St. 277. Noticeable is the good accordance between redox values and texture of sediment. In this sample the top layer texture is characterized by a felt of sponge spicules, which is a dominant feature in many samples from the continental shelf.

Another characteristic of the bottom sediment observed to be common both on the Halley and the Kapp Norvegia transects is the presence of a flocculent layer at the top of the sediments close to the ice shelf.

Note on nutrient content in the water
D. Gouleau

Comparing silicate and ammonium concentrations between the overlying bottom water from the MUC cores and the deepest rosette water sample, one notes no significant difference for silicate content.

In contrast to that, the MUC ammonium content is significantly higher than in the deepest rosette water sample. In the deepest water column samples the higher concentration on the shelf stations of the Halley Bay transect is noticeable (Table 5).

Table 5. Comparison of ammonium and silicate in samples of overlying water from MUC cores and from the deepest rosette water sample.

| STATION | $NH_4$ MUC | $NH_4$ ROSETTE | $Si(OH)_4$ MUC | $Si(OH)_4$ ROSETTE |
|---|---|---|---|---|
| 229 | 1.57 | 0.18 | 67.65 | 62.06 |
| 235 | 1.17 | 0.30 | 94.11 | 96.00 |
| 241 | 1.53 | 0.36 | 110.00 | 105.67 |
| 245 | 0.83 | 0.45 | 88.37 | 73.20 |
| 248 | 0.76 | 0.16 | 84.42 | 80.49 |
| 249 | 0.93 | 0.01 | 104.12 | 101.96 |
| 250 | 0.56 | 0.00 | 119.15 | 121.29 |
| 252 | 0.15 | 0.00 | 125.07 | 123.70 |
| 253 | 0.32 | 0.01 | 136.93 | 135.88 |
| 295 | 0.25 | 0.00 | 135.70 | 133.31 |
| 297 | 0.15 | 0.00 | 135.94 | 131.33 |

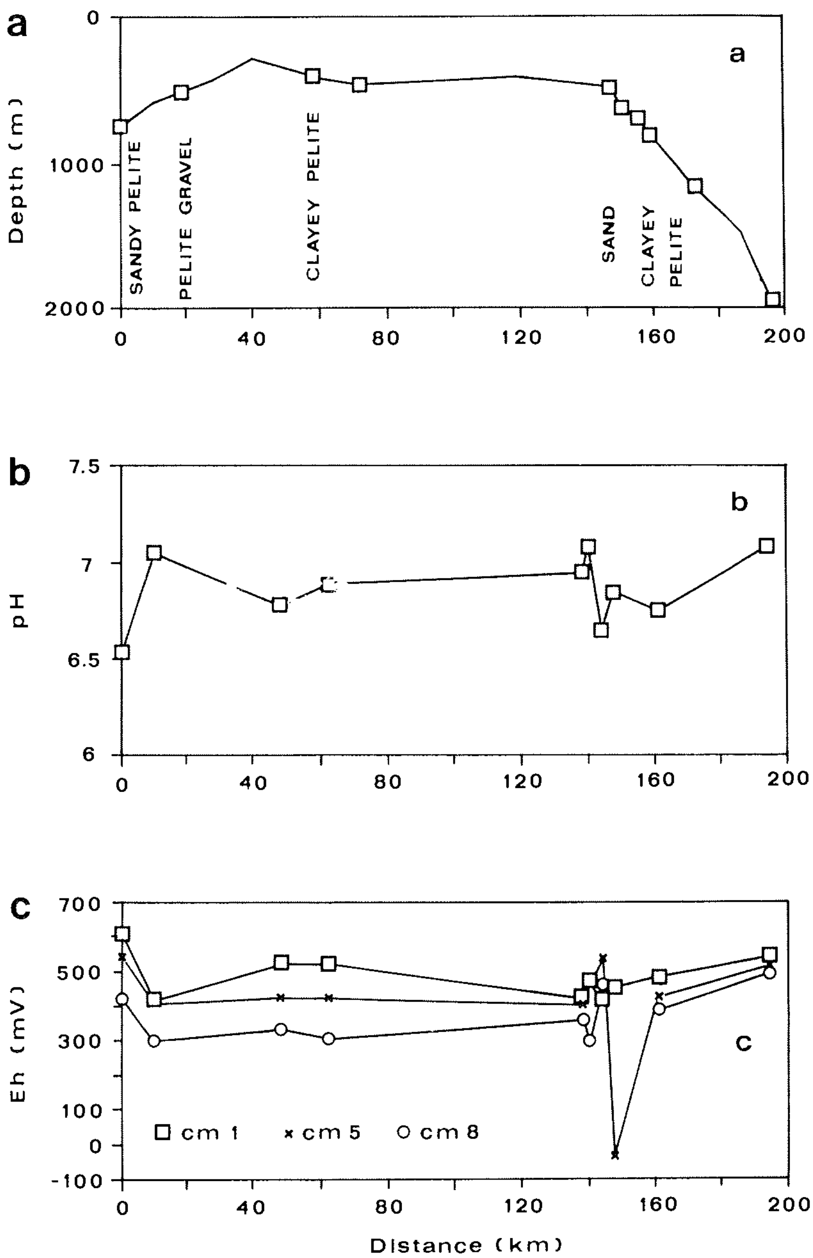



Figure 39: Halley Bay Transect: (a) bottom profile with sampling sites and general description of sediment texture; (b) uncorrected pH values on top of sediment; (c) Eh values at 1, 5 and 8 cm depth.

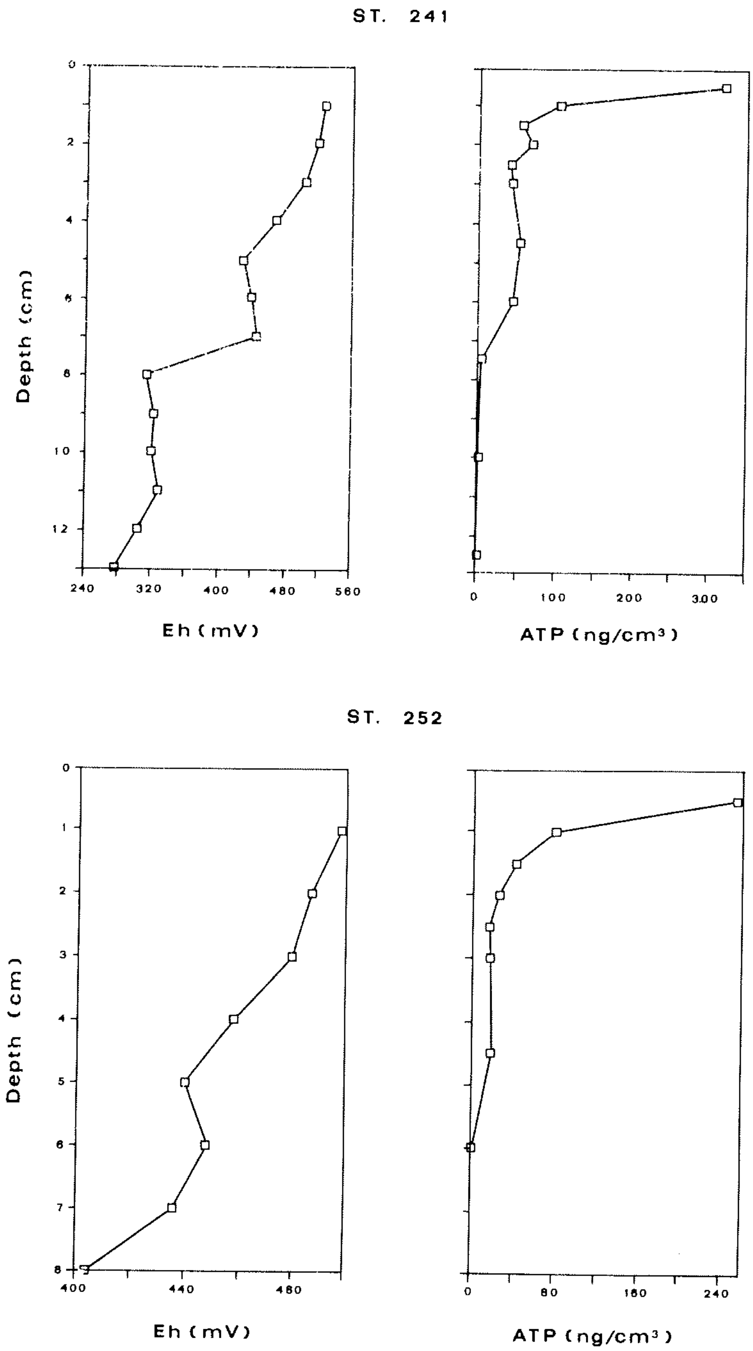



Figure 40: Vertical profiles for Eh and ATP (expressed in ng $cm^{-3}$ of wet sediment) in the upper centimeters of sediment at two stations (Halley Bay Transect).

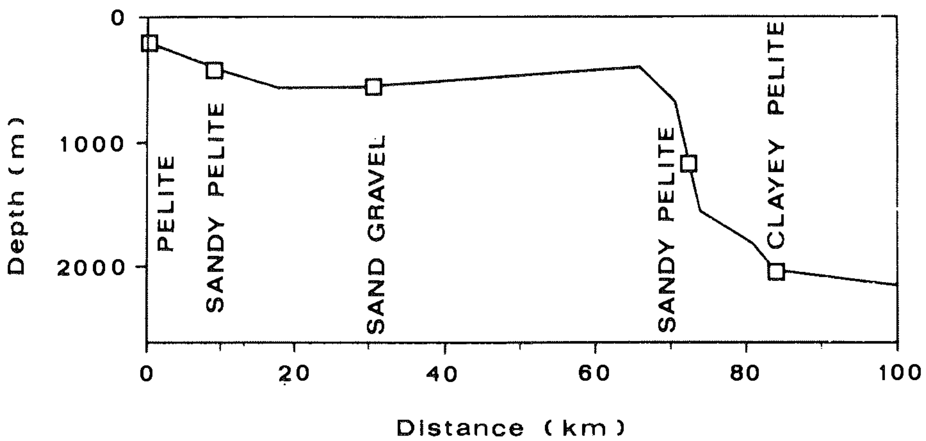



Figure 41: Kapp Norvegia Transect: bottom profile with sampling sites and general description of sediment texture.

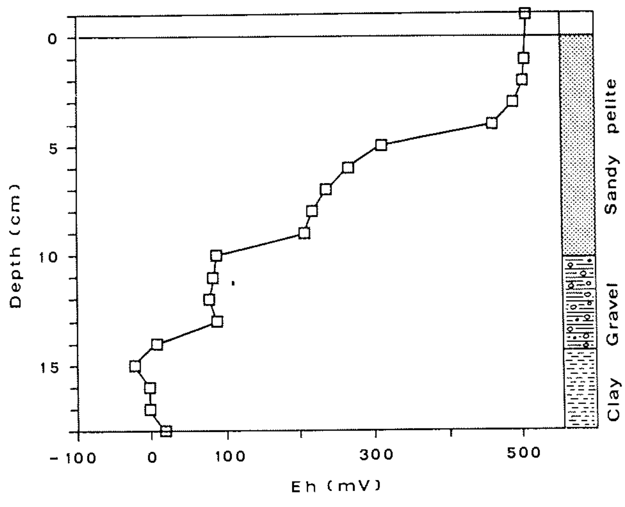



Figure 42: Example of vertical profile of measured Eh values and texture of sediment in St. 277 off Kapp Norvegia.

## 3.6 Benthic microflagellates and bacteria in the sediments of the eastern Weddell Sea

R.P.M. Bak, G. Nieuwland

### Objectives

That microflagellates can be important components of marine ecosystems is known for more than a decade (e.g. SOROKIN, 1977). Data concerning their role as predators, as prey and in mineralisation have accumulated during the last years (e.g. FENCHEL, 1987). However, investigations have concentrated on pelagic systems. While the implications of the existance of an alternative, microbial food web as a possible link to higher trophic levels or as an "energy sink" is becoming increasingly clear, virtually nothing is known about the microflagellates in the sediments.

That protozoan cells occur in sediments, even at great depths, was established in the pioneering studies of BURNETT (1973). The densities of microflagellates and ciliates have been assessed in tropical (ALONGI, 1986, 1987) and temperate (BAK & NIEUWLAND, in press) shallow marine habitats. Fluctuations in densities of benthic microflagellates (< 20 µm) appear to be positively related to bacterial production (BAK & NIEUWLAND, in press) and high densities of the nanobenthos may be indicative of high microbial activity.

The present study aims at a check of the role of microflagellates and bacteria in sediments of the high Antarctic.

### Work at sea

Cores of the multicorer were subsampled (see MUC Annex) with 26 mm diameter cores. Sediment layers at 0 to 3, 30 to 33 and 60 to 63 mm were prepared for analyses of bacterial densities and biomass, densities of microflagellates and other protozoan cells in the size classes < 2, 2 to 5, 5 to 10 and 10 to 20 µm. Samples of bacteria were stored to be analysed in the laboratory. Small protists were fixed, stained and extracted from the sediments (for methods see BAK & NIEUWLAND, in press) and counted aboard (for method see chapter 2.2, this volume). All counts were made within 30 hours after fixation and staining.

The number of cores available for study depended on the amount of material collected with the multicorer. When quantities were sufficient, the densities of ciliates in the top sediment layer were studied (method ALONGI, 1986).

### Preliminary results

Along the Halley Bay benthic transect 11 stations have been sampled from the ice shelf to deeper water: St. 226 (600 m depth), 229 (500 m), 230 (250 m), 235 (400 m), 241 (460 m), 245=258 (500 m), 248 (600 m), 249 (700 m), 250 (800 m), 252 (1200 m), 253 (2000 m).

Numbers of heterotrophic flagellates were highest in the station closest to the ice edge (226), fluctuated around an intermediate level at the stations seawards to a depth of 800 m (250) and were very low in deep water (252 and 253, Fig. 43). Densities were highest in the surface layer of the sediment and very low at depths of 30 and 60 mm, at the deeper stations < $10^3$ $cm^{-3}$. Converted to biomass, highest values were 3 x $10^3$ mg C $cm^{-3}$.

On the surface area covered by the multicorer (few $dm^{-2}$), there was at some stations an appreciable variation in densities on a smaller spatial scale (see St. 241, Fig. 43).

There are basically two sets of stations as far as the benthic microflagellate populations are concerned: a relatively shallow water set with depths from 250 to 800 m and a deep water set at greater depths. The shallower set is characterized by varying but occasially relatively high densities of heterotrophic flagellates, depending perhaps on variations in macro-environmental factors along the transect as well as on small scale spatial variation at a particular sampling site. The deep set consists of invariably low density populations.

Five benthic stations have been sampled along the Kapp Norvegia transect: St. 274 (200 m depth), 277 (400 m), 278 (540), 294 (1200 m) and 295 (2000 m). Densities of flagellates correspond to those found along the Halley Bay transect.

For a more definitive interpretation of the distributions of the different densities along the transect additional data, such as numbers and biomass of bacteria, are necessary. There are few comparable data on flagellate densities. BURNETT´s (1973) figures include an array of other groups of organisms. Compared with data for intertidal flats in a temperate climate (BAK & NIEUWLAND, in press) and ocean bottoms in offshore upwelling regions (Mauretania) (BAK & NIEUWLAND, in press) the densities are low to very low.

References

ALONGI, D.M., 1986. Quantitative estimates of benthic protozoa in tropical marine systems using silica gel: a comparison of methods. Estuarine Coastal Shelf Sci. 23, 443-450.

ALONGI, D.M., 1987. The distribution and composition of deep-sea microbenthos in abathyal regions of the western Coral Sea. Deep-Sea Res. 34, 1245-1254.

BAK, R.P.M. & G. NIEUWLAND, in press. Seasonal fluctuations in benthic protozoan populations at different depths in marine sediments. Neth. J. Sea Res.

BURNETT, B.R., 1973. Observations of the microfauna of the deep-sea benthos using light and scanning electron microscopy. Deep-Sea Res. 20, 413-417.

FENCHEL, T., 1987. Ecology of protozoa. Science Tech. Publ. Madison, pp. 1-197.

SOROKIN, Y.I., 1977. The heterotrophic phase of plankton succession in the Japan Sea. Mar. Biol. 41, 107-117.

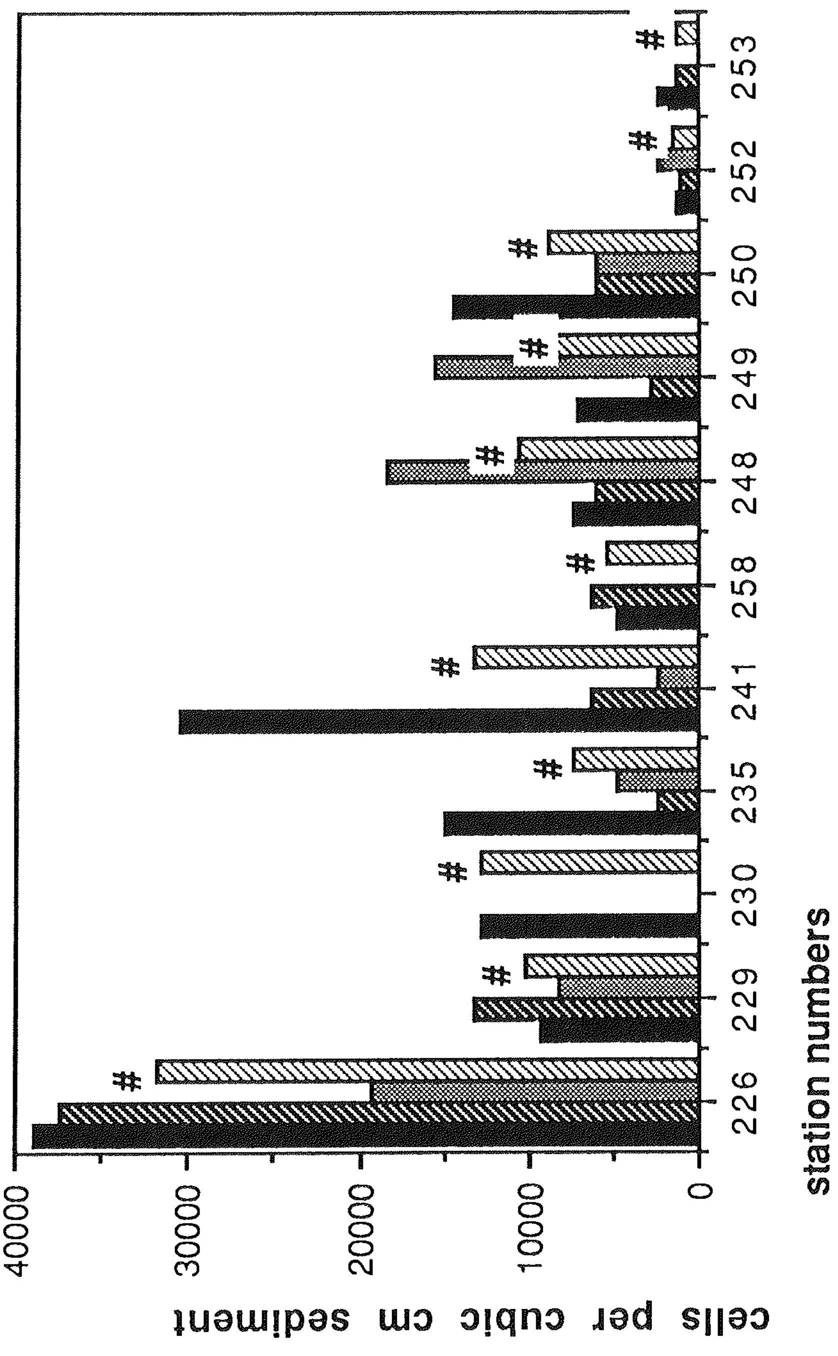



Figure 43: Numbers of flagellates ( sediment depth 0 to 3 mm) in different cores at stations along the Halley Bay transect. Means (lightly hatched bars) are indicated by the hatch symbols.

## 3.7 Meiobenthos on the Halley Bay and Kapp Norvegia transects

H.-U. Dahms, R.L. Herman, E. Schockaert

### Objectives

As part of an integrated qualitative and quantitative study of all components of the Antarctic benthic fauna particular attention was paid to the meiobenthos. This is the intermediate sized group of organisms between the micro- and macrobenthos and is the most numerous fraction in soft bottom communities. Despite their large numbers and ubiquitous presence in marine sediments little is known about the factors controlling abundance and distribution of these organisms.

Therefore, meiobenthos was the subject of a detailed study along depth profiles from shallow waters towards the deep sea. These results will be related to information concerning environmental and biological characteristics obtained in cooperation with other participants.

### Work at Sea

A total of 11 stations along a transect off Halley Bay (HB) and 5 stations in the Kapp Norvegia area (KN) were sampled for meiofauna. Except for three shallow stations in the KN transect all samples were obtained using a multicorer and distributed according to the priority scheme as mentioned in the MUC Annex (cf. Fig. 44a). In the shallow KN transect stations meiofauna was subsampled using 10 $cm^2$ plastic cores out of a MG box.

To study the small-scale distribution 4 samples up to 10 cm into the sediment were taken. Two additional cores for vertical distribution were sectioned into 1 cm slices for the 0 to 5 cm part and in 5 to 10 cm and 10 to 15 cm parts for the fauna possibly living deeper.

All quantitative samples were fixed with warm formalin up to a final concentration of 4 %. All meiofauna were sieved over a 38 µm sieve.

### Preliminary Results

Representatives of 16 meiofauna taxa were recorded. These are in the order of decreasing abundance: Nematoda, Copepoda Harpacticoida, Kinorhyncha, Ostracoda, Polychaeta, Mollusca, Turbellaria, Priapulida, Hydrozoa, Amphipoda, Tantulocarida, Halacaridae, Sipunculida, Monobryozoa, Isopoda and Cumacea.

### Meiofauna of the overlying bottom water

Although little meiofauna is found in the water column , the trapped water of 101 cores of 11 HB transect stations and of 23 cores of 2 KN transect stations was screened for meiofauna. The presence/absence of the 11 taxa found is given in Table 6. On the Halley Bay transect a mean of 4 taxa per station occurs and on the Kapp Norvegia transect a mean of 3 taxa is noted.

Table 6. Meiofauna taxa in bottom water samples.

| Station No. | 226 | 229 | 235 | 241 | 245 | 248 | 249 | 250 | 252 | 253 | 294 | 295 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | 582 | 502 | 399 | 458 | 492 | 633 | 681 | 806 | 1183 | 1958 | 1199 | 2080 |
| N cores (12) | 10 | 9 | 8 | 12 | 9 | 10 | 11 | 10 | 12 | 10 | 11 | 12 |
| Nematoda | * | * | * | * | * | * | * | * | * | * | * | * |
| Polychaeta | * | * | | | | * | | | | | | * |
| Priapulida | | | * | | | | | | | | | |
| Kinorhyncha | | | | | | | | | | * | | |
| Mollusca | | | | | * | | | | | | | |
| Harpacticoida | * | * | * | * | * | * | * | * | * | * | * | * |
| Ostracoda | | | * | | * | * | | | * | * | | |
| Amphipoda | * | * | | | * | * | * | | * | | | |
| Isopoda | | | | * | | | | | | | | |
| Cumacea | | | | | | | | * | | | | |
| Euphausiacea | | | | | * | | | | * | | | |

Nematodes and Harpacticoida were found at all stations. Other well represented groups were Ostracoda and Polychaeta (at resp. 5 and 4 stations), and bottom dwelling Amphipoda are recorded at half of the stations. Of particular interest was the occurrence of a euphausiid Calyptopis larva at depths of 500 m and 1200 m.

Meiofauna of the upper sediment layer

Twelve 0 to 1cm sediment sections of 10 $cm^2$ were examined for their meiofauna content. A total of 16 different taxa were found (Table 7). Since only the top centimeter layer was examined, total densities have to be considered as minimal estimates . They ranged from 100 to 1800 individuals per 10 $cm^2$.

Table 7. Meiofauna taxa in the sediment.

| Station No. | 226 | 229 | 235 | 241 | 245 | 248 | 249 | 250 | 252 | 253 | 294 | 295 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | 582 | 502 | 399 | 458 | 492 | 633 | 681 | 806 | 1183 | 1958 | 1199 | 2080 |
| N cores (12) | 10 | 9 | 8 | 12 | 9 | 10 | 11 | 10 | 12 | 10 | 11 | 12 |
| Hydrozoa | * | | | * | | | | | * | | | |
| Nematoda | * | * | * | * | * | * | * | * | * | * | * | * |
| Turbellaria | * | * | | | * | | | | | * | | |
| Polychaeta | * | * | | * | * | * | * | * | * | | * | |
| Priapulida | * | * | | * | | | | | * | | | |
| Kinorhyncha | * | * | * | * | * | | | | * | * | * | * |
| Mollusca | * | * | * | * | | | * | * | | | * | |
| Halacarida | | | | | * | | | | | | | |
| Harpacticoida | * | * | * | * | * | * | * | * | * | * | * | * |
| --Nauplii | * | * | * | * | * | * | * | * | * | * | * | * |
| Ostracoda | * | * | * | * | * | * | | | * | * | | * |
| Amphipoda | | | | | | * | | * | | | | |
| Cumacea | | | | | | | | * | | | | |
| Isopoda | | | | * | | | | | | | | |
| Tantulocarida | * | | * | | | | | | | | | |
| Sipunculida | | | | | * | | | | | | | |
| Monobryozoa | | * | | | | | | | | | | |
| Total | 1150 | 1320 | 440 | 1800 | 220 | 100 | 200 | 480 | 520 | 390 | 560 | 120 |
| N taxa | 10 | 9 | 7 | 8 | 8 | 5 | 4 | 6 | 7 | 5 | 5 | 4 |

Nematoda was the most abundant taxon, as in nearly every aquatic habitat. Their mean dominance was about 86 %, which is slightly lower compared with communities from analogous sediments elsewhere. Copepoda Harpacticoida and Kinorhyncha were evenly well represented in the Halley Bay transect stations near the ice shelf edge. In the deeper stations Kinorhyncha became less important. This trend is also found for Ostracoda and the smaller Polychaeta.

In contrast to many other soft bottom communities Polychaeta, and even more striking Turbellaria, were less abundant. All other groups such as Hydrozoa, Halacaridae, Priapulida, Sipunculida and Bryozoa (Monobryozoa) are only found occasionally.

Of special interest is the presence of Tantulocarida, which are external parasites of other crustaceans, at two Halley Bay stations. These records of this recently established order of Crustacea are new for the Southern Ocean.

Juvenile bivalves occurred regularly in the samples, and there was a peak density of 370 tiny gastropods (cf. *Omalogyra*, P. ARNAUD , pers. comm.) at St. 229 of the Halley Bay transect.

A mean of 6.9 taxa were found over all 11 HB stations. At the moment it is only possible to compare the two deepest stations (1200 m and 2000 m) of the two transects. Here total density and number of taxa were slightly lower at the KN stations than at the HB stations.

These results give a first impression of the overall composition of the meiobenthos community. Most of the material needs to be further processed in the laboratory both for numerical and taxonomic purposes. The absence of Tardigrada and Gastrotricha in the samples analysed so far is remarkable, for these are two common and well spread meiofauna taxa elsewhere in marine habitats (see, however, report by PETERSEN, this volume).

Turbellarians

All turbellarians have been found in sediment or washed out of bryozoans and sponges from the bottom trawl or Agassiz trawl, and occasionally from the multibox corer. Large quantities of sediment or bryozoans have been studied, and relatively few specimens were found, of many species only one individual. No turbellarian has been found in the cores from the multicorer. This demonstrates the remarkably low density of turbellarians in the area.

The species found at different stations are listed in Table 8. In very fine and silty sediments no turbellarians were found at all (St. 14/226, 235, 249, 250, 252 on the Halley Bay transect and St. 14/274, 278, 290, 292, 294 off Kapp Norvegia), while in some others one or two specimens were found (e.g. St. 229, 241, 271). Surprisingly enough, at each of the deepest 2000 m stations (253 and 295) two individuals of the same species were found.

Table 8. Turbellaria found on the Halley Bay and Kapp Norvegia transects.

| Station No.* | 223 | 229 | 230 | 234 | 241 | 245 | 248 | 253 | 258 | 271 | 277 | 284 | 291 | 295 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACOELA | | | | | | | | | | | | | | |
| Div. spp. | | | | | | + | | | | | | | | |
| NEMERTODERMATIDA | | | | | | | | | | | | | | |
| *Nemertodermata* spec. | | | | | | + | | | | | + | | | |
| MACROSTOMIDA | | | | | | | | | | | | | | |
| cf. *Dolichomacrostomum* | | | | | | | | | | | + | | | |
| PROLECITHOPHORA | | | | | | | | | | | | | | |
| *Cumulata* div. spp. | + | | + | | | + | + | | + | | + | + | + | |
| *Plagiostomidae* div. spp. | + | | + | | | + | + | | + | | + | + | + | |
| PROSERIATA | | | | | | | | | | | | | | |
| *Proseriata* spec.juv. | | | | | | | + | | + | | | | | |
| TYPHLOPLANOIDA | | | | | | | | | | | | | | |
| *Trigonostomum* spec. | | | | | | | | | | | | | + | |
| *Proxenetes* spec.1 | | | | | | | + | | | | | | | |
| *Proxenetes* spec.2 | | | | | | | | | + | | | | | |
| *Proxenetes* spec.3 | | | | | | | | | | + | | | | |
| *Messoplana* spec. | | + | | + | + | + | | | | + | | | | |
| *Typhloplanida* spec.1 | | | | | | | + | | | | | | | |
| *Typhloplanida* spec.2 | | | | | | | | | + | | | | | |
| KALYPTORHYNCHIA | | | | | | | | | | | | | | |
| SCHIZORHYNCHIA | | | | | | | | | | | | | | |
| *Schizorhynchidae* spec.juv. | | | | | | | + | | + | | | | | |
| EUKALYPTORHYNCHIA | | | | | | | | | | | | | | |
| cf. *Gyratricella attemsi* | | | + | | | | | | | | | | | |
| *Gyratrix* spec. | | | | | | | | | | | + | | | |
| *Porrocystis assimilis* | | | + | + | | + | + | | + | | | + | + | |
| *Austrorhynchus* spec.1 | + | | | | | | | | | | | + | | |
| *Austrorhynchus* spec.2 | | | | | | | | | + | | | | | |
| *Austrorhynchus* spec.3 | | | | | | | | | | | | + | | |
| *Polycystidae* spec. | + | | | | | | | | | | | | | |
| *Gnathorhynchidae* spec.juv. | + | | | | | | | | | | | | | |
| *Eukalyptorhynchia* spec.1 | | | | + | | + | | | | | | | | |
| *Eukalyptorhynchia* spec.2 | | | | | | | | + | | | | | | |
| *Eukalyptorhynchia* spec.3 | | | | | | | | | + | | | | | |
| *Eukalyptorhynchia* spec.4 | | | | | | | | | | | | + | | |
| *Eukalyptorhynchia* spec.5 | | | | | | | | | | | | + | | |
| *Eukalyptorhynchia* spec.6 | | | | | | | | | | | | | + | |
| *Eukalyptorhynchia* spec.7 | | | | | | | | | | | | | | + |

* For depths see station list in the Annex.

For the time being it can be said that alltogether more than 30 species have been found (at least 15 are new to science; the exact number of Acoela and of Prolecithophora species can only be determined after sectioning). About 11 species are from the Halley Bay transect, 22 from Kapp Norvegia, where more bryozoan bottoms were encountered. The turbellarian fauna composition on these bryozoans shows some resemblance with the fauna on algae in temperate and tropical areas. The fact that only 1 juvenile of Proseriata and Schizorhynchia (typical sanddwellers) has been found each is undoubtedly due to the absence of coarse sand in the research area.

## Harpacticoida

Living harpacticoid specimens were collected both for maintenance and for cultivation purposes. Among meiofauna taxa Harpacticoida is the group most feasible for cultivation purposes. Harpacticoida, thus, might serve as a model-group for whole life-cycle studies in vitro of Antarctic or other polar invertebrates which have not been done with other organisms yet.

Besides evidence on behaviour, growth, colour-pattern and physiological parameters, rearing of multiple generations gives further evidence on embryonic and postembryonic development as well as on life-history traits. Evidence obtained from polar species will be compared with that from temperate regions.

Juveniles, males and nonovigerous females from nearly all sampling stations were collectively kept in 250 ml glass dishes, filled with 34 ppm seawater to which sterilized coarse sand grains were added as substrate, fed on miscellaneous sea-ice algae and kept at -1°C at a light-dark cycle of 12:12 hours in the cooled container. Those females which produced egg sacs later on were isolated into individual petri dishes as was done with ovigerous females taken immediately from field samples. Their offspring provides the stock of single-female cultures. 154 ovigerous females out of 9 families have been isolated and 23 have already released naupliar offspring during the cruise.

Investigation of sea-ice samples revealed 3 species of harpacticoid copepods with a wide distributional range in the Weddell Sea: *Drescheriella glacialis*, *Harpacticus* cf. *furcatus* and *Tisbe* n.sp.. Both the first occur south of Elephant Island (St. 14/219), along the Antarctic Peninsula and down to the Drescher Inlet as has been revealed also by previous cruises. From Station 14/265 taken on 11 February 1989 all naupliar stages and 119 juvenile and adult copepodids of the most abundant *D. glacialis* were isolated ( C I: 2, C II: 24, C III: 35, C IV: 29, female C V: 12, male C V: 5, female C VI: 7, male C VI: 5). The specimens were still alive and comprised all developmental stages. The sex ratio was slightly shifted to the female side. Three of the 7 females carried egg sacs of about the same huge size with a high number (approximately 140) of eggs. All the males had 2 (!) symmetrical spermatophores in their vasa deferentiae. This indicates that reproductive activity of this species had not ceased during that time of the year.

Besides sea-ice samples several kinds of gear were used for collecting meiofauna qualitatively (Fig 44b). Sediment and macrofauna of the MUC, MG, AGT, GSN and BPN were stirred up in huge buckets filled with seawater and the supernatant containing most of the lighter meiofauna specimens was decanted over a 80 µm screen. Presorting for separating the living harpacticoids then took place on ice with the aid of a dissecting microscope. It has to be emphasized that a much higher amount of specimens of all meiofauna taxa was collected with the larger bottom gear than with the multicorer due to the smaller surface area covered by this gear. Stations sampled qualitatively for meiofauna according to different gears were as follows: MUC see above; MG (St. 14/252, 277, 295); AGT (St. 14/230, 234, 241, 245, 252, 253, 271, 272, 295, 312); GSN (St. 14/217, 224, 226, 234, 241, 248, 249, 284, 291, 294); BPN (St. 14/253, 256, 258).

Of striking interest was the discovery of hundreds of specimens belonging to the recently established entomostracan crustacean order Facetotecta which has been found exclusively in both AGT and GSN of St. 14/234 and less abundant in GSN at St. 14/249. This is the first record of this primarily planktonic (!) group for the Southern Ocean.

As for Harpacticoida, the Cletodidae become remarkably dominant at the 1200 m and 2000 m stations.

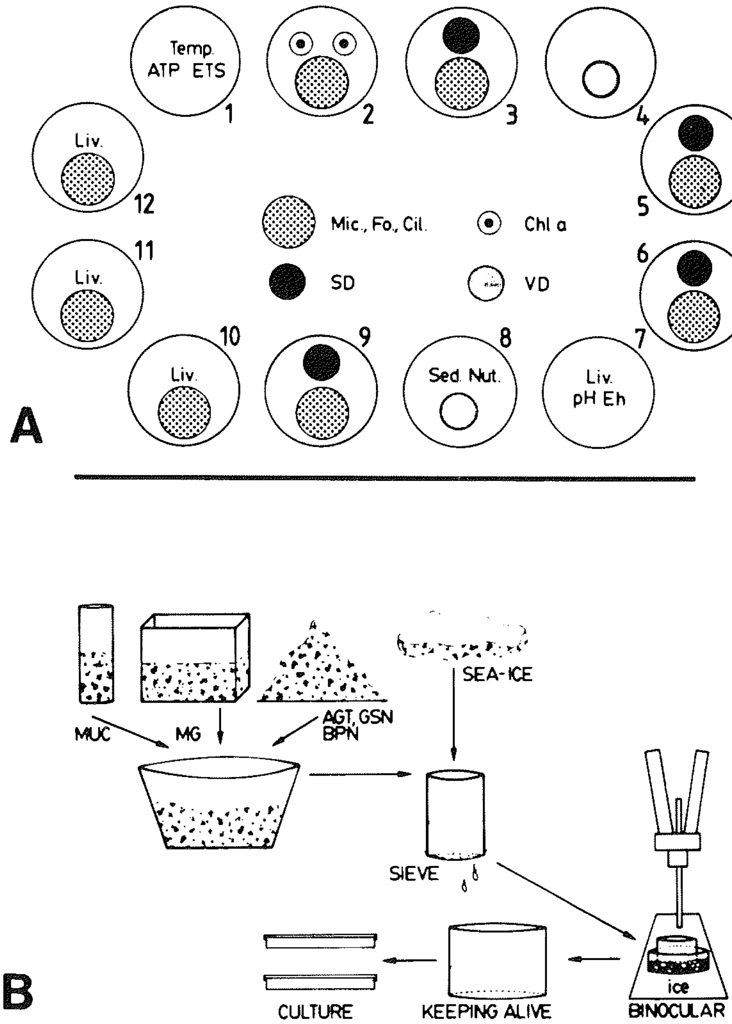



Figure 44: Sampling and cultivation of meiofauna resp. Harpacticoida.
(a) Sampling and rearing of meiofauna (vic. Harpacticoida).
(b) Sampling scheme and distribution of MUC cores (1-12) (Temp.: temperature, ATP: Adenosintriphosphate, ETS: electron transport system, Liv.: living material, Sed.: sediment/granulometry, Nut.: nutrients, Mic.: microflagellates, Fo.: foraminifera, Cil.: ciliates, Chl a: Chlorophyll a, SD: spatial distribution/meiofauna (20 $cm^2$), VD: vertical distribution/meiofauna (10 $cm^2$).

## 3.8 Macrobenthos sampling for community studies and other purposes on the Weddell Sea shelf and slope

### 3.8.1 Introduction

G.H. Petersen, P.M. Arnaud

The Weddell Sea is still a rather unknown sea, and much of the basic faunistic and biogeographic information is lacking particularly for the deep waters. Part of the program was to establish this necessary foundation for future work. Further, a large amount of material had to be collected to solve specific questions. Thus the problems faced during the cruise range from taxonomy , ecology, biogeography and life history to chemical analysis and collecting material to investigate the origin of the Antarctic benthos.

The Weddell Sea lacks some important features of marine life, e.g. tidal zonation and the macroalgae and all the assemblages depending on these. This is due to the shelf ice which covers most of the Weddell Sea continental shelf down to a depth of 100 - 200 m. The question of marine life under the shelf ice was not investigated during this cruise.

Based on previous experience described in VOSS (l988) and GUTT (l988) it was decided to select two transects: off Halley Bay and off Kapp Norvegia, as representative for the shelf and slope benthos in the eastern Weddell Sea. The samples were to be taken from the shallowest possible depth (ca. 200 m) down to ca. 2000 m on the slope. It was not possible for logistic reasons to sample the depths around 4,000 m, which are the characteristic depths for the Weddell Sea basin. Unfortunately, the large data sets of depth positions from previous cruises have not yet been processed, hence the best map available for the planning was only a preliminary map prepared by EKAU and GUTT. Although this proved to be very useful, more precise charts of the region are urgently needed.

This chapter includes all those studies which do not deal with specific groups of animals such as amphipods, shrimps etc. but which are either directed toward the macrobenthic community as a whole or comprise sampling of a number of macrobenthic taxa for special studies (food, evolutionary questions, etc.).

References

GUTT, J., l988. On the distribution and ecology of sea cucumbers (Holothuroidea, Echinodermata) in the Weddell Sea (Antarctica). Berichte zur Polarforschung 41, 87 pp.

VOSS, J., 1988. Zoogeography and community analysis of macrozoobenthos of the Weddell Sea (Antarctica). (In German). Berichte zur Polarforschung 45, 144 pp.

### 3.8.2 Semiquantitative study of macrobenthic assemblages on the Weddell Sea shelf and slope using trawl catch subsamples

P.M. Arnaud, J. Galeron, W. Arntz, G.H. Petersen

Objectives

The quantitative evaluation of macrobenthic assemblages at greater depths is very difficult since there is no single gear or method able to provide the whole necessary information. Bottom cores provide useful quantitative data mainly about the small macrofauna and bottom photographs can do the same for part of the macro-epifauna. Trawls and dredges can collect this macro-epifauna, enabling some identification of invertebrates shown by the photographs. However, it is difficult to use their catch for a quantitative evaluation of bottom invertebrates because it is difficult to estimate the "swept area" (VOSS, l988).

Furthermore the catch of a trawl can be sorted in total and proportions of groups derived from whole counting, only if this catch is not too large. On board 'Polarstern' the catch of the Agassiz trawl can reach several tons and that of the bottom trawl over 10 tons, so subsampling is necessary. To complement multibox-cores and bottom photography we have investigated the macrobenthos assemblages from subsamples taken from the trawl catches. Comparative analysis of results derived from the different approaches applied during this cruise should provide a better understanding of the macrobenthos communities in the eastern Weddell Sea.

Work at sea

From each suitable trawl catch we took 50 liters at random after excluding all fish, large sponges and stones larger than gravel, and sorted them in the laboratory. In a few cases, when the catch did not reach 50 liters, it was used in total as a subsample and the result was extrapolated to 50 liters.

Subsamples were taken from 28 trawl catches out of 5l from depths ranging from 200 to 2000 m on the Halley and Kapp Norvegia transects and off Vestkapp, and sorted. On the Halley transect 7 subsamples were taken from the Agassiz trawls, 7 from the bottom trawls and l from the semipelagic trawl. On the Kapp Norvegia transect 7 subsamples from the Agassiz trawls and 4 from the bottom trawls were taken. Off Vestkapp subsamples were taken from 4 Agassiz trawls. Each subsample was sieved on three mesh sizes: l0, 2, and l mm. The material retained by the largest mesh size was sorted on board into 37 groups of invertebrates (such as gorgonarians, asteroids or polychaetes). These groups were counted, fixed in 4 % formalin and preserved later in 70 % Alcohol. Part of the subsamples had to be discarded because it could not be identified (e.g. gravel, fragments of animals). The material from the 2 and l mm mesh were preserved for sorting at the CENTOB (French Sorting Center) in Brest, which later will distribute the material to specialists.

The material sorted on board consists of ca. 22,000 free living invertebrates plus a large material of colonial animals. Only the free living animals will be considered for this report.

When the total catch of the trawl was greater than 50 liters, the rest of the catch was examined for rarer and more remarkable species. This material, labelled "RS"= Rough Sample, was preserved separately to supplement qualitatively the informations given by the subsample.

Abundance

The number of free living invertebrates in a subsample is obviously related to the size of the animals and to the volume of material that is discarded from that subsample. Thus small invertebrates or a small amount of discarded material will give high numbers in the 50 liters subsample. However the composition of invertebrates in the catch is supposed to reflect the actual proportion of the invertebrates on the bottom at least to some extent.

Gear selectivity

The three trawls used (bottom, Agassiz and semipelagic) can be compared at the 800 m station off Halley, where all were used. The maximum number of macrobenthic animals per 50 liter ("100 %") was obtained by the bottom trawl. The result from the Agassiz trawl was 83 %, and that from the semipelagic trawl 26 % of the abundance obtained in the bottom trawl subsamples. This is a result of the design of the gears including the mesh size. There is also a bias to be expected from clogging of the meshes in the codend; e.g. a trawl filled with sponge spicules or bryozoans will retain more animals of small size than an empty one. Furthermore, the efficiency of the trawls may be quite different on soft and hard bottoms. Since there is apparently no way of taking these factors into account, no attempt has been made at correcting the abundance figures.

The results from the semipelagic trawl were not used for the later comparisons, but the bottom and Agassiz trawls were considered to give similar values for abundance of the free living macrobenthic invertebrates. An exception is the shrimps which were l2 times more abundant in the bottom trawl catch than in the Agassiz trawl catch. So the results from these two were treated together, excluding the shrimps.

Preliminary results

Comparison between the Halley and Kapp Norvegia transects

The following crude comparisons (Tables 9a-c) are based on the subsample fraction retained by the 10 mm screen; they do not yet consider the other two fractions sent to CENTOB. Furthermore, the above mentioned limitations of the data should always be kept in mind.

The largest "absolute" abundances per 50 liter subsample on the Halley transect were found between 600 m and l200 m with a maximum at 800 m. At Kapp Norvegia the abundance at 800 m was much lower.

These differences are partly due to different occurrence of some groups. For example, crinoids showed two peaks off Halley at 300 and 800 m and only one off Kapp Norvegia at 700 m. Pycnogonids had a marked peak at 800 m off Halley, but generally extremely low densities on the Kapp Norvegia transect.

Relative abundances are given as percentages calculated from the numbers in the subsamples. The echinoderms were the dominant group representing 50 % of the total of free living invertebrates off Halley and 47 % off Kapp Norvegia. Ophiuroids dominated among the echinoderms on both transects and with two peaks at 500 and at 800 to l200 m, with many small specimens at the deeper stations. Holothuroids had a maximum at 400 m and 600 m. Asteroids revealed two maxima off Halley (400 m and 2000 m) and only one off Kapp Norvegia (2000 m).

The trends obtained from the subsamples may reflect the actual situation on the bottom, but it is too early to give suggestions for explanations of the differences observed. It is necessary that the results obtained by subsampling be compared with those taken by other gear and underwater photography; at least for epibenthic species this comparison should arrive at conclusions concerning the "true" density of larger animals in different areas.

Conclusions

Much more work has to be done on this material. Sorting must be completed at the CENTOB, and additional information obtained during the cruise (hydrography, chemistry, box cores, photographs etc.) will be of great value in the interpretation of the data. However the following preliminary conclusions can be drawn already:

- The subsample method yields large quantities of material and provides a useful description of the trawl catch contents. To what extent they reflect the real situation on the bottom can be concluded only after comparison with results derived from other parallel investigations.

- The assemblages sampled are mainly referable to the "Eastern shelf community" as described by VOSS (l988) .

- The number of free living macroinvertebrates excl. shrimps is not high in catches from the shelf, but generally very high at the shelf-slope border (400 to 800 m). At this time we can only hypothesize on possible causes; e.g. a greater competition from sponges on the shelf or more productive current systems on the shelf-slope border.

- The Halley transect seems to be richer than that off Kapp Norvegia. This may tentatively be explained by the steeper profile off Kapp Norvegia. At Halley the bryozoans dominate at 500 to 600 m and at Kapp Norvegia they dominate from 400 to 800 m, indicating differences in currents and input of food.

Tab. 9(a). Occurrence of macroinvertebrates in trawl catches. Subsamples taken from the trawl catches are indicated by an asterisk (*).

no sign = absent
(-) = very rare
(+) = rare
(O) = rather common
(•) = common
(●) = very common

**AGASSIZ TRAWL (AGT)**

| AGT No.[1] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | * | * | | | | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | |
| Depth range (m) | 593 626 | 601 614 | 500 509 | 498 496 | 270 280 | 275 279 | 399 404 | 457 462 | 483 484 | 699 712 | 799 810 | 1153 1223 | 1996 2012 | 294 305 | 352 399 | 406 409 | 193 197 | 196 212 | 301 330 | 402 450 | 575 609 | 672 677 | 522 531 | 2025 2037 | 320 471 |
| Hexactinellida | - | | + | | ● | ● | ● | - | ● | + | | - | O | ● | ● | O | O | • | + | ● | + | ● | • | | |
| Demospongia | ● | • | ● | • | • | • | • | • | • | • | + | + | • | ● | • | • | • | • | ● | • | • | ● | O | + | |
| Actiniaria | - | - | - | + | | - | + | • | | - | O | + | O | + | O | O | + | - | + | + | O | - | - | + | - |
| Zoantharia | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scleractinia | | - | - | | - | | + | O | - | O | • | • | + | - | + | O | | | - | - | - | - | - | - | |
| Stylasteroidea | | | | | | | | | O | | | | | O | | | | | | | | • | - | | |
| Hydroidea | | | | | - | | | | | | | | | O | - | O | - | - | | O | + | + | O | | |
| Alcyonaria | | | - | | | | | - | | - | | | | - | | + | | | | | | + | O | | + |
| Pennatularia | - | | + | • | | - | • | - | | - | | + | O | + | | + | - | | | | | - | - | | |
| Gorgonaria | + | - | + | + | • | • | + | O | - | O | + | - | • | + | • | ● | O | - | • | • | O | O | O | • | |
| Bryozoa | • | O | O | + | • | • | + | + | ● | | | | + | • | ● | O | O | ● | ● | ● | • | ● | ● | | |
| Brachiopoda | • | - | + | | + | - | | | • | - | | • | + | | - | + | - | - | | - | | - | - | O | |
| Turbellaria | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemertini | | | - | | | - | | | - | - | | | - | - | | | | - | - | | | - | - | | |
| Echiurida | | | | | | | - | | | | | | | | | | | | | - | | | | | |
| Priapulida | | - | | | | | | + | | | | - | | | | | | | | | - | | | | |
| Sipunculida | - | | | | | | + | + | - | | | | • | - | | | | + | | | | | + | + | |
| Polychaeta Errantia | + | O | + | • | • | • | • | O | • | • | O | • | O | O | O | • | O | O | O | O | O | O | O | • | - |

1) Nos. 1 to 13: Halley Bay, 14 to 17 off Vestkapp, 18 to 26: Kapp Norvegia, 27: Spiess sea-mountain

Table 9(a) cont'd

| AGT No.[1] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | * | * | | | | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | |
| Depth range (m) | 593<br>626 | 601<br>614 | 500<br>509 | 498<br>496 | 270<br>280 | 275<br>279 | 399<br>404 | 457<br>462 | 483<br>484 | 699<br>712 | 799<br>810 | 1153<br>1223 | 1996<br>2012 | 294<br>305 | 352<br>399 | 406<br>409 | 193<br>197 | 196<br>212 | 301<br>330 | 402<br>450 | 575<br>609 | 672<br>677 | 522<br>531 | 2025<br>2037 | 320<br>471 |
| Polychaeta | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sedentaria | • | + | + | • | • | • | • | • | | • | ○ | - | - | + | | + | - | + | ○ | | | | | ○ | |
| Aplacophora | | | | - | | | | | + | | | - | | | - | | - | - | | | | | | | |
| Polyplacophora | | | | | | + | | | + | - | | | | | + | | - | | | - | - | | - | - | |
| Prosobranchia | - | | - | - | + | + | • | + | ○ | ○ | ○ | - | + | - | - | | - | - | - | - | • | + | - | | |
| Opisthobranchia | | | | | + | + | + | + | + | - | + | | + | - | | | | + | | | | | - | - | |
| Scaphopoda | - | | | | | ○ | - | | + | | | + | - | | | | | | | - | + | | | ○ | |
| Bivalvia | - | | - | • | + | + | • | • | • | ○ | | + | • | • | • | + | + | ○ | - | - | + | + | - | - | |
| Cephalopoda | - | + | | | + | | • | + | ○ | ○ | - | + | - | - | + | + | | | + | - | + | | | + | |
| Pycnogonida | - | - | - | + | + | - | + | ○ | ○ | ● | ● | ○ | ○ | + | ○ | • | • | - | • | + | ● | ○ | ● | + | |
| Decapoda | | • | ○ | ● | • | • | ● | ● | | | ● | ● | ○ | ○ | • | • | - | - | + | • | ● | • | • | ● | •[2] |
| Mysidacea | - | | | + | | + | • | ○ | | - | ○ | + | - | + | ○ | ○ | - | | + | + | ○ | | + | + | |
| Cumacea | | | | | + | - | | | + | | | - | + | | ○ | - | | | | | | | | | |
| Isopoda | | | - | - | + | ○ | - | + | ○ | • | ○ | + | - | - | + | + | ○ | - | | + | - | ○ | + | • | |
| Amphipoda | | • | - | - | • | + | + | + | • | ● | + | - | - | ○ | ● | • | • | • | • | • | • | • | • | - | |
| Cirripedia | | - | | | | | + | | | + | - | - | | | + | ○ | | | | - | | • | • | • | |
| Crinoidea | | | - | - | • | - | ○ | ○ | - | ● | ○ | • | + | • | • | ● | • | ○ | ● | ● | ● | ● | ● | + | |
| Asteroidea | • | | + | + | • | • | • | • | • | • | ○ | + | • | | + | ○ | ○ | + | ○ | ○ | • | • | • | ● | - |
| Ophiuroidea | - | - | ○ | • | ● | • | • | • | • | ● | ● | ● | ○ | • | • | ● | ● | ● | • | ● | ● | ● | ● | ● | ○ |
| Echinoidea | | | | | | | | | | | | | | | | | | | | | | | | | |
| Regularia | - | | + | + | + | + | • | ○ | + | • | • | ○ | • | ○ | - | + | ● | ○ | • | • | | ○ | ○ | • | • |
| Echinoidea | | | | | | | | | | | | | | | | | | | | | | | | | |
| Irregularia | | | | | | | • | ○ | | • | • | ● | ○ | | - | + | | | - | - | | ● | - | + | |
| Holothuroidea | - | | ○ | • | • | • | + | ○ | • | ● | ○ | ○ | • | + | ○ | • | ○ | - | • | • | ○ | • | • | ● | - |
| Pterobranchia | | ○ | | + | | • | + | ○ | | + | ○ | | | + | ○ | ● | • | • | • | • | ● | - | | - | |
| Ascidiae | | - | | + | • | + | • | ○ | + | ○ | ○ | + | | - | ○ | + | ○ | • | • | ○ | + | | ○ | + | |

1) Nos. 1 to 13: Halley Bay, 14 to 17 off Vestkapp, 18 to 26: Kapp Norvegia, 27: Spiess sea-mountain
2) On Spiess sea-mountain Lithodidae, otherwise Caridea only

Table 9(b). Occurrence of macroinvertebrates in trawl catches. Subsamples taken from the trawl catches are indicated by an asterisk (*).

No sign = absent
(-) = very rare
(+) = rare
(O) = rather common
(•) = common
(●) = very common

**SEMIPELAGIC TRAWL (BPN)**

| BPN No.[1] | 1 | 2 | 3 | 4 | 5 | 6 * | 7 |
|---|---|---|---|---|---|---|---|
| Depth range (m) | 382<br>399 | 457<br>463 | 484<br>509 | 587<br>611 | 666<br>690 | 798<br>810 | 602<br>617 |
| Hexactinellida | • | | ● | | | • | • |
| Demospongia | • | | ● | • | O | ● | ● |
| Actiniaria | | | O | - | | • | + |
| Zoantharia | | | | | | - | |
| Scleractinia | | | - | - | | • | |
| Stylasteroidea | | | O | + | + | - | • |
| Hydroidea | | | | - | - | + | O |
| Alcyonaria | | | | | | | |
| Pennatularia | O | + | | | | + | + |
| Gorgonaria | | + | | + | | | O |
| Bryozoa | | | O | + | + | | - |
| Brachiopoda | | | O | - | | - | |
| Turbellaria | | | | | | | |
| Nemertini | | | | | | | |
| Echiurida | | | | | | | |
| Priapulida | | | | | | | |
| Sipunculida | | | | - | | | |
| Polychaeta Errantia | - | | O | + | - | O | O |
| Polychaeta Sedentaria | | | - | + | | + | |
| Aplacophora | | | | - | | | |
| Polyplacophora | | | - | | | | |
| Prosobranchia | | | - | | | • | + |
| Opisthobranchia | | | + | - | | + | + |
| Scaphopoda | | | | | | | |
| Bivalvia | | | - | - | | | |
| Cephalopoda | - | - | - | - | | O | O |
| Pycnogonida | | - | + | • | + | ● | ● |
| Decapoda | O | + | | | | ● | • |
| Mysidacea | | | | | | | |
| Cumacea | | | | | | | |
| Isopoda | | | O | | + | • | O |
| Amphipoda | O | - | | + | O | • | O |
| Cirripedia | | | | | | | |
| Crinoidea | | | O | O | | • | • |
| Asteroidea | | - | • | O | | O | • |
| Ophiuroidea | - | | O | • | O | ● | O |
| Echinoidea Regularia | + | - | - | - | + | O | O |
| Echinoidea Irregularia | O | | | | | • | |
| Holothuroidea | - | | + | | + | • | • |
| Pterobranchia | - | | | | | | |
| Ascidiae | - | | • | + | + | + | O |

1) Nos. 1 to 6: off Halley Bay, 7: off Vestkapp

Table 9(c). Occurrence of macroinvertebrates in trawl catches. Subsamples taken from the trawl catches are indicated by an asterisk (*).

no sign = absent.
(-) = very rare
(+) = rare
(O) = rather common
(•) = common
(●) = very common

**BOTTOM TRAWL (GSN)**

| GSN No.[1] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subsample | | | * | * | * | | * | * | | * | | * | * | * | * |
| Depth range (m) | 182 213 | 394 414 | 232 239 | 185 187 | 569 574 | 500 506 | 404 407 | 451 453 | 509 518 | 593 602 | 701 708 | 794 805 | 402 412 | 499 515 | 771 793 |
| Hexactinellida | - | | + | - | + | • | ● | ● | ● | ● | • | - | ● | + | + |
| Demospongia | ● | • | ● | ● | ● | • | • | ● | ● | • | • | • | • | ● | ● |
| Actiniaria | O | • | O | O | + | - | • | • | + | + | O | - | O | - | - |
| Zoantharia | | | | | | | | | | | | | - | | |
| Scleractinia | O | | - | - | + | - | O | O | O | + | - | + | | O | + |
| Stylasteroidea | | | | | | | | | + | | | | | + | |
| Hydroidea | + | - | O | + | | | | | | | | - | O | | - |
| Alcyonaria | | | | | | | | - | | | - | - | | O | + |
| Pennatularia | | | | - | + | | O | • | | | | | | | - |
| Gorgonaria | • | • | O | • | • | - | + | O | - | • | O | O | O | O | • |
| Bryozoa | + | | + | + | • | • | + | + | ● | ● | - | | ● | ● | ● |
| Brachiopoda | | | | - | + | • | - | | O | + | | | + | O | + |
| Turbellaria | | | | | | | | - | - | | | | | | |
| Nemertini | | | | - | - | - | + | | | - | | | - | | - |
| Echiurida | | | | + | - | - | + | | - | | | | | | |
| Priapulida | | | | | + | - | + | | | | | | | | - |
| Sipunculida | | | | - | • | + | • | - | - | - | | | | | |
| Polychaeta Errantia | + | ● | ● | O | • | + | O | O | | • | O | O | • | • | O |
| Polychaeta Sedentaria | | | | - | • | - | + | • | | + | - | - | | | |
| Aplacophora | | | - | - | | | | - | | - | | | | O | |
| Polyplacophora | | | | O | | | | - | • | • | | | • | + | - |
| Prosobranchia | | | O | + | + | + | + | O | + | • | - | + | O | + | - |
| Opisthobranchia | | | - | + | + | | + | + | | - | | - | O | | + |
| Scaphopoda | | | | | | | - | - | + | - | - | | - | - | |
| Bivalvia | O | • | - | + | + | - | • | • | + | • | - | | - | O | + |
| Cephalopoda | + | + | + | + | • | + | • | + | O | • | • | + | + | + | + |
| Pycnogonida | • | O | O | O | + | - | + | O | • | • | ● | ● | + | O | O |
| Decapoda | • | - | + | | ● | • | ● | ● | | - | O | ● | • | • | ● |
| Mysidacea | + | | • | | + | + | • | + | | | | | | | O |
| Cumacea | | | | | | | | | | - | | | | - | |
| Isopoda | • | ● | • | + | - | | + | + | ● | • | + | + | O | + | + |
| Amphipoda | + | • | ● | O | • | + | + | + | ● | • | + | | ● | ● | • |
| Cirripedia | - | | | | | | | - | - | | | • | | | |
| Crinoidea | | + | | O | ● | + | O | • | | + | + | • | • | ● | ● |
| Asteroidea | • | + | O | O | • | + | O | • | + | • | • | • | O | O | ● |
| Ophiuroidea | • | ● | - | ● | ● | - | • | ● | + | ● | ● | ● | ● | ● | ● |
| Echinoidea Regularia | • | + | + | + | • | - | • | O | • | • | • | • | O | O | • |
| Echinoidea Irregularia | | + | • | | | | O | O | | + | O | • | - | - | |
| Holothuroidea | ● | O | ● | ● | • | - | O | • | - | ● | ● | • | • | • | • |
| Pterobranchia | | | | O | | - | O | - | | | | | O | + | |
| Ascidiae | + | + | O | ● | • | - | O | O | + | • | + | - | • | O | + |

1) Nos. 1 to 3: Elephant and Signy Islands, 4 and 13 to 15: off Kapp Norvegia, 5 to 12: Halley Bay

### 3.8.3 Sampling of macrozoobenthos with the multibox corer

M. Klages, S. Hain

During EPOS leg 3 the multibox corer (MG) was used at 21 stations at depths between 260 and 2020 m. This gear was used for the second time in the Antarctic and yielded a large number of samples with undisturbed surface. At the first 9 stations the collected samples were sieved over 500 mm mesh size, but at all the following stations we cut off the upper 15 cm of the sediment and preserved that material in 5 % formalin buffered with hexamethylentetramin. At each station two boxes were fixed with 70 % ethanol for future sorting of small calcareous organisms (e.g. molluscs, brachiopods) at the AWI. The rest of approximately 120 bottles with preserved material has been sent to the CENTOB (French Sorting Center, Brest) for sorting out all systematic invertebrate groups later to be distributed among specialists in Europe.

### 3.8.4 Material for the study of food uptake and digestion of Antarctic benthic invertebrates

B. Dittrich

Food and feeding mechanisms of high Antarctic benthic invertebrates are little known. For this reason a large amount of specimens of various benthic invertebrate species has been collected to investigate the functional morphology of the digestive tract and the digestive physiology of Antarctic invertebrates.

The focus of interest lies on representatives of the systematic groups amphipods, isopods, polychaetes, sipunculids and pantopods. These organisms will be investigated microscopically (light and electron microscopy) concerning the morphology and histology of their organs of food uptake and food transport (mouth parts, fore- and midgut). The nature of the food items will also be considered.

Besides functional morphology, the investigation of some aspects of digestive physiology within several systematic groups of benthic invertebrates is planned. Of particular interest is the question how digestion takes place at these extremely low temperatures. The results obtained in the Antarctic will be compared with those from closely related species of temperate regions.

Concerning the morphological investigations, most of the samples have been preserved in formalin or - for later use in electron microscopy - in glutaraldehyde and postfixed in osmiumtetroxide.

For the purpose of studying enzymatic activities the digestive tracts of different invertebrates have been deep-frozen after determination of the pH values of the corresponding regions of the gut.

### 3.8.5 Material for the assessment of the origin of Antarctic benthos

G.H. Petersen, T. Schiötte

The origin and age of the Antarctic marine fauna will be estimated from phylogenetic and stratigraphic studies on selected groups. Material for the necessary studies on morphology, anatomy, ontogeny and subsequently phylogeny has been collected and preserved according to the instructions of the specialists of the following taxonomic groups (the name of the specialist is in parenthesis): Pterobranchia (Claus Nielsen) - Echinoidea (Margit Jensen) - Cirripedia (G. Höpner Petersen) - Tardigrada (Reinhardt M. Kristensen). The preliminary results from the Weddell Sea can be summarized as follows:

Pterobranchia: They have a crucial phylogenetic position, and they may be related to graptolites. They were supposed to be searched carefully for, but they turned out to be very abundant at several stations, and a large and well preserved material was obtained. Their occurrence near the scientific winter stations may even make them useful for year-round studies. The material collected contains a number of youth stages that will make it especially valuable in phylogenetic studies.

Echinoidea: Antarctic sea urchins have long been regarded as "old" or "primitive", but it has been difficult to obtain material that would allow a closer study of their anatomy and ontogeny. From the Weddell Sea a large material of sea urchins of different size-classes has been collected and properly preserved in different fixatives.

Cirripedia: They are rare in the investigated area and were only found at I5 stations. However, their relative abundance supports the hypothesis that the present Antarctic benthos has rather undisturbed phylogenetic lines back to a mesozoic ocean. Observations on living animals in the aquarium showed that the scalpellids collected are microfilterfeeders, and not voracious predators like lepadids.

Tardigrada: Bottom samples for the retrieval of this group were preserved in different ways. The meiofauna group on board searched for this group, but in spite of this, Tardigrada were not found. After our return to Copenhagen the sediment samples have, however, yielded several species of tardigrades in the initial examinations by R.M. Kristensen.

The attempt to reconstruct the geological history of the Antarctic marine fauna through the indirect phylogenetic methods will eventually be completed with studies from other groups, for example sponges, molluscs, fish, marine mammals and birds. Material from the Antarctic Ocean may also be used to test the current hypotheses concerning speciation, macroevolution and extinction.

## 3.9 Underwater photography

J. Gutt

### Objectives

Underwater photography has been used during several previous expeditions in the Weddell Sea to accumulate information on the epibenthic ecosystem. It is a most effective method to obtain biological information that cannot be obtained by using traditional sampling equipment. Dredges are not quantitative and corers sample too small an area to deduce a comprehensive view of the organisms on the sea floor. As already known from the Weddell Sea shelf, there are large scale differences in benthic assemblages. Therefore during EPOS leg 3 using the technique of underwater photography two significantly different, but for the Weddell Sea typical, communities (VOSS, 1988; GUTT, 1988) were to be investigated. The Southern Trench Community is characterized by low diversities, the missing of suspension feeders and soft-bottom. The Eastern Shelf Community on a poorly sorted sediment is highly diversified and dominated by sponges and bryozoans. The Southern shelf community has an intermediate position. From separate stations it is also known that there can be a high degree of patchiness in a spatial scale of 1 to 100 meters. The important biological parameters and scientific questions which will be analysed from the photographs are:

1. Qualitative data
   -Dominant taxonomic groups
   -Dominant feeding types
   -Percentage of sessile animals
   -Description of associated animals
   -Preferred substrate of the animals.

2. Quantitative data
   - Small scale densities
   - Percentage of coverage of the sea floor with animals such as bryozoans or hydrozoans.
   - Small scale (1 to 100 m) and large scale (1 to 100 km) distribution patterns of different taxonomic groups
   - Biomass.

Using this technique it is only possible to investigate the megafauna living on the substrate.

### Work at sea

The underwater camera consists of two housings, one of them containing a 70 mm camera and the other a pair of strobe lights. Below the gear a trigger weight is hung. When this weight touches the bottom during lowering the camera, a bottom contact switch is closed and this triggers the camera as well as both strobe lights. This information is brought on board via a single conductor cable. To take a next photograph the gear must be raised for a few meters and then lowered again until the weight touches the bottom for a second time etc.. This sequence is repeated up to a maximum determined by the film length. This is usually 75 exposures per cast. The photographs are taken vertically above the bottom. The photographed area is rectangular and has a constant area of 0.56 $m^2$. All the colour slide films were developed on board. Altogether nearly 2000 pictures have been taken at 27 stations.

Preliminary results

A very rough impression of the photographed benthic life can be given although it was impossible to examine the slides on board in detail. The fauna of the slope off Halley Bay (500 to 900 m) on the continental shelf may be part of what VOSS (1988) describes as Eastern Shelf Community. However, it seemed to be poorer in different taxa and biomass than the community at Kapp Norvegia. Thus it may also partly belong to the Southern Shelf Community. The sediment with patches of gravel and stones was poorly sorted. Close to the ice shelf edge at St. 256 a very imporished fauna of only few shrimps and echinoderms was observed (Fig. 45). Many small mounds of a diameter of about 15 cm were probably the result of activity by unknown infauna animals. There were no stones and gravel. These pictures are similar to those of St. 270, south of Vestkapp. However, in the latter area few small sponges were present. The deepest station on the Halley Bay transect (St. 261) showed less biomass than most of the shallower stations. However several different holothurians of the vagrant type, more than 2 ophiuroids per $m^2$ and some sea urchins were present. The deepest station in the Vestkapp area (St. 294) also showed different motile holothurians, more than 6 ophiuroids per $m^2$ as well as mysids, shrimps and polychaete tubes. The northern station of these two deep-sea stations had a significantly more poorly sorted sediment than the more southern one. Whether they both can be considered to be part of the Southern Trench Community must be decided later. All other stations seem to belong to the Eastern Shelf Community with different degrees of richness in forms and biomass. This large scale patchiness of different taxonomic groups was best shown at St. 304, 305, 306 and 307. The two shallower ones (100 m) revealed less biomass, but a diverse community consisting of polychaetes, echinoderms, hemichordates, infaunal sponges and other groups. Large epifaunal sponges were very rare. These had their highest concentration at the two 200 m stations on the Kapp Norvegia transect (Fig. 46). Possibly the poorness of epifauna near the ice shelf edge is a result of the vicinity of the ice shelf. The lower densities of epifaunal biomass on the slope may be due to unknown depth dependant environmental factors.

Some photographs from the Spiess sea-mount showed a few lithodid crabs and large sea urchins as the dominant mega-epifauna. The stony seafloor was covered with a layer of small yellowish rodlets, possibly spines of the sea urchins.

References

GUTT, J., 1988. Zur Verbreitung und Ökologie der Seegurken (Holothuroidea, Echinodermata) im Weddellmeer (Antarktis). Berichte zur Polarforschung 41, 87 pp.

VOSS, J., 1988. Zoogeographie und Gemeinschaftsanaylse des Makrozoobenthos des Weddellmeeres (Antarktis). Berichte zur Polarforschung 45, 144 pp.

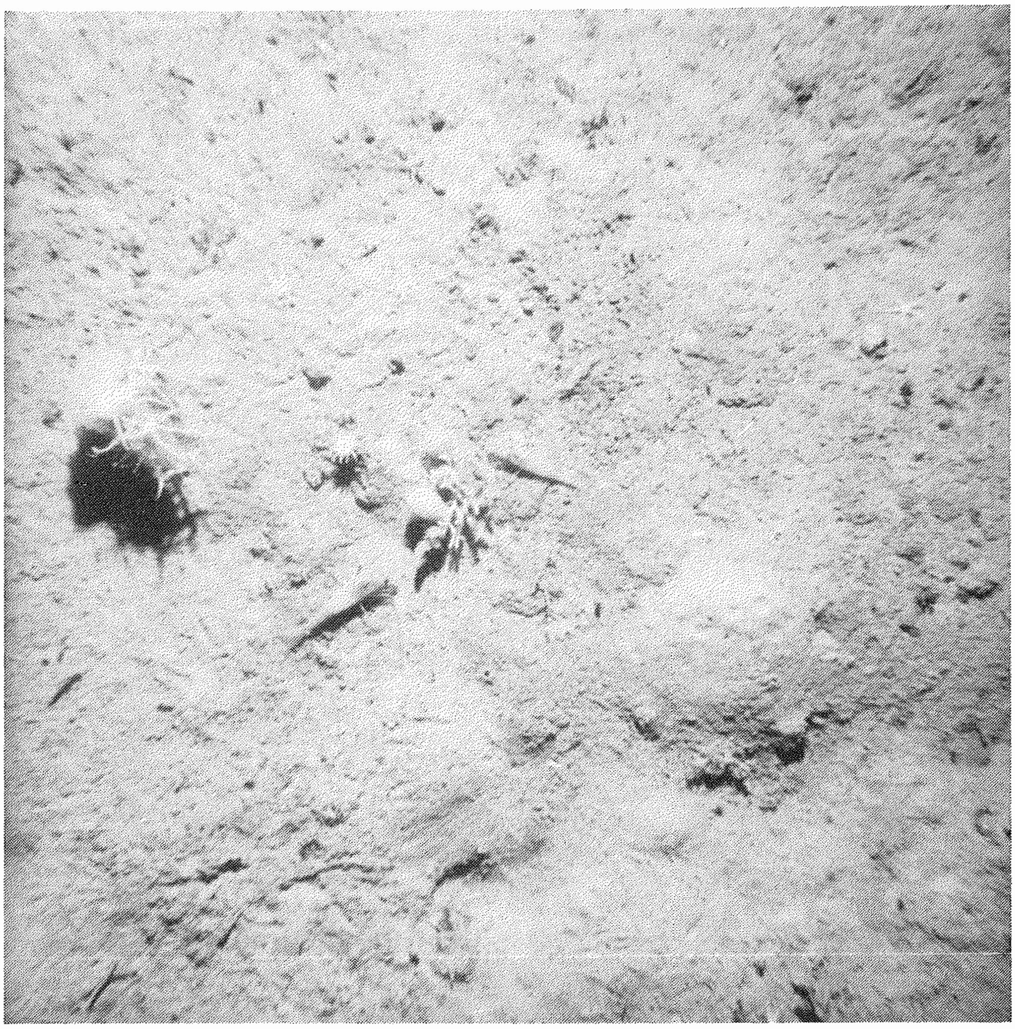


Figure 45: Impoverished benthic fauna close to the shelf ice edge (St. 256 off Halley Bay).

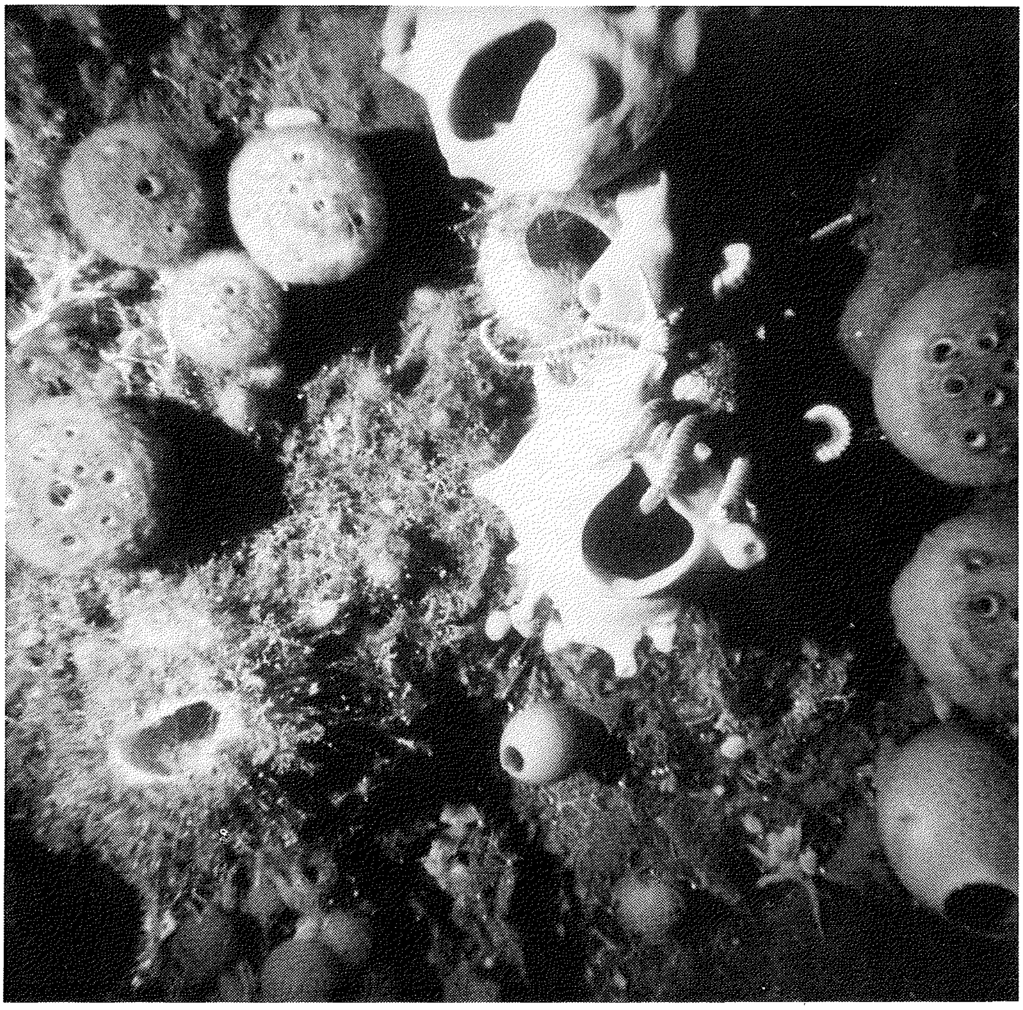


Figure 46: Concentration of large epifaunal sponges off Kapp Norvegia (St. 307).

## 3.10 Ecological and faunistic investigations on shelled molluscs

S. Hain, P.M. Arnaud

### Introduction

In Antarctic and sub-Antarctic regions shelled gastropods (Prosobranchia and Opisthobranchia) and bivalves have a low biomass in comparison to other benthic groups such as sponges, bryozoans or echinoderms. Nevertheless the high species number of about 400 Antarctic taxa (86 gastropod and 39 bivalve species were found in the eastern Weddell Sea on previous expeditions) indicates that the molluscs are an important compartment of the benthic ecosystem.

All of the following preliminary results were obtained from specimens encountered by rough sorting on deck. Detailed studies of the subsamples taken from several trawl samples will give more precise information about the molluscs collected during EPOS leg 3.

### Objectives

The principal aims of investigation were

- to complete zoogeographical and faunistic analyses of the eastern Weddell Sea undertaken during previous expeditions;
- to collect material for the study of gastropod feeding behaviour by selected species;
- to study the biology and behaviour of living specimens in aquaria.

### Preliminary results

The three bottom trawls at Elephant Island obtained 15 gastropod and bivalve species. *Neobuccinum eatoni*, *Harpovoluta charcoti*, *Pontiothauma ergata* and *Aforia magnifica* (Prosobranchia) as well as *Cyclocardia astartoides* and *Lissarca notorcadensis* (Bivalvia) have a circum-Antarctic distribution and were also present in samples from the eastern Weddell Sea, whereas the other molluscan species collected (Fam. Trochidae, Buccinidae, Muricidae and Philinidae) have a more limited distribution, restricted to the Antarctic Peninsula or sub-Antarctic regions.

The molluscs collected during the Halley Bay transect confirmed the faunistic analyses made by VOSS (1988). Near the shelf ice edge, the Eastern Shelf Community was indicated by the limpet-like *Parmaphorella mawsoni* (Prosobranchia), whereas the material from St. 235 to 261 showed a molluscan composition more or less typical of the Southern Trench Community. These samples were dominated by the gastropod species *Harpovoluta charcoti*, *Pontiothauma ergata*, *Aforia magnifica* and smaller species of the family Trochidae. The bivalves *Lissarca notorcadensis* (very abundant on sea urchin spines), *Philobrya sublaevis* (often attached to polychaete tubes), *Adacnarca nitens* and *Limatula hodgsoni* were found most frequently. Several protobranch bivalves, for example, *Propeleda longicaudata* and *Malletia sabrina* were common on soft substrates.

Down to 600 m the molluscs showed no obvious depth stratification. With increasing depth the molluscan fauna became impoverished in terms of numbers and species. At St. 252 (1200 m) *Aforia magnifica* was indicated by only dead shells. The sample from St. 253 (2000 m) contained 7 small molluscan species, showing a mixture of true deep water gastropods (4 species of the families Trochidae, Scaphandriidae and Philinidae) and species with a very wide bathymetric distribution range (2 species of the family Buccinidae and Turridae).

The species *Fissurrisepta antarctica* and *Schizotrochus amoenus* (Gastropoda, Prosobranchia) were found for the first time in the Weddell Sea. Both species occurred only on one big boulder of St. 226/AGT2, a fact supporting the patchiness in distribution of many Antarctic benthic organisms.

The molluscs obtained from the stations at Kapp Norvegia were typical of the Eastern Shelf Community. *Parmaphorella mawsoni* was very abundant at shallower stations as well as *Falsimargarita gemma*, *Antimargarita dulcis* (Fam. Trochidae) and smaller species of the families Buccinidae and Turridae. *Harpovoluta charcoti*, the typical gastropod species for the Halley transect, was nearly absent. The bivalve composition was much the same as in the Halley region, only *Limopsis marionensis* and *Limatula hodgsoni* were found more frequently. St. 295 at 2000 meter water depth showed a mixture similar to St. 253. A first study of the sample yields one real deep water species of the family Pectinidae (Bivalvia) and one specimen of *Poromya antarctica*, a species also occurring in shallower waters.

The following general conclusions about the faunistic composition can be derived from the preliminary analyses:

1. The molluscs of the Southern Trench Community are more related to the terrigenous soft bottom substrates than the species of the Eastern Shelf Community. Most molluscs of the latter assemblage are epizoic on sponges, bryozoans and ascidians, e.g. the "second floor" of the benthic ecosystem.

2. Hard substrates like stones and boulders or the occasionally found whale bones and jaws of Cephalopods are not used as a substrate by molluscs. The only exceptions are 2 or 3 prosobranch species, which probably feed on bryozoans attached to the stones. In contrast with the brachiopods, bivalves were not found attached with a byssus to terrigenous hard substrates.

The studies of about 500 living molluscs and gastropod egg masses in a temperature controlled laboratory container revealed several autecological data.

The most striking observation was the life cycle of species of the genus *Marseniopsis* (Gastropoda, Prosobranchia). The eggs of this group were found attached to an ascidian colony. The larvae have a typical "Echinospira" shape with a gelatinous covering around the shelled embryo. These larvae are the only mesopelagic larvae of benthic Antarctic gastropods found up to now. Caught with the RMT net, about 40 specimens of this veliger were transferred to small aquaria. The size range of the gelatinous covering varies between 3.2 mm and 10.1 mm in diameter depending on the developmental stage or different species. The exact determination will be carried out at the AWI by SEM scanning and comparing the protoconch of larvae and adult individuals of the different *Marseniopsis* species. Most of the larvae were right at the end of their pelagic stage and began to metamorphose in the aquaria. They settled with the foot on the aquarium wall, the four velar lobes were reduced and the mantle built up the typical adult shape, overgrowing the whole shell.

A new type of continuous water exchange in the aquarium system on 'Polarstern' allows the maintenance of very sensitive animals, for example the actinian *Isosycionis alba*, covering the shell of *Harpovoluta charcoti*. This relationship seems to be obligatory, only very young gastropods of about 10 mm shell size were found without actinia. One individual of *H. charcoti* was found with two actinians. Initial observations on feeding behaviour were made during the cruise. *I. alba* may well be a mollusc predator because several specimens were found with gastropod shells in their gut.

For *Pontiothauma ergata*, two large individuals of this turrid species with special harpoon-like radula teeth were occasionally observed feeding on nemertean worms.

Studies of the gastropod feeding behaviour will be continued at the AWI by analysing the stomach content of preserved material and also by studying faecal pellets taken from single freshly caught specimens.

First experiments using different types of substrate in the aquaria show that some bivalves (*Propeleda longicaudata*, *Malletia sabrina*, *Cyclocardia astartoides*) are shallow burrowers in soft sediments. Gastropods of the family Naticidae dig into the sediment, producing typical v-shaped tracks. Further investigations of this type could be helpful for identification of tracks observed with underwater camera systems and will reveal more information about the ecology of several molluscan taxa.

## 3.11 Studies on amphipod biology

C. de Broyer, M. Klages

### Objectives

The final objective of this program is to evaluate the role of the gammaridean amphipods in the Eastern Weddell Sea benthic communities. Taxonomy and faunistics, bathymetrical and zoogeographical distribution as well as habitat and microhabitat identification form the first topics to be investigated.

A qualitative and quantitative assessment of the role of the gammaridean amphipods in the trophic web proceeds by studying the feeding eco-ethology of amphipods and their importance as prey for other invertebrates and for demersal fish.

Estimation of the abundance and biomass of endobenthic amphipods will be obtained from the multibox corer samples.

The life history of selected species, representatives of the most important families and exhibiting different feeding types, was investigated in long term experiments on living material in aquaria on board and will be continued later at the AWI in Bremerhaven. This study concentrates on the reproduction parameters, the growth parameters (embryonic development, moults, growth rate and longevity) as well as on the metabolism. The living material also allows observations to be made on some aspects of the behaviour relevant to the characterization of the mode of life, the identification of the microhabitat and the feeding habits.

Although the amphipods form a conspicuous group among Antarctic benthos the knowledge of their biology and ecology is limited to only six species (3 Lysianassidae and 3 Pontogeneiidae) among 550 species occurring in the Southern Ocean.

Work at sea

Gammaridean amphipods were collected from 46 (40 in the Eastern Weddell Sea) trawl catches (GSN, AGT, BPN), some RMT hauls, two baited traps and from the corer samples (MG and MUC). The early loss of the autonomous trap system prevented systematic trap sampling. Samples of potential predators of amphipods were taken for stomach content analysis.

Sorting living specimens from the catches and rearing them in aquaria (30 l) received first priority. In addition to swimming, burrowing, feeding and hatching behaviour observations, twelve feeding experiments were conducted mainly on scavenging species. Colour photographs of living specimens were taken systematically to record the natural colours and behavioural traits.

Preliminary results

About 5000 specimens of 88 species (provisional number) have been sorted from the Weddell Sea samples. Four species belonging to 4 different families are considered new to science and one of them will probably form the Type of a new podocerid genus. The lysianassoid component of the fauna is dominant in terms of number of species and is followed by the acanthonotozomatids and the paramphithoids. This observation conforms to the family composition of the East Antarctic fauna previously described by KNOX & LOWRY (1977) except for the paramphithoid component which seems proportionally more diverse in the eastern Weddell Sea. A first overview of the samples suggests a higher species diversity in the samples from the Kapp Norvegia transect than from the Halley Bay transect.

The comparison of catches using different equipment (GSN, AGT, BPN, REU, RMT) at some stations provided reliable data to clarify the habitat of some species. For instance, the RMT hauls yielded 4 species occurring on or close to the bottom (*Abyssorchomene plebs, A. rossi, Epimeriella macronyx, Eusirus microps*) indicating their bentho-pelagic habitat.

The traps collected *A. plebs* (about 3500 specimens) and *Waldeckia obesa* in one case and in the other case 6 different species; *Tryphosella sp.1* and *sp.2*, *Abyssorchomene nodimanus*, *W. obesa*, *Kerguelenia sp.* and *Pseudorchomene coatsi. Kerguelenia sp.* and *Tryphosella sp. 1* were apparently caught in traps for the first time.

The feeding experiments provided first data on the feeding rate of the most common scavengers. They indicated a relatively low consumption of meat by *Uristes gigas* and *Tryphosella sp.1* but showed the voracity of *A. plebs*, *A. rossi* and *Waldeckia obesa*. *A. plebs*, for instance, is able to eat more than its own weight of fish, beef or octopus meat during a 24h period. It has been calculated that 1000 *A. plebs* can eat a 1 kg fish in less than 5 days. These first results suggest a significant role for the scavengers in the food web.

About 2500 specimens of some 25 species are kept alive in temperature controlled laboratory containers. Among these 9 key species have been identified and selected for long-term studies of their autecology, life history, behaviour and some aspects of their physiology at the AWI in Bremerhaven. These species include *Epimeria excisipes*, *E. macrodonta* and *E. robusta* (Fam. Paramphithoidae), the burrower and presumed predator deposit feeder *Paraceradocus gibber* (Fam. Gammaridae), the predator *Eusirus perdentatus* (Fam. Eusiridae), the tube builder and deposit feeder *Ampelisca richardsoni* (Fam. Ampeliscidae) characteristic of the Eastern Shelf Community (VOSS 1988), the Acanthonotozomatid *Gnathiphimedia mandibularis,* presumably a bryozoan and hydrozoan feeder, and three Lysianassoid scavengers *Abyssorchomene plebs, Waldeckia obesa* and *Uristes gigas*.

References

KNOX, G.A. & LOWRY, J.K., 1977. A comparison between the benthos of the Southern Ocean and the North Polar Ocean with special reference to the Amphipoda and the Polychaeta. *In*: M.J. Dunbar (ed.) Polar Oceans. Proceedings of the Polar Oceans Conference, Montreal, May 1974. Arctic Institute of North America, 432-462.

VOSS, J., 1988. Zoogeographie und Gemeinschaftsanalyse des Makrozoobenthos des Weddellmeeres (Antarktis). Ber. z. Polarforsch., 45, 1-145.

## 3.12 Distribution and reproductive biology of shrimps in the inner Weddell Sea

A. Clarke, W. Arntz, D. Gore

### Distribution and general biology

#### Objectives

The general distribution of shrimps (Decapoda; Caridea) in the inner Weddell Sea is well known from previous cruises of 'Polarstern'. The aim of this part of the study was to further document the distribution, particularly in relation to bathymetry and hydrography, and with special reference to age-class structure and reproduction.

Preliminary results

Four species of shrimps were collected on EPOS leg 3; these were:

Hippolytidae
*Chorismus antarcticus*
*Lebbeus antarcticus*

Crangonidae
*Notocrangon antarcticus*

Nematocarcinidae
*Nematocarcinus longirostris*

All have been recorded before, but of special interest were large hauls of ovigerous female *Nematocarcinus* from 1200 m off Halley Bay, and from 2000 m off Kapp Norvegia. The size structure of all the catches will be analysed in Bremerhaven; however it is worth noting that *Nematocarcinus* coming from hauls deeper than 1000 m were particularly large. The overall depth distribution of caridean decapods recorded on the cruise is shown in Fig. 47.

Catches during EPOS leg 3 with the bottom trawl, Agassiz trawl (and occasionally when hitting the bottom for some time, the semipelagic trawl) confirmed previous 'Polarstern' data that *Notocrangon antarcticus*, *Chorismus antarcticus* and *Nematocarcinus longirostris* are common species on the eastern Weddell Sea shelf and slope, whereas *Lebbeus antarcticus* is rare. They also indicate that each of the three common species has its preferred depth range: *Chorismus* from the shallowest bottoms near the ice-edge to 500 m, *Notocrangon* from about 300 to 600 m, and *Nematocarcinus* from 700 to at least 2000 m. The two former species had a slightly deeper distribution off Kapp Norvegia than off Halley. *Lebbeus* spp. was found only around 500 to 600 m off Halley. On a single occasion (GSN15 at 800 m depth off Kapp Norvegia) specimens of all four genera occurred together. A fifth species hitherto not recorded in the Weddell Sea was obtained from 400 and 800 m depth off Kapp Norvegia.

Egg size and chemical composition in high latitude crustaceans

Objectives

Marine invertebrates show an enormous range of egg sizes. It has been known for a long time that species from higher latitudes tend to have larger eggs than those from lower latitudes, and this is often referred to as Thorson's rule. This latitudinal cline in egg size appears both between species, and within species. However, apart from a study of *Serolis* (*Ceratoserolis*) *trilobitoides* (= *cornuta*) by WÄGELE (1987), and preliminary data from frozen eggs for *Chorismus antarcticus* and *Notocrangon antarcticus*, data on egg size in high latitude marine invertebrates are lacking in the Southern Ocean. Furthermore, there are very few data (and none from high latitudes) relating egg size and chemical composition. This is vital information so that a distinction can be drawn between an increase in volume as the result of swelling (for example by uptake of seawater following extrusion), and a genuine increase in yolk content.

We therefore chose to examine egg size and chemical composition in two groups of crustaceans, namely caridean decapods and serolid isopods.

These groups are particularly useful for such studies because they brood their eggs and so both fecundity and egg size can easily be measured. We proposed to try and answer three major questions:

- Are there statistically significant variations in egg size between individuals?
- Does mean egg size vary significantly from site to site, and particularly with latitude?
- Do larger eggs contain more yolk?

Egg size was measured on ship using an eyepiece micrometer, and these measurements will be repeated (more precisely and with less subjective bias) in England by image analysis of 35 mm photographs of whole clutches of eggs in seawater. Frozen egg samples will also be measured in FRG by image analysis, allowing a comparison of data from fresh and frozen eggs. Lipid and protein content were measured on ship using semi-micro wet chemical techniques. Egg dry mass, organic content, ash content and elemental composition (C, N, P) will be measured in UK on dried samples containing a known number of carefully prepared eggs.

Preliminary results

Newly spawned females were collected for the following species (the figures in brackets indicate the number of individuals analysed on 'Polarstern'; others were frozen for analysis in the laboratory):

Decapoda
- *Chorismus antarcticus* (123 ovigerous females)
- *Lebbeus antarcticus* (2)
- *Notocrangon antarcticus* (34)
- *Nematocarcinus longiristris* (81)

Isopods
- *Serolis trilobitoides* (15)
- *Serolis meridionalis* (3)

The data for serolid isopods confirm the trend reported by WÄGELE (1987) for eggs to be larger at higher latitudes. There was a statistically significant variation in egg size, both within *Serolis trilobitoides* and between the two species, and in both cases there were significant positive correlations between egg volume and protein content.

Positive correlations between egg volume and chemical composition (protein content and lipid content) were also found for *Notocrangon antarcticus*. Of particular interest in this species was the presence of large numbers of pale eggs in many individuals. These were believed to be caused by infection, possibly by a fungus. The proportion of these eggs in the clutch was found to vary significantly between sites. Thus successive hauls on the Halley Shelf (AGT7 at 400 metres and GSN8 at 450 metres depth the next day) produced females with median infection rates of 6.7 % (AGT7, n = 20) and 28.3 % (GSN8, n = 9); these data are significantly different (Mann-Whitney statistic = 233, P = 0.0017).

In order to process the large numbers of ovigerous female *Nematocarcinus* and *Chorismus* in a reasonable period of time, egg sizes were not measured on board (apart from the initial samples of *Chorismus* which suggested that egg sizes were larger in the Weddell Sea than at South Georgia). However in both species there were significant variations in egg protein and lipid content between eggs from different individuals. In addition there were indications of an increase in egg protein content with female size (carapace length); this would suggest that larger female shrimps are producing larger eggs. This will need confirmation from more detailed work in England and Germany.

In conclusion we can offer tentative answers to the three questions posed above:

1. Egg size does vary significantly between individuals.

2. Egg size varies between sites, with larger eggs generally at higher latitudes.

3. This variation in egg size appears to be of ecological and evolutionary significance because it is associated with an increased in yolk content (that is egg protein and egg lipid content).

References

WÄGELE, J.W., 1987. On the reproductive biology of *Ceratoserolis trilobitoides* (Crustacea: Isopoda): Latitudinal variation of fecundity and embryonic development. Polar Biology 7, 11-24.

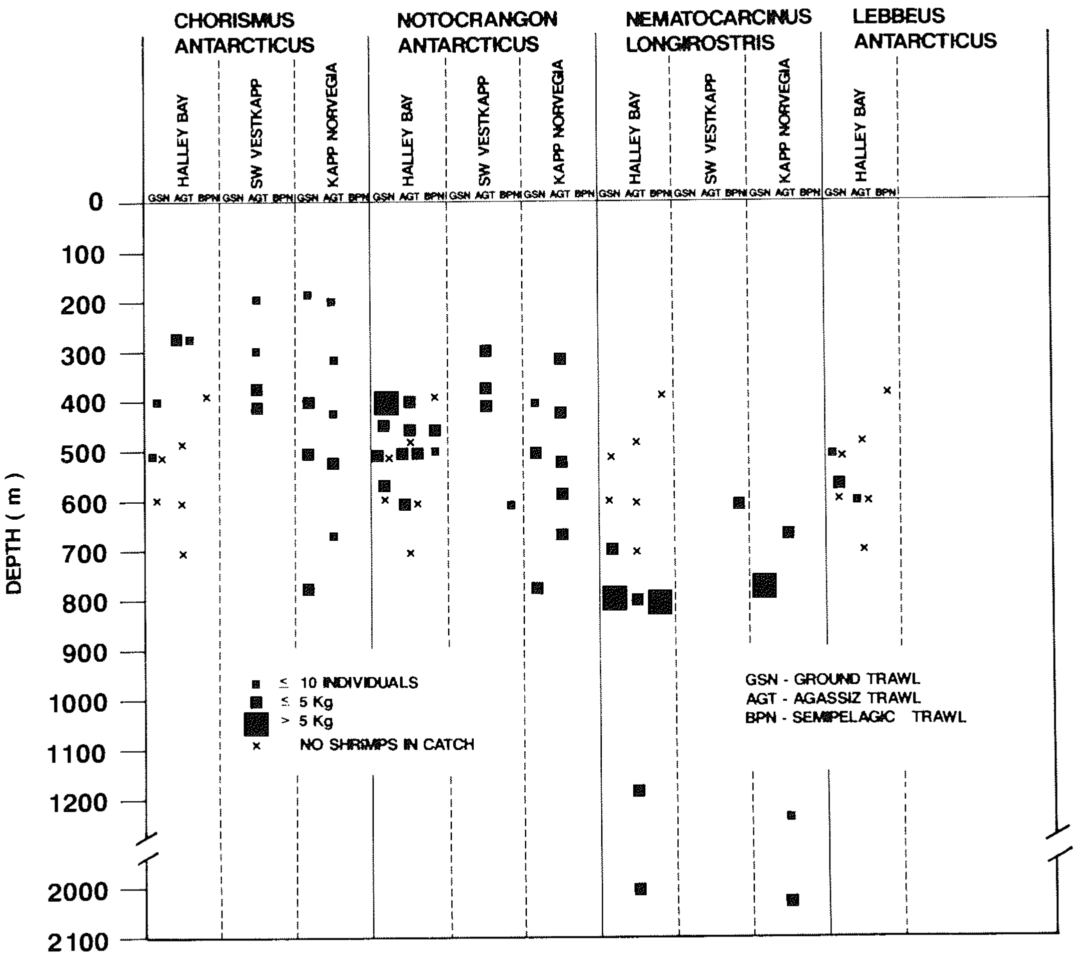



Fig. 47. Amounts of caridean shrimps caught during EPOS leg 3 in the south-eastern Weddell Sea. Depths presented in this graph always refer to the start of the haul.

## 3.13 Ecology and taxonomy of sponges in the eastern Weddell Sea shelf and slope communities

D. Barthel, O. Tendal, K. Panzer

### Introduction

While there exist some investigations on sponges from other Antarctic areas, the inner Weddell Sea remains largely a white spot in this respect. In the outer part of the Weddell Sea, sponges have been recorded from the Antarctic Peninsula, the Scotia Arc and South Georgia, and at some of the stations taken by the French "Scotia" expedition. There are no records from the inner Weddell Sea (KOLTUN, 1964/66 and 1969), except for zoogeographical surveys and community analyses of the Weddell Sea fauna (e.g. VOSS, 1988), where hexactinellid sponges have been mentioned in broad terms, and their likely role in the ecosystem is strongly emphasized. Demosponges were never investigated before. Thus, EPOS 3 provided an excellent opportunity to fill the gap by studying sponge faunistics and ecology in the Weddell Sea.

### Objectives

The main objectives of the study were:

- identification and faunistics of the Weddell Sea sponges (O.T.);
- analysis of tissue composition as a basis for biomass determinations (D.B.);
- population structure and reproduction of the dominant sponge species (D.B.);
- investigations of in- and epifauna organisms among the dominant sponge species, especially hexactinellids (K.P.);
- preparation of material for subsequent chemical analyses (O.T.); and
- growth form analysis (D.B./O.T.).

### Work at sea

During the cruise, samples were taken with GSN, AGT and BPN. Most of the catches were sorted through completely, catches which were too large were subsampled. Additional important material was provided by the "subsample group", the "museum group" and the meiofauna group. According to the different topics, the material was washed, sorted, described and fixed or frozen. Demosponges were preliminary identified on the basis of fresh squash preparations, while hexactinellids were classified into 8 different types on the basis of phenotype; the 8 types are considered to be different species for the present. This was necessary as identification of hexactinellid species could not be done on board. For size/frequency distribution, sponges of a given species were measured and weighed and some characteristic specimens kept for later species identification or confirmation. A number of specimens was also dissected immediately for detection of infauna. Much of the material initially fixed in 4 % buffered formaldehyde was transferred into 80 % alcohol after some weeks.

Preliminary results

Taxonomy, faunistics and distribution

During EPOS leg 3 a first species list of the sponge fauna of the eastern Weddell Sea has been provided. From selected samples taken with GSN, AGT and BPN approximately 150 species were preliminarily identified (Table 10), the largest number of sponges species ever taken by a single Antarctic expedition. The known geographical distribution has been considerably extended for many species, and a number of expected circumantarctic distribution patterns have been "closed". Some genera, viz. *Craniellopsis*, *Prosuberites*, *Tylodesma* and *Xestospongia* seem to be recorded in the Antarctic for the first time. Species possibly new to science are found in some of the genera mentioned above, and besides in the genera *Plicatellopsis*, *Inflatella*, *Lissodendoryx* and *Ectyodoryx*.

Quite a number of species represented with only few specimens from earlier Antarctic records were found again (Table 10), and extended descriptions of growth forms and variation can be made, facilitating future identification work. The study of fresh material providing informations on colour, texture, consistency, smell, variations in growth forms, etc. leads to the conclusion that some earlier synonymizations have gone too far. In a number of species hitherto known only as fragments, the full bodyform and size has been established, as have also new maximum sizes for some species.

Eurybathy is observed elsewhere in the Antarctic for many sponge species, mainly from 100 m down to 900 m (KOLTUN, 1969 and 1970). Our 2000 m stations provide considerable extensions of the known depth range for at least a dozen species, some of which are well known and widely distributed, such as *Polymastia invaginata*, *Pseudosuberites hyalinus*, *Isodictya setifera*, *Myxilla mollis*, *Jophon spatulatus* and *Ectyodoryx ramilobosa.*

The 150 species recorded here for the eastern Weddell Sea represent about 50 % of the known Antarctic sponge fauna. However, the species contents of the samples show very little overlap, both between the same kind of gear and between different gears. For example, at 600 m in the Halley Bay transect, the two GNSs contained 12 and 19 species respectively, but only 2 were found in both, and the BPN contained 11 species, with only 2 and 4 respectively common with the two GNSs. These numbers can, to some degree, be explained to represent the patchy distribution of the fauna, but they may also indicate that parts of the sponge fauna has been inadequately sampled.

Faunal changes/transitions with depth may be interpreted from comparisons of species numbers and fauna compositions in samples from different depths. On the Halley Bay transect, the number of species found at different depths is obviously only a function of the number of samples. and the between-depth comparisons showed no clear pattern (Table 11). The 2000 m station may, however, be in the upper part of a transition zone, since the 5 species occurring only there seem to be deep-sea species. The other 13 species are all known from shallower depths.

Table 10. Sponges preliminarily identified during EPOS leg 3. The list is based on approximately half of the samples, predominantly those from deeper water. Identification was done on squash preparations and carried on to the lowest taxonomic level possible under the conditions.
* indicates that the species was hitherto known from one or two records only.

Homoscleroporida

* Oscarella sp.
Plakina monolopha Schulze
P. trilopha Schulze

Choristida

Monosyringa longispina (Lendenfeld)

Spirophorida

Tetilla leptoderma Sollas
Tetilla sp.
Cinachyra antarctica (Carter)
C. barbata Sollas
Craniellopsis sp.

Hadromerida

Polymastia invaginata Kirkpatrick
P. isidis Thiele
Tentorium papillatum (Kirkpatrick)
T. semisuberites (Schmidt)
Sphaerotylus antarcticus Kirkpatrick
S. schoenus (Sollas)
S. capitatus (Vosmaer)
Suberites caminatus Ridley and Dendy
* S. microstomus Ridley and Dendy
Prosuberites sp.
Pseudosuberites sulcatus Thiele
P. antarcticus (Carter)
P. hyalinus (Ridley and Dendy)
P. mollis Ridley and Dendy
P. nudus Koltun
P. sp.
Latrunculia apicalis Ridley and Dendy
L. bocagei Ridley and Dendy
Stylocordyla borealis (Loven)

Axinellida

* Axinella marina Ridley and Dendy
* A. antarctica (Koltun)
Raspailia irregularis Hentschel
Plicatellopsis fragilis Koltun
P. sp.

Halichondrida

Halichondria hentscheli Koltun
• Hymeniacidon torquata Topsent
• H. rubiginosa Thiele
H. sp.

Poecilosclerida

Mycale magellanica (Ridley)
M. gaussiana Hentschel
M. tridens Hentschel
M. acerata Kirkpatrick
Asbestopluma belgicae Topsent
Biemna sp.
Tylodesma sp.
Isodictya obliquidens (Hentschel)
I. erinacea (Topsent)
I. setifera (Topsent)
* I. cavicornuta (Dendy)
I. antarctica (Kirkpatrick)
* I. kerguelensis (Ridley and Dendy)
I. toxophila Burton
* Plumocolumella cribroporosa (Burton)
* P. ramosa (Ridley and Dendy)
Guitarra fimbriata Carter
Hoplakithara dendyi Kirkpatrick
Cercidochela lankesteri Kirkpatrick
Amphilectus rugosus
Inflatella latrunculoides (Ridley and Dendy)
I. coelosphaeroides Koltun
I. belli (Kirkpatrick)
I. sp.
Crella crassa (Hentschel)
Myxilla mollis (Ridley and Dendy)
• M. lissostyla Burton
M. asigmata Topsent
M. elongata Topsent
M. australis Topsent
• M. insolens Koltun
* Lissodendoryx innominata Burton
L. styloderma Hentschel
L. sp.
Iotrochota somovia Koltun
• Myxichela pilosa (Ridley and Dendy)
Kirkpatrickia variolosa (Kirkpatrick)
K. radiatus Topsent
K. aceratus Hentschel
Acanthorhabdus fragilis Burton
Tedania tantula (Kirkpatrick)
T. vanhoeffeni Hentschel
T. charcoti Topsent
T. oxeata Topsent
T. triraphis Koltun
Burtonanchora sp. ?
Hymedesmia sp.

Table 10 cont'd

Clathria toxipraedita Topsent
C. pauper Broensted
C. sp.
Axociella nidificata (Kirkpatrick)
A. flabellata (Topsent)
* A. rameus Koltun
A. sp.
Pseudanchinoe toxifera (Topsent)
Artemisina plumosa Hentschel
* A. tubulosa Koltun
Myxodoryx hanitschi (Kirkpatrick)
Ectyodoryx anacantha Hentschel
E. ramilobosa (Topsent)
E. sp.
* Bipocillopsis nexus Koltun
Anchinoe glaberrima (Topsent)

Haplosclerida
Haliclona dancoi (Topsent)
* H. bilamellata Burton
H. sp.
Gellius calyx Ridley and Dendy
G. rudis Topsent
G. fimbriatus Kirkpatrick
G. bidens Topsent
G. phakelloides (Kirkpatrick)
* Haliclonissa verrucosa Burton
Adocia glacialis (Ridley and Dendy)
A. sp.
Calyx arcuarius (Topsent)
C. kerguelensis (Hentschel)
Xestospongia sp.
Microxina benedi (Topsent)
* M. simplex (Topsent)

Dendroceratida
Dendrilla membranosa (Pallas)

Further:

| | |
|---|---|
| large unidentified demosponge species | 3 |
| encrusting species from rocks, at least | 10 |
| calcareous species | 5 to 7 |
| hexactinellid species | 7 to 10 |

Table 11. Halley Bay transect. Number of samples and sponge species taken at different depths and the number of species common to samples from different depths, based on 91 species. The number of total species as well as the species overlap decreases with the number of samples taken at the different depths. Depths rounded to full 100 m.

| No. of samples | Depth (m) | 600 | 700 | 800 | 1200 | 2000 | No. of species found only at that depth |
|---|---|---|---|---|---|---|---|
| 3 | 600 | 39 | | | | | 13 |
| 3 | 700 | 12 | 31 | | | | 6 |
| 3 | 800 | 13 | 16 | 45 | | | 15 |
| 1 | 1200 | 2 | 2 | 3 | 10 | | 3 |
| 1 | 2000 | 6 | 5 | 7 | 1 | 18 | 5 |

Depth distribution, population structure and reproduction of hexactinellid sponges

The one very characteristic feature of the Antarctic sponge fauna is the mass occurrence of large hexactinellids i.e. glass sponges in relatively shallow water, while this group is otherwise almost exclusively confined to the deep sea. The only data available on the Weddell Sea hexactinellids showed them to be the dominant benthic group on the eastern Weddell Sea shelf with a tendency to decrease in abundance from the north east to the south west (VOSS, 1988).

As said before, 8 different types were defined on the basis of phenotype. Characteristics used were colour, absence/presence and pattern of surface spiculation, absence/presence of conules on the surface, presence and strength of basal spicule tufts and texture of the tissue. When used by the three team members, the system usually gave consistent classifications.

A compilation of the hexactinellid type composition at different stations and depths (Table 12) shows Type II to be dominant at most stations. Both at Halley Bay and Kapp Norwegia, the non-spiculated Types IV, V and VI are mainly found in the shallower depths while the heavily spiculated Types II, III and VII occur with high abundances even at greater depths. The distribution of the remaining Types I and VIII is patchy according to our samples. In Type I this is probably a sampling artefact, as this species tears extremely easily and specimens may just have been torn and washed out in some trawls. In Type VIII, however, patchiness may be a result of reproduction by budding.

In catches with large amounts of material, size/frequency distributions of several hexactinellid types were established. The resulting curves (Fig. 48) are without any cohort peaks even in the small size classes. The size distribution can vary very much from habitat to habitat; Type II sponges from the hexactinellid dominated St. 248 (600 m, substrate gravel) reach a much larger maximum size than those from the bryozoan dominated St. 245 (600 m, substrate bryozoan debris). The reasons for these differences are largely unknown as yet.

Hexactinellids found were usually checked for signs of budding or the presence of larvae. Larvae could not be found in any case, but tissue samples from different specimens were fixed for subsequent electron microscopic inspection for reproductive elements. Budding was observed only in Type VIII. Table 13 shows that specimens below 4 cm height do not possess any buds, and the mean number of buds per individual generally increases with size. We can thus conclude that sponges of less than 4 cm height really were immature buds torn off the parent sponge or just having fallen off.

Table 12. Depth distribution of different types of hexactinellids at the Halley Bay transect. +++: very abundant; ++: present in a number of specimens; +: present with one or two individuals; -: absent.
Types: Type I: brown, pink, reddish, conules on surface, spicules protruding from conules, short root tuft. Type II: white, yellow, orange, small conules on surface, spicules protruding from conules, no basal spicule tuft. Type III: grey, small conules on surface, but less than in Type II, few protruding spicules, very weak basal spicule tuft, tears easily. Type IV: white, grey, absolutely smooth surface, oscules contracted, short basal spicule tuft. Type V: yellowish, grey, absolutely smooth, strong basal root tuft, contracted oscules, tissue very dense and easy to tear. Type VI: grey white, absolutely smooth strong basal root tuft, tears easily. Type VII: white, grey, surface smooth, covered with thick, even spicules, small basal root tuft. Type VIII: "potato-type", white, grey, covered with feltlike mass of short spicules. Small oscules, numerous buds, comparatively small (up to about 16 cm height).

| Station | Depth | Gear | Bottom type | Type hexactinellid | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | II | III | VII | VIII | I | IV | V | VI |
| 230 | 250 | AGT | gravel | +++ | - | +++ | - | ++ | - | ++ | ++ |
| 230 | 250 | AGT | gravel | - | - | - | - | +++ | + | ++ | ++ |
| 235 | 400 | AGT | M/R | ++ | +++ | ++ | - | + | - | + | + |
| 235 | 400 | GSN | M/R | ++ | +++ | ++ | - | + | - | + | + |
| 256 | 400 | BPT | ? | ++ | + | + | - | - | - | - | + |
| 241 | 444 | GSN | M/R | +++ | +++ | + | - | + | - | + | + |
| 229 | 500 | GSN | M/R | Fragments only, net torn | | | | | | | |
| 229 | 500 | AGT | M/R | - | - | - | - | - | - | - | + |
| 245 | 500 | AGT | bryozoans | +++ | - | - | - | - | - | - | - |
| 245 | 500 | GSN | bryozoans | +++ | + | - | - | + | - | - | - |
| 258 | 500 | BPT | ? | +++ | + | - | - | + | - | - | + |
| 226 | 600 | GSN | M/R | - | - | ++ | - | - | - | - | + |
| 226 | 600 | AGT | M/R | - | - | - | ++ | - | - | - | - |
| 248 | 600 | GSN | ? | +++ | + | - | - | + | - | - | - |
| 269 | 600 | BPT | hydrocor. | ++ | - | + | - | + | - | + | - |
| 247 | 700 | GSN | ? | ++ | + | + | - | + | - | - | - |
| 250 | 800 | GSN | ? | 1 fragment type II - leftover from last catch? | | | | | | | |
| 252 | 1200 | AGT | M | - | - | - | - | - | - | - | - |
| 253 | 2000 | AGT | ? | several deep-sea hexactinellids | | | | | | | |

Table 13. Number of buds per individual in different size classes of Type VIII hexactinellid, St. 270, 300 m depth, AGT. Sample size: 373 individuals.

| Height [cm] | | | n | % without buds | Mean no. buds per individual |
|---|---|---|---|---|---|
| 2.1 | to | 3.0 | 2 | 100 | - |
| 3.1 | to | 4.0 | 8 | 100 | - |
| 4.1 | to | 5.0 | 53 | 72 | 0.4 |
| 5.1 | to | 6.0 | 68 | 50 | 0.8 |
| 6.1 | to | 7.0 | 52 | 25 | 1.8 |
| 7.1 | to | 8.0 | 58 | 28 | 2.5 |
| 8.1 | to | 9.0 | 47 | 23 | 3.1 |
| 9.1 | to | 10.0 | 31 | 3 | 3.2 |
| 10.1 | to | 11.0 | 18 | 17 | 3.3 |
| 11.1 | to | 12.0 | 15 | 13 | 3.1 |
| 12.1 | to | 13.0 | 6 | - | 7.5 |
| 13.1 | to | 14.0 | 4 | 25 | 5.0 |
| 14.1 | to | 15.0 | - | - | - |
| 15.1 | to | 16.0 | 1 | - | 4.0 |

The observations at Halley Bay and Kapp Norvegia agree very well, Halley Bay generally being the richer of the two areas. The decrease in abundance postulated by VOSS (1988) could not be confirmed by us. Even one of those stations seemingly dominated by bryozoans turned out to be hexactinellid dominated (about 60 %), when the many small individuals were carefully sorted out from the bryozoan debris.

Additionally, the depth range of most hexactinellids extended down to at least 800 m, typical deep sea-species were found at the 2000 m stations.

Biomass determinations on Weddell Sea sponges

Biomass estimates for Weddell Sea sponges were completely lacking up to now, estimates for other Antarctic areas were mostly done by giving wet weight per unit area. As the true amount of organic substance per unit wet weight can vary a great deal due to more or less pronounced spiculation, samples from all hexactinellid types and from the more common to abundant demosponge species were frozen for determination of organic substance. This we consider the first step necessary for future detailed biomass estimates.

Growth form analysis

Growth forms of both hexactinellids and demosponges were recorded not only for taxonomic description purposes, but also to see if the more or less abundant occurrence of certain growth forms could point to current regimes and sedimentation in the habitat.

Our observations revealed that the hexactinellid species present on the eastern Weddell Sea shelf are virtually all vase shaped, with varying oscular opening sizes. In the demosponges, massive, lumpy shapes dominate, very often in combination with a very firm outer cortex, more or less "sealing" the sponges. Those species whith caverneous surface structures often produced copious amounts of slime. The predominance of high vase shaped, "sealed" and slimy sponges may point to strategies of coping with high amounts of either sedimenting or resuspended particles, which could clog the sponge's canal system. Interestingly enough, sponges with large amounts of particles (roughly 20 to 200 µ diam.) integrated in their tissues were common, possibly an alternative strategy to deal with high amounts of sediment.

At stations with smaller or larger boulders, encrusting species otherwise hardly found were collected. Encrusting sponges were up to now rarely described for the Antarctic, which apparently is not due to their actual absence, but rather to the fact that boulders were previously either not sampled at all or not inspected. In contrast, fan-shaped species as they are common in Arctic and subarctic waters, were rare and mostly very small, a phenomenon requiring further analysis.

Infauna of Antarctic sponges

A closer inspection of Weddell Sea benthos (VOSS, 1988) showed that sponges occur with a high biomass mainly on the eastern shelf.

First use of underwater photography and underwater video (GUTT, 1988) made obvious that these sponges serve as a very important secondary hard substrate for a large number of animals, e.g. holothurians, cirripedes, and echiurids. Especially the top of larger sponges is utilized as an elevation by filter feeders which thus can reach different current conditions.

Additional observations are:

- animals like fishes, use the big osculum of larger sponges as a hiding place

- very small animals, like halacarids, live in the tissue and canal system of sponges using them as a biotope

- nudibranchs, perhaps also one other gastropod, feed on sponge tissue.

Because of the very big amount of sponges the work was concentrated on those:

- which seemed to be in a good condition
- which occurred in large numbers
- which occurred at various depths.

The selected sponges were carefully freed from epifauna and animals living in the oscula, then washed, measured, weighed and finally fixed or frozen.

In Kiel this material will be cut in 1 cm pieces and then carefully dissected under the binocular to look for animals living in the tissue and pores of sponges. The identification of most of the collected sponges and their infauna will also be done in Kiel; thus, only one preliminary result is given below.

At St. 270 (300 m) a subsample of 30 l was taken of the here dominant hexactinellid Type VIII. These 30 l (372 specimens) represent about 20 % of the total amount of this sponge type in the whole Agassiz trawl. 39 % (146 specimens) of all collected sponges were inhabited by infauna.

Fig. 49 shows that most of the collected sponges had a maximum length of about 4 to 9 cm. There is a tendency that larger and thus probably older sponges show a higher degree of inhabitation. Sponges less than 3.5 cm or larger than 10 cm were found in very small numbers only (between 1 and 6 specimens) and therefore were neglected in the examinations.

The infauna of this sponge-type is divided in three different taxa:

1. Molluscs represented by
   - prosobranchs
   - nudibranchs
   - bivalves
   - solenogastres
2. Crustaceans represented by
   - isopods
   - amphipods
3. Polychaetes

In the case of prosobranchia only one species, *Trochaclis antarctica* was found in increasing numbers with increasing size of host sponge. Most likely *Trochaclis antarctica* is feeding on sponge tissue with a very distinct radula.

Another gastropod, a so far unidentified nudibranch species, was found only in sponges of medium size range. Closer investigation of stomach and gut contents revealed sponge spicules.

The isopods, probably *Gnathia* sp., prefer the smaller sponges with a maximum length of 4 to 7 cm. One sponge was inhabited by a large amount of isopods; one can often find one male together with a lot of females, sometimes the females are gravid. The male is mostly found at the top of the osculum, probably to fend off other males.

An important observation is that most of the infauna found seems to be specialized on a particular sponge species, so there is only one species of gastropod, nudibranch and isopod. This phenomen has been observed for other sponge species too, which had their own specific infauna.

Perspectives

The most important aspects for future cooperation lie in the joint evaluation of our data and the photo sledge pictures made by Julian Gutt. After the cruise, the members of the sponge group will continue to work together, and there will be cowork with other institutions in Berlin (reproduction of hexactinellids) and Copenhagen (chemistry).

References

DAYTON, P.K., 1979. Observations on growth, dispersal and population dynamics of some sponges in McMurdo Sound, Antarctica. *In*: C. Levi and N. Boury-Esnault (eds.): Sponge biology, C.N.R.S. Vol. 291, 271-282, Paris.

DAYTON, P.K., G.A. Robillard, R.T. Paine & L.B. Dayton, 1974. Biological accommodation in the benthic community at McMurdo Sound, Antarctica. Ecol. Monographs 44(1), 105-128.

GUTT, J., 1988. Zur Verbreitung und Ökologie der Seegurken (Holothuroidea, Echinodermata) im Weddellmeer (Antarktis). Berichte zur Polarforschung 41, 87 pp.
KOLTUN, V.M.,1964. Sponges of the Antarctic. 1. Tetraxonida and Cornacuspongida. In, Biological results of the Soviet Antarctic Expedition 1955/1958, Vol. 2, Issled. Faunei Morei, Moskva-Leningrad, p. 6/131. (English translation: 1966, Israel Program for Scientific Translations, Jerusalem).
KOLTUN, V.M., 1969. Porifera. In, Antarctic Map Folio Series, American Geographical Society, 2 pp, plate 3-4.
KOLTUN, V.M., 1970. Sponges of the Arctic and the Antarctic: A faunistic review. In, Symp. zool. Soc. London 25, 285-297.
VOSS, J., 1988. Zoogeographie und Gemeinschaftsanalyse des Makrozoobenthos des Weddellmeeres (Antarktis). Berichte zur Polarforschung 45, 145 pp.

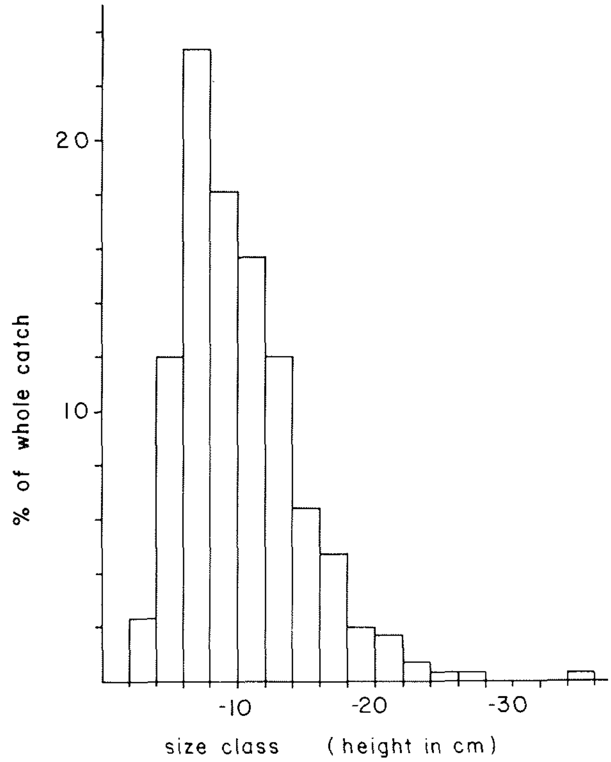



Figure 48: Size/frequency distribution of Type II hexactinellid at the bryozoan dominated St. 245, 600 m depth, substrate mud and bryozoan debris. AGT and GSN. Sample size 299 individuals, 2 cm size classes. Size here is the total height of the sponge.
The distribution is continuous and does not give any indication of cohorts or "breaks" in the population structure. More than 50 % of the animals are smaller than 10 cm, far below the maximum possible size for this type.

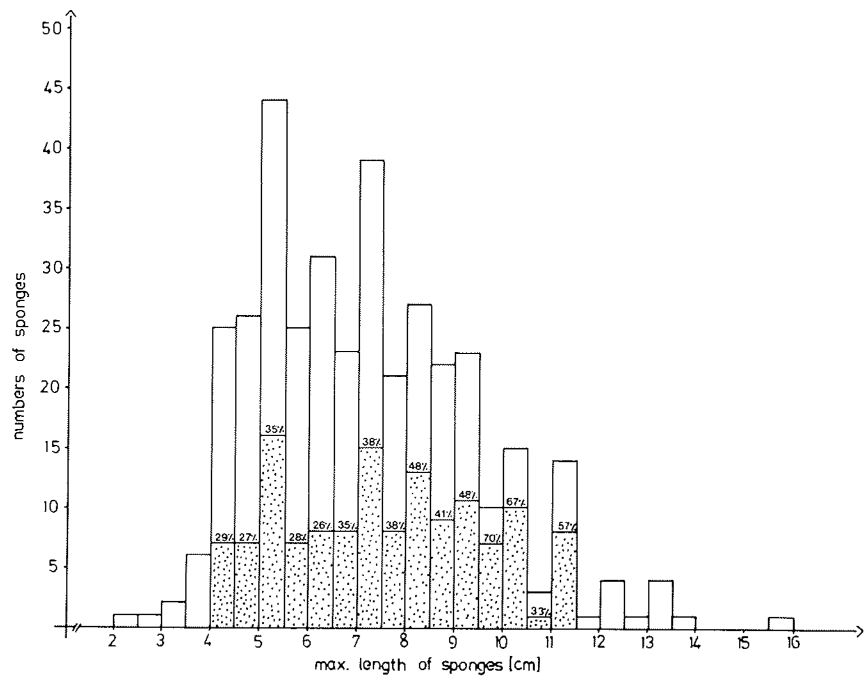



Figure 49: Size/frequency distribution and infauna in the hexactinellid Type VIII. Dotted bars and % values denote the fraction of sponges with infauna in each size class. Sponges with a size below 4.0 and above 11.5 cm were excluded from the evaluation, as they were only found in few individuals. Sample size 372 individuals, 146 (39 %) with infauna.

## 3.14 Fish fauna of the eastern Weddell Sea

J.-C. Hureau, E. Balguerías, G. Duhamel, K.-H. Kock, C. Ozouf-Costaz, M. White

### Objectives

In order to achieve maximum integration of the ichthyological investigations with the main objectives of EPOS leg 3, the specific fish studies were focussed on:

- A description of the micronekton communities in the eastern Weddell Sea with particular reference to the transition from the neritic to the oceanic community in relation to the physical and chemical structure of the water column, bathymetry and biotic factors; together with the description of the ichthyoplankton vertical distribution resulting from diel variations in the light environment. These latter studies continue and extend previous observations on ichthyoplankton in the area by HUBOLD (1984), KELLERMANN (1986), BOYSEN-ENNEN (1988) and PIATKOWSKI (1988);

- a general study on the composition of the demersal fish fauna of the eastern Weddell Sea, including taxonomy and phylogeny (using morphological, karyological and enzyme polymorphism techniques), biogeography, horizontal and vertical distribution of the species, to identify and describe fish communities inhabiting these waters and compare them to those in other areas like the Antarctic Peninsula region or other coasts of the continent, in continuation of earlier studies by DeWITT and HUREAU (1979), KOCK *et al.* (1984), HUBOLD (1984), EKAU (1988) and SCHWARZBACH (1988);

- a study of the biological characteristics, e.g. growth and reproduction, of the most abundant species;

- a food analysis to study the trophic interactions with the other organisms from the water column and the benthic communities;

- several additional investigations and collections. These included endoparasites of *Pleuragramma antarcticum*, ectoparasites of most species, samples for heavy metals and pesticide analysis, systematic collection of all the species for various museums, and samples of otoliths as reference material for identification.

The knowledge of the biological characteristics is necessary to evaluate the size of the populations, their biomass and the potential of each fish species which could be or which is already the subject of exploitation. Some High Antarctic fish species (*Pleuragramma antarcticum*, *Chaenodraco wilsoni*) are already subject to commercial exploitation. These data will be useful in the framework of the international research programme of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to conserve and manage these resources in relationship to the High Antarctic marine ecosystem.

Work at sea

Several fishing gears were used to achieve the various objectives and investigate the bottom and midwater layers (Table 14) in the different areas and transects studied. Originally it was planned to work only in the Vestkapp area. This plan was abandoned in favour of a comparison of two transects off Halley Bay and Kapp Norvegia, at the request of the benthologists. In both areas, bottom trawls and Agassiz trawls were used. At the Halley Bay transect, semipelagic trawls were made at the same positions as six of the bottom trawls, so a direct comparison of the efficiency of these two types of fishing equipment was possible. Off Vestkapp only one semipelagic trawl was made, but this was destroyed after touching a bank of sharp coral. At the Kapp Norvegia transect, the bad weather, the rough bottom topography and the lack of time reduced the possibilities of bottom trawl sampling.

Table 14. Gears used to collect fish and juvenile fish.

| Area | Elephant Isl. S. Orkneys | 47°W transect | Halley Bay transect | Vestkapp transect | Kapp Norvegia transect |
|---|---|---|---|---|---|
| Name of gear | | | | | |
| Bottom trawl (GSN) | 3 | | 8 | | 4 |
| Semipelagic trawl (BPN) | | | 6 | 1 | |
| Agassiz trawl (AGT) | | | 13 | 4 | 7 |
| Rectangular Midwater trawl (RMT) | 1 | | 17 | | 12 |
| Bongo net (BO) | | 6 | | | |
| Multinet (MN) | | 6 | | | |

The first objective was achieved by using the multiple RMT 8+1, Bongo net and Multinet, and the other objectives were realised by sampling with the bottom trawl, the semipelagic trawl and the Agassiz trawl. The first bottom trawl deployed at Kapp Norvegia was not quantitatively analysed.

The following six types of fishing equipment were always deployed during "daylight", except for some of the RMT hauls during the 24 hour Time Station at Kapp Norvegia where "night" hauls were undertaken:

1. The multiple rectangular midwater trawl with net apertures of 1 $m^2$ (300 micron-metre mesh) and 8 $m^2$ (4.5 mm mesh) (RMT 8+1M), was deployed on an 18 mm coaxial conducting trawl wire. Information from the net and commands to the net were recorded by an onboard computing system. The progress of the haul (depth, temperature, volume filtered, tilt angle, time and status of the net) were displayed in real time using software developed at the AWI. The standard RMT 8+1M haul sampled the water column in 300 to 200, 200 to 70 and 70 to 0 m strata along the Halley Bay transect and Kapp Norvegia transect. Additional hauls from near the seafloor to 300 m were made at the outer 6 stations at the Halley Bay transect to obtain samples from the whole water column. A routine haul of 800 to 300, 200 to 100 and 100 to 0 m was adopted at the 24 hour Time Station to sample both the mesopelagic components and near-surface micronekton. The gear was deployed as an upward oblique haul. The samples were maintained in seawater at ambient temperature before being processed in the laboratory. The approximate volume and major components were assessed, then the RMT 8 net samples were rough sorted to extract ichthyoplankton and squid for examination during the progress of EPOS leg 3. The remainder of each sample was then fixed in buffered 4% seawater-formaldehyde solution. The RMT 1 samples were fixed directly for further examination.

2. A Bongo net. Standard vertical hauls, 300 to 0 m, were made with Bongo nets (mesh 300 micro-metres) to sample the macro-zooplankton.

3. A multiple net with mouth opening 0.25 $m^2$ and mesh of 200 micro-metres (Multinet) was hauled vertically 1000 to 0 m to collect zooplankton in five different depth strata : 1000 to 500, 500 to 300, 300 to 150, 150 to 50, 50 to 0 m.

4. A commercial-scale 140 feet (47 m) headline bottom trawl with a 20 (12 mm) liner in the codend. The same trawl was used for groundfish survey in the Scotia Arc area (KOCK, 1986). The horizontal and vertical dimensions of the mouth were appr. 22 m and 3 m, respectively. Catches from this net were analysed quantitatively for species and size composition of the different species.

5. A commercial-scale sized 1088 meshes semipelagic (benthopelagic) trawl with a 12 mm liner in the codend. This trawl was used for the first time in the Weddell Sea and proved to be successful in fishing the near-bottom layers. It was towed with the ground rope 0 to 2 m above the bottom to discover the occurrence and size groups of species living a bentho-pelagic way of life and therefore likely to be under-represented or omitted in conventional bottom trawl catches. The approximate mouth opening was 18 x 18 m. Catches from this net have been analysed quantitatively for species and size compositions.

6. An Agassiz trawl with a 10 (4) mm codend. The horizontal and vertical mouth opening was 3 x 1 m. Catches from this net were primarily used to provide live fish and so were only analysed qualitatively for species composition, especially in the deeper layers investigated (1200 and 2000 m) not reached by the two other bottom gears.

It should be mentioned also that before investigating the eastern shelf of the Weddell Sea, three bottom trawls were deployed at the beginning of the cruise on the northern coast of Elephant Island (2 hauls) and on the western shelf of South Orkneys (1 haul). These three hauls were mainly used to test the equipment and to provide some fresh and live material for the physiologists.

During the 47°W transect only pelagic hauls with Multinet, Bongo net and Fransz net were deployed at each of the six stations in order to collect zooplankton and micronekton. This transect was investigated to achieve an integration between the three legs of EPOS and demonstrate the changes that take place in the water column seasonally.

In the Weddell Sea, at each bottom station, after separating the fish from the rest of the catch from each fishing gear, the work on board followed a strict protocol :

- Immediately on the working deck, the live fish were maintained in cold seawater to allow some scientists to undertake their experiments (see RANKIN *et al.*, this Volume) or to keep some species alive for a period of hours to several days for karyotyping. All these live specimens had to be weighed and measured before being removed from the catch.

- Then the other fish were taken to the fish laboratory where they were sorted into species, weighed and measured to the lower mm. For the abundant species, e.g. *Chionodraco myersi*, *Trematomus lepidorhinus*, *Pleuragramma antarcticum*, length frequency distributions were computed on board. For these species, sex and maturity stages were determined using the Everson scale (EVERSON, 1977).

- As soon as possible, 30 specimens per haul of the most abundant species were frozen for future investigation of stomach contents in Hamburg, for removal of otoliths and scales and for fecundity analysis in Paris.

- As soon as possible, samples (349 in total) of muscle and liver were taken and deep-frozen for future analysis of enzyme polymorphisms. Some samples of muscles from 8 species were also frozen for heavy metal and pesticide analysis. Gonads from 21 species were removed on board for fecundity analysis. Scales and otoliths were kept for growth study in 30 species. A collection of otoliths has been made (25 species) for descriptive morphology, to expand the reference collection from species of the High Antarctic.

- Samples of *Pleuragramma antarcticum* were collected to obtain material for a continuing investigation of the response of Antarctic fish to infestation by parasites. It has been demonstrated that this species of fish is normally infested with the larval stages of a cestode, *Diphyllobothrium* sp.. Large numbers of the larval stage are found encysted in the intestinal mesenteries. Initial examination of these samples in the U.K. demonstrated a characteristic inflammatory reaction by *P. antarcticum* and so further material was collected during EPOS leg 3 to study this phenomenon.

- Finally specimens of all the species were preserved in formalin for further taxonomic work or for museum collections.

A summary of all the samples collected and preserved is given in Table 15. A total of more than 180,000 fish specimens (about 95 % *Pleuragramma antarcticum*) weighing more than 2100 kg have been investigated.

Table 15. Samples collected for further studies.

| | Number of specimens | Number of species |
|---|---|---|
| Frozen specimens for stomach contents | 2045 | 31 |
| Gonads for fecundity analysis | 157 | 21 |
| | + frozen specimens | 30 |
| Scales + otoliths (growth study) | 2127 | 30 |
| Otoliths (reference collection) | 50 | 25 |
| Chromosomes | 170 | 45 |
| Muscle and liver (Enzyme polymorphism study) | 349 | 46 |
| Fish specimens for reference collections | > 1160 | > 73 |
| Larval + small juvenile fish specimens | > 5200 | 25 |
| Muscles for heavy metals and pesticide analysis | 82 | 8 |

Using live fish of as many species as possible, it has been possible to make chromosome preparations in order to combine karyotypic characters with morphological and biochemical characters to determine the most probable phylogenetic affinities within the suborder Notothenioidei. About 1000 chromosome preparations (170 specimens of 45 species) were obtained from anterior kidney cells at the metaphase stage, after a colchicine injection time ranging from 4 to 27 hours. The very small chromosome size (2 to 6 micrometres) as well as the ship's vibrations prevented any count or detailed high power microscopic or photomicrographic investigations. Therefore this material will be studied in Paris later on, including stainings, banding techniques when possible, photos, counts, sorting and measurements of the chromosome arm length using a computer assisted image system.

Preliminary results

All the information given below should be considered very preliminary. Further investigations on all the preserved and frozen material will be made during the next months before obtaining final scientific results.

Demersal fish investigations

A total of 64 species of demersal fish was identified from the eastern shelf and slope of the Weddell Sea (73 species if the species collected at Elephant Island and South Orkneys are included). We should point out that such a diversity of species has not yet been found in the High Antarctic. Table 16 shows the distribution of these species within the six families of Notothenioidei and the other families, compared to the previously known species from the same area (EKAU, 1988; SCHWARZBACH, 1988), and also from the whole High Antarctic. These estimations may have to be revised in the future because several of the species from the families Artedidraconidae, Liparididae, Zoarcidae and Rajidae need to be identified or revised.

Table 16. Distribution of species within the main Antarctic fish families.

| | WEDDELL SEA | | HIGH ANTARCTIC | TOTAL NUMBER | |
|---|---|---|---|---|---|
| | EPOS 3 | (previously known) | | OF SPECIES KNOWN | |
| ARTEDIDRACONIDAE | 12 | (11) | 19 | 20 | |
| BATHYDRACONIDAE | 9 | (11) | 15 | 16 | |
| BOVICHTHYIDAE | 0 | (0) | 1 | 3 | |
| CHANNICHTHYIDAE | 9 | (8) | 10 | 16 | |
| HARPAGIFERIDAE | 0 | (0) | 1 | 6 | |
| NOTOTHENIIDAE | 12 | (13) | 20 | 53 | 3 |
| Other families | 22 | (7) | about 45 | - | |
| Total | 64 | (50) | about 111 | | |

The regular depth distribution of the stations (every 100 metres on the Halley Bay transect) has allowed a study of the vertical distribution of the species. Some species (e.g. *Trematomus centronotus*, *Pagothenia bernacchii* and *P. hansoni*, *Chionodraco hamatus*, *Pagetopsis macropterus*, *Gerlachea australis*, *Racovitzia glacialis*, *Artedidraco* spp., *Dolloidraco longedorsalis*....) do not appear to be distributed below 500 or 600 metres, while some other typical bathyal species or families only occur below 700 or 800 metres (e.g. *Bathydraco macrolepis*, *Bathydraco scotiae*, *Chionobathyscus dewitti*, Macrouridae and some Liparididae). It is of particular interest that *Chionobathyscus dewitti*, a representative of the white-blooded family Channichthyidae was recorded for the first time during EPOS leg 3 at a depth greater than 2000 metres at both the Halley Bay and Kapp Norvegia transects.

A direct comparison between the two transects at Halley Bay and Kapp Norvegia is difficult for several reasons. The bottom profiles were markedly different: at Halley Bay, a true shelf was sampled whereas in Kapp Norvegia only the slope was quantitatively studied. We did not find any fundamental difference in the fish fauna of these two transects, and the slight differences observed were probably the result of different sampling procedures.

Some very preliminary results from Halley Bay transect can be described: it was found that males of *Chionodraco myersi* are smaller (mean length = 29.4 cm) than the females (mean length = 31.6 cm) for a total of 733 fish measured. A similar result was obtained with *Trematomus lepidorhinus*. A study of the length of *Pleuragramma antarcticum* has shown a clear increase of the mean length with depth (Fig. 50): from 12.44 cm at 300 m to 19.10 cm at 700 m (more than 2700 fish measured). At 600 metres depth the increase in size was small but this result is probably due to the small number (66) of specimens caught at that depth.

Concerning the comparison of the efficiency of the bottom trawl and the semi-pelagic trawl, the number of species caught by the latter was smaller than the number caught by the former one. No difference has been observed in the length frequency distribution of *Pleuragramma antarcticum* between the two types of trawl at 400 m depth, which indicates that the same size classes of this species were present on the bottom and above the bottom. In *Trematomus lepidorhinus* different size classes were caught using the two different trawls. The smaller specimens were caught by the bottom trawl (length smaller than 20 cm), whereas the larger specimens (more than 25 cm) were caught by the benthopelagic trawl.

If we consider the biological characteristics of the Weddell Sea fishes, only very preliminary results have been obtained. Further results will be obtained from the specimens and samples frozen or preserved. *Chionodraco myersi* feeds mostly on *Pleuragramma antarcticum*, *Euphausia crystallorophias* and *E. superba*, whereas *Chaenodraco wilsoni* feeds exclusively on krill.

Concerning the reproduction, seven species (*Trematomus eulepidotus*, *T. centronotus*, *Artedidraco skottsbergi*, *A. loennbergi*, *Cygnodraco antarcticus*, *Chionodraco hamatus* and *Chionobathyscus dewitti*) were found at or close to their spawning season.

Midwater fish investigations

Rough sorting of the RMT8 net samples yielded a total of >5200 larval and small juvenile fish of 25 species. Most of these were collected from the Halley Bay transect and time station samples. A total of 4301 individual larval and juvenile fish of 19 species were collected during the sampling at Halley Bay transect. The identifications should be considered tentative, however, the most numerous species were readily recognizable. Members of the suborder Notothenioidei dominated the samples with three species of channichthyids (icefish) and *Pleuragramma antarcticum* (Antarctic silverfish) being the most common.

Interpretation of the results must be viewed with some caution because of the lack of replicate samples but the observations suggest that there was a neritic community at the stations near to the ice-shelf dominated by a nototheniid post-larva, *Trematomus centronotus*, and an icefish, *Dacodraco hunteri*, whereas a more oceanic community was observed at the seaward end of the transect where the larval stages of *P. antarcticum*, two icefish, *Chionodraco myersi* and *Pagetopsis sp.* together with the oceanic indicator species, *Notolepis sp.*, *Bathylagus sp.* and myctophids were sampled.

The time station was conducted as an experiment to examine the order of magnitude in variation of micronekton numbers and species likely to result from factors such as net avoidance and vertical migration during the diel cycle. Such processes can radically affect sampling in the water column and on the seafloor with the majority of types of nets. The ichthyoplankton was largely composed of oceanic species and abundance was low in comparison with the numbers found along the Halley Bay transect. 193 specimens of 14 species were represented in the RMT8 catches. A diurnal pattern was noted in the total numbers of specimens caught at each time interval, there being about a 50 % reduction in numbers during "daylight". The mesopelagic fish were represent-ed by the three species of myctophid and the *Bathylagus* species. All of these displayed distinctive patterns of vertical distribution. They were normally found in the deepest net (800 to 300) except for the early larval stages of *Electrona antarctica* which was found at all levels sampled. These four species also tended to increase in numbers as well as occurring at shallower depths at night.

At the majority of stations most specimens and species were found in the upper 70 m layer, however at St. 252 over 2000 m, this pattern was inverted by an abundance of *P. antarcticum* in the 300 to 200 m layer.

Commonly a sharp demarcation is noted between neritic and oceanic micro-nekton communites at the junction of the continental shelf and slope. This was not well defined on the Halley Bay transect because although the ichthyo-plankton community became more oceanic towards the seaward end of the transect, neritic components such as the ice-fish were still a significant part of the catches. The seaward extension of this neritic community is probably a result of the wide shelf in the south eastern Weddell Sea and this results in a poorly demarcated transition zone.

Interpretation of the mass transport of water in the eastern Weddell Sea (CARMACK & FORSTER, 1977) suggests that the easterly directed shelf cur-rent divides into two with a part that swings to the south and another which progresses to the west following the major continental slope edge. The distribution pattern of fish larvae could well be a result of this current system.

Previous observations of the ichthyoplankton have been made in the Weddell Sea by HUBOLD (1984), KELLERMANN (1986), BOYSEN-ENNEN & PIATKOWSKI (1988); 10 species of fish have been recorded from the region as planktonic larval stages by these authors. It has been suggested that there is a westerly movement of the dominant pelagic species *P. antarcticum* from a spawning ground in the north-east Weddell Sea to a recruitment area off the Filchner ice-shelf. The increasing abundance towards the seaward end of the transect of this species is consistent with this earlier interpretation. Examination of the size frequency of the post-larval *P. antarcticum* demonstrated an ontogenetic descent with the larger post-larvae and juveniles occurring at deeper levels.

References

BOYSEN-ENNEN, E. & U. PIATKOWSKI, 1988. Meso- and Macrozooplankton Communities in the Weddell Sea, Antarctica. Polar Biol. 9, 17-35.

DeWITT H.H. & J.C. HUREAU, 1979. Fishes collected during "Hero" cruise 72-2 in the Palmer Archipelago, Antarctica, with description of two new genera and three new species. Bull. Mus. natn. Hist. nat., 4 ser., 1, sect. A (3): 775-820.

EKAU W., 1988. Ökomorphologie nototheniider Fische aus dem Weddellmeer, Antarktis. Ber. Polarforsch. 51, 1-94.

EVERSON I., 1977. The living resources of the Southern Ocean. FAO GLO/SO/77/1, 1-156.

HUBOLD K.G., 1984. The spatial distribution of *Pleuragramma antarcticum* (Pisces, Nototheniidae) near the Filchner and Larsen Ice Shelves (Weddell Sea/Antarctica). Polar Biol. 3 (4), 231-236.

KELLERMANN A., 1986. Zur Biologie der Jugendstudien der Notothenioidei (Pisces) an der Antarktischen Halbinsel. Ber. Polarforsch, 31, 1-148.

KOCK K.-H., 1986. The state of exploited Antarctic fish stocks in the Scotia Arc region during SIBEX (1983-1985). Arch. FischWiss. 37 (Beih. 1), 129-186.

KOCK K.-H. , R. SCHNEPPENHEIM & V. SIEGEL, 1984. A contribution to the fish fauna of the Weddell Sea. Arch. FischWiss. 34 (2/3), 103-120.

SCHWARZBACH W., 1988. Die Fischfauna des östlichen und südlichen Weddellmeeres: geographische Verbreitung, Nahrung und trophische Stellung der Fischarten. Ber. Polarforsch. 54, 1-94.

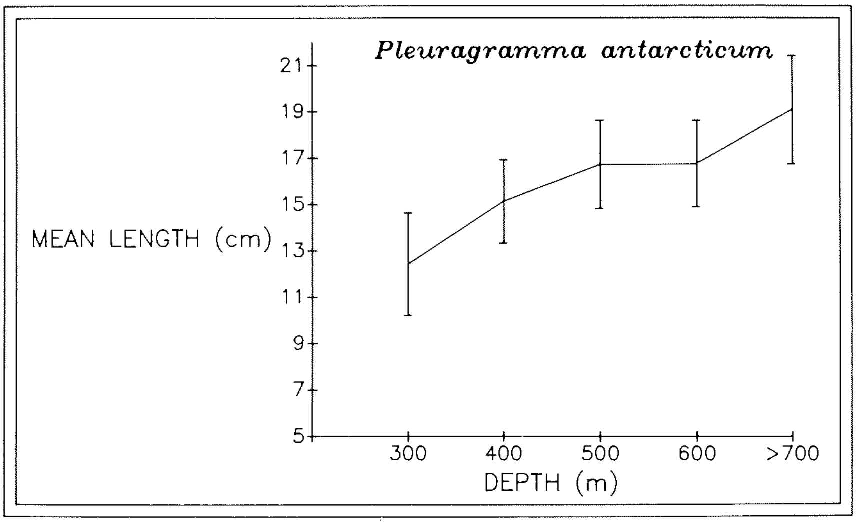



Figure 50: Length increase (cm) of *Pleuragramma antarcticum* with depth (m) on the Halley Bay transect.

# 4. EXPERIMENTAL STUDIES ON BOARD

## 4.1 Uptake and assimilation of $^{15}N$-nitrate and $^{15}N$-ammonia by phytoplankton and ice algae

G. Döhler

### Objectives

The aim of this study is to obtain information on the nitrogen metabolism of Antarctic phytoplankton under different enviromental conditions (e.g. changes in temperature, light quality and quantity). The impact of enhanced levels of ultraviolet-B irradiance on phytoplankters and ice algae was the main topic of the experiments simulating a depletion of the stratospheric ozone layer. The response of Antarctic phytoplankton to UV-B stress and a possible adaptation to the conditions of the "ozone hole", e.g. via special protecting mechanisms were of interest, too.

### Work at Sea

The activities during EPOS leg 3 have been the following:

- collection of phytoplankton by the Fransz net ( 50 to 0 m depths);
- collection of phytoplankton by CTD at different depths;
- collection of ice algae at Stations 219 and 265, as well as from small ponds on ice floes at different localities;
- $^{15}N$ experiments in the isotope container;
- estimation of ATP content (see VOSJAN, DÖHLER & NIEUWLAND, this volume).

### Methods

Samples from different stations of transect 47°W and during the Halley Bay and Kapp Norvegia transects were exposed to changes in temperature and light intensity in special plexiglass vessels (UV-transparent and non-transparent). Projectors have been used for illumination with white light. UV-B radiation was achieved with Philips lamps (TL 20 W/12) and cut-off filters (Schott & Gen., Mainz; WG 305, 3 mm thickness). Different doses were obtained by changing the exposure time. The plankton samples were bubbled with normal air during the experiments. After a pre-illumination period (white light) of 10 to 15 min $^{15}N$-labelled compounds were added. Samples were collected by a syringe after different photosynthetic or dark periods,filtrated on Whatman filters (GF/C, 2,5 cm) and heated 2 h at 60°C. The analysis of $^{15}N$ will be carried out in Frankfurt using the Dumas method and with an atomic emission spectrometer (NOI-5 Zeiss, Jena or N 1500 Jasco). Procedures have been described in more detail by DÖHLER & ROSSLENBROICH (1981) and DÖHLER & BIERMANN (1985).

Work in the isotope container

- Transect 47°W

Phytoplankton samples from St. 213 and 214 were used for the estimation of the uptake rates of $^{15}N$-ammonia ( 96 atom %, final concentration in the suspension 60 $\mu$M): 3 h UV-B radiation followed by 2 h white light irradiance and 1 h dark period at 4°C. An aliquot (20 ml) was put into 80 % ethanol for measurements of $^{15}N$-incorporation into the amino acids. The same experiments were performed with the phytoplankton from St. 215 and 217 but using $^{15}N$-nitrate (95.5 atom % , final concentration in the suspension 60 $\mu$M). Uptake rates of $^{15}N$-ammonia and $^{15}N$-nitrate of the same phytoplankton sample (St. 218) were studied at +2°C up to 60 min ; samples were collected at different photosynthetic periods. Samples of St. 219 were exposed to UV-B also during the dark period after feeding $^{15}N$-ammonia and $^{15}N$-nitrate. In addition to that, ice algae collected from St. 219 have been used for the investigation of the influence of 3 h UV-B radiation on $^{15}N$-ammonia and $^{15}N$-nitrate uptake at different temperatures (2.5° to 10°C).

Parallel to a $^{15}N$-experiment with the ice algae J. Vosjan measured the ATP content. H.-U. Dahms studied the ice fauna using the same samples.

Main species in the phytoplankton samples were *Corethron criophilum*, *Rhizosolenia sp.*, *Chaetoceros sp.* More diatom species were found in the sea ice samples, with *Chaetoceros*, *Coscinodiscus*, *Actinocyclus* and some *Odontella* and *Dactyliosolen* as dominant genera.

- Halley Bay transect

Phytoplankton samples collected by the Fransz net at St. 226 to 235 contained mostly krill faeces; therefore only few experiments could be carried out. The genera composition was relatively poor: *Coscinodiscus, Rhizosolenia* and *Dactyliosolen.* Generally, uptake of $^{15}N$-ammonia and $^{15}N$-nitrate were investigated up to 6 h UV-B radiation. Different concentrations of $^{15}N$-ammonia and $^{15}N$-nitrate (30 to 360 $\mu$M) have been used for the samples of St. 245, 248, 249, 250 and 252. The plankton of these stations contained more: *Coscinodiscus, Dactyliosolen, Eucampia, Chaetoceros criophilum*, *Rhizosolenia* and some dinoflagellates. The different doses of UV-B irradiance should lead to more information on the nitrogen metabolism of the phytoplankton collected by the Fransz net compared to samples collected by CTD. Uptake of $^{15}N$-ammonia and $^{15}N$-nitrate was studied with samples from 10, 20, 30 and 40 m depths. Assimilation rates of samples from St. 258, 259 and 260 were investigated at different white light intensities; the experiments were performed using plastic vessels. Phytoplankton collected by the Fransz net (St. 249) was used for studies on $^{15}N$ incorporation into the amino acids.

- Off Vestkapp and Kapp Norvegia transect

Uptake rates of $^{15}N$-ammonia and $^{15}N$-nitrate of natural phytoplankton collected by CTD at 20 m depth were investigated for a comparison at St. 264, 265, 268, 274, 278, 282, 284, 289, 295 and 296. Photosynthetic periods of 2, 4 and 6 h were used for the $^{15}N$ experiments. South of Vestkapp (Station 265) ice-algae from the bottom layers of ice-floes as well as from small ponds on top of the floes were collected. The green colour of these ponds may have been caused by the degradation of phytopigments. Uptake and assimilation of $^{15}N$-ammonia (30 and 60 μM, 1 mM) and $^{15}N$-nitrate (30 and 60 μM) by the ice algae during UV-B radiation from 0.5 to 5 h exposure as well as the influence of 4h UV-B stress on the uptake rates were estimated. This plankton community contained small species of *Rhizosolenia, Dactyliosolen, Coscinodiscus* and various dinoflagellates. In another series of experiments $^{15}N$ incorporation into amino acids was the main topic. Phytoplankton collected by the Fransz net was used for the estimation of the effect of UV-B radiation on the uptake of $^{15}N$-ammonia (60 μM) and $^{15}N$-nitrate (60 μM) during low and strong white light irradiation. Main photoautotrophic species were *Corethron criophilum, Chaetoceros criophilum* and *Rhizosolenia alata.* Phytoplankton samples were collected for cultivating purposes at home.

References

DÖHLER, G. & H.-J. ROSSLENBROICH, 1981. Photosynthetic assimilation of $^{15}N$-ammonia and $^{15}N$-nitrate in the marine diatoms *Bellerochea yucatanensis* (von Stosch) and *Skeletonema costatum.*- Z. Naturforsch. 36 c, 834-839.

DÖHLER, G. & I. BIERMANN, 1985. Effect of salinity on $^{15}N$-ammonia and $^{15}N$-nitrate assimilation of *Bellerochea yucatanensis* and *Thalassiosira rotula.*-Biochem. Physiol. Pfl. 180, 589-598.

## 4.2 Effect of UV-B irradiance on the ATP content of pelagic nano- and microplankton of Antarctic waters

J.H. Vosjan, G. Döhler, G. Nieuwland

Objectives

The reduction of ozone in the stratosphere causes an increase of the solar UV-B radiation reaching the earth's surface. Besides the influence on metabolic processes UV-B irradiance can affect organisms in aquatic and terrestrial ecosystems in different ways (WORREST, 1982; DÖHLER, 1985). No data exist on the influence of UV-B on the biological components of the Antarctic ecosystems.

In Antarctic waters with a low amount of particles and yellow substances the UV will penetrate to deeper layers than in more turbid waters. However, as transmittance of radiant energy of 310 nm in clear sea water exhibits maximum values of 86 %/m (JERLOV, 1986), UV light will not penetrate very deep here either.

The nano- and microplankton (algae, bacteria, protozoa) plays a central role in the foodweb and therefore in the carbon cycle of these systems. Adenosine-triphosphate (ATP) is continuously formed in the catabolism and continuously used in all energy consuming reactions of living organisms. So if there is an effect of UV-B irradiance on the synthesis of ATP it will be reflected immediately in all other reactions of the organisms and if there is an effect on anabolic synthesizing reactions it will also have its consequences for the biomass formed.

In biological oceanography the measurement of ATP is often used as a total microbial community measurement (KARL, 1980; VOSJAN & NIEUWLAND, 1987). The aim of this study was to measure the effect of UV-B irradiation on the ATP concentration in microbial communities in the upper layer of Weddell Sea waters.

Work at sea

Water samples were taken with a rosette sampler from the upper 2, 10 and 30 m water layers in the Halley Bay area of the Weddell Sea (St. 258, 259, 260). The samples were put into plexiglass cuvettes, which were illuminated from one side with white light and from the other side with ultraviolet (Philips, 12 TL 20°W) at a distance of 10 cm to the cuvettes. Cut-off filter (WG 305, Schott & Gen., Mainz) has been used for removing the shorter wave lengths of the UV. One cuvette was not UV transparent and served as a control, whereas the other cuvette let penetrate UV-B light into the water sample. The samples were stirred and bubbled with normal air and kept at 2°C. This is a few degrees above the in-situ temperature. After 1/2 or 1 hour adaptation the UV light was started and every half hour an aliquot of 10 ml was taken out of the cuvettes. The amount of ATP in the suspended material was measured immediately. The ATP content was measured after the luciferine-luciferase method (see VOSJAN & NIEUWLAND, 1987; this volume).

Preliminary results

The ATP content of the different samples of the upper 30 m of the water column was between 650 and 270 ng per liter. The deepest layers contained the lowest amount of ATP. During the incubation time a decrease in the ATP content in the control as well as in the UV-B irradiated plankton was found. After about 1.5 hour of UV radiation the ATP concentration declined significantly in the samples of the UV transparent vessels compared to the control. Fig. 51 shows the ATP concentrations of two plankton samples during the irradiation. The control showed variations in the values and a slow decrease. However, in the UV transparant cuvette the ATP content of the plankton decreased after 1.5 hour irradiation very rapidly and after 5 hours the decrease slowed down. Fig. 52 shows the percentage of the ATP content of the irradiated samples compared to the control at the same time. Values of UV-B irradiated cells were compared to the data of the non UV-B exposed samples (= 100 %) and presented as percentage decrease or increase. In four experiments with samples from the surface, 10 m and 30 m depths a decrease of 75 % was found after 5 hours. The ATP content of cells in the UV transparent cuvette compared to the control was reduced to 20, 26, 27, 28 % (average 25 %). This clearly shows the damaging effect of UV-B irradiance on the ATP content of natural microbial populations. However this dramatic effect might not be realistic in the natural habitat because of the lower irradiance and the moving of living particles in the mixed layer. Therefore the exposure time to UV in the UV irradiated water layer will be lower. Highest damage may be expected during calm wind conditions when the plankton is in the upper water layers.

References

DÖHLER, G., 1985. Effect of UV-B radiation (290 to 320 nm) on the nitrogen metabolism of several marine diatoms.- J. Plant Physiol. 118,391-400.
JERLOV, N.G., 1976. Marine Optics. Elsevier, Amsterdam 231pp.
KARL, D.M., 1980. Cellular nucleotide measurements and applications in microbial ecology.- Microbiol. Rev. 44, 739-796.
VOSJAN, J.H. and G. NIEUWLAND, 1987. Microbial biomass and respiratory activity in the surface waters in the east Banda Sea and the northwest Arafura Sea (Indonesia) at the time of the southeast monsoon.- Limnol.Oceanogr. 32, 767-775.
WORREST, R. C., 1982. Review of literature concerning the impact of u.v.-B radiation upon marine organisms.- In: The role of solar ultraviolet in marine ecosystems. J.Calkins ed. Plenum Publ. Comp. 429-457.

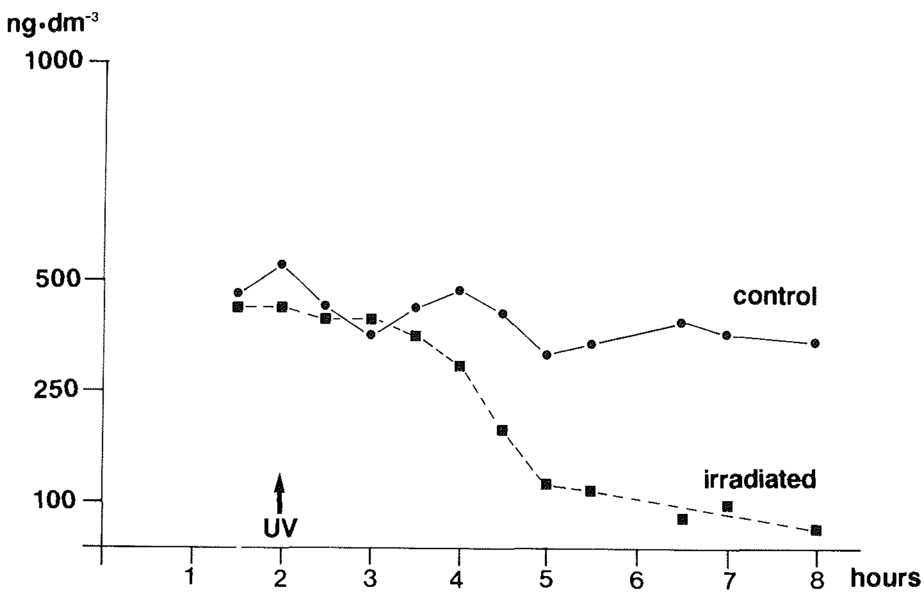



Figure 51: The effect of UV-B irradiation on the ATP content of plankton. ATP concentration of control and irradiated sample is plotted against time.

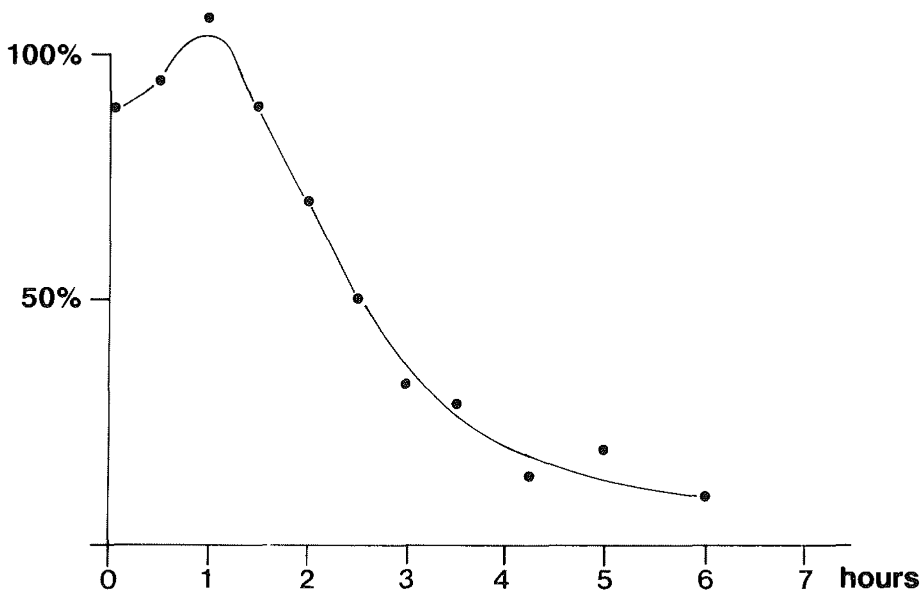



Figure 52: ATP content of irradiated samples given as percentages of the control plotted against time of UV-B irradiation.

## 4.3 Physiological studies on teleost fish

J.C. Rankin, T.P. Johnson, A. Kunzmann, A.P.A. Wöhrmann

### Introduction

Three striking features of the shelf seas of the high Antarctic, namely very low and constant water temperatures, extreme seasonality of ice conditions and high oxygen concentrations, make it a most interesting 'laboratory' for physiological investigations.

For many problems in physiology a particular species or group of animals provides an extremely convenient experimental model contributing to elucidation of basic physiological mechanisms (the "August Krogh Principle"). Thus studies on the molecular basis of muscle contraction benefit from investigating the effects of varying temperature in poikilothermic animals. A number of interesting studies have been carried out on sub-Antarctic species and the opportunity to study extremely stenothermal high Antarctic species adds a new dimension to this work.

One of the most fascinating groups of animals to respiratory and circulatory physiologists is the Channichthyidae. Icefish are the only vertebrates lacking respiratory pigments. The lack of haemoglobin is accompanied by a very small number of blood cells. All experimental work to date has been carried out on one species, *Chaenocephalus aceratus*, because of its availability at

Palmer and Signy, so the opportunity to work on different species which may have different life styles was especially welcome to identify physiological features consequent upon the lack of haemoglobin, in contrast to those possibly related to the habits of a single species.

Reduction in haematocrit is found in other notothenioid fish; blood parameters for about 25 species, mainly of the genera *Trematomus* and *Notothenia*, have been documented. Few papers have presented complete data on blood oxygen carrying capacity or gill surface area of Antarctic fish and most concentrate on comparisons between red- and white-blooded species rather than on intrafamiliar studies or investigations of links to ecology and mode of life.

The gangliosides, a class of complex lipids particularly abundant in the central nervous system, fit into a temperature-correlated pattern. Preliminary neurobiological studies have shown that variation in brain ganglioside composition is a molecular mechanism involved in cold adaptation in Antarctic fish, gangliosides of cold-adapted poikilotherm species have higher concentrations of sialic acid and more polar groups than other, warm-adapted species. There are at present no histochemical and cytological investigations of notothenioid brain structure. Antifreeze glycoprotein (AFGP) appears to be absent from *Pleuragramma antarcticum* and although it may not be necessary in deep water fish such as *Aethotaxis mitopteryx* it is difficult to understand how *Pleuragramma* can survive in very cold water containing ice pellets. A new glycoprotein has been found in notothenioids and its function and possible occurrence in Weddell Sea fish needs investigating.

Objectives

Further elucidation of the anatomy of the system of hypobranchial arches draining the gills ventrally in icefish. What do these vessels supply and are they found in all species? Studies on the relationship between gill blood flow and water exchange in icefish. Investigation of the effect of catecholamines on gill blood flow and water exchange in icefish (JCR).

Investigation of muscle growth. Hypertrophy or hyperplasia of muscle fibres? Collection of fixed and rapidly frozen muscle samples from as wide a diversity of species as possible for histochemical and ultrastructural studies. Studies on the mechanics of live isolated bundles of muscle fibres (TPJ).

Studies on blood physiology of the physiologically rather uninvestigated Weddell Sea fish and completion of existing data. Comparison of data on a finer scale, even within closely related groups, in an ecological context. Attempting to link all data about respiration (i.e. gill function, blood parameters and oxygen consumption) in a wider context, maybe together with data about growth, reproduction, feeding and mode of life, to a more general picture about ´energy budget` under individual ecological conditions. In other words: to live in this or that environment you had better have these or those "tools" to do the job (AK).

Biochemical, histochemical and cytological investigation of brain function. Is the morphometry of the central nervous system, synaptic clefts and myelin, and the localisation of calcium ions and $Ca^{2+}$-ATPase in the synaptic cleft different to the condition in non-Antarctic teleosts? Are there glycogen stores in the brain as in some other teleosts in winter? Investigation of antifreeze glycoproteins in Antarctic fish, their presence or absence in different species and new forms of antifreeze. Collection of live fish for rearing experiments to investigate ontogeny, early life history, swimming behaviour and diel rhythms (APAW).

Work at sea

Material

Fish were caught using a variety of gear mainly at Halley Bay, Vestkapp and Kapp Norvegia in the eastern Weddell Sea but also in the vicinities of Elephant and Signy Islands. For details regarding gear, species composition, numbers caught and station list see HUREAU et al. and PIATKOWSKI et al. (this volume). Details of fish used in physiological experiments will be given below.

Gill Blood Circulation and Water Exchange (J.C.R.)

The arrangement of efferent branchial blood vessels was investigated by injection of either Microfil or Acrifix (commercial rubber latex and plastic compounds respectively) into the bulbus cordis of the hearts of heparin-injected fish or, in the case of some larger specimens, into the hypobranchial artery. 8 species of channichthyid and 4 species of nototheniid were injected with Microfil; 6 species of channichthyid with Acrifix. The latter specimens were frozen and will be dissolved in concentrated potassium hydroxide solution, leaving plastic casts of blood vessels which will be examined by scanning electron microscopy. The Microfil injected fish were preserved in ethanol; following complete dehydration the tissues will be cleared in methyl salicylate and photographed under a dissecting microscope.

Preliminary dissections showed that all the icefish had complete hypobranchial systems leading from the gills to the very well vascularised muscles of the pectoral fins. The relative sizes of the vessels showed variation between species but the basic patterns were the same. This also applied to the nototheniids examined, suggesting that retention of a functional hypobranchial system may be related to the importance of labriform locomotion in nototheniids rather than to the absence of haemoglobin in channichthyids.

Isolated cannulated gill arches were perfused at constant rates with fish Ringer's solution from a peristaltic pump. Input pressure was monitored with a pressure transducer and recorded as a measure of branchial vascular resistance. Noradrenaline added to the perfusate was found to produce a concentration-dependent decrease in resistance of perfused gills from *Cryodraco antarcticus* and *Chionobathyscus dewitti* as had been previously shown for *Chaenocephalus aceratus* (Fig. 53). Gills were fixed by immersion in glutaraldehyde whilst being perfused with noradrenaline solution or control Ringer. Branchial vascular resistance hardly changed for several hours after fixation, indicating that blood vessels had been fixed without change in diameter. These gills will be used to quantify anatomically the vasodilatory effects of the catecholamine. Gills were also fixed during perfusions with control Ringer at different efferent pressures for comparison of lamellar filling. Non-perfused gills were fixed for comparison.

Water exchange across the gill epithelia was measured by immersion of perfused gills in baths containing radioactive tritiated water (HTO). Influx will be calculated from appearance of radioactivity in the perfusate. Effects of varying perfusion rate, afferent and efferent pressures and noradrenaline concentrations were investigated. An *in vivo* experiment to measure the effect of catecholamines on gill water fluxes was also carried out in *Chionodraco rostrospinosus*. Control and adrenaline-injected fish were injected with HTO and the radioactivity of samples of the aquarium water taken over a 48 hour period will be measured; this will permit calculation of water turnover rates.

Muscle physiology (T.P.J.)

Muscle samples from specimens of *Notothenia gibberifrons* of a large size range caught off Elephant and Signy Islands were taken for electron microscopical and histochemical analysis. Previous investigations of fish caught in the region of Signy Island have shown that these Antarctic species have larger muscle fibre diameters (for all muscle types) than temperate species of marine teleosts as for example, the sculpin (*Myoxocephalus scorpius*). It is known that in this species hyperplasia (ie. increase in fibre number) is more important in adult growth than hypertrophy (ie. increase in fibre diameter). The large fibre diameter of Antarctic fish suggests that hypertrophy is more important in adult growth.

The next section of work involved obtaining fixed and rapidly frozen samples from as wide a diversity of species as possible.

Previous work on species from Signy Island has demonstrated a number of histochemical and ultrastructural details unique to Antarctic teleosts. The objective was to investigate these features in species living closer to the ice-shelf and therefore living at a consistently lower temperature. For example, high mitochondrial density may serve to partially compensate for the detrimental effects of low temperature on enzyme reaction and diffusion rates. In species inhabiting the shelf off Signy Island, mitochondria constitute 30 to 60 % of the fibre volume. Perhaps, therefore, one may expect a further increase in density in species living closer to the ice shelf.

Three muscle types were chosen for investigation to provide a complete picture of these adaptations; fast and slow myotomal muscle and slow muscle fibres from the major pectoralis adductor muscle. Specimens taken included representatives of the families Artedidraconidae, Bathydraconidae and Nototheniidae. To complete this study whole frozen specimens have also been taken to investigate the general "muscular design" of these species, ie. body shape and the proportions and distribution of the various muscle fibre types.

The final section of this study consisted of experiments performed on board ship. The technique studies the mechanics of live isolated bundles of muscle fibres. Only a limited number of temperate species studied so far provide suitable preparations, so the first task was to work through a number of species and muscle fibre types to obtain a suitable preparation. Specimens of

*Notothenia gibberifrons*, *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus* were tried using both abdominal myotomes and the pectoral musculature, but with only limited success. One large specimen of *Pseudochaenichthys* did however produce some interesting data on the effects of temperature on twitch contraction in fast abdominal musculature. This preliminary work also served to test the equipment before arriving in the Weddell Sea where the main bulk of the study was performed.

Trawling in the Weddell Sea provided a good number of specimens of *Trematomus* species especially *T. lepidorhinus*. It was possible to obtain a good preparation from the fast muscle of the major pectoralis adductor of this species. Isolated bundles of fibres were connected by silver foil hooks to a silicon blade force transducer at one end and the arm of a servo-motor system, designed to produce controlled changes in length, at the other. The preparation was kept immersed in a constant flow of cooled Ringer solution throughout the experiment.

Stimulating the preparation externally through silver electrodes immersed in the Ringer, the isometric performance of the muscle was investigated at different temperatures (see Fig. 54). By using the servo-motor system, the relationship between force and velocity (P-V curves) as described by the Hill and Marsh equations was also investigated (see Fig. 55). Data were also obtained for one specimen of *T. loennbergi* which yielded very similar results. This third aspect of the study produced some very interesting results which will be compared with data already obtained for North Sea species.

Blood physiological investigations (A.K.)

Fish were transferred to aquaria immediately and allowed at least 12 hours to recover from stress due to capture and handling; in most cases at least 48 hours was allowed. In the case of repeated measurements fish were kept for a number of weeks.

Three major types of sample were taken:

- 178 blood samples for determination of pH, $pO_2$, $pCO_2$, RBC number, haematocrit (Hct), haemoglobin (Hb), mean corpuscular haemoglobin content (MCHC) in whole blood (1a) and plasma was collected for analysis of total proteins and lipids and several selected enzymes and hormones in collaboration with other scientists (1b). The cells will be used for purification of Hb and structural (AA sequence) and functional studies (oxygen affinity, P50, Bohr and Hill effects) on Hb in co-operation with DI PRISCO (IIGB, Naples) and GRIESHABER (Univ. Düsseldorf) (1c). Samples were taken from 28 species of 20 genera and 4 families. For more than 10 species this was the first record of blood parameters.

- 108 liver and heart samples from 21 species of 15 genera and 3 families for investigations on metabolism of key enzymes of purified mitochondria in collaboration with JANKOWSKY (Univ. Kiel).

- 46 gill samples from 16 species of 12 genera and 3 families for assessment of gill surface area and gill area index.

Blood samples were collected from the caudal vein of unanaesthetized fish into heparinised syringes, the whole sampling procedure being routinely completed within 20 seconds of first handling of a specimen. Samples were either worked up immediately, deep frozen at -80°C or fixed in 4 % glutaraldehyde.

There were no obvious differences in the blood of bathydraconids or artedidraconids in comparison with notothenids as far as Hct, RBC number or HB was concerned. The RBCs of some selected species (e.g. *Pleuragramma antarcticum*, *Racovitzia glacialis* and particularly all examined *Pogonophryne* species) seemed to be more fragile than others. Moreover, the blood of *Pogonophryne* spp. was of a remarkable light red colour and started to become slimy independently of the concentration of heparin used to prevent coagulation. The blood of some *Pogonophryne* specimens and a few *Gerlachea* had a clearly visible fatty component (2 to 3 vol %) after centrifugation in microcapillaries. Specimens of several taxa were able to reduce their initial (post-capture) rather high $CO_2$ levels to almost zero after several days in the aquaria, in some cases (*R. glacialis*, *Aethotaxis mitoperyx*, *Gymnodraco acuticeps*) amazingly rapidly.

Detailed results from 1(a) will be available in a few weeks time. Investigations are still continuing on specimens still alive in the aquaria. The analysis of plasma - 1(b) and cells - 1(c) will take several months and will mainly be done in collaboration with scientists from Naples, Düsseldorf and Kiel. The analysis of the liver and heart samples and the assessments of gill areas will take much longer and cannot be expected before 1990.

Neurobiological, biochemical and ecological investigations (APAW)

351 fishes of 42 species were collected. The majority were Notothenioidei (36 species, 337 specimens) with 11 species of Nototheniidae, especially *P. antarcticum* and *T. lepidorhinus*, 10 species of Channichthyidae, especially *Chionodraco myersi*, 7 species of Bathydraconidae and 8 species of Artedidraconidae. Brain, liver, muscle and other tissues were preserved using three main methods:

- For biochemical investigations on gangliosides brains and livers were deep-frozen at -80°C. 99 brain samples were collected from 24 species for quantitative determination of gangliosides. Brains (50 or more from each species) from *P. antarcticum*, *Chaenodraco wilsoni*, *C. myersi* and *Bathydraco marri* were frozen for chemical studies of ganglioside structure. These studies will be carried out in collaboration with EGGE (Univ. Bonn) and HANDA (Univ. Nagoya, Japan).

- For histochemical and cytological investigations brains were preserved with different fixatatives (paraform-glutaraldehyde, glutaraldehyde and Bouin). 95 brains and 22 larvaes were fixed.

- Material for AFGP analysis (whole fish or muscle) was deep-frozen at -30°C.

Eggs, larvae and adult fishes were kept in aquaria in the AWI cool-container 010 under controlled water temperature (-1.0°C) and light regimes (red light).

The oxygen content of the aquaria water was measured regularly. The fishes will be used for physiological studies on behaviour in co-operation with RAHMANN (Univ. Stuttgart-Hohenheim).

Preliminary observations during preparation revealed clear and distinct differences between families regarding the consistency of the cranium and the position of the brain. Channichthyids have a weak, soft, thin cartilagenous cranium, through which the brain is partly visible. A very similar situation was found in the bathydraconids, whereas the artedidraconids and nototheniids showed a very thick and bony cranium. The extreme case was found in notothenids with a deeply embedded brain surrounded by a gelatinous blubbery tissue. The sequence of increasing brain size per unit body weight was found to be nototheniids < artedidraconids < bathydraconids < channichthyids, the latter having by far the biggest brains. All nototheniids had an increasing size of optic tectum with increasing size of eye. The optic tectum was the dominant feature of the brain in macroscopic terms.

Detailed qualitative, mainly done in collaboration with scientists from Bonn, Göttingen and Nagoya, and quantitative results on gangliosides will be available in summer 1989. The analysis of the histochemical and cytological samples cannot be expected before 1990.

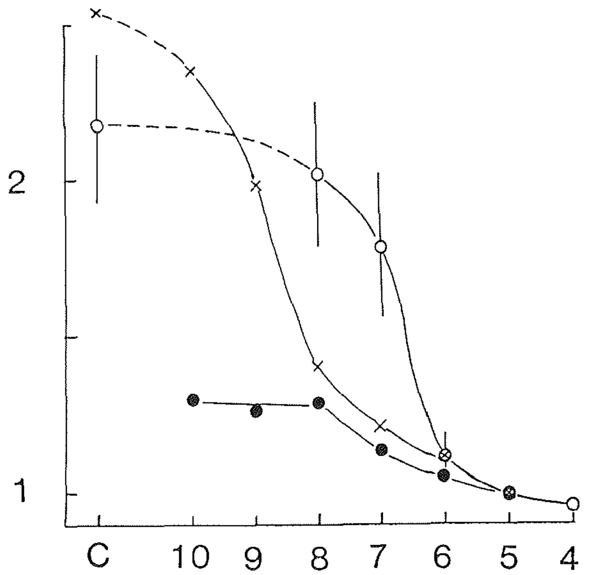



Figure 53: Concentration-response curves for the effect of noradrenaline on branchial vascular resistance in *Cryodraco antarcticus* (open circles, n = 5 gills from 3 fish, vertical lines represent standard errors of means) and *Chionobathyscus dewitti* (closed circles,1 gill, definitive identification awaited) compared with previous results from *Chaenocephalus aceratus* (crosses, Rankin, in press). Abscissa: Relative branchial vascular resistance (input pressure at constant flow, $10^{-5}$ molar noradrenaline = 1). Ordinate: -log molar concentration of noradrenaline (C = control).

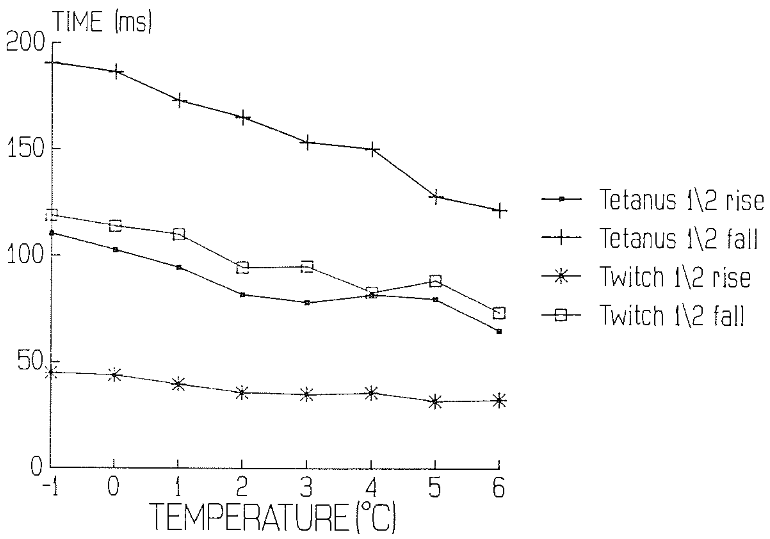



Figure 54: Half rise and relaxation times plotted against temperature for twitch and tetanic contractions in isolated fin muscle preparations of *Trematomus lepidorhinus*. S.E., ≤ 16 ms and grouped in 1°C intervals.

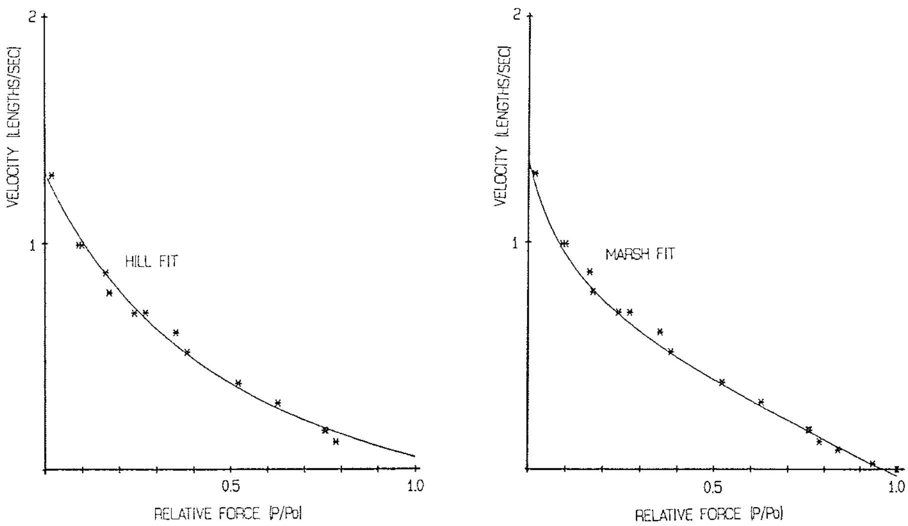



Figure 55: The force velocity relation determined at 1°C for fin muscle preparations of *Trematomus lepidorhinus*. Data are fitted to both the Hill and Marsh (hyperbolic-linear) equations.

ANNEX

Abkürzungen / Abbreviations

| | |
|---|---|
| AGT | Agassiz trawl |
| Argos | Argos buoy (deployment) |
| BB | Fish larvae net |
| BO | Bongo net |
| BPN | Semipelagic (benthopelagic, 1088) trawl |
| CTD | Conductivity temperature depth recorder |
| FN | Fransz net |
| FTS | Photo sled |
| GSN | Bottom trawl |
| MG | Multibox corer |
| MP | Artificial substrate frame (retrieval) |
| MN | Multinet |
| MUC | Multicorer |
| REU | Baited traps |
| RMT | Rectangular midwater trawl |
| SB | Rubber boat |
| UWE | Remotely operating vehicle |
| XBT | Expendable bathythermograph |

| | |
|---|---|
| D | Day |
| E | Evening (dusk) |
| M | Morning (daybreak) |
| N | Night |

Station list

| Stat. No. | Date | Position Start/End | | Echo Depth [m] | Gear | Haul No. | Day Time | Start/ End [UTC] | Haul Dur. [min.] | Max. Gear depth [m] | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 210 | 14/01/89 | 53°37,4'S | 066°08,7'W | 2310 | XBT | 1 | D | 0:40 | | | XBT profile |
| | | 60°30,0'S | 056°00,0'W | 3622 | | | | 13:47 | | | |
| 211 | 15/01/89 | 60°59,8'S | 055°12,1'W | 213 | GSN | 1 | D | 17:31 | 15 | | |
| | | 60°59,3'S | 055°10,5'W | 207 | | | | 17:46 | | | |
| | | 60°59,0'S | 055°09,6'W | 258 | UWE | 1 | D | 18:45 | 47 | | technical test |
| | | 60°59,4'S | 055°09,4'W | 279 | | | | 19:32 | | | |
| 212 | 15/01/89 | 60°50,0'S | 055°38,9'W | 414 | GSN | 2 | D | 22:01 | 15 | | |
| | | 60°49,7'S | 055°40,3'W | 397 | | | | 22:16 | | | |
| 213 | 17/01/89 | 57°01,0'S | 046°57,0'W | 3417 | CTD | 1 | M | 6:00 | 58 | 1500 | |
| | | 57°00,8'S | 046°56,3'W | 3452 | FN | 1 | M | 7:10 | 5 | 300 | much clogging |
| | | 57°00,8'S | 046°57,3'W | 3298 | MN | 1 | M | 7:38 | 24 | 1000 | clogging in MN5 |
| | | 57°00,8'S | 046°56,3'W | 3484 | BO | 1 | M | 8:19 | 6 | 300 | clogging |
| 214 | 17/01/89 | 57°59,9'S | 046°59,8'W | 3208 | CTD | 2 | D | 15:50 | 60 | 1500 | |
| | | 57°58,6'S | 047°00,9'W | 3216 | FN | 2 | D | 16:56 | 6 | 300 | |
| | | 57°58,6'S | 047°00,9'W | 3232 | MN | 2 | D | 17:30 | 29 | 1000 | clogging in MN5 |
| | | 57°58,6'S | 047°00,8'W | 3230 | BO | 2 | D | 18:08 | 8 | 300 | |
| 215 | 18/01/89 | 59°00,6'S | 046°59,7'W | 2726 | CTD | 3 | M | 6:07 | 48 | 1500 | |
| | | 59°00,5'S | 046°59,7'W | 2705 | FN | 3 | M | 7:09 | 5 | 300 | |
| | | 59°00,5'S | 046°59,7'W | 2708 | MN | 3 | M | 7:39 | 23 | 1000 | station after storm |
| | | 59°00,5'S | 046°59,7'W | 2762 | BO | 3 | D | 8:18 | 6 | 300 | station after storm |
| 216 | 18/01/89 | 59°59,8'S | 046°59,7'W | 3663 | CTD | 4 | D | 13:41 | 64 | 1500 | |
| | | 59°59,6'S | 047°01,2'W | 3612 | FN | 4 | D | 14:58 | 5 | 300 | |
| | | 59°59,6'S | 047°01,2'W | 3700 | MN | 4 | D | 15:32 | 26 | 1000 | |
| | | 59°59,6'S | 047°01,2'W | 3776 | BO | 4 | D | 16:17 | 5 | 300 | |
| 217 | 18/01/89 | 60°37,6'S | 046°58,1'W | 237 | GSN | 3 | D | 20:24 | 15 | | living material |
| | | 60°36,8'S | 046°59,1'W | 235 | | | | 20:39 | | | |
| 218 | 18/01/89 | 60°59,8'S | 046°58,5'W | 1620 | CTD | 5 | N | 23:24 | 56 | 1486 | |
| | | 60°59,8'S | 046°58,9'W | 1461 | FN | 5 | N | 0:42 | 6 | 300 | |
| | | 60°59,8'S | 046°58,8'W | 1508 | MN | 5 | N | 1:16 | 24 | 1000 | |
| | | 60°59,8'S | 046°58,9'W | 1467 | BO | 5 | N | 1:56 | 9 | 300 | |
| 219 | 19/01/89 | 61°30,0'S | 047°00,0'W | 550 | CTD | 6 | M | 5:25 | 30 | 528 | |
| | | 61°29,7'S | 046°59,6'W | 547 | FN | 6 | M | 6:07 | 6 | 300 | |
| | | 61°29,7'S | 046°59,6'W | 549 | MN | 6 | M | 6:33 | 14 | 520 | |
| | | 61°29,7'S | 047°00,0'W | 553 | SB | 1 | D | 6:55 | 20 | | ice catching |
| | | 61°29,8'S | 046°59,6'W | 540 | BO | 6 | D | 7:00 | 9 | 300 | |
| 220 | 20/01/89 | 61°43,4'S | 038°54,4'W | 1886 | RMT | 1 | D | 9:10 | 22 | 300 | trial station |
| 221 | 23/01/89 | 70°29,5'S | 008°18,0'W | 245 | REU | 1 | D | 16:13 | | 245 | deployment |
| 222 | 24/01/89 | 70°29,2'S | 08°18,6'W | 247 | SB | 2 | T | 20:09 | 38 | | no retrieval of REU 1 |
| 223 | 25/01/89 | 71°14,2'S | 012°35,9'W | 384 | UWE | 2 | D | 8:46 | 44 | | technical test |
| | | 71°14,9'S | 012°40,8'W | 380 | | | | 9:30 | | | |
| | | 71°13,6'S | 012°41,8'W | 370 | RMT | 2 | D | 10:40 | 24 | 300 | RMT8 not opened |
| 224 | 25/01/89 | 71°16,6'S | 013°08,8'W | 192 | UWE | 3 | D | 13:01 | 72 | | technical test |
| | | 71°16,3'S | 013°07,9'W | 178 | | | | 14:13 | | | |
| | | 71°16,3'S | 130°07,8'W | 181 | MUC | 1 | D | 14:26 | 15 | | disgard |
| | | 71°16,1'S | 013°07,5'W | 173 | MG | 1 | D | 15:05 | 11 | | not quantitative |
| | | 71°15,8'S | 013°04,2'W | 186 | GSN | 4 | D | 16:00 | 15 | | live material |
| | | 71°15,3'S | 013°01,7'W | 187 | | | | 16:15 | | | |
| | | 71°15,1'S | 012°59,8'W | 193 | MG | 2 | D | 17:58 | 15 | | not quantitative |
| | | 71°15,3'S | 012°59,7'W | 198 | MUC | 2 | D | 18:17 | 15 | | disgard |
| 225 | 25/01/89 | 71°07,7'S | 012°12,1'W | 566 | mooring | 1 | N | 23:07 | 83 | | KN 3 retrieval |
| 226 | 28/01/89 | 75°19,5'S | 026°00,6'W | 670 | CTD | 7 | M | 6:03 | 42 | 644 | |
| | | 75°18,7'S | 025°58,0'W | 677 | RMT | 3 | D | 7:11 | 26 | 300 | |
| | | 75°19,3'S | 025°59,4'W | 680 | BB | 1 | D | 7:48 | 30 | | |
| | | 75°19,3'S | 025°59,4'W | 680 | | | | 8:18 | | | |
| | | 75°18,1'S | 025°55,4'W | 660 | BO | 7 | D | 8:31 | 9 | 300 | |
| | | 75°17,8'S | 025°58,8'W | 631 | FN | 7 | D | 8:48 | 6 | 50 | |
| | | 75°15,9'S | 025°58,3'W | 574 | GSN | 5 | D | 9:59 | 16 | | |
| | | 75°15,7'S | 025°54,2'W | 569 | | | | 10:15 | | | |
| | | 75°15,7'S | 025°48,6'W | 582 | MUC | 3 | D | 11:40 | 31 | | success rate 10/12 |
| | | 75°15,3'S | 025°49,7'W | 577 | MG | 3 | D | 12:23 | 36 | | |
| | | 75°17,1'S | 025°53,5'W | 593 | AGT | 1 | D | 13:46 | 73 | | 3 big boulders |
| | | 75°17,3'S | 025°57,4'W | 624 | | | | 14:59 | | | |
| | | 75°17,3'S | 026°03,4'W | 614 | AGT | 2 | D | 15:50 | 79 | | 3 big boulders |
| | | 75°18,9'S | 026°07,0'W | 601 | | | | 17:09 | | | |
| | | 75°18,9'S | 026°07,0'W | 601 | FN | 8 | D | 17:13 | 3 | 50 | |
| 227 | 28/01/89 | 75°21,1'S | 025°40,8'W | 781 | CTD | 8 | D | 18:17 | 34 | 765 | |
| | | 75°21,9'S | 025°34,6'W | 791 | BO | 8 | D | 19:07 | 9 | 300 | snow fall |
| 228 | 28/01/89 | 75°14,4'S | 026°42,1'W | 399 | REU | 2 | E | 21:27 | 4320 | 399 | deployment |
| 229 | 29/01/89 | 75°17,6'S | 026°20,5'W | 500 | CTD | 9 | M | 6:04 | 37 | 500 | |
| | | 75°16,9'S | 026°17,8'W | 502 | RMT | 4 | D | 7:08 | 22 | 300 | |
| | | 75°16,1'S | 026°15,6'W | 500 | BO | 9 | D | 7:58 | 8 | 300 | |
| | | 75°16,1'S | 026°16,2'W | 504 | FN | 9 | D | 8:11 | 22 | 300 | |
| | | 75°14,8'S | 026°13,4'W | 506 | GSN | 6 | D | 9:42 | 8 | | trawl stuck |
| | | 75°14,3'S | 026°13,3'W | 500 | | | | 9:50 | | | |
| | | 75°13,1'S | 026°13,5'W | 494 | MUC | 4 | D | 11:05 | 27 | | disgard |
| | | 75°14,1'S | 026°14,0'W | 502 | MUC | 5 | D | 13:12 | 23 | | success rate 9/12 |
| | | 75°14,4'S | 026°13,0'W | 506 | MG | 4 | D | 13:46 | 34 | | |
| | | 75°14,9'W | 026°12,5'W | 509 | AGT | 3 | D | 14:38 | 71 | | |
| | | 75°15,5'S | 026°16,5'W | 500 | | | | 15:49 | | | |
| | | 75°15,7'S | 026°16,7'W | 498 | AGT | 4 | D | 15:57 | 74 | | small catch |
| | | 75°11,7'S | 026°18,4'W | 498 | | | | 17:11 | | | |

Station list

| Stat. No. | Date | Position Start/End | | Echo Depth [m] | Gear | Haul No. | Day Time | Start/ End [UTC] | Haul Dur. [min.] | Max. Gear depth [m] | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 30/01/89 | 75°14,2'S | 026°59,4'W | 270 | AGT | 5 | D | 6:01 | 56 | | |
| | | 75°12,9'S | 027°01,2'W | 280 | | | | 6:57 | | | |
| | | 75°14,5'S | 026°38,9'W | 275 | AGT | 6 | D | 7:33 | 56 | | |
| | | 75°13,8'S | 026°59,9'W | 279 | | | | 8:29 | | | |
| | | 75°13,5'S | 027°00,8'W | 273 | CTD | 10 | D | 8:50 | 26 | 276 | |
| | | 75°13,9'S | 027°02,3'W | 283 | RMT | 5 | D | 10:34 | 24 | 240 | RMT1-2 not sampled |
| | | 75°13,2'S | 026°59,6'W | 240 | FN | 10 | D | 11:32 | 13 | 50 | |
| | | 75°13,3'S | 027°00,1'W | 247 | MUC | 6 | D | 12:06 | 38 | | disgard |
| | | 75°13,5'S | 027°00,8'W | 271 | MUC | 7 | D | 12:49 | 14 | | disgard |
| | | 75°12,8'S | 026°59,4'W | 244 | MG | 5 | D | 13:20 | 18 | | |
| | | 75°12,8'S | 026°59,5'W | 247 | MUC | 8 | D | 13:55 | 15 | | disgard |
| | | 75°13,2'S | 026°58,8'W | 244 | BO | 10 | D | 11:54 | 6 | 200 | |
| 231 | 30/01/89 | 75°23,6'S | 026°55,3'W | 241 | CTD | 11 | D | 16:14 | 18 | 229 | |
| 232 | 30/01/89 | 75°29,9'S | 027°03,7'W | 234 | CTD | 12 | D | 17:31 | 14 | 226 | |
| 233 | 30/01/89 | 75°42,4'S | 027°27,9'W | 304 | CTD | 13 | D | 19:30 | 25 | 294 | |
| 234 | 30/01/89 | 75°52,5'S | 027°45,6'W | 416 | CTD | 14 | D | 21:18 | 29 | 405 | |
| 235 | 31/01/89 | 75°08,8'S | 027°31,8'W | 400 | RMT | 6 | D | 6:25 | 30 | 300 | |
| | | 75°09,2'S | 027°33,8'W | 402 | CTD | 15 | D | 7:07 | 26 | 383 | |
| | | 75°09,1'S | 027°33,5'W | 400 | BO | 11 | D | 7:48 | 8 | 300 | |
| | | 75°08,9'S | 027°33,2'W | 404 | AGT | 7 | D | 8:09 | 78 | | good haul, |
| | | 75°08,1'S | 027°49,5'W | 399 | | | | 9:27 | | | small stones |
| | | 75°08,0'S | 027°28,9'W | 399 | FN | 11 | D | 9:38 | 6 | 52 | |
| | | 75°09,1'S | 027°34,7'W | 407 | GSN | 7 | D | 11:07 | 15 | | |
| | | 75°09,8'S | 027°37,9'W | 405 | | | | 11:22 | | | |
| | | 75°10,6'S | 027°35,4'W | 399 | MUC | 9 | D | 13:10 | 21 | | success rate 8/12 |
| | | 75°10,5'S | 027°34,2'W | 399 | MG | 6 | D | 14:17 | 24 | | |
| | | 75°10,5'S | 027°33,1'W | 399 | UWE | 4 | D | 15:03 | 44 | | technical test |
| | | 75°10,6'S | 027°32,1'W | 384 | | | | 15:47 | | | |
| 236 | 31/01/89 | 75°15,0'S | 026°41,8'W | 400 | CTD | 16 | D | 18:10 | 29 | 378 | |
| | | 75°15,2'S | 026°42,7'W | 398 | BO | 12 | D | 18:52 | 6 | 210 | haul interrupted |
| 237 | 31/01/89 | 75°14,2'S | 026°44,7'W | 399 | REU | 3 | D | 19:12 | 4320 | | retrieval |
| 238 | 31/01/89 | 75°05,0'S | 026°24,8'W | 367 | CTD | 17 | D | 21:04 | 24 | 355 | |
| | | 75°04,5'S | 026°24,3'W | 367 | BO | 13 | D | 21:43 | 8 | 300 | |
| 239 | 31/01/89 | 74°55,9'S | 026°06,4'W | 290 | BO | 14 | E | 23:14 | 8 | 250 | |
| | | 74°55,6'S | 026°04,8'W | 305 | CTD | 18 | E | 23:28 | 17 | 290 | |
| 240 | 01/02/89 | 74°45,0'S | 025°51,0'W | 569 | CTD | 19 | M | 1:08 | 27 | 548 | |
| | | 74°44,8'S | 025°50,6'W | 567 | BO | 15 | N | 1:54 | 8 | 300 | |
| 241 | 01/02/89 | 75°06,3'S | 028°07,5'W | 468 | RMT | 7 | D | 7:24 | 29 | 300 | |
| | | 75°06,6'S | 028°02,0'W | 458 | CTD | 20 | D | 8:03 | 28 | 453 | |
| | | 75°07,1'S | 027°59,6'W | 461 | BO | 16 | D | 8:49 | 8 | 300 | |
| | | 75°07,1'S | 027°59,5'W | 462 | AGT | 8 | D | 9:11 | 85 | | net turned over |
| | | 75°04,7'S | 028°00,4'W | 457 | | | | 10:36 | | | |
| | | 75°04,6'S | 027°59,8'W | 456 | FN | 12 | D | 10:47 | 5 | 50 | |
| | | 75°02,9'S | 028°00,3'W | 451 | GSN | 8 | D | 12:41 | 16 | | |
| | | 75°04,0'S | 028°00,0'W | 453 | | | | 12:57 | | | |
| | | 75°05,5'S | 028°00,4'W | 458 | MUC | 10 | D | 14:22 | 21 | | success rate 12/12 |
| | | 75°05,5'S | 028°01,0'W | 462 | MG | 7 | D | 15:35 | 25 | | |
| 242 | 01/02/89 | 75°03,0'S | 028°25,0'W | 453 | Argos | 1 | D | 17:00 | | | |
| 243 | 01/02/89 | 74°56,7'S | 029°25,7'W | 399 | CTD | 21 | D | 19:10 | 27 | 383 | |
| | | 74°56,7'S | 029°25,7'W | 400 | BO | 17 | D | 19:52 | 8 | 300 | |
| 244 | 01/02/89 | 74°40,2'S | 029°35,1'W | 570 | REU | 4 | N | 22:34 | | | deployment, no retrie |
| 245 | 02/02/89 | 74°39,9'S | 029°39,3'W | 505 | FTS | 1 | D | 15:04 | 36 | | |
| | | 74°40,1'S | 029°39,6'W | 505 | | | | 15:40 | | | |
| | | 74°40,1'S | 029°40,4'W | 486 | RMT | 8 | D | 6:26 | 29 | 300 | |
| | | 74°40,1'S | 029°40,3'W | 480 | CTD | 22 | D | 7:07 | 23 | 483 | |
| | | 74°40,6'S | 029°40,4'W | 490 | BO | 18 | D | 7:47 | 9 | 300 | |
| | | 74°39,7'S | 029°41,6'W | 483 | AGT | 9 | D | 8:18 | 94 | | very large catch |
| | | 75°40,4'S | 029°37,2'W | 484 | | | | 9:52 | | | |
| | | 74°40,5'S | 029°37,3'W | 486 | FN | 13 | D | 10:01 | 6 | 50 | |
| | | 74°40,2'S | 029°40,0'W | 459 | BB | 3 | D | 10:21 | 20 | | |
| | | 74°40,2'S | 029°40,0'W | 459 | | | | 10:41 | | | |
| | | 74°39,9'S | 029°36,7'W | 516 | GSN | 9 | D | 11:49 | 15 | | |
| | | 74°39,3'S | 029°40,0'W | 511 | | | | 12:04 | | | |
| | | 74°39,6'S | 029°42,1'W | 492 | MUC | 11 | D | 13:37 | 22 | | success rate 9/12 |
| | | 74°39,8'S | 029°40,3'W | 500 | MG | 8 | D | 14:12 | 26 | | |
| 246 | 02/02/89 | 74°16,1'S | 029°49,6'W | 1709 | Argos | 2 | D | 18:50 | | | |
| 247 | 02/02/89 | 74°38,3'S | 029°42,1'W | 605 | FTS | 2 | D | 21:30 | 40 | | |
| | | 74°38,4'S | 029°42,4'W | 646 | | | | 22:10 | | | |
| 248 | 03/02/89 | 74°38,9'S | 029°37,5'W | 615 | RMT | 9 | D | 6:26 | 30 | 300 | |
| | | 74°39,4'S | 029°35,7'W | 624 | CTD | 23 | M | 7:07 | 25 | 579 | |
| | | 74°39,4'S | 029°36,9'W | 600 | BO | 19 | D | 7:49 | 9 | 300 | |
| | | 74°39,9'S | 029°31,3'W | 602 | GSN | 10 | D | 9:23 | 16 | | |
| | | 74°39,3'S | 029°34,4'W | 599 | | | | 9:39 | | | |
| | | 74°38,9'S | 029°41,4'W | 542 | FN | 14 | D | 10:25 | 8 | 50 | |
| | | 74°39,1'S | 029°42,2'W | 525 | BB | 4 | D | 10:43 | 21 | | |
| | | 74°39,1'S | 029°42,2'W | 525 | | | | 11:04 | | | |
| | | 74°38,1'S | 029°39,5'W | 633 | MUC | 12 | D | 11:32 | 27 | | success rate 10/12 |
| | | 74°38,4'S | 029°40,4'W | 610 | MG | 9 | D | 12:12 | 32 | | |
| | | 74°38,6'S | 029°39,3'W | 607 | FTS | 3 | D | 13:48 | 35 | | |
| | | 74°38,7'S | 029°39,5'W | 597 | | | | 14:23 | | | |

Station list

| Stat. No. | Date | Position Start/End | | Echo Depth [m] | Gear | Haul No. | Day Time | Start/ End [UTC] | Haul Dur. [min.] | Max. Gear depth [m] | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 249 | 04/02/89 | 74°35,9'S | 029°42,6'W | 707 | RMT | 10 | D | 6:56 | 30 | 300 | |
| | | 74°36,9'S | 029°40,1'W | 700 | CTD | 24 | D | 7:55 | 22 | 676 | |
| | | 74°36,9'S | 029°41,2'W | 670 | BO | 20 | D | 8:31 | 9 | 300 | |
| | | 74°36,1'S | 029°41,9'W | 733 | | | | 10:59 | | | |
| | | 74°37,3'S | 029°38,2'W | 701 | GSN | 11 | D | 9:45 | 15 | | |
| | | 74°36,7'S | 029°40,7'W | 702 | | | | 10:00 | | | |
| | | 74°35,9'S | 029°41,8'W | 738 | FN | 15 | D | 10:49 | 10 | 50 | |
| | | 74°36,8'S | 029°41,8'W | 681 | MUC | 13 | D | 11:13 | 31 | | disgard |
| | | 74°36,8'S | 029°41,8'W | 681 | MUC | 14 | D | 12:08 | 27 | | success rate 11/12 |
| | | 74°36,6'S | 029°40,3'W | 705 | MG | 10 | D | 12:54 | 36 | | |
| | | 74°36,7'S | 029°39,5'W | 703 | FTS | 4 | D | 14:00 | 30 | | |
| | | 74°36,5'S | 029°42,1'W | 704 | | | | 14:30 | | | |
| | | 74°36,2'S | 029°42,5'W | 699 | AGT | 10 | D | 15:04 | 142 | | 1/2 h trawling time |
| | | 75°34,5'S | 029°50,0'W | 712 | | | | 17:26 | | | |
| 250 | 04/02/89 | 74°34,8'S | 029°39,4'W | 814 | CTD | 25 | D | 18:03 | 37 | 796 | |
| | | 74°35,0'S | 029°39,6'W | 813 | BO | 21 | D | 18:56 | 9 | 300 | |
| | | 74°36,8'S | 029°39,7'W | 825 | RMT | 11 | D | 20:06 | 29 | 300 | |
| | | 74°36,3'S | 029°35,6'W | 796 | GSN | 12 | D | 9:02 | 15 | | |
| | | 74°35,7'S | 029°38,0'W | 805 | | | | 9:17 | | | |
| | | 74°35,2'S | 029°40,7'W | 798 | FN | 16 | D | 10:02 | 10 | 50 | |
| | | 74°34,9'S | 029°40,1'W | 806 | BB | 5 | D | 10:25 | 23 | | |
| | | 74°34,9'S | 029°40,1'W | 806 | | | | 10:48 | | | |
| | | 74°35,1'S | 029°40,2'W | 806 | MUC | 15 | D | 10:58 | 34 | | success rate 10/12 |
| | | 74°34,6'S | 029°40,4'W | 820 | MG | 11 | D | 12:02 | 38 | | |
| | | 74°34,9'S | 029°40,4'W | 811 | FTS | 5 | D | 13:10 | 30 | | |
| | | 74°34,8'S | 029°40,3'W | 814 | | | | 13:40 | | | |
| | | 74°35,1'S | 029°39,9'W | 799 | AGT | 11 | D | 14:11 | 194 | | 1 h trawling time |
| | | 75°32,4'S | 029°53,0'W | 810 | | | | 17:25 | | | |
| | | 74°32,0'S | 029°53,0'W | 839 | MG | 12 | D | 17:57 | 49 | | |
| | | 74°32,0'S | 029°51,9'W | 864 | | | | 18:46 | | | |
| 251 | 05/02/89 | 74°20,3'S | 029°47,0'W | 1500 | CTD | 26 | D | 20:16 | 61 | 1458 | |
| 252 | 06/02/89 | 74°28,9'S | 029°38,7'W | 1188 | RMT | 12 | M | 6:30 | 26 | 300 | |
| | | 74°27,4'S | 029°41,8'W | 1183 | CTD | 27 | D | 7:06 | 39 | 1142 | |
| | | 74°27,8'S | 029°41,8'W | 1200 | BO | 22 | D | 8:03 | 8 | 300 | |
| | | 74°28,2'S | 029°41,9'W | 1153 | AGT | 12 | D | 8:20 | 302 | | 2 h trawling time |
| | | 74°31,6'S | 029°17,9'W | 1223 | | | | 13:22 | | | |
| | | 74°32,0'S | 029°17,7'W | 1196 | FN | 17 | D | 13:34 | 8 | 54 | |
| | | 74°32,2'S | 029°17,7'W | 1183 | MUC | 16 | D | 13:48 | 46 | | success rate 12/12 |
| | | 74°32,2'S | 029°18,7'W | 1185 | MG | 13 | D | 14:57 | 46 | | |
| 253 | 07/02/89 | 74°08,8'S | 029°18,5'W | 1993 | RMT | 13 | D | 8:27 | 33 | 300 | |
| | | 74°09,5'S | 029°40,7'W | 1987 | CTD | 28 | D | 9:11 | 77 | 1973 | |
| | | 74°09,5'S | 029°41,4'W | 2012 | AGT | 13 | D | 10:37 | 429 | | 2 h trawling time |
| | | 74°08,0'S | 030°03,3'W | 1996 | | | | 17:46 | | | |
| | | 74°08,0'S | 030°03,6'W | 1966 | FN | 18 | D | 17:59 | 7 | 50 | |
| | | 74°08,2'S | 030°04,2'W | 1958 | MUC | 17 | D | 18:34 | 69 | | success rate 10/12 |
| | | 74°08,5'S | 030°05,0'W | 1948 | MG | 14 | E | 20:07 | 73 | | |
| 254 | 07/02/89 | 73°59,7'S | 030°06,7'W | 2258 | CTD | 29 | D | 22:32 | 83 | 2207 | |
| 255 | 08/02/89 | 73°50,8'S | 030°06,9'W | 2612 | CTD | 30 | E | 1:05 | 99 | 2555 | |
| 256 | 08/02/89 | 75°10,9'S | 027°36,4'W | 399 | BPN | 1 | D | 9:23 | 30 | 364 | |
| | | 75°11,9'S | 027°33,5'W | 382 | | | | 9:53 | | | |
| | | 75°13,1'S | 027°37,2'W | 393 | FTS | 6 | D | 11:13 | 37 | | |
| | | 75°12,7'S | 027°37,4'W | 386 | | | | 11:50 | | | |
| 257 | 08/02/89 | 75°08,2'S | 027°59,1'W | 460 | BPN | 2 | D | 13:45 | 30 | 439 | |
| | | 75°06,1'S | 028°00,0'W | 457 | | | | 14:15 | | | |
| | | 75°05,3'S | 027°58,9'W | 457 | CTD | 31 | D | 15:15 | 20 | 439 | |
| | | 75°05,9'S | 028°00,7'W | 456 | RMT | 14 | D | 16:49 | 34 | 420 | |
| 258 | 09/02/89 | 74°41,0'S | 029°28,2'W | 508 | RMT | 15 | D | 6:45 | 47 | 471 | |
| | | 74°41,8'S | 029°23,8'W | 490 | CTD | 32 | D | 7:47 | 28 | 461 | |
| | | 74°40,2'S | 029°36,6'W | 484 | BPN | 3 | D | 9:29 | 30 | 466 | |
| | | 74°38,9'S | 029°42,6'W | 509 | | | | 9:59 | | | |
| | | 74°39,7'S | 029°39,0'W | 502 | MUC | 18 | D | 11:13 | 31 | | success rate 10/12 |
| 259 | 09/02/89 | 74°40,2'S | 029°16,7'W | 590 | BPN | 4 | D | 13:49 | 30 | 572 | |
| | | 74°40,6'S | 029°11,8'W | 605 | | | | 14:19 | | | |
| | | 74°41,5'S | 029°04,9'W | 600 | CTD | 33 | D | 15:24 | 37 | 579 | |
| | | 74°39,7'S | 029°16,3'W | 654 | RMT | 16 | D | 17:31 | 24 | 624 | |
| | | 74°40,9'S | 029°26,1'W | 590 | FTS | 7 | D | 18:50 | 30 | | |
| | | 74°41,0'S | 029°25,5'W | 570 | | | | 19:20 | | | |
| 260 | 10/02/89 | 74°37,2'S | 029°38,7'W | 700 | RMT | | | 6:57 | 32 | 670 | |
| | | 74°39,1'S | 029°30,0'W | 686 | CTD | 34 | D | 8:20 | 34 | 656 | |
| | | 74°39,3'S | 029°26,5'W | 688 | BPN | 5 | D | 10:24 | 30 | 649 | |
| | | 74°39,6'S | 029°19,3'W | 667 | | | | 10:54 | | | |
| | | 74°40,0'S | 029°14,3'W | 715 | FTS | 8 | D | 12:15 | 40 | | |
| | | 74°40,3'S | 029°14,7'W | 695 | | | | 12:55 | | | |
| 261 | 10/02/89 | 74°36,5'S | 029°41,2'W | 799 | BPN | 6 | D | 14:49 | 30 | 780 | |
| | | 74°35,1'S | 029°41,2'W | 798 | | | | 15:19 | | | |
| | | 74°34,0'S | 029°46,2'W | 823 | CTD | 35 | D | 16:20 | 35 | 794 | |
| | | 74°35,9'S | 029°36,1'W | 808 | RMT | 18 | D | 18:35 | 45 | 774 | |
| | | 74°33,6'S | 029°11,6'W | 1201 | FTS | 9 | N | 0:35 | 80 | | |
| | | 74°33,0'S | 029°12,1'W | 1202 | | | | 1:55 | | | |
| 262 | 10/02/89 | 74°31,1'S | 029°20,3'W | 1207 | RMT | 19 | E | 22:21 | 57 | 997 | |
| 263 | 11/02/89 | 74°27,1'S | 026°35,6'W | 1774 | Argos | 3 | D | 6:28 | | | |

Station list

| Stat. No. | Date | Position Start/End | | Echo Depth [m] | Gear | Haul No. | Day Time | Start/ End [UTC] | Haul Dur. [min.] | Max. Gear depth [m] | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 264 | 11/02/89 | 74°06,4'S | 025°02,6'W | 1650 | CTD | 36 | D | 9:48 | 52 | 1595 | |
| 265 | 11/02/89 | 74°00,2'S | 025°03,3'W | 2168 | Argos | 4 | D | 11:50 | | | |
| 266 | 11/02/89 | 73°27,6'S | 022°33,8'w | 1513 | CTD | 37 | D | 19:10 | 40 | 1429 | |
| 267 | 12/02/89 | 72°55,2'S | 021°45,2'W | 3027 | Argos | 5 | D | 0:50 | | | |
| 268 | 12/02/89 | 72°56,4'S | 020°02,2'W | 1532 | CTD | 38 | D | 6:00 | 46 | 1465 | |
| 269 | 12/02/89 | 72°54,7'S | 019°49,4'W | 602 | BPN | 7 | D | 10:10 | 15 | 602 | |
| | | 72°55,3'S | 019°49,2'W | 617 | | | | 10:25 | | | |
| 270 | 12/02/89 | 73°21,3'S | 020°44,2'W | 300 | FTS | 10 | D | 15:10 | 35 | | |
| | | 73°21,4'S | 020°45,1'W | 297 | | | | 15:45 | | | |
| | | 73°21,3'S | 020°45,1'W | 294 | AGT | 14 | D | 15:58 | 62 | | large catch |
| | | 73°20,4'S | 020°45,6'W | 305 | | | | 17:00 | | | |
| 271 | 12/02/89 | 73°17,0'S | 020°59,4'W | 399 | AGT | 15 | D | 17:53 | 73 | | vol. about 1 $m^3$ |
| | | 73°16,4'S | 020°54,6'W | 352 | | | | 19:06 | | | |
| 272 | 13/02/89 | 73°26,9'S | 021°33,6'W | 409 | AGT | 16 | D | 6:00 | 94 | | vol. about 1 $m^3$ |
| | | 73°25,7'S | 021°30,2'W | 406 | | | | 7:34 | | | |
| 273 | 13/02/89 | 73°34,3'S | 021°04,3'W | 198 | FTS | 11 | D | 9:10 | 30 | | |
| | | 73°34,7'S | 021°04,3'W | 297 | | | | 9:40 | | | |
| | | 73°34,8'S | 021°03,9'W | 197 | AGT | 17 | D | 9:54 | 48 | | catch washed out |
| | | 73°35,6'S | 021°01,0'W | 193 | | | | 10:42 | | | |
| 274 | 15/02/89 | 71°38,1'S | 012°10,4'W | 155 | CTD | 39 | D | 6:07 | 18 | 152 | |
| | | 71°38,7'S | 012°12,0'W | 310 | RMT | 20 | D | 7:32 | 22 | 277 | |
| | | 71°37,1'S | 012°10,4'W | 200 | FN | 19 | D | 8:22 | 5 | 50 | |
| | | 71°37,1'S | 012°10,4'W | 206 | MUC | 19 | D | 8:30 | 13 | | disgard |
| | | 71°36,9'S | 012°10,0'W | 202 | MUC | 20 | D | 8:54 | 12 | | disgard |
| | | 71°37,1'S | 012°10,9'W | 211 | MG | 15 | D | 9:22 | 20 | | |
| | | 71°37,0'S | 012°11,4'W | 227 | FTS | 12 | D | 10:10 | 35 | | |
| | | 71°36,7'S | 012°10,6'W | 223 | | | | 10:45 | | | |
| | | 71°38,8'S | 012°09,4'W | 196 | AGT | 18 | D | 14:08 | 52 | | about 1-2 tons |
| | | 71°38,3'S | 012°13,1'W | 212 | | | | 15:00 | | | |
| 275 | 15/02/89 | 71°38,0'S | 012°15,2'W | 301 | FTS | 13 | D | 15:30 | 35 | | |
| | | 71°33,3'S | 012°34,5'W | 289 | | | | 16:05 | | | |
| | | 71°39,5'S | 012°34,7'W | 301 | AGT | 19 | D | 16:17 | 62 | | good catch |
| | | 71°39,0'S | 012°11,7'W | 330 | | | | 17:19 | | | |
| | | 71°39,5'S | 012°04,4'W | 236 | REU | 5 | D | 18:16 | 2940 | 236 | deployment |
| 276 | 15/02/89 | 71°38,6'S | 012°09,4'W | 118 | FTS | 14 | D | 18:50 | 25 | | |
| | | 71°38,2'S | 012°09,5'W | 106 | | | | 19:15 | | | |
| 277 | 16/02/89 | 71°39,4'S | 012°36,1'W | 397 | FTS | 15 | D | 17:45 | 20 | | |
| | | 71°39,6'S | 012°35,9'W | 400 | | | | 18:05 | | | |
| | | 71°40,0'S | 012°35,9'W | 407 | MG | 16 | E | 19:03 | 36 | | no success |
| | | 71°39,8'S | 012°34,9'W | 405 | MG | 17 | E | 20:00 | 45 | | |
| 278 | 17/02/89 | 71°24,7'S | 012°32,9'W | 486 | CTD | 40 | D | 9:22 | 25 | 478 | |
| | | 71°25,6'S | 012°30,6'W | 465 | FTS | 16 | D | 10:45 | 40 | | |
| | | 71°25,1'S | 012°31,1'W | 450 | | | | 11:25 | | | |
| | | 71°28,5'S | 012°36,6'W | 555 | MG | 18 | D | 13:10 | 48 | | no success |
| | | 71°28,4'S | 012°33,6'W | 554 | MG | 19 | D | 14:35 | 44 | | no success |
| | | 71°29,3'S | 012°32,1'W | 537 | MG | 20 | D | 15:38 | 44 | | |
| | | 71°29,8'S | 012°30,8'W | 542 | FTS | 17 | D | 16:50 | 45 | | |
| | | 71°30,1'S | 012°34,6'W | 548 | | | | 17:35 | | | |
| 279 | 17/02/89 | 71°39,5'S | 012°04,4'W | 236 | REU | 6 | D | 19:15 | | | retrieval |
| 280 | 17/02/89 | 71°40,9'S | 012°06,5'W | 107 | FTS | 18 | E | 20:58 | 32 | | |
| | | 71°36,6'S | 012°06,1'W | 168 | | | | 21:30 | | | |
| 281 | 17/01/89 | 71°39,0'S | 012°21,1'W | 389 | AGT | 20 | E | 22:14 | 78 | | net and frame com- |
| | | 71°39,8'S | 012°21,8'W | 423 | | | | 23:32 | | | pletely destroyed |
| | | 71°39,5'S | 012°21,1'W | 402 | AGT | 21 | N | 0:58 | 85 | | vol. 100-200 l |
| | | 71°36,9'S | 012°25,0'W | 450 | | | | 2:23 | | | |
| 282 | 18/02/89 | 71°31,7'S | 012°27,4'W | 609 | AGT | 22 | N | 3:15 | 100 | | 50-70 l fauna |
| | | 71°30,6'S | 012°29,3'W | 575 | | | | 4:55 | | | |
| | | 71°31,2'S | 012°32,7'W | 583 | CTD | 41 | D | 6:02 | 26 | 560 | |
| | | 71°32,3'S | 012°31,1'W | 625 | RMT | 21 | D | 7:22 | 32 | 300 | |
| | | 71°33,6'S | 012°29,4'W | 615 | FN | 20 | D | 8:06 | 3 | 50 | |
| 283 | 18/02/89 | 71°11,5'S | 013°13,8'W | 401 | RMT | 22 | D | 11:19 | 32 | 300 | |
| | | 71°12,8'S | 013°19,1'W | 400 | CTD | 42 | D | 12:05 | 25 | 386 | |
| 284 | 18/02/89 | 71°12,0'S | 013°14,0'W | 402 | GSN | 13 | D | | 13:41 | 13 | |
| | | 71°12,2'S | 013°16,8'W | 412 | | | | 13:54 | | | |
| 285 | 18/02/89 | 71°11,3'S | 013°19,5'W | 636 | FTS | 19 | | 16:05 | 25 | | |
| | | 71°11,8'S | 013°20,1'W | 624 | | | | 16:30 | | | |
| 286 | 18/02/89 | 71°23,9'S | 014°58,7'W | 2047 | Argos | 6 | D | 20:15 | | | |
| 287 | 18/02/89 | 70°44,9'S | 014°40,5'W | 2636 | Argos | 7 | D | 23:53 | | | |
| 288 | 19/02/89 | 70°49,8'S | 012°41,0'W | 2215 | Argos | 8 | D | 3:33 | | | |
| 289 | 19/02/89 | 71°11,2'S | 013°25,5'W | 700 | CTD | 43 | D | 6:00 | 42 | 644 | |
| | | | | 674 | | | | 6:42 | | | |
| 289 | 19/02/89 | 71°12,0'S | 013°27,9'W | 672 | AGT | 23 | D | 7:17 | 116 | | premature stop |
| | | 71°14,2'S | 013°36,0'W | 677 | | | | 9:13 | | | |
| | | 71°14,3'S | 013°36,1'W | 695 | FN | 21 | D | 9:18 | 8 | 55 | |
| 290 | 19/02/89 | 71°05,9'S | 012°34,0'W | 522 | AGT | 24 | D | 12:14 | 98 | | small catch |
| | | 71°06,5'S | 012°42,3'W | 531 | | | | 13:52 | | | |
| | | 71°04,1'S | 012°40,0'W | 658 | MUC | 21 | D | 16:40 | 24 | | |
| 291 | 19/02/89 | 71°06,1'S | 012°33,5'W | 499 | GSN | 14 | D | 15:12 | 6 | | |
| | | 71°05,9'S | 012°34,8'W | 515 | | | | 15:18 | | | |
| 292 | 19/02/89 | 71°03,8'S | 012°42,1'W | 561 | MG | 21 | D | 17:25 | 49 | | |

Station list

| Stat. No. | Date | Position Start/End | | Echo Depth [m] | Gear | Haul No. | Day Time | Start/ End [UTC] | Haul Dur. [min.] | Max. Gear depth [m] | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 293 | 20/02/89 | 71°05,8'S | 012°47,3'W | 798 | FTS | 20 | D | 6:30 | 40 | | |
| | | 71°05,9'S | 012°47,6'W | 863 | | | | 7:10 | | | |
| | | 71°05,6'S | 012°46,6'W | 774 | RMT | 23 | D | 7:59 | 23 | 300 | |
| | | 71°06,2'S | 012°53,8'W | 771 | GSN | 15 | D | 9:48 | | | |
| | | 71°05,7'S | 012°58,4'W | 793 | | | | 10:02 | | | |
| 294 | 20/02/89 | 71°06,2'S | 013°02,0'W | 1199 | MUC | 22 | D | 11:31 | 49 | | success rate 11/12 |
| | | 71°05,8'S | 013°03,8'W | 1168 | MG | 22 | D | 12:42 | 81 | | |
| | | 71°06,9'S | 013°07,6'W | 1132 | FTS | 21 | D | 14:45 | 45 | | |
| | | 71°06,5'S | 013°07,1'W | 1117 | | | | 15:30 | | | |
| | | 71°05,3'S | 013°03,2'W | 1199 | MG | 23 | D | 16:03 | 69 | | |
| | | 71°05,9'S | 013°04,9'W | 1240 | AGT | 25 | E | 17:42 | 234 | | 1 h trawling time |
| | | 71°07,2'S | 013°10,4'W | 1242 | | | | 21:36 | | | |
| 295 | 21/02/89 | 71°07,4'S | 013°44,7'W | 1937 | RMT | 24 | D | 8:05 | 37 | 300 | |
| | | 71°06,6'S | 013°37,0'W | 2012 | CTD | 44 | D | 6:02 | 73 | 1953 | |
| | | 71°07,5'S | 013°50,7'W | 2013 | FN | 22 | D | 8:54 | 7 | 50 | |
| | | 71°07,9'S | 013°50,2'W | 2080 | MUC | 23 | D | 9:13 | 76 | | success rate 12/12 |
| | | 71°08,8'S | 013°48,1'W | 2037 | MG | 24 | D | 10:51 | 143 | | |
| | | 71°08,8'S | 013°48,1'W | 2037 | AGT | 26 | D | 13:34 | 368 | | 2 h trawling time |
| | | 71°09,4'S | 013°49,1'W | 2025 | | | | 19:42 | | | |
| 296 | 21/02/89 | 71°11,1'S | 013°28,6'W | 1077 | CTD | 45 | N | 22:02 | 53 | 985 | |
| 297 | 21/02/89 | 71°10,9'S | 013°31,1'W | 1560 | CTD | 46 | N | 23:55 | 63 | 1490 | |
| 298 | 22/02/89 | 71°08,3'S | 013°38,8'W | 1810 | CTD | 47 | N | 1:45 | 67 | 1759 | |
| 299 | 22/02/89 | 71°02,2'S | 014°00,4'W | 2142 | CTD | 48 | N | 4:09 | 70 | 2168 | |
| 300 | 22/02/89 | 70°42,6'S | 012°21,5'W | 2123 | mooring | 1 | D | 9:30 | 113 | 369 | AWI 205, deployment |
| 301 | 22/02/89 | 70°56,4'S | 011°57,7'W | 1522 | mooring | 2 | D | 14:10 | 32 | 265 | AWI 204, deployment |
| 302 | 22/02/89 | 71°02,0'S | 011°44,6'W | 676 | mooring | 3 | D | 16:50 | 66 | 251 | KN 3, deployment |
| 303 | 22/02/89 | 71°02,7'S | 011°45,0'W | 434 | mooring | 4 | D | 18:40 | 34 | 320 | AWI 203, deployment |
| 304 | 22/02/89 | 71°08,8'S | 011°28,9'W | 100 | FTS | 22 | N | 21:15 | 35 | | |
| | | 71°08,7'S | 011°27,6'W | 99 | | | | 21:50 | | | |
| 305 | 22/02/89 | 71°09,6'S | 011°28,1'W | 100 | FTS | 23 | N | 22:15 | 45 | | |
| | | 71°09,7'S | 011°27,7'W | 97 | | | | 23:00 | | | |
| 306 | 23/02/89 | 71°07,3'S | 011°41,4'W | 211 | FTS | 24 | N | 0:00 | 45 | | |
| | | 71°07,1'S | 011°41,5'W | 201 | | | | 0:45 | | | |
| 307 | 23/02/89 | 71°06,5'S | 011°39,6'W | 194 | FTS | 25 | N | 1:15 | 40 | | |
| | | 71°06,2'S | 011°39,0'W | 194 | | | | 1:55 | | | |
| 308 | 23/02/89 | 71°02,9'S | 012°15,5'W | 1465 | CTD | 49 | M | 4:01 | 59 | 1375 | |
| | | 71°00,2'S | 012°12,7'W | 1579 | RMT | 25 | M | 5:59 | 61 | 800 | time station haul 1 |
| | | 71°02,7'S | 012°14,8'W | 1404 | CTD | 50 | D | 7:35 | 36 | 503 | |
| | | 71°00,0'S | 012°14,6'W | 1480 | RMT | 26 | D | 10:00 | 62 | 800 | time station haul 2 |
| | | 71°01,6'S | 012°15,8'W | 1701 | CTD | 51 | D | 11:50 | 111 | 1375 | |
| | | 71°00,7'S | 012°16,3'W | 1511 | RMT | 27 | D | 14:00 | 50 | 800 | time station haul 3 |
| | | 71°01,6'S | 012°15,4'W | 1666 | CTD | 52 | D | 16:01 | 22 | 500 | |
| | | 71°00,8'S | 012°18,3'W | 1717 | RMT | 28 | D | 17:53 | 54 | 800 | time station haul 4 |
| | | 71°01,6'S | 012°15,3'W | 1693 | CTD | 53 | D | 19:57 | 53 | 1529 | |
| | | 71°00,4'S | 012°14,8'W | 1474 | RMT | 29 | E | 22:13 | 51 | 800 | time station haul 5 |
| | | 71°01,6'S | 012°15,4'W | 1669 | CTD | 54 | N | 23:58 | 34 | 499 | |
| | | 70°59,4'S | 012°14,2'W | 1473 | RMT | 30 | N | 2:06 | 64 | 800 | time station haul 6 |
| 309 | 24/02/89 | 71°08,0'S | 012°19,8'W | 526 | MP | 2 | D | 12:13 | 118 | 526 | no success |
| | | 71°07,6'S | 012°30,3'W | 762 | | | | 14:11 | | | |
| | | 71°07,0'S | 012°20,6'W | 308 | MP | 3 | D | 14:25 | 161 | 308 | success |
| | | 71°09,0'S | 012°24,0'W | 414 | | | | 17:06 | | | |
| 310 | 28/02/89 | 64°54,1'S | 002°33,7'W | 5053 | mooring | 5 | D | 8:00 | 160 | 327 | WS 3 retrieval |
| | | 64°55,4'S | 002°35,4'W | 5044 | mooring | 6 | D | 11:00 | 160 | 318 | WS 4 deployment |
| 311 | 28/02/89 | 64°56,4'S | 002°35,5'W | 5045 | CTD | 55 | D | 13:55 | 138 | 4889 | |
| 312 | 03/03/89 | 54°44,0,'S | 000°05,5'E | 328 | FTS | 26 | D | 7:25 | 40 | | |
| | | 54°44,0'S | 000°05,6'E | 342 | | | | 8:05 | | | |
| | | 54°44,0'S | 000°05,6'E | 426 | FTS | 27 | D | 9:30 | 40 | | |
| | | 54°44,0'S | 000°05,6'E | 408 | | | | 10:10 | | | |
| | | 54°43,9'S | 000°06,3'E | 471 | AGT | 27 | D | 10:45 | 55 | | |
| | | 54°47,7'S | 000°05,3'E | 320 | | | | 11:40 | | | |
| | | 54°43,7'S | 000°04,7'E | 466 | AGT | 28 | D | 12:43 | 53 | | |
| | | 54°43,6'S | 000°06,3'E | 320 | | | | 13:36 | | | |
| 313 | 03/03/89 | 54°48,4'S | 000°02,5'E | 1320 | AGT | 29 | D | 15:10 | 200 | | |
| | | 54°43,9'S | 000°08,0'E | 680 | | | | 18:30 | | | |
| 314 | 05/03/89 | 50°09,4'S | 005°44,5'E | 3757 | mooring | 7 | D | 7:20 | 250 | 355 | PF 2 retrieval |

Note: In the case of GSN, BPN and RMT start/end and haul duration refer to the position or time when the gear touches/leaves the seafloor or the net opens/closes. In case of all other gears start/end or time refer to the moment or position when the equipment touches/leaves the water surface. If there are no positions or times for start and end of a gear the information refers to the start.

Number of samples taken by different bottom gears by depths

| DEPTHS | FOT | MUC | MG | AGT | GSN | BPN | REU |
|---|---|---|---|---|---|---|---|
| 0 - 50 | - | - | - | - | - | - | - |
| 51 - 150 | 4 | - | - | - | - | - | - |
| 151 - 250 | 5 | 6 | 4 | 2 | 1 | - | 2 |
| 251 - 350 | 3 | 1 | - | 5 | 2 | - | - |
| 351 - 450 | 2 | 1 | 3 | 5 | 4 | 1 | 1 |
| 451 - 550 | 3 | 5 | 4 | 6 | 3 | 2 | 1 |
| 551 - 650 | 4 | 2 | 5 | 3 | 2 | 2 | - |
| 651 - 750 | 2 | 3 | 1 | 2 | 1 | 1 | - |
| 751 - 850 | 2 | 1 | 2 | 1 | 2 | 1 | - |
| 851 - 1250 | 2 | 2 | 3 | 3 | - | - | - |
| 1251 - 2050 | - | 2 | 2 | 2 | - | - | - |
| > 2050 | - | - | - | - | - | - | - |
| Total | 27 | 23 | 24 | 29 | 15 | 7 | 4 |

Weather conditions

| MMYY | DDHH | Lat / Lon | DDD | FF | N | Weather | TITI | RF% | QNH | TwTW | Sea |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/89 | 1406 | 54.2S / 646.W | W | 18 | / | no observations | 10.6 | 72 | 1002.9 | 10.6 | 1.5m |
| 01/89 | 1409 | 54.7S / 63.6W | WNW | 19 | 7 | almost covered | 9.7 | 82 | 1001.7 | 10.3 | 1.5m |
| 01/89 | 1412 | 55.3S / 62.8W | WNW | 10 | 6 | clear | 9.2 | 81 | 1000.1 | 8.8 | 0.5m |
| 01/89 | 1415 | 55.9S / 62.2W | NW | 12 | 3 | clear | 8.4 | 87 | 998.0 | 8.4 | 1.0m |
| 01/89 | 1418 | 56.5S / 61.5W | NW | 10 | 1 | clear | 8.7 | 92 | 996.9 | 8.8 | 0.5m |
| 01/89 | 1421 | 57.1S / 60.7W | WNW | 14 | 6 | cloudy | 8.3 | 83 | 996.3 | 8.3 | 1.0m |
| 01/89 | 1506 | 58.9S / 58.2W | WNW | 14 | 8 | covered | 4.9 | 99 | 992.6 | 4.7 | 2.0m |
| 01/89 | 1509 | 59.5S / 57.5W | WNW | 12 | 7 | hazy | 4.5 | 98 | 992.3 | 4.7 | 1.0m |
| 01/89 | 1512 | 60.1S / 56.6W | WNW | 10 | 7 | hazy | 4.1 | 99 | 992.2 | 4.5 | 0.5m |
| 01/89 | 1515 | 60.7S / 55.8W | NW | 10 | 7 | fog | 3.9 | 98 | 991.6 | 3.7 | 0.5m |
| 01/89 | 1518 | 61.0S / 55.2W | W | 8 | 7 | fog | 3.1 | 99 | 991.8 | 2.7 | 0.5m |
| 01/89 | 1521 | 60.9S / 55.3W | NW | 6 | 7 | hazy | 4.0 | 98 | 992.2 | 2.6 | 0.0m |
| 01/89 | 1609 | 59.5S / 52.5W | W | 11 | 8 | covered | 4.0 | 99 | 993.6 | 4.1 | 0.5m |
| 01/89 | 1612 | 59.0S / 51.5W | W | 12 | 7 | hazy | 4.2 | 98 | 994.6 | 4.3 | 0.5m |
| 01/89 | 1615 | 58.7S / 50.7W | W | 14 | 7 | hazy | 4.0 | 94 | 995.4 | 4.2 | 0.5m |
| 01/89 | 1618 | 58.3S / 49.7W | WNW | 14 | 6 | cloudy | 5.1 | 90 | 996.0 | 5.6 | 1.0m |
| 01/89 | 1621 | 57.9S / 49.0W |  | 6 | 3 | clear | 6.1 | 85 | 996.8 | 6.5 | 0.0m |
| 01/89 | 1706 | 57.0S / 47.0W | NNE | 8 | 8 | covered | 5.1 | 96 | 997.4 | 5.6 | 0.5m |
| 01/89 | 1709 | 57.0S / 46.9W | ENE | 14 | 7 | almost covered | 5.7 | 95 | 996.4 | 5.9 | 0.5m |
| 01/89 | 1712 | 57.5S / 47.0W | ENE | 22 | 8 | rain | 4.2 | 97 | 994.6 | 4.7 | 1.5m |
| 01/89 | 1715 | 57.9S / 47.0W | ENE | 26 | 8 | rain | 3.8 | 97 | 991.8 | 4.3 | 1.5m |
| 01/89 | 1718 | 58.0S / 47.0W | ENE | 31 | 8 | rain | 4.4 | 98 | 987.5 | 4.5 | 2.0m |
| 01/89 | 1721 | 58.4S / 47.0W | E | 35 | 8 | rain | 3.5 | 97 | 984.6 | 4.6 | 3.0m |
| 01/89 | 1803 | 59.0S / 47.2W | E | 35 | 9 | hazy | 2.0 | 99 | 979.8 | 3.9 | 3.0m |
| 01/89 | 1806 | 59.0S / 47.1W | E | 16 | 9 | fog | 2.9 | 99 | 977.8 | 3.7 | 3.0m |
| 01/89 | 1809 | 59.0S / 47.0W | NNE | 12 | 9 | fog | 2.8 | 98 | 978.1 | 3.8 | 1.0m |
| 01/89 | 1812 | 59.7S / 47.0W | E | 14 | 9 | fog | 2.6 | 98 | 979.1 | 3.0 | 1.5m |
| 01/89 | 1815 | 60.0S / 47.0W | E | 15 | 9 | fog | 2.0 | 98 | 979.7 | 3.2 | 1.5m |
| 01/89 | 1818 | 60.2S / 47.0W | SE | 16 | 8 | hazy | 1.0 | 98 | 979.3 | 2.2 | 1.5m |
| 01/89 | 1903 | 61.1S / 46.9W | SE | 14 | 9 | fog | 0.1 | 99 | 978.3 | 0.8 | 0.0m |
| 01/89 | 1906 | 61.5S / 47.0W | SE | 12 | 9 | fog | 0.5 | 98 | 978.3 | 1.2 | 0.0m |
| 01/89 | 1909 | 61.5S / 46.5W | SE | 10 | 8 | snow | 0.3 | 96 | 977.5 | 0.8 | 0.0m |
| 01/89 | 1912 | 61.3S / 45.5W | SE | 10 | 8 | hazy | 0.3 | 96 | 976.4 | 0.8 | 0.0m |
| 01/89 | 1915 | 61.5S / 44.5W | SE | 12 | 8 | snow | 0.3 | 97 | 975.0 | 0.7 | 0.0m |
| 01/89 | 1918 | 61.7S / 43.4W | SE | 8 | 8 | snow | 0.6 | 98 | 974.0 | 0.6 |  |
| 01/89 | 2006 | 61.8S / 40.0S | SE | 10 | 8 | hazy | 0.3 | 98 | 975.6 | 0.0 |  |
| 01/89 | 2009 | 61.7S / 38.9W | SW | 8 | 8 | snow | -0.1 | 99 | 974.7 | 0.1 |  |
| 01/89 | 2012 | 61.9S / 38.2W | SSW | 6 | 8 | snow | 0.3 | 96 | 974.6 | 0.3 |  |
| 01/89 | 2015 | 62.1S / 37.1W | SSW | 4 | 8 | hazy | 0.6 | 97 | 974.6 | 0.4 |  |
| 01/89 | 2018 | 62.4S / 35.9W | NNE | 6 | 9 | fog | 0.4 | 98 | 976.5 | 0.6 |  |
| 01/89 | 2103 | 63.5S / 32.7W | NE | 5 | 8 | fog | -0.4 | 97 | 978.4 | 0.5 |  |
| 01/89 | 2106 | 63.9S / 31.7W | NE | 5 | 9 | fog | -0.3 | 97 | 978.6 | 0.6 |  |
| 01/89 | 2109 | 64.2S / 30.6W | NE | 7 | 9 | snow | 0.0 | 97 | 978.6 | 0.7 |  |
| 01/89 | 2112 | 64.6S / 29.5W | NE | 6 | 8 | hazy | 0.0 | 98 | 978.7 | 0.7 | 0.5m |
| 01/89 | 2115 | 65.0S / 28.3W | NE | 6 | 8 | snow | 0.3 | 97 | 978.8 | 1.0 | 0.5m |
| 01/89 | 2118 | 65.3S / 27.0W | NE | 6 | 9 | snow | 0.0 | 98 | 978.4 | 0.9 | 0.5m |
| 01/89 | 2203 | 66.5S / 23.4W | E | 15 | 8 | hazy | 0.2 | 99 | 977.1 | 1.4 | 0.5m |
| 01/89 | 2206 | 66.8S / 22.2W | E | 15 | 8 | snow | 0.4 | 98 | 976.7 | 1.6 | 1.5m |
| 01/89 | 2209 | 67.1S / 20.9W | E | 20 | 8 | hazy | 0.6 | 98 | 977.2 | 1.5 | 2.0m |
| 01/89 | 2212 | 67.5S / 19.8W | E | 23 | 8 | hazy | 0.7 | 98 | 978.1 | 1.6 | 2.0m |
| 01/89 | 2215 | 67.8S / 18.6W | E | 23 | 8 | snow | 0.8 | 98 | 978.9 | 1.8 | 2.5m |
| 01/89 | 2218 | 68.2S / 17.4W | E | 23 | 8 | hazy | 0.6 | 98 | 980.2 | 1.9 | 2.5m |
| 01/89 | 2303 | 691.S / 14.0W | ENE | 30 | 8 | hazy | 0.1 | 98 | 983.5 | 2.0 | 2.5m |
| 01/89 | 2306 | 69.4S / 12.7W | ENE | 30 | 8 | snow | 0.0 | 99 | 984.9 | 1.9 | 2.5m |
| 01/89 | 2309 | 69.7S / 11.4W | ENE | 30 | 8 | hazy | -0.2 | 97 | 986.9 | 0.3 | 2.5m |
| 01/89 | 2312 | 70.1S / 10.1W | ENE | 25 | 8 | covered | 0.1 | 78 | 987.8 | 0.1 | 2.0m |
| 01/89 | 2315 | 70.4S / 8.7W | ENE | 25 | 8 | snow | -0.2 | 87 | 989.3 | -0.1 | 2.0m |

| MMYY | DDHH | Lat / Lon | DDD | FF | N | Weather | TITI | RF% | QNH | TwTW | Sea |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/89 | 2318 | 70.5S / 8.2W | ENE | 19 | 8 | snow | -0.3 | 92 | 989.2 | -1.0 | |
| 01/89 | 2406 | 70.6S / 8.1W | E | 28 | 8 | snow | -1.1 | 90 | 987.3 | -1.5 | |
| 01/89 | 2409 | 70.6S / 8.1W | E | 30 | 8 | snow | -0.8 | 88 | 987.2 | -1.3 | |
| 01/89 | 2412 | 70.6S / 8.1W | E | 28 | 8 | snow | -0.4 | 89 | 986.8 | -1.3 | |
| 01/89 | 2415 | 70.6S / 8.1W | E | 36 | 7 | almost covered | -0.1 | 83 | 985.9 | -1.3 | |
| 01/89 | 2418 | 70.5S / 8.1W | E | 35 | 7 | almost covered | -0.2 | 83 | 985.9 | -1.3 | |
| 01/89 | 2503 | 70.9S / 10.6W | E | 34 | / | no observations | -2.0 | 77 | 987.1 | -1.5 | |
| 01/89 | 2506 | 70.9S / 11.4W | E | 26 | 7 | almost covered | -2.6 | 72 | 987.8 | -1.5 | |
| 01/89 | 2509 | 71.2S / 12.6W | E | 36 | 6 | cloudy | -2.3 | 66 | 988.3 | -1.3 | 2.0m |
| 01/89 | 2512 | 71.2S / 12.7W | ENE | 34 | 6 | cloudy | -0.2 | 64 | 988.8 | -1.1 | 2.0m |
| 01/89 | 2515 | 71.3S / 13.1W | E | 24 | 6 | cloudy | 0.0 | 63 | 990.1 | -1.0 | 2.5m |
| 01/89 | 2518 | 71.3S / 13.0W | E | 21 | 7 | almost covered | -0.2 | 72 | 990.5 | -1.0 | 2.0m |
| 01/89 | 2603 | 71.3S / 13.1W | E | 18 | 3 | clear | -1.3 | 65 | 992.9 | -1.0 | |
| 01/89 | 2606 | 71.6S / 14.3W | E | 8 | 2 | clear | -0.1 | 62 | 993.3 | -1.5 | |
| 01/89 | 2609 | 71.8S / 15.4W | NE | 6 | 2 | clear | -0.6 | 67 | 993.6 | -1.3 | |
| 01/89 | 2612 | 71.9S / 16.6W | SE | 6 | 2 | clear | -0.9 | 66 | 994.3 | -1.3 | |
| 01/89 | 2615 | 72.2S / 17.7W | uml | 4 | 1 | clear | -1.1 | 72 | 994.6 | -1.3 | |
| 01/89 | 2618 | 72.5S / 18.7W | uml | 3 | 3 | clear | -0.4 | 73 | 994.9 | -1.4 | |
| 01/89 | 2703 | 73.0S / 19.8W | SSW | 6 | 0 | clear | -2.5 | 90 | 995.9 | -1.3 | |
| 01/89 | 2706 | 73.2S / 20.3W | SW | 3 | 0 | clear | -2.0 | 94 | 996.2 | -1.4 | |
| 01/89 | 2709 | 73.5S / 212.W | W | 8 | 7 | almost covered | -0.2 | 78 | 996.5 | 0.4 | 0.0m |
| 01/89 | 2712 | 73.8S / 22.6W | W | 8 | 7 | almost covered | 0.7 | 65 | 996.6 | 0.8 | 0.0m |
| 01/89 | 2715 | 74.0S / 24.0W | WNW | 10 | 8 | covered | 1.0 | 85 | 996.6 | 0.5 | 0.0m |
| 01/89 | 2718 | 74.3S / 25.5W | WSW | 5 | 8 | snow | 0.4 | 90 | 996.1 | 0.0 | |
| 01/89 | 2803 | 75.3S / 26.0W | E | 6 | 8 | covered | -1.2 | 91 | 995.1 | 1.3 | |
| 01/89 | 2806 | 75.3S / 26.0W | ENE | 7 | 8 | snow | -1.3 | 94 | 994.7 | 1.1 | |
| 01/89 | 2809 | 75.3S / 25.9W | NE | 6 | 8 | snow | -0.9 | 93 | 993.9 | 1.0 | 0.0m |
| 01/89 | 2812 | 75.3S / 25.8W | NNE | 6 | 8 | snow | -0.2 | 89 | 992.8 | 1.3 | 0.0m |
| 01/89 | 2815 | 75.3S / 25.9W | NNE | 6 | 7 | hazy | 1.1 | 83 | 991.8 | 1.3 | 0.0m |
| 01/89 | 2818 | 75.3S / 25.9W | E | 8 | 8 | snow | 0.0 | 92 | 990.0 | 1.1 | 0.5m |
| 01/89 | 2903 | 75.3S / 26.1W | WSW | 19 | 7 | almost covered | -0.9 | 67 | 987.3 | 1.0 | 1.0m |
| 01/89 | 2906 | 75.3S / 26.3W | WSW | 11 | 8 | covered | -0.8 | 55 | 986.2 | 0.4 | 0.5m |
| 01/89 | 2909 | 75.3S / 26.3W | NNW | 14 | 8 | covered | -1.2 | 55 | 984.6 | 0.7 | 0.5m |
| 01/89 | 2912 | 75.3S / 26.2W | WNW | 10 | 7 | almost covered | -0.9 | 52 | 983.8 | 0.2 | 0.5m |
| 01/89 | 2915 | 75.2S / 26.2W | WNW | 8 | 7 | almost covered | -0.5 | 52 | 982.8 | 0.7 | 1.0m |
| 01/89 | 2918 | 75.3S / 26.4W | NNE | 11 | 7 | almost covered | -0.4 | 57 | 981.8 | 0.7 | 1.0m |
| 01/89 | 3003 | 75.2S / 27.3W | ENE | 21 | / | snow | -0.9 | 82 | 980.5 | 0.7 | 1.5m |
| 01/89 | 3006 | 75.2S / 27.0W | ENE | 25 | 7 | snow | -1.6 | 90 | 980.4 | 0.5 | 1.5m |
| 01/89 | 3009 | 75.2S / 27.0W | EN E | 26 | 7 | snow | -1.9 | 88 | 982.6 | 0.3 | 1.5m |
| 01/89 | 3012 | 75.2S / 27.0W | ENE | 29 | 8 | fog | -2.0 | 87 | 983.8 | -0.2 | 1.5m |
| 01/89 | 3015 | 75.2S / 27.0W | ENE | 26 | 7 | snow | -1.8 | 82 | 985.3 | -0.1 | 1.5m |
| 01/89 | 3018 | 75.5S / 27.1W | E | 22 | 7 | almost covered | -2.5 | 84 | 987.2 | -0.5 | 1.0m |
| 01/89 | 3103 | 75.4S / 26.9W | E | 16 | / | no observations | -2.1 | 78 | 990.3 | 0.8 | 1.0m |
| 01/89 | 3106 | 75.2S / 27.6W | ENE | 14 | 7 | almost covered | -1.3 | 75 | 990.5 | 0.6 | 1.0m |
| 01/89 | 3109 | 75.1S / 27.5W | ENE | 12 | 7 | almost covered | -0.7 | 68 | 991.6 | 0.5 | 1.0m |
| 01/89 | 3112 | 75.1S / 27.6W | E | 18 | 1 | clear | -4.1 | 100 | 992.2 | 0.6 | 1.0m |
| 01/89 | 3115 | 75.2S / 27.6W | E | 16 | 3 | clear | -1.4 | 76 | 992.4 | 0.6 | |
| 01/89 | 3118 | 75.2S / 26.9W | E | 14 | 1 | clear | -1.4 | 71 | 992.6 | 0.2 | 1.0m |
| 02/89 | 0103 | 74.8S / 26.0W | SE | 11 | 1 | clear | -2.5 | 72 | 992.2 | 0.9 | |
| 02/89 | 0106 | 75.0S / 27.6W | SE | 10 | 1 | clear | -1.9 | 53 | 992.5 | 0.4 | 0.5m |
| 02/89 | 0109 | 75.1S / 28.0W | ESE | 5 | 1 | clear | -1.4 | 51 | 992.7 | 0.7 | 0.0m |
| 02/89 | 0112 | 75.0S / 28.0W | S | 10 | 1 | clear | -2.2 | 47 | 992.4 | 0.4 | 0.5m |
| 02/89 | 0115 | 75.1S / 28.0W | S | 7 | 1 | clear | -1.8 | 40 | 992.3 | 0.6 | 0.5m |
| 02/89 | 0118 | 75.0S / 28.7W | S | 10 | 6 | cloudy | -0.3 | 57 | 991.1 | 0.8 | 0.5m |
| 02/89 | 0203 | 74.6S / 29.5W | SW | 14 | / | no observations | -0.9 | 63 | 990.1 | 0.4 | 1.0m |
| 02/89 | 0206 | 74.7S / 29.5W | WSW | 12 | 7 | almost covered | -2.0 | 61 | 988.8 | 0.5 | 1.0m |
| 02/89 | 0209 | 74.7S / 29.7W | WSW | 17 | 8 | covered | -2.3 | 64 | 988.2 | 0.8 | 1.0m |
| 02/89 | 0212 | 74.7S / 29.5W | SW | 12 | 8 | covered | -3.1 | 64 | 987.1 | 0.2 | 1.0m |
| 02/89 | 0215 | 74.7S / 29.7W | W | 14 | 8 | covered | -2.8 | 63 | 986.1 | 0.4 | 1.0m |
| 02/89 | 0218 | 74.4S / 29.7W | W | 18 | 8 | covered | -2.4 | 62 | 984.9 | 0.5 | 1.5m |
| 02/89 | 0306 | 74.6S / 29.6W | NNW | 10 | 8 | covered | -3.2 | 74 | 982.5 | 0.2 | 0.0m |

| MMYY | DDHH | Lat / Lon | DDD | FF | N | Weather | TITI | RF% | QNH | TwTW | Sea |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 02/89 | 0309 | 74.7S / 29.4W | WNW | 10 | 8 | covered | -2.5 | 49 | 981.7 | 0.1 | 0.5m |
| 02/89 | 0312 | 74.6S / 29.6W | SW | 15 | 8 | covered | -3.1 | 69 | 980.6 | 0.3 | 1.0m |
| 02/89 | 0315 | 74.6S / 29.6W | W | 10 | 8 | covered | -2.7 | 58 | 979.0 | 0.4 | 1.0m |
| 02/89 | 0318 | 74.3S / 29.8W | W | 18 | 8 | covered | -3.0 | 65 | 976.8 | 0.4 | 1.5m |
| 02/89 | 0403 | 74.6S / 29.7W | SSW | 8 | 9 | no observations | -4.2 | 53 | 974.6 | 0.3 | 1.0m |
| 02/89 | 0406 | 74.6S / 29.7W | WSW | 19 | 8 | snow | -4.1 | 74 | 975.2 | 0.2 | 1.5m |
| 02/89 | 0409 | 74.6S / 29.7W | W | 17 | 7 | snow | -4.0 | 69 | 978.3 | 0.1 | 1.5m |
| 02/89 | 0412 | 74.6S / 29.7W | W | 10 | 7 | almost covered | -2.9 | 61 | 981.5 | 0.2 | 1.0m |
| 02/89 | 0415 | 74.6S / 29.7W | WNW | 12 | 7 | almost covered | -3.1 | 60 | 983.8 | 0.0 | 1.0m |
| 02/89 | 0418 | 74.6S / 29.7W | NNW | 8 | 7 | almost covered | -2.7 | 57 | 985.9 | 0.2 | 0.5m |
| 02/89 | 0503 | 74.6S / 29.6W | WSW | 4 | / | no observations | -2.5 | 53 | 991.6 | 0.3 | |
| 02/89 | 0506 | 74.6S / 29.7W | uml | 2 | 7 | almost covered | -1.2 | 52 | 992.7 | 0.1 | |
| 02/89 | 0509 | 74.6S / 29.5W | uml | 3 | 8 | covered | -1.0 | 47 | 993.8 | 0.1 | |
| 02/89 | 0512 | 74.6S / 29.7W | E | 6 | 7 | almost covered | -1.0 | 49 | 994.5 | 0.2 | 0.0m |
| 02/89 | 0515 | 74.6S / 29.7W | uml | 2 | 8 | covered | -1.7 | 60 | 994.5 | 0.3 | |
| 02/89 | 0518 | 74.5S / 29.9W | S | 5 | 7 | almost covered | -0.4 | 53 | 994.3 | 0.3 | 0.0m |
| 02/89 | 0603 | 74.4S / 29.6W | S | 3 | 6 | cloudy | -1.3 | 57 | 992.9 | 0.5 | |
| 02/89 | 0606 | 74.4S / 29.6W | SW | 4 | 6 | cloudy | -1.0 | 57 | 992.2 | 0.4 | 0.0m |
| 02/89 | 0609 | 74.5S / 29.7W | WNW | 4 | 8 | covered | -1.1 | 57 | 992.0 | 0.3 | |
| 02/89 | 0612 | 74.5S / 29.4W | NW | 7 | 8 | covered | -0.7 | 53 | 992.4 | 0.2 | |
| 02/89 | 0615 | 74.5S / 29.3W | W | 6 | 8 | covered | -0.6 | 65 | 992.9 | 0.2 | |
| 02/89 | 0618 | 74.4S / 29.4W | W | 9 | 8 | snow | -1.1 | 80 | 993.0 | 0.3 | 0.5m |
| 02/89 | 0703 | 74.1S / 29.8W | NNW | 4 | 8 | covered | 0.4 | 61 | 995.1 | 0.3 | |
| 02/89 | 0706 | 74.1S / 29.8W | S | 4 | 8 | covered | -0.6 | 76 | 995.7 | 0.4 | |
| 02/89 | 0709 | 74.1S / 29.7W | S | 6 | 7 | almost covered | -0.8 | 74 | 996.2 | 0.4 | 0.0m |
| 02/89 | 0712 | 74.1S / 29.7W | S | 4 | 7 | almost covered | -0.5 | 79 | 996.8 | 0.4 | 0.0m |
| 02/89 | 0715 | 74.1S / 29.9W | SSW | 8 | 7 | almost covered | -0.4 | 68 | 997.0 | 0.5 | 0.5m |
| 02/89 | 0718 | 74.1S / 30.0W | SSW | 13 | 8 | covered | -1.7 | 75 | 997.2 | 0.4 | 0.5m |
| 02/89 | 0803 | 73.8S / 30.1W | WSW | 12 | 7 | almost covered | -1.3 | 64 | 998.6 | 0.4 | 1.5m |
| 02/89 | 0806 | 74.4S / 29.1W | W | 12 | 7 | almost covered | -1.6 | 64 | 997.9 | 0.2 | 1.5m |
| 02/89 | 0809 | 75.1S / 27.6W | WSW | 14 | 8 | covered | -0.6 | 70 | 997.1 | 0.4 | 1.5m |
| 02/89 | 0812 | 75.2S / 27.6W | SSW | 20 | 6 | cloudy | -1.2 | 66 | 997.6 | 0.1 | 1.5m |
| 02/89 | 0815 | 75.1S / 28.0W | SSW | 11 | 6 | cloudy | -0.6 | 60 | 998.6 | 0.6 | 1.5m |
| 02/89 | 0818 | 75.1S / 28.0W | SW | 7 | 7 | almost covered | -1.6 | 62 | 988.9 | 0.6 | 0.5m |
| 02/89 | 0903 | 74.8S / 29.1W | NW | 6 | 5 | cloudy | -2.1 | 57 | 997.3 | 0.1 | |
| 02/89 | 0906 | 74.7S / 29.6W | uml | 4 | 6 | cloudy | -1.6 | 56 | 996.0 | 0.1 | |
| 02/89 | 0909 | 74.7S / 29.4W | NNE | 6 | 6 | cloudy | -1.5 | 59 | 994.3 | 0.0 | |
| 02/89 | 0912 | 74.6S / 29.6W | NNE | 6 | 5 | cloudy | -1.0 | 61 | 992.9 | 0.0 | 0.0m |
| 02/89 | 0915 | 74.7S / 29.1W | NE | 10 | 7 | almost covered | -1.4 | 600 | 991.2 | 0.1 | 0.5m |
| 02/89 | 0918 | 74.6S / 29.3W | ENE | 11 | 7 | snow | 0.4 | 67 | 989.5 | 0.2 | 0.5m |
| 02/89 | 1003 | 75.1S / 28.6W | E | 11 | / | no observations | -1.6 | 70 | 985.6 | 0.8 | 0.5m |
| 02/89 | 1006 | 74.6S / 29.6W | SW | 10 | 8 | snow | -2.5 | 89 | 984.2 | 0.0 | 0.5m |
| 02/89 | 1009 | 74.6S / 29.5W | SW | 4 | 7 | snow | -2.2 | 80 | 983.8 | 0.1 | 0.0m |
| 02/89 | 1012 | 74.7S / 29.3W | uml | 2 | 3 | snow | -0.2 | 72 | 983.7 | 0.3 | |
| 02/89 | 1015 | 74.6S / 29.6W | E | 5 | 3 | clear | -0.2 | 65 | 983.8 | 0.6 | |
| 02/89 | 1018 | 74.6S / 29.7W | E | 9 | 7 | snow | -1.9 | 77 | 984.6 | 0.2 | 0.5m |
| 02/89 | 1103 | 74.5S / 28.7W | E | 10 | / | snow | -1.7 | 82 | 986.1 | 0.3 | 0.5m |
| 02/89 | 1106 | 74.5S / 26.7W | ENE | 15 | 0 | clear | -3.8 | 75 | 987.1 | -1.0 | |
| 02/89 | 1109 | 74.2S / 25.6W | E | 14 | 0 | clear | -5.4 | 88 | 987.0 | -1.0 | |
| 02/89 | 1112 | 74.0S / 25.0W | ENE | 14 | 0 | clear | -2.8 | 81 | 986.5 | -0.9 | |
| 02/89 | 1115 | 73.8S / 24.1W | ENE | 16 | 8 | fog | -4.7 | 95 | 986.4 | -1.1 | |
| 02/89 | 1118 | 73.6S / 22.9W | ENE | 10 | 3 | clear | -2.7 | 91 | 986.4 | -1.5 | |
| 02/89 | 1203 | 72.9S / 21.0W | E | 18 | / | no observations | -2.2 | 82 | 984.1 | -1.3 | |
| 02/89 | 1206 | 72.9S / 19.9W | ENE | 26 | 7 | almost covered | -3.9 | 85 | 983.5 | -1.3 | 1.0m |
| 02/89 | 1209 | 72.9S / 19.8W | ENE | 22 | 7 | almost covered | -2.2 | 93 | 983.3 | -1.2 | 1.0m |
| 02/89 | 1212 | 72.9S / 19.8W | ENE | 25 | 8 | snow | -1.8 | 94 | 982.9 | -1.2 | 1.0m |
| 02/89 | 1215 | 73.3S / 20.7W | ENE | 26 | 8 | snow | -1.1 | 94 | 982.8 | -1.4 | 1.0m |
| 02/89 | 1218 | 73.3S / 20.9W | ENE | 26 | 8 | snow | -0.3 | 93 | 982.2 | -1.1 | 1.0m |
| 02/89 | 1303 | 73.5S / 21.4W | ENE | 31 | 8 | covered | -1.5 | 89 | 978.8 | -1.3 | 1.0m |
| 02/89 | 1306 | 73.5S / 21.6W | ENE | 37 | 8 | covered | -1.8 | 90 | 977.3 | -1.4 | 1.0m |
| 02/89 | 1309 | 73.5S / 21.2W | ENE | 44 | 8 | snow | -2.0 | 88 | 975.9 | -1.3 | 2.5m |

| MMYY | DDHH | Lat / Lon | DDD | FF | N | Weather | TITI | RF% | QNH | TwTW | Sea |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 02/89 | 1312 | 73.5S / 20.8W | ENE | 42 | 8 | hazy | -2.0 | 92 | 974.2 | -1.4 | 2.5 m |
| 02/89 | 1315 | 73.0S / 19.8W | ENE | 53 | 9 | fog | -1.9 | 94 | 970.4 | -1.1 | 3.0m |
| 02/89 | 1318 | 72.7S / 19.2W | ENE | 49 | 8 | hazy | -0.3 | 96 | 970.4 | -1.1 | 5.0m |
| 02/89 | 1403 | 72.5S / 18.1W | ENE | 41 | 9 | fog | -0.6 | 97 | 975.0 | -0.6 | 3.5m |
| 02/89 | 1406 | 72.4S / 17.5W | ENE | 38 | 9 | fog | -0.8 | 97 | 976.3 | -0.8 | 4.5m |
| 02/89 | 1409 | 72.3S / 16.9W | NE | 38 | 8 | snow | -0.5 | 90 | 978.2 | -0.7 | 3.0m |
| 02/89 | 1412 | 72.2S / 15.8W | NE | 40 | 8 | hazy | -1.1 | 89 | 979.2 | -1.1 | 3.0m |
| 02/89 | 1415 | 72.0S / 15.2W | ENE | 39 | 8 | hazy | -0.9 | 93 | 980.6 | -1.1 | 3.5m |
| 02/89 | 1418 | 71.8S / 14.6W | ENE | 38 | 8 | hazy | -1.1 | 92 | 981.2 | -1.1 | 3.5m |
| 02/89 | 1503 | 71.5S / 12.3W | NE | 36 | / | hazy | -2.0 | 93 | 981.6 | -1.2 | 3.0m |
| 02/89 | 1506 | 71.6S / 12.2W | NE | 47 | 7 | fog | -2.2 | 94 | 978.7 | -1.2 | 2.0m |
| 02/89 | 1509 | 71.6S / 12.2W | ENE | 40 | 8 | snow | -1.0 | 92 | 980.9 | -1.2 | |
| 02/89 | 1512 | 72.6S / 12.2W | NE | 50 | 7 | snow | -2.0 | 95 | 976.4 | -1.1 | 1.0m |
| 02/89 | 1515 | 71.6S / 12.2W | E | 12 | 6 | clear | -0.3 | 93 | 978.6 | -1.1 | 0.5m |
| 02/89 | 1518 | 71.6S / 12.1W | ENE | 37 | 7 | hazy | -2.0 | 93 | 974.4 | -1.1 | 1.0m |
| 02/89 | 1606 | 71.7S / 12.2W | ENE | 48 | 7 | hazy | -1.1 | 73 | 967.3 | -1.2 | 2.0m |
| 02/89 | 1609 | 71.6S / 12.6W | ENE | 49 | 7 | hazy | -3.1 | 81 | 967.1 | -1.0 | 2.0m |
| 02/89 | 1612 | 71.5S / 12.6W | E | 41 | 6 | cloudy | -1.1 | 69 | 966.0 | -1.0 | 2.0m |
| 02/89 | 1615 | 71.6S / 12.6W | ESE | 29 | 6 | cloudy | -1.9 | 91 | 968.2 | -0.9 | 2.0m |
| 02/89 | 1618 | 71.6S / 12.6W | E | 35 | 6 | cloudy | -0.9 | 90 | 967.4 | -0.9 | 2.0m |
| 02/89 | 1703 | 71.5S / 12.6W | E | 46 | / | no observations | -1.2 | 94 | 969.7 | -1.0 | 2.0m |
| 02/89 | 1706 | 71.5S / 12.6W | ENE | 53 | 7 | hazy | -1.0 | 90 | 968.2 | -1.0 | 2.0m |
| 02/89 | 1709 | 71.4S / 12.5W | ENE | 42 | 7 | hazy | -0.8 | 90 | 971.3 | -1.0 | 1.5m |
| 02/89 | 1712 | 71.4S / 12.5W | E | 50 | 7 | hazy | -0.7 | 91 | 973.6 | -0.9 | 1.5m |
| 02/89 | 1715 | 71.5S / 12.6W | E | 41 | 6 | cloudy | -0.4 | 92 | 976.7 | -0.9 | 1.5m |
| 02/89 | 1718 | 71.5S / 12.6W | E | 36 | 7 | almost covered | -0.3 | 92 | 979.4 | -0.8 | 1.5m |
| 02/89 | 1803 | 71.6S / 12.3W | SE | 7 | 0 | clear | -2.1 | 92 | 987.3 | -1.1 | |
| 02/89 | 1806 | 71.5S / 12.5W | S | 7 | 1 | clear | -1.6 | 91 | 987.5 | -1.0 | |
| 02/89 | 1809 | 71.5S / 12.5W | SSW | 8 | 0 | clear | -2.1 | 88 | 987.9 | -1.1 | 0.5m |
| 02/89 | 1812 | 71.2S / 13.2W | SW | 14 | 0 | clear | -0.2 | 94 | 988.2 | -1.0 | 1.0m |
| 02/89 | 1815 | 71.2S / 13.3W | SSW | 22 | 4 | cloudy | -1.0 | 92 | 987.9 | -0.7 | 1.0m |
| 02/89 | 1818 | 71.2S / 13.5W | SSW | 22 | 8 | covered | -1.2 | 91 | 986.8 | -0.7 | 1.5m |
| 02/89 | 1903 | 70.8S / 13.1W | SSW | 25 | / | no observations | -2.5 | 92 | 986.2 | -0.3 | 2.0m |
| 02/89 | 1906 | 71.1S / 13.3W | SW | 24 | 7 | almost covered | -2.0 | 94 | 985.9 | -0.8 | 2.0m |
| 02/89 | 1909 | 71.2S / 13.6W | SW | 25 | 7 | hazy | -1.0 | 92 | 985.9 | -0.9 | 2.0m |
| 02/89 | 1912 | 71.1S / 12.6W | SSW | 24 | 8 | hazy | -1.6 | 93 | 986.0 | -0.9 | 2.0m |
| 02/89 | 1915 | 71.1S / 12.4W | SW | 25 | 7 | almost covered | -0.6 | 92 | 985.0 | -0.9 | 2.0m |
| 02/89 | 1918 | 71.1S / 12.6W | SW | 26 | 7 | almost covered | -0.4 | 92 | 984.0 | -0.7 | 2.0m |
| 02/89 | 2003 | 71.1S / 12.7W | ENE | 10 | 8 | covered | -3.5 | 92 | 980.9 | -0.8 | 0.0m |
| 02/89 | 2006 | 71.1S / 12.8W | ENE | 16 | 8 | snow | -4.2 | 94 | 979.4 | -0.9 | 1.0m |
| 02/89 | 2009 | 71.1S / 12.8W | ENE | 20 | 8 | snow | -3.6 | 95 | 978.8 | -0.8 | 1.5m |
| 02/89 | 2012 | 71.1S / 13.0W | ENE | 21 | 8 | snow | -4.0 | 94 | 979.4 | -0.7 | 1.5m |
| 02/89 | 2015 | 71.1S / 13.1W | ENE | 19 | 8 | snow | -3.2 | 94 | 979.9 | -0.7 | 1.5m |
| 02/89 | 2018 | 71.1S / 13.1W | ENE | 22 | 8 | snow | -3.6 | 94 | 980.1 | -0.8 | 1.5m |
| 02/89 | 2103 | 71.1S / 13.8W | SE | 8 | / | no observations | -3.8 | 96 | 985.7 | -0.5 | 0.0m |
| 02/89 | 2106 | 71.1S / 13.6W | SE | 4 | 8 | covered | -3.2 | 92 | 986.5 | -0.7 | |
| 02/89 | 2109 | 71.1S / 13.8W | S | 10 | 6 | cloudy | -3.6 | 90 | 987.6 | -0.7 | 0.5m |
| 02/89 | 2112 | 71.1S / 13.8W | SSW | 12 | 3 | clear | -2.5 | 70 | 988.3 | -0.6 | 0.5m |
| 02/89 | 2115 | 71.2S / 13.9W | S | 12 | 5 | cloudy | -2.9 | 89 | 988.5 | -0.5 | 0.5m |
| 02/89 | 2118 | 71.2S / 14.1W | SSW | 9 | 7 | almost covered | -2.0 | 70 | 988.5 | -0.3 | 0.5m |
| 02/89 | 2203 | 71.1S / 13.7W | S | 14 | 7 | almost covered | -2.5 | 71 | 987.4 | -0.6 | 1.0m |
| 02/89 | 2206 | 71.0S / 13.9W | SW | 16 | 7 | almost covered | -2.5 | 62 | 987.4 | -0.4 | 1.5m |
| 02/89 | 2209 | 70.7S / 12.4W | SSW | 20 | 5 | cloudy | -3.1 | 66 | 986.5 | -0.6 | 1.5m |
| 02/89 | 2212 | 70.7S / 12.4W | SSW | 23 | 6 | cloudy | -3.3 | 62 | 986.9 | -0.6 | 1.5m |
| 02/89 | 2215 | 70.9S / 11.9W | SSW | 23 | 2 | clear | -4.5 | 71 | 986.8 | -0.7 | 1.5m |
| 02/89 | 2218 | 71.0S / 11.8W | SSW | 25 | 6 | cloudy | -4.5 | 64 | 987.0 | -0.7 | 2.0m |
| 02/89 | 2303 | 71.1S / 11.8W | ENE | 9 | 8 | covered | -6.2 | 74 | 987.6 | -0.9 | 0.5m |
| 02/89 | 2306 | 71.0S / 12.2W | NE | 15 | 8 | covered | -4.5 | 74 | 986.5 | -0.8 | 0.5m |
| 02/89 | 2309 | 71.0S / 12.3W | NE | 21 | 8 | snow | -4.2 | 81 | 986.1 | -0.8 | 1.0m |
| 02/89 | 2312 | 71.0S / 12.2W | ENE | 24 | 8 | hazy | -4.6 | 80 | 985.6 | -0.8 | 1.5m |
| 02/89 | 2315 | 71.0S / 12.3W | ENE | 24 | 7 | snow | -3.6 | 78 | 985.3 | -0.7 | 1.5m |

| MMYY | DDHH | Lat / Lon | DDD | FF | N | Weather | TITI | RF% | QNH | TwTW | Sea |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 02/89 | 2318 | 71.0S / 12.3W | E | 21 | 7 | almost covered | -3.7 | 74 | 985.4 | -0.7 | 1.5m |
| 02/89 | 2403 | 71.0S / 12.3W | ENE | 11 | 8 | snow | -3.3 | 83 | 986.0 | -0.8 | 0.5m |
| 02/89 | 2406 | 71.1S / 12.3W | ESE | 10 | 8 | snow | -4.1 | 83 | 985.9 | -0.8 | 0.5m |
| 02/89 | 2409 | 71.1S / 12.4W | ENE | 13 | 8 | hazy | -3.1 | 78 | 985.2 | -0.8 | 0.5m |
| 02/89 | 2412 | 71.1S / 12.3W | ENE | 12 | 7 | almost covered | -3.2 | 78 | 984.1 | -0.8 | 0.5m |
| 02/89 | 2415 | 71.1S / 12.3W | ENE | 5 | 7 | almost covered | -1.3 | 85 | 982.5 | -0.9 | 0.5m |
| 02/89 | 2418 | 71.1S / 12.2W | S | 9 | 8 | snow | -3.6 | 79 | 981.6 | -0.8 | 0.5m |
| 02/89 | 2503 | 70.5S / 8.8W | S | 9 | / | hazy | -6.0 | 83 | 977.0 | -1.0 | 0.0m |
| 02/89 | 2506 | 70.6S / 8.1W | SSW | 4 | 7 | fog | -7.6 | 86 | 975.3 | -1.0 | 0.0m |
| 02/89 | 2509 | 70.6S / 8.1W | S | 11 | 7 | almost covered | -6.8 | 84 | 974.4 | -1.0 | 0.0m |
| 02/89 | 2512 | 70.6S / 8.1W | S | 13 | 2 | clear | -11.4 | 76 | 973.4 | -0.8 | 0.0m |
| 02/89 | 2515 | 70.6S / 8.1W | SW | 17 | 0 | clear | -9.1 | 58 | 971.7 | -0.7 | 0.5m |
| 02/89 | 2518 | 70.6S / 8.1W | WSW | 25 | 0 | clear | -9.3 | 67 | 969.8 | -0.8 | 0.5m |
| 02/89 | 2603 | 70.5S / 8.1W | SW | 28 | 0 | clear | -12.4 | 79 | 969.5 | -1.0 | 1.0m |
| 02/89 | 2606 | 70.6S / 8.1W | SW | 26 | 0 | clear | -14.0 | 85 | 972.4 | -1.0 | 1.0m |
| 02/89 | 2609 | 70.6S / 8.1W | SW | 19 | 0 | clear | -16.6 | 84 | 976.3 | -1.0 | 1.0m |
| 02/89 | 2612 | 70.6S / 8.1W | S | 14 | 0 | clear | -14.3 | 80 | 980.4 | -0.9 | 0.5m |
| 02/89 | 2615 | 70.6S / 8.1W | SSW | 7 | 2 | clear | -12.0 | 58 | 982.3 | -0.9 | 0.5m |
| 02/89 | 2618 | 70.6S / 8.1W | SSW | 4 | 2 | clear | -9.2 | 118 | 983.2 | -0.9 | |
| 02/89 | 2703 | 70.0S / 7.8W | NE | 30 | 7 | almost covered | -2.5 | 63 | 984.7 | -0.6 | 2.0m |
| 02/89 | 2706 | 69.4S / 7.2W | NE | 28 | 8 | covered | -2.1 | 66 | 983.2 | -0.2 | 2.0m |
| 02/89 | 2709 | 68.9S / 6.6W | NE | 32 | 8 | hazy | -1.3 | 75 | 981.6 | -0.2 | 2.0m |
| 02/89 | 2712 | 68.3S / 6.0W | ENE | 32 | 8 | hazy | -0.5 | 80 | 979.7 | 0.0 | 2.5m |
| 02/89 | 2715 | 67.9S / 5.5W | ENE | 27 | 7 | hazy | 0.6 | 92 | 978.3 | 0.2 | 2.5m |
| 02/89 | 2718 | 67.3S / 4.9W | ENE | 25 | 8 | hazy | 0.7 | 75 | 977.5 | 0.4 | 2.5m |
| 02/89 | 2803 | 65.7S / 3.3W | ESE | 18 | 8 | covered | 0.4 | 70 | 976.6 | 0.3 | 1.5m |
| 02/89 | 2806 | 65.2S / 2.8W | SE | 16 | 8 | covered | 0.6 | 63 | 976.6 | 0.4 | 1.0m |
| 02/89 | 2809 | 64.9S / 2.5W | SE | 15 | 8 | covered | 0.9 | 67 | 978.3 | 0.7 | 1.0m |
| 02/89 | 2812 | 64.9S / 2.6W | SSW | 14 | 8 | covered | 0.6 | 66 | 979.4 | 0.5 | 0.5m |
| 02/89 | 2815 | 64.9S / 2.6W | SW | 18 | 8 | shower | 0.8 | 77 | 980.2 | 0.5 | 0.5m |
| 02/89 | 2818 | 64.7S / 2.5W | SW | 29 | 8 | covered | 0.6 | 67 | 980.5 | 0.5 | 2.0m |
| 03/89 | 0103 | 63.3S / 2.1W | SW | 32 | 8 | covered | 1.1 | 73 | 984.4 | 0.4 | 3.5m |
| 03/89 | 0106 | 62.9S / 2.0W | WSW | 32 | 8 | covered | 1.0 | 75 | 986.6 | 0.5 | 3.5m |
| 03/89 | 0109 | 62.4S / 1.8W | WSW | 27 | 8 | covered | 0.9 | 78 | 988.9 | 0.5 | 3.5m |
| 03/89 | 0112 | 61.8S / 1.6W | WSW | 18 | 8 | covered | 0.7 | 83 | 991.2 | 0.6 | 3.0m |
| 03/89 | 0115 | 61.1S / 1.5W | W | 19 | 8 | covered | 0.3 | 92 | 992.1 | 0.4 | 3.0m |
| 03/89 | 0118 | 60.6S / 1.4W | WNW | 17 | 7 | almost covered | 0.7 | 94 | 992.4 | 0.5 | 1.0m |
| 03/89 | 0203 | 58.5S / 0.9W | NW | 24 | 8 | covered | 1.2 | 79 | 992.9 | 0.9 | 1.5m |
| 03/89 | 0206 | 58.2S / 0.8W | NW | 22 | 7 | almost covered | 1.1 | 77 | 992.9 | 0.9 | 1.5m |
| 03/89 | 0209 | 57.7S / 0.7W | NW | 22 | 8 | covered | 1.4 | 77 | 992.9 | 1.0 | 2.0m |
| 03/89 | 0212 | 57.2S / 0.5W | NW | 16 | 7 | almost covered | 1.4 | 95 | 992.3 | 1.2 | 1.5m |
| 03/89 | 0215 | 56.8S / 0.4W | NW | 13 | 8 | snow | 1.3 | 94 | 990.8 | 1.0 | 1.0m |
| 03/89 | 0218 | 56.3S / 0.3W | W | 12 | 8 | hazy | 1.1 | 99 | 989.8 | 1.3 | 0.5m |
| 03/89 | 0306 | 54.8S / 0.1E | W | 26 | 8 | covered | 2.3 | 85 | 992.7 | 1.4 | 2.0m |
| 03/89 | 0309 | 54.7S / 0.1E | WNW | 20 | 7 | almost covered | 2.6 | 74 | 993.8 | 1.6 | 2.5m |
| 03/89 | 0312 | 54.7S / 0.1E | W | 15 | 8 | hazy | 2.3 | 79 | 994.9 | 1.6 | 1.5m |
| 03/89 | 0315 | 54.8S / 0.1E | W | 23 | 8 | covered | 3.1 | 87 | 995.6 | 1.5 | 1.5m |
| 03/89 | 0318 | 54.7S / 0.1E | WNW | 24 | 8 | covered | 2.6 | 90 | 995.4 | 1.8 | 2.0m |
| 03/89 | 0403 | 53.5S / 1.7E | NW | 36 | / | hazy | 3.3 | 81 | 989.9 | 2.1 | 4.5m |
| 03/89 | 0406 | 53.0S / 2.3E | WNW | 34 | 8 | hazy | 3.2 | 87 | 990.2 | 2.0 | 4.0m |
| 03/89 | 0409 | 52.5S / 2.9E | WSW | 26 | 7 | hazy | 3.1 | 82 | 994.1 | 2.5 | 2.0m |
| 03/89 | 0412 | 52.0S / 3.5E | WSW | 29 | 7 | almost covered | 3.6 | 77 | 997.0 | 3.0 | 2.5m |
| 03/89 | 0415 | 51.7S / 3.9E | W | 28 | 7 | almost covered | 3.6 | 76 | 999.1 | 2.8 | 2.5m |
| 03/89 | 0418 | 51.3S / 4.3E | W | 32 | 8 | covered | 2.0 | 97 | 1000.7 | 2.8 | 3.0m |
| 03/89 | 0503 | 50.2S / 5.7E | NW | 31 | 9 | hazy | 5.5 | 94 | 1000.7 | 4.1 | 3.5m |
| 03/89 | 0506 | 50.1S / 5.8E | NW | 35 | 8 | hazy | 6.5 | 95 | 997.3 | 4.2 | 3.5m |
| 03/89 | 0509 | 50.2S / 5.8E | NW | 44 | 8 | rain | 6.5 | 97 | 993.7 | 4.1 | 5.0m |
| 03/89 | 0512 | 49.8S / 6.1E | WNW | 44 | 8 | hazy | 7.0 | 98 | 992.8 | 4.6 | 6.0m |
| 03/89 | 0515 | 49.4S / 6.5E | WNW | 42 | 8 | hazy | 7.6 | 97 | 994.3 | 5.2 | 5.0m |
| 03/89 | 0518 | 48.9S / 6.9E | WNW | 42 | 8 | hazy | 8.3 | 84 | 996.3 | 5.9 | 5.0m |
| 03/89 | 0603 | 47.4S / 8.2E | WNW | 35 | 9 | hazy | 9.0 | 97 | 1005.4 | 6.9 | 4.5m |

| MMYY | DDHH | Lat / Lon | DDD | FF | N | Weather | TITI | RF% | QNH | TwTW | Sea |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 03/89 | 0606 | 46.9S / 8.6E | WNW | 33 | 8 | hazy | 9.5 | 96 | 1008.4 | 7.9 | 4.5m |
| 03/89 | 0609 | 46.4S / 9.0E | WNW | 33 | 8 | hazy | 10.7 | 94 | 1011.3 | 8.6 | 4.5m |
| 03/89 | 0612 | 45.9S / 9.4E | WNW | 29 | 8 | covered | 11.7 | 89 | 1013.0 | 9.6 | 3.5m |
| 03/89 | 0615 | 45.5S / 9.7E | WNW | 28 | 7 | almost covered | 12.3 | 93 | 1013.8 | 10.3 | 2.5m |
| 03/89 | 0618 | 45.1S / 10.1E | WNW | 25 | 8 | covered | 12.3 | 95 | 1015.4 | 10.5 | 3.0m |
| 03/89 | 0703 | 43.9S / 11.0E | WNW | 26 | / | no observations | 13.0 | 81 | 1012.2 | 10.7 | 2.5m |
| 03/89 | 0706 | 43.5S / 11.4E | WNW | 34 | 8 | covered | 14.2 | 94 | 1009.5 | 12.4 | 2.5m |
| 03/89 | 0709 | 43.1S / 11.7E | WNW | 48 | 8 | covered | 15.2 | 84 | 1009.1 | 12.5 | 3.0m |
| 03/89 | 0712 | 42.7S / 12.0E | NNW | 38 | 6 | cloudy | 15.9 | 86 | 1008.3 | 12.6 | 3.0m |
| 03/89 | 0715 | 42.2S / 12.4E | NNW | 37 | 6 | clear | 16.7 | 94 | 1008.2 | 12.3 | 3.0m |
| 03/89 | 0718 | 41.7S / 12.7E | NNW | 34 | 7 | almost covered | 17.6 | 91 | 1009.2 | 14.6 | 3.0m |
| 03/89 | 0803 | 40.1S / 14.0E | NW | 27 | 9 | no observations | 21.6 | 85 | 1011.4 | 21.9 | 2.5m |
| 03/89 | 0806 | 39.7S / 14.3E | WNW | 25 | 8 | covered | 21.8 | 84 | 1012.8 | 23.1 | 2.5m |
| 03/89 | 0809 | 39.3S / 14.5E | NNW | 17 | 6 | cloudy | 21.4 | 76 | 1014.4 | 21.9 | 1.5m |
| 03/89 | 0812 | 38.8S / 14.9E | NNW | 8 | 4 | cloudy | 21.7 | 62 | 1015.0 | 22.3 | 0.5m |
| 03/89 | 0815 | 38.5S / 15.2E | WNW | 11 | 3 | clear | 22.1 | 88 | 1015.2 | 21.7 | 0.5m |
| 03/89 | 0818 | 38.1S / 15.5E | NW | 10 | 6 | cloudy | 21.6 | 63 | 1016.1 | 21.7 | 0.5m |
| 03/89 | 0903 | 37.0S / 16.1E | SW | 13 | 0 | clear | 21.8 | 67 | 1016.5 | 22.5 | 0.5m |
| 03/89 | 0906 | 36.6S / 16.4E | SW | 8 | 4 | cloudy | 22.8 | 63 | 1017.8 | 22.3 | 0.5m |
| 03/89 | 0909 | 36.2S / 16.7E | S | 4 | 6 | cloudy | 24.0 | 65 | 1019.0 | 22.3 | 1.0m |

Multicorer sampling scheme (MUC Annex)

Multicorer (MUC) sampling scheme for the study of meio-, micro- and nano-benthos and of the sediment

Participants:

Abiotic factors: A. Boldrin, S. Rabitti and D. Gouleau

Biotic components:
- ATP and ETS: J. Vosjan and G. Nieuwland
- Micro- and nanobenthos: R. Bak and G.Nieuwland
- Meiobenthos: R.L. Herman, H.-U. Dahms and E. Schockaert

The multicorer (MUC) is a device designed to obtain undisturbed bottom samples. Equipped with a hydraulic system the MUC inserts 12 plastic tubes of 25 $cm^2$ each slowly into soft sediments so that a minimum of compression occurs. Penetration speed varies from 0.2 m/sec to 1.2 m/sec according to the depth and nature of the substrate.

At least 8 undisturbed cores were necessary to fulfil the minimal needs of the participants of this multidisciplinary group. The cores were distributed according to the following scheme (cf. Fig. 44 in Chapter 3.8):

- CORE 1: ATP & ETS
- CORE 2: 100 ml of overlying water; Chl a ( 2 x 1$cm^2$)
  Microflag., Foram. & Ciliates ( 1 x 5.2 $cm^2$)
- CORE 3: Microflag., Foram. & Ciliates ( 1 x 5.2 $cm^2$)
  Meio (SD)
- CORE 4: Sediment and Nutrients (15 $cm^2$)
  Meio (VD)
- CORE 5: Microflag., Foram. & Ciliates
  Meio (SD)
- CORE 6: Microflag., Foram. & Ciliates
  Meio (SD)
- CORE 7: 100 ml of overlying water; pH & Eh
  Meio (Living)
- CORE 8: Sediment and Nutrients
  Meio (VD)
- CORE 9: Microflag., Foram. & Ciliates
  Meio (SD)
- CORE 10: Microflag., Foram. & Ciliates
  Meio (Living)
- CORE 11: Microflag., Foram. & Ciliates
  Meio (Living)
- CORE 12: Microflag., Foram. & Ciliates
  Meio (Living)

All overlying water was tapped off into a corresponding 2-liter bottle. Care was taken to note the core number of all samples to allow results to be correlated later.

SD = Spatial Distribution (20 $cm^2$) ; VD = Vertical Distribution (10 $cm^2$).

# Macrobenthos Specialists

DISTRIBUTION TO SPECIALISTS OF THE EPOS leg 3
MACROBENTHIC MATERIAL

| | |
|---|---|
| PORIFERA | : D. Barthel (Kiel), K. Panzer (Kiel), O. Tendal (Köbenhavn) |
| CNIDARIA | |
| Hydroidea | : Vervoort (Leiden) |
| Scleractinia | : H. Zibrowius (Marseille) |
| Hydrocorallia | : H. Zibrowius (Marseille) |
| Actiniaria | : K. Rieman-Zürneck (Bremerhaven), D. Doumenc (Paris) |
| Zoantharia | : |
| Gorgonaria | : M. Grasshoff (Frankfurt) |
| Pennatularia | : M.J. d'Hondt (Paris) |
| TURBELLARIA | : E. Schokaert (Diepenbeek) |
| HIRUDINEA | : |
| NEMERTINI | : |
| PRIAPULIDA | : V. Storch (Heidelberg) |
| SIPUNCULIDA | : Saiz Salinas (Spain), E. Cutler (Washington) |
| ECHIURIDA | : |
| POLYCHAETA | : G. Hartmann-Schröder (Hamburg) |
| OLIGOCHAETA | : Ch. Erseus (Sweden) |
| MOLLUSCA | |
| Cephalopoda Octopoda | : C. Roper (Washington), S. Kühl-Kellermann (Bremerhaven and Hawaii) |
| Nudibranchia | : C. Poizat (Marseille), H. Wägele (Oldenburg) |
| Aplacophora | : L. von Salvini-Plawen (Wien) |
| Other groups | : P.M. Arnaud (Marseille), S. Hain (Bremerhaven) |
| ACARI | : I. Bartsch (Hamburg) |
| PYCNOGONIDA | : F. Krapp (Bonn) |
| CRUSTACEA | |
| Ostracoda | : G. Hartmann (Hamburg, K. Wouters (Brussels) |
| Copepoda Harpacticoida | : H.K. Schminke (Oldenburg), H.-U. Dahms (Oldenburg) |
| Cirripedia | : G.H. Petersen (Köbenhavn), W. Klepal (Wien) |
| Mysidacea | : M. Ledoyer (Marseille) |
| Cumacea | : M. Ledoyer (Marseille), U. Marquardt (Bremerhaven) |
| Tanaidacea | : J. Sieg (Osnabrück) |
| Isopoda | : W. Wägele (Oldenburg), B. Kensley (Washington) |
| Amphipoda | : C. de Broyer (Brussels), M. Klages (Bremerhaven) |
| Decapoda | : W. Arntz (Bremerhaven), M. Türkay (Frankfurt), H. Tiefenbacher (München) |
| BRYOZOA | : H. Ristedt (Bonn), Hayward (U.K.), J.L. d'Hondt (Paris) |
| BRACHIOPODA | : B. Laurin (Dijon) |
| ECHINODERMATA | |
| Asteroidea | : M. Jangoux (Brussels) |
| Ophiuroidea | : I. Bartsch (Hamburg), C. Vadon (Paris) |
| Echinoidea (Irregular) | : B. David (Dijon) |
| Echinoidea (regular) | : C. De Ridder (Brussels) |
| Holothuroidea | : C. Massin (Brussels) and (800 m and deeper) J. Gutt (Bremerhaven) |
| Crinoidea (Comatulida) | : Roux (Paris) |
| Crinoidea (Pedunculata) | : Roux (Paris) |
| ASCDIACEA | : C. Monniot (Paris), F. Monniot (Paris) |

## Meiobenthos Specialists

DISTRIBUTION TO SPECIALISTS OF THE EPOS leg 3
MEIOBENTHIC MATERIAL

| | |
|---|---|
| GENERAL MEIOFAUNA COMPOSITION | : R.L. Herman (Gent), H.-U. Dahms (Oldenburg) |
| TAXONOMY | |
| HYDROZOA | : |
| NEMATODA | : F. Decraemer (Brussels), A. Vanreusel (Gent), S. Lorenzen (Kiel), M. Vincx (Gent) |
| TURBELLARIA | : E. Schockaert (Diepenbeek) |
| POLYCHAETA | : J. Govaere (Brussels) |
| PRIAPULIDA | : J. Vanderland (Leiden) |
| KINORHYNCHA | : R.L. Herman (Gent) |
| MOLLUSCA | : C. Poizat (Marseille) |
| HALACARIDA | : I. Bartsch (Hamburg) |
| COPEPODA | : H.K. Schminke (Oldenburg) |
| COPEPODA Harpacticoida | : H.-U. Dahms (Oldenburg), F. Fiers (Brussels), M. Gee (Plymouth), R.L. Herman (Gent), R. Huys (Gent) |
| FICETOTECTA | : H.-U. Dahms (Oldenburg) |
| OSTRACODA | : K. Wouters (Brussels) |
| AMPHIPODA | : C. de Broyer (Brussels) |
| CUMACEA | : M. Ledoyer (Marseille) |
| ISOPODA | : J.W. Wägele (Oldenburg) |
| TANAIDACEA | : J. Sieg (Osnabrück) |
| TANTULOCARIDA | : R.L. Herman (Gent) |
| SIPUNCULIDA | : J. Vanderland (Leiden) |
| BRYOZOA | : J.L. d'Hondt (Paris) |

PARTICIPATING INSTITUTIONS AND SCIENTISTS in ANT VII/4 - EPOS leg 3

| | | |
|---|---|---|
| Argentina | | |
| | Ministerio de Economía<br>Instituto Nacional de Investigación<br>y Desarrollo Pesquero (INIDEP)<br>Mar del Plata | Todisco |
| Belgium | | |
| | Institut Royal des Sciences Naturelles<br>de Belgique<br>29 rue Vautier<br>B-1040 Bruxelles | de Broyer |
| | Museum voor Dierkunde<br>Laboratoria voor Morfologie<br>en Systematiek der Dieren<br>K.L. Ledeganckstraat 35<br>B-9000 Gent | Herman |
| | Limburgs Universitair Centrum<br>Researchgroup Zoology, Dept. SBM<br>B-3610 Diepenbeek | Schockaert |
| Denmark | | |
| | Köbenhavns Universitet<br>Zoologisk Museum<br>Universitetsparken 15<br>DK-2100 Köbenhavn Ö | Petersen, Schiötte,<br>Tendal |
| España | | |
| | Instituto Español de Oceanografía<br>Centro Oceangráfico Costero<br>de Canarias<br>Carretera de San Andrés, s/n<br>Apartado de Correos 1373<br>Santa Cruz de Tenerife<br>Islas Canarias | Balguerías |
| France | | |
| | Station Marine d'Endoume<br>Rue de la Batterie des Lions<br>F-13007 Marseille | Arnaud |

France

| | | |
|---|---|---|
| | Muséum National d'Histoire Naturelle<br>Ichtyologie Générale et Appliquée<br>43 rue Cuvier<br>F-75231 Paris Cedex 05 | Duhamel, Hureau,<br>Ozouf-Costaz |
| CENTOB | CENTOB, IFREMER<br>B.P. 70<br>F-29263 Plouzané | Galeron |
| | Institut d'Etudes Marines<br>Faculté des Sciences<br>Laboratoire de Géologie Marine<br>2 rue de la Houssinière<br>F-44072 Nantes Cedex 03 | Gouleau |

F.R. Germany

| | | |
|---|---|---|
| AWI | Alfred-Wegener-Institut für<br>Polar- und Meeresforschung<br>Postfach 12 01 61<br>Columbusstrasse<br>D-2850 Bremerhaven | Arntz, Dimmler,<br>Dittrich, Gutt,<br>Hain, Klages, Klindt,<br>Rohardt, Schleif |
| IfM | Institut für Meereskunde<br>an der Universität Kiel<br>Düsternbrooker Weg 20<br>D-2300 Kiel 1 | Barthel, Panzer,<br>Piatkowski |
| | Universität Oldenburg<br>Fachbereich 7<br>Postfach 25 03<br>D-2900 Oldenburg | Dahms |
| | Botanisches Institut<br>der Universität<br>Siesmayerstrasse 70<br>D-6000 Frankfurt 11 | Döhler |
| BuFo | Bundesforschungsanstalt für Fischerei<br>Institut für Seefischerei<br>Palmaille 9<br>2000 Hamburg 50 | Kock |
| IPÖ | Institut für Polarökologie<br>Universität Kiel<br>Olshausenstrasse 40-60<br>D-2300 Kiel 1 | Kunzmann,<br>Wöhrmann |

| | | |
|---|---|---|
| F.R. Germany | | |
| | Universität Bremen<br>Fachbereich 5<br>Postfach 33 04 40<br>D-2800 Bremen 33 | Ruhland |
| Great Britain | | |
| BAS | British Antarctic Survey<br>High Cross<br>Madingley Road<br>Cambridge CB3 0ET | Clarke, Gore, White |
| | University of St. Andrews<br>Gatty Marine Laboratory<br>Dept. of Biol. and Preclinical Medicine<br>St. Andrews Fife KY16 8LB | Johnson |
| | University College of North Wales<br>School of Biological Sciences<br>Bangor LL57 2UW | Rankin |
| The Netherlands | | |
| NIOZ | Nederlands Instituut voor<br>Onderzoek der Zee<br>Postbox 59<br>NL-1790 AB Den Burg/Texel | Bak, Nieuwland,<br>Vosjan |
| Italy | | |
| | Istituto di Biologia del Mare, CNR<br>Riva 7 Martiri 1364/A<br>I-30122 Venezia | Boldrin, Rabitti |

PARTICIPANTS ANT VII/4 - EPOS leg 3

| Name | First name | Institute | Country |
|---|---|---|---|
| Arnaud | Patrick | | F |
| Arntz | Wolf | AWI | FRG |
| Bak | Rolf | NIOZ | NL |
| Balguerías | Eduardo | | E |
| Barthel | Dagmar | IfM | FRG |
| Boldrin | Alfredo | | I |
| Broyer, de | Claude | | B |
| Clarke | Andrew | BAS | UK |
| Dahms | Hans-Uwe | | FRG |
| Dimmler | Werner | AWI | FRG |
| Dittrich | Birgit | AWI | FRG |
| Döhler | Günter | | FRG |
| Duhamel | Guy | | F |
| Galeron | Joelle | CENTOB | F |
| Gore | Deborah | BAS | UK |
| Gouleau | Dominique | | F |
| Gutt | Julian | AWI | FRG |
| Hain | Stefan | AWI | FRG |
| Herman | Rudy | | B |
| Hureau | Jean-Claude | | F |
| Johnson | Tim | | UK |
| Klages | Michael | AWI | FRG |
| Klindt | Holger | AWI | FRG |
| Kock | Karl-Hermann | BuFo | FRG |
| Kunzmann | Andreas | IPÖ | FRG |
| Nieuwland | Gerard | NIOZ | NL |
| Ozouf-Costaz | Catherine | | F |
| Panzer | Kathrin | IfM | FRG |
| Petersen | Gottfried Höpner | | DK |
| Piatkowski | Uwe | IfM | FRG |
| Rabitti | Sandro | | I |
| Rankin | Cliff | | UK |
| Rohardt | Gerd | AWI | FRG |
| Ruhland | Götz | | FRG |
| Schiötte | Tom | | DK |
| Schleif | Udo | AWI | FRG |
| Schockaert | Ernest | | B |
| Tendal | Ole | | DK |
| Todisco | Cosme | | Argentina |
| Vosjan | Jan | NIOZ | NL |
| White | Martin | BAS | UK |
| Wöhrmann | Andreas | IPÖ | FRG |

SHIP'S CREW ANT VII/4 - EPOS leg 3

| | |
|---|---|
| Kapitän | Jonas |
| 1. Naut. Offizier | Götting |
| Naut. Offizier | Schiel |
| Naut. Offizier | Varding |
| Naut. Offizier | Weihe |
| Arzt | Dr. Rose |
| Leitender Ingenieur | Briedenhahn |
| 1. Ingenieur | Schulz |
| 2. Ingenieur | Monostori |
| 2. Ingenieur | Fengler |
| Elektroniker | Schuster |
| Elektroniker | Nitsche |
| Elektroniker | Hoops |
| Elektroniker | Elvers |
| Elektroniker | Both |
| Funkoffizier | Butz |
| Funkoffizier | Müller |
| Koch | Klasen |
| Kochsmaat/Bäcker | Klauck |
| Kochsmaat/Koch | Kröger |
| 1. Steward | Peschke |
| Stewardess/Nurse | Lieboner |
| Stewardess | Hoppe |
| Stewardess | Feigler |
| Stewardess | Hopp |
| 2. Steward | Fang |
| 2. Steward | Lai |
| Wäscher | Shyu |
| Bootsmann | Voltin |
| Zimmermann | Kassubeck |
| Matrose | Arias |
| Matrose | Meis |
| Matrose | Novo Lov. |
| Matrose | Prol Otero |
| Matrose | Pereira |
| Lagerhalter | Barth |
| Maschinen-Wart | Jordan |
| Maschinen-Wart | Fritz |
| Maschinen-Wart | Buchas |
| Maschinen-Wart | Reimann |
| Maschinen-Wart | Albrecht |
| Maschinen-Wart | Heurich |
| zusätzl. Bootsmann | Schwarz |
| zusätzl. Bootsmann | Hopp |

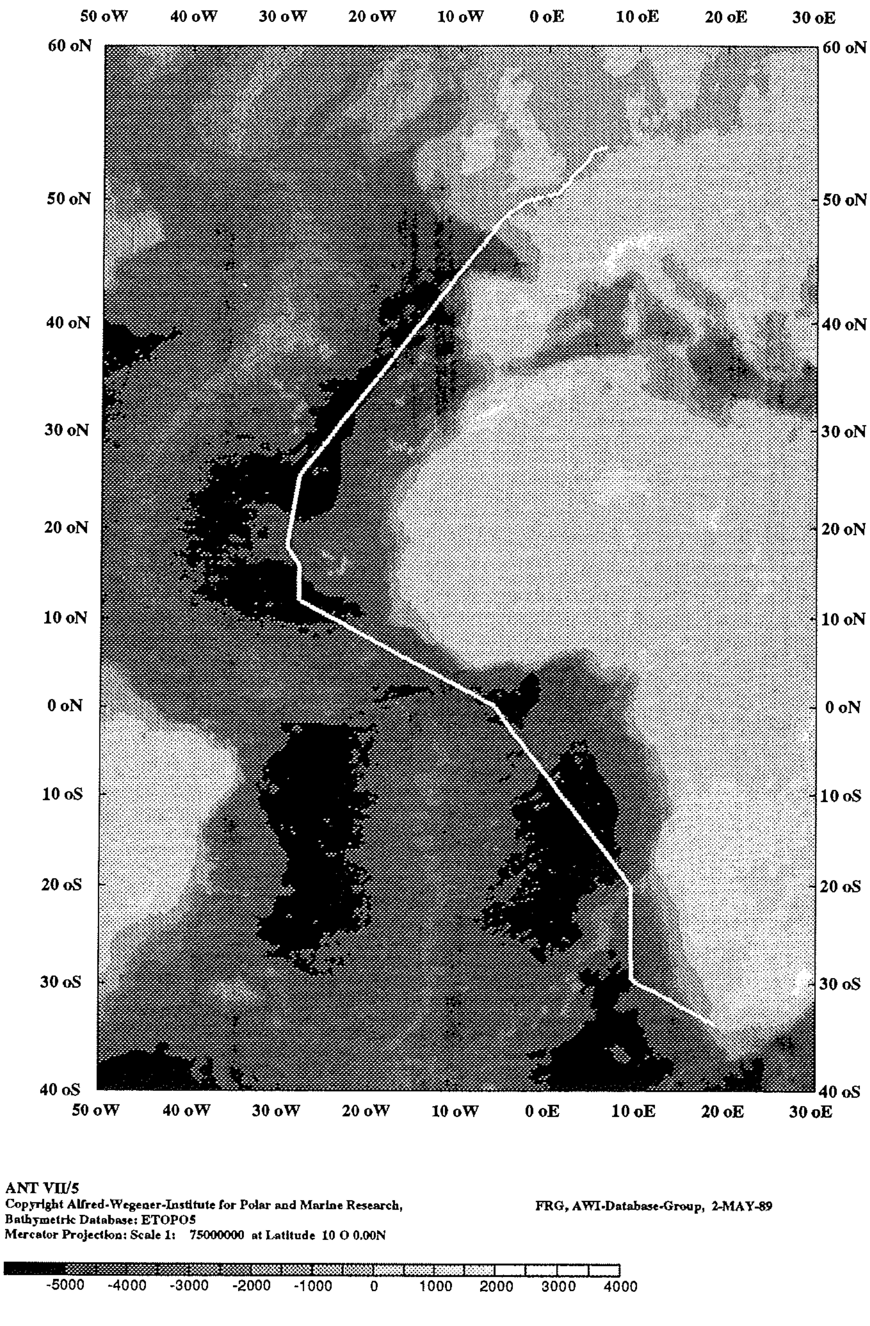



Figure 56: Cruise ANT VII/5 of "Polarstern" from Cape Town to Bremerhaven

# 1. ANT VII/5 CAPE TOWN - BREMERHAVEN
March 12 - April 6, 1989

## 1.1.1 ZUSAMMENFASSUNG UND FAHRTVERLAUF

W. Ernst

Auf der Reise von Kapstadt nach Bremerhaven standen spurenstoffchemische Arbeiten im Vordergrund. Daneben wurde eine Reihe biologischer Fragestellungen bearbeitet; physikalische Messungen ergänzten das Forschungsprogramm.

Im Rahmen der luftchemischen Messungen wurden Schwefelverbindungen, Ozon, Salpetersäure sowie Schwermetalle im Aerosol bestimmt. Bei der Analyse von Wasserproben standen Schwermetalle und organische Spurenstoffe natürlichen und anthropogenen Ursprungs im Vordergrund. Die Konzentrationen einiger Metalle, wie Cadmium, Kupfer und Blei wurden bereits an Bord bestimmt. Die Metallgehalte von Neustonproben, die, über die gesamte Fahrtroute verteilt, gefangen wurden, werden im Heimatlabor analysiert. Die extrem niedrigen Gehalte an Organohalogenverbindungen in den Neustonfängen werden ebenfalls im Heimatlabor bestimmt, da kontaminationsfreie Reinigungsschritte für die gewonnenen Extrakte erforderlich sind. Für die Isolierung organischer Wasserinhaltsstoffe waren Extraktionen großer Wassermengen bis zu 6 000 l mit einem kontinuierlich arbeitenden Zentrifugalextraktor notwendig, um kleine Substanzkonzentrationen sicher nachweisen zu können.

Während der gesamten Reise wurden kontinuierlich Nährsalze mit einem Autoanalyzer-System gemessen. Einbezogen wurden hierbei auch Tiefenprofile, um die Ausdehnung der nährstoffarmen Deckschicht festzustellen.

Von mehreren Arbeitsgruppen wurden Vorgänge der Bildung gasförmiger Schwefelverbindungen aus dem Phytoplankton in Abhängigkeit von der Zusammensetzung des Planktons untersucht. In diese Untersuchungen wurden Messungen des Dimethylsulfoniumpropionats als Vorstufe des Dimethylsulfids (DMS), sowie ATP- und DMS-Analysen im Phytoplankton bzw. im Wasser durchgeführt.

Eine mikrobiologische Arbeitsgruppe arbeitete in den Tiefseebecken an einem Projekt über die Tiefenanpassung bakterieller Populationen. Hierbei wurde erstmalig ein Druckwasserschöpfer eingesetzt, mit dem Proben im druckkonstanten Zustand gewonnen wurden.

Zur Untersuchung des Partikelflusses zum Meeresboden wurde im Gebiet Walfischrücken eine Sinkstoffalle aufgenommen. Aus dem gewonnenen Material wurden an Bord mikroskopische und REM-Präparate hergestellt. Eine neue Verankerung mit zwei Sinkstoffallen in unterschiedlichen Tiefen wurde ausgebracht.

Die physikalisch-ozeanographische Arbeitsgruppe setzte verschiedene Sonden im hydrographischen Schacht ein, mit denen Salzgehalt und Temperatur sowie die Chlorophyllfluoreszenz gewonnen wurde. Messungen der Temperaturverteilung in Containern dienten der Untersuchung des Temperaturbelastungspotentials von Transportmitteln in subtropischen und tropischen Klimazonen.

### 1.1.2 Summary and Itinerary

W. Ernst

During the cruise from Cape Town to Bremerhaven emphasis has been laid on the analysis of trace compounds in the atmosphere, in water and in organisms; but also biological studies and physical measurements were carried out.

Determinations of volatile compounds comprised sulphur compounds, ozone, nitric acid; furthermore aerosols were sampled for the analysis of heavy metals. In surface water samples some metals, such as cadmium, copper and lead, were determined on board. Levels of heavy metals as well as halogenated organic compounds in neuston which were sampled during the cruise at more than 40 stations, are performed in the land based laboratory. For the extractions of organic trace compounds from water sample sizes up to 6 000 l were used, in order to reliably identify low concentrations of these compounds originating from natural and anthropogenic sources. Nutrients were measured using an autoanalyzer system and also depth profiles were taken for identifying the magnitude of the nutrient deficient surface layer.

The work of several groups were related to the formation of dimethyl sulfide (DMS) including the analysis of its precursor in phytoplankton, of ATP in plankton and DMS in water.

Microbiological work was carried out in the deep sea basins to study the adaptation of bacterial populations to depths of 5 000 m. A new sampler was tested which allowed deep water samples to be taken under constant "in situ"-pressure. Measurements of temperature, salinity and chlorophyll were executed continuously using appropriately designed sensors.

On 12 March "Polarstern" left Cape Town with 29 scientists and 43 crew. Going on a north-easterly course "Polarstern" arrived at its first deep sea station in the Cape Basin on 14 March. In the further cruise deep sea stations were sampled in the the Angola, Guinea, Sierra Leone and CapeVerde Basin (Fig. 56). Occasionally a rubber boat was launched at these stations for sampling water remote from the ship. On considerable distances covered, "Polarstern" was pitching due to robust sea and high speed. After a fast passage of the Channel "Polarstern" arrived at Bremerhaven on 6 April.

## 1.2 REPORTS OF THE WORKING GROUPS

### 1.2.1 WEATHER CONDITIONS

H.G.Hill, H.Köhler

At the start of the cruise, fresh-to-strong south-westerly winds were experienced as a result of a low pressure which was moving eastwards south of the Cape. The next few days were marked by a distinctly weak south-east trade-wind the sub-tropical high pressure was relatively far west.
This area was left at about 10° S. To the disapointment of those groups which would have liked to have seen rain for their measurements, a clearly formed tropical convergence was not discernible on entry to the equitorial low pressure trough. Only "clusters" moved out from the Gulf of Guinea westwards. They merely resulted in temporary, unprolific precipitation. In succession they formed a rather incomplete line approximately along latitude 5° N.
The north-east trade wind area was sailed through between 12° N and 25° N. Wind strengths of average 4-5, at times 6-7, together with wind driven Sahara dust were observed.
In the meantime, a strong meandering current over the North Atlantic had appeared which led from about the 30.3.89 on to a cold air exchange stretching far to the south, forming a corresponding trough over the East Atlantic. At the same time, strong north-westerly winds, with stormy gusts, were noted.
A strong cyclogenesis, which was intensified by the inclusion of an Atlantic warm front and the tail-end of a low off the Irish westcoast, was discernible from the 3.4.89. onwards.
Between this low and the Scandinavian high pressure ridge stretching as far as Ireland, a strong and persistent north-westerly current set in that resulted in a north-easterly storm from Finisterre onwards and lasted until our arrival in the North Sea.

Meßdaten der Bordwetterwarte FS "Polarstern"

SMVX00 SMXX 000000 Seegebiet 00

| YYMM | DDHH | Latit. | Longit | DDD | FF | N | Wetter | | TLTL | RF% | QNH | TwTw | See | dsvs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8903 | 1303 | 32.6S | 15.7E | SW | 26 | 9 | keineBeob | 20.4 | 78 | 1014.5 | 20.4 | 3.0m | NW | 13kt |
| 8903 | 1306 | 32.4S | 15.1E | SSW | 24 | 4 | wolkig | 20.4 | 80 | 1016.6 | 20.9 | 2.5m | W | 13kt |
| 8903 | 1309 | 32.2S | 14.7E | SSW | 20 | 1 | heiter | 21.1 | 50 | 1018.0 | 22.2 | 3.0m | NW | 8kt |
| 8903 | 0312 | 32.0S | 14.3E | S | 14 | 1 | heiter | 21.2 | 49 | 1019.1 | 21.8 | 2.5m | NW | 8kt |
| 8903 | 1315 | 31.8S | 13.9E | S | 20 | 1 | heiter | 21.7 | 50 | 1018.4 | 21.8 | 2.5m | NW | 8kt |
| 8903 | 1318 | 31.5S | 13.2E | S | 16 | 2 | heiter | 21.3 | 54 | 1018.8 | 22.3 | 2.0m | NW | 13kt |
| 8903 | 1403 | 30.5S | 11.0E | SE | 11 | 9 | keine Beob | 21.6 | 68 | 1019.0 | 22.5 | 1.5m | NW | 13kt |
| 8903 | 1406 | 30.2S | 10.3E | SE | 10 | 7 | fast bedkt | 22.0 | 53 | 1019.0 | 22.3 | 0.5m | NW | 13kt |
| 8903 | 1409 | 29.8S | 9.6E | S | 9 | 7 | fast bedkt | 21.7 | 52 | 1019.7 | 22.0 | 0.5m | NW | 13kt |
| 8903 | 1412 | 29.6S | 9.2E | SSW | 9 | 8 | bedeckt | 22.2 | 54 | 1019.6 | 22.3 | 0.5m | NW | 3kt |
| 8903 | 1415 | 29.6S | 9.2E | S | 16 | 7 | fast bedkt | 22.2 | 52 | 1018.8 | 22.3 | 0.5m | Station | |
| 8903 | 1418 | 29.0S | 9.2E | S | 19 | 7 | fast bedkt | 22.6 | 54 | 1018.5 | 22.7 | 1.0m | N | 13kt |
| 8903 | 1503 | 26.8S | 9.2E | SE | 20 | 9 | keine Beob | 22.9 | 61 | 1015.8 | 23.0 | 2.0m | N | 13kt |
| 8903 | 1506 | 26.3S | 9.2E | SE | 14 | 8 | bedeckt | 23.0 | 61 | 1016.0 | 23.0 | 2.0m | N | 8kt |
| 8903 | 1509 | 25.5S | 9.2E | ESE | 12 | 7 | fast bedkt | 23.6 | 54 | 1016.6 | 23.2 | 1.5m | N | 13kt |
| 8903 | 1512 | 24.8S | 9.1E | ESE | 14 | 7 | fast bedkt | 23.9 | 54 | 1015.0 | 23.4 | 1.5m | N | 13kt |
| 8903 | 1515 | 24.0S | 9.1E | SE | 16 | 7 | fast bedkt | 23.7 | 57 | 1012.9 | 23.4 | 1.5m | N | 13kt |
| 8903 | 1518 | 23.3S | 9.1E | SE | 18 | 7 | fast bedkt | 23.8 | 54 | 1012.5 | 23.9 | 1.5m | N | 13kt |
| 8903 | 1603 | 21.1S | 9.1E | ESE | 10 | 9 | keine Beob | 23.5 | 57 | 1011.4 | 23.7 | 1.0m | N | 13kt |
| 8903 | 1606 | 20.5S | 9.1E | ESE | 8 | 7 | fast bedkt | 23.6 | 55 | 1012.0 | 23.9 | 0.5m | N | 13kt |
| 8903 | 1609 | 20.0S | 9.1E | S | 5 | 7 | fast bedkt | 23.8 | 55 | 1013.7 | 24.1 | 0.0m | N | 8kt |
| 8903 | 1612 | 20.0S | 9.1E | S | 4 | 7 | fast bedkt | 25.5 | 48 | 1014.2 | 24.2 | 0.0m | Station | |
| 8903 | 1615 | 19.4S | 8.6E | SSW | 8 | 2 | heiter | 24.6 | 52 | 1013.3 | 24.7 | 0.0m | NW | 13kt |
| 8903 | 1618 | 18.9S | 8.2E | SSW | 6 | 7 | fast bedkt | 24.6 | 55 | 1014.6 | 24.9 | 0.0m | NW | 13kt |
| 8903 | 1703 | 17.1S | 6.9E | SE | 13 | | keine Beob | 24.9 | 58 | 1013.1 | 25.7 | 1.0m | NW | 13kt |
| 8903 | 1706 | 16.6S | 6.5E | SE | 11 | 6 | wolkig | 25.1 | 58 | 1013.7 | 25.4 | 1.0m | NW | 13kt |
| 8903 | 1709 | 16.0S | 6.0E | ESE | 10 | 6 | wolkig | 26.2 | 54 | 1015.7 | 26.2 | 1.0m | NW | 13kt |
| 8903 | 1712 | 15.4S | 5.5E | SE | 7 | 1 | heiter | 26.6 | 56 | 1014.7 | 26.7 | 0.5m | NW | 13kt |
| 8903 | 1715 | 14.8S | 5.0E | SE | 8 | 0 | heiter | 26.7 | 57 | 1013.2 | 26.9 | 0.5m | NW | 13kt |
| 8903 | 1718 | 14.1S | 4.6E | SE | 10 | 0 | heiter | 27.0 | 54 | 1013.2 | 26.6 | 0.5m | NW | 13kt |
| 8903 | 1803 | 12.5S | 3.3E | SE | 8 | 9 | heiter | 26.4 | 60 | 1013.1 | 27.0 | 0.5m | NW | 13kt |
| 8903 | 1806 | 11.9S | 2.9E | SE | 12 | 3 | heiter | 27.0 | 65 | 1013.1 | 27.4 | 0.5m | NW | 13kt |
| 8903 | 1809 | 11.9S | 2.9E | SE | 12 | 1 | heiter | 27.8 | 61 | 1015.3 | 27.5 | 0.5m | Station | |
| 8903 | 1812 | 11.9S | 2.9E | SE | 14 | 2 | heiter | 27.5 | 63 | 1014.1 | 27.6 | 1.0m | Station | |
| 8903 | 1815 | 11.6S | 2.7E | SE | 10 | 3 | heiter | 27.9 | 62 | 1012.1 | 28.2 | 1.0m | NW | 8kt |
| 8903 | 1818 | 11.0S | 2.2E | SE | 10 | 2 | heiter | 27.9 | 61 | 1012.3 | 28.6 | 0.5m | NW | 13kt |
| 8903 | 1903 | 9.3S | 0.9E | SE | 13 | | keine Beob | 28.0 | 64 | 1011.6 | 28.4 | 1.0m | NW | 13kt |
| 8903 | 1906 | 8.7S | 0.5E | SE | 14 | 2 | heiter | 28.2 | 64 | 1012.4 | 28.5 | 1.0m | NW | 13kt |
| 8903 | 1909 | 8.2S | 0.1E | SE | 12 | 7 | fast bedkt | 29.5 | 61 | 1015.0 | 28.9 | 1.0m | NW | 13kt |
| 8903 | 1912 | 7.6S | 0.3W | SE | 14 | 7 | fast bedkt | 30.1 | 61 | 1014.0 | 29.0 | 1.0m | NW | 13kt |
| 8903 | 1915 | 6.9S | 0.9W | SE | 9 | 7 | fast bedkt | 29.6 | 65 | 1011.4 | 29.4 | 1.0m | NW | 18kt |
| 8903 | 1918 | 6.3S | 1.3W | SE | 12 | 7 | fast bedkt | 29.6 | 67 | 1011.6 | 29.3 | 1.0m | NW | 13kt |
| 8903 | 2003 | 4.6S | 2.5W | ESE | 7 | | keine Beob | 29.5 | 69 | 1011.5 | 29.9 | 1.0m | NW | 13kt |
| 8903 | 2006 | 4.0S | 3.0W | SSW | 6 | | keine Beob | 29.0 | 69 | 1011.6 | 29.7 | 0.0m | NW | 13kt |
| 8903 | 2009 | 3.5S | 3.3W | S | 8 | 6 | wolkig | 29.3 | 72 | 1013.3 | 29.7 | 0.5m | NW | 13kt |
| 8903 | 2012 | 3.0S | 3.8W | S | 10 | 7 | fast bedkt | 29.8 | 70 | 1012.6 | 29.7 | 0.5m | NW | 13kt |
| 8903 | 2015 | 2.3S | 4.3W | S | 7 | 7 | Schauer | 28.2 | 70 | 1011.2 | 29.6 | 1.0m | NW | 13kt |
| 8903 | 2018 | 1.8S | 4.7W | NW | 9 | 8 | bedeckt | 26.9 | 74 | 1012.1 | 29.6 | 0.5m | NW | 13kt |
| 8903 | 2103 | 0.1S | 5.9W | NW | 7 | 9 | keine Beob | 28.9 | 72 | 1011.3 | 29.6 | 0.5m | NW | 13kt |
| 8903 | 2106 | 0.3N | 6.3W | W | 7 | 9 | Schauer | 28.9 | 69 | 1010.9 | 29.8 | 0.5m | NW | 8kt |
| 8903 | 2109 | 0.4N | 6.4W | WSW | 4 | 6 | wolkig | 29.9 | 67 | 1013.0 | 29.9 | 0.0m | NW | 3kt |
| 8903 | 2112 | 0.4N | 6.4W | uml | 2 | 3 | heiter | 30.8 | 63 | 1012.3 | 30.6 | 0.0m | Station | |
| 8903 | 2115 | 0.4N | 6.4W | uml | 2 | 3 | heiter | 30.7 | 61 | 1010.4 | 32.1 | 0.0m | Station | |
| 8903 | 2118 | 0.7N | 7.1W | SW | 7 | 6 | wolkig | 30.1 | 66 | 1010.6 | 30.2 | 0.5m | W | 13kt |
| 8903 | 2203 | 1.7N | 8.8W | W | 3 | | keine Beob | 29.4 | 67 | 1010.8 | 30.0 | 0.0m | NW | 13kt |
| 8903 | 2206 | 2.0N | 9.5W | uml | 2 | 6 | wolkig | 29.3 | 70 | 1011.0 | 30.0 | 0.0m | NW | 13kt |
| 8903 | 2209 | 2.3N | 10.0W | W | 5 | 6 | wolkig | 29.3 | 71 | 1012.8 | 30.1 | 0.5m | NW | 8kt |
| 8903 | 2212 | 2.6N | 10.5W | W | 4 | 5 | wolkig | 28.6 | 69 | 1013.6 | 30.3 | 0.5m | NW | 13kt |
| 8903 | 2215 | 2.9N | 11.2W | WNW | 3 | 7 | fast bedkt | 30.1 | 67 | 1011.1 | 31.0 | 0.0m | NW | 13kt |

| YYMM | DDHH | Latit. | Longit | DDD | FF | N | Wetter | TLTL | RF% | QNH | TwTw | See | dsvs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8903 | 2218 | 3.3N | 11.9W | SW | 4 | 4 | wolkig | 30.1 | 64 | 1010.6 | 30.6 | 0.0m | NW 13kt |
| 8903 | 2303 | 4.2N | 13.5W | W | 7 | 0 | heiter | 29.4 | 69 | 1011.1 | 30.3 | 1.0m | NW 13kt |
| 8903 | 2306 | 4.6N | 14.2W | WNW | 7 | 3 | heiter | 29.4 | 71 | 1011.1 | 30.0 | 1.0m | NW 13kt |
| 8903 | 2309 | 4.8N | 14.6W | WNW | 6 | 6 | wolkig | 29.4 | 70 | 1012.9 | 29.9 | 0.5m | NW 8kt |
| 8903 | 2312 | 5.1N | 15.2W | WNW | 9 | 6 | wolkig | 30.3 | 67 | 1013.9 | 30.3 | 1.0m | NW 13kt |
| 8903 | 2315 | 5.5N | 15.9W | WNW | 13 | 6 | wolkig | 29.8 | 68 | 1011.9 | 30.1 | 1.0m | NW 13kt |
| 8903 | 2318 | 5.7N | 16.3W | NW | 9 | 7 | diesig | 29.9 | 69 | 1010.7 | 29.6 | 1.0m | NW 8kt |
| 8903 | 2403 | 5.9N | 16.9W | WNW | 8 |  | keine Beob | 28.4 | 76 | 1012.7 | 29.0 | 1.0m | NW 8kt |
| 8903 | 2406 | 6.4N | 17.5W | WSW | 11 | 0 | heiter | 28.4 | 72 | 1011.3 | 28.9 | 1.5m | NW 13kt |
| 8903 | 2409 | 6.6N | 18.1W | W | 12 | 7 | diesig | 28.4 | 71 | 1013.0 | 28.8 | 1.0m | W 13kt |
| 8903 | 2412 | 7.0N | 18.7W | WNW | 11 | 7 | fast bedkt | 28.2 | 72 | 1014.3 | 28.6 | 1.5m | NW 13kt |
| 8903 | 2415 | 7.3N | 19.3W | WNW | 8 | 7 | fast bedkt | 28.6 | 62 | 1012.4 | 28.9 | 1.5m | NW 13kt |
| 8903 | 2418 | 7.7N | 20.0W | WNW | 10 | 6 | heiter | 28.6 | 64 | 1011.1 | 29.3 | 1.5m | NW 13kt |
| 8903 | 2503 | 8.7N | 21.9W | WNW | 10 |  | heiter | 26.2 | 68 | 1013.3 | 27.9 | 1.0m | NW 13kt |
| 8903 | 2506 | 9.1N | 22.6W | NNE | 12 | 2 | heiter | 25.8 | 69 | 1012.3 | 26.9 | 1.0m | NW 13kt |
| 8903 | 2509 | 9.4N | 23.1W | NNE | 15 | 7 | diesig | 25.8 | 70 | 1013.0 | 26.9 | 1.5m | NW 13kt |
| 8903 | 2518 | 10.4N | 25.1W | NNE | 11 | 7 | diesig | 25.9 | 68 | 1012.8 | 26.0 | 1.0m | NW 13kt |
| 8903 | 2603 | 11.5N | 27.1W | NNE | 18 |  | diesig | 24.9 | 72 | 1015.3 | 24.9 | 2.0m | NW 13kt |
| 8903 | 2606 | 11.9N | 27.8W | NE | 20 | 4 | diesig | 24.8 | 69 | 1014.4 | 24.6 | 2.0m | NW 13kt |
| 8903 | 2609 | 12.1N | 28.0W | NE | 21 | 5 | diesig | 24.9 | 70 | 1015.5 | 24.6 | 2.0m | NW 3kt |
| 8903 | 2612 | 12.1N | 28.0W | NE | 17 | 7 | diesig | 25.4 | 71 | 1017.2 | 24.8 | 2.0m | Station |
| 8903 | 2615 | 12.1N | 28.0W | NE | 17 | 6 | diesig | 25.6 | 72 | 1016.2 | 24.9 | 2.0m | Station |
| 8903 | 2618 | 12.6N | 28.0W | NNE | 18 | 6 | diesig | 25.4 | 72 | 1015.5 | 25.0 | 2.0m | N 8kt |
| 8903 | 2703 | 14.7N | 28.0W | NE | 23 |  | diesig | 24.1 | 73 | 1017.5 | 24.0 | 2.5m | N 13kt |
| 8903 | 2706 | 15.5N | 28.0W | ENE | 24 | 7 | fast bedkt | 23.5 | 70 | 1016.8 | 23.3 | 2.5m | N 13kt |
| 8903 | 2709 | 16.0N | 28.0W | NE | 26 | 7 | fast bedkt | 23.4 | 69 | 1019.3 | 23.2 | 2.5m | N 13kt |
| 8903 | 2712 | 16.6N | 28.4W | NE | 27 | 7 | fast bedkt | 23.5 | 66 | 1021.5 | 23.1 | 2.5m | NW 13kt |
| 8903 | 2715 | 17.2N | 28.8W | ENE | 28 | 7 | diesig | 23.4 | 67 | 1020.5 | 23.0 | 2.5m | NW 13kt |
| 8903 | 2718 | 17.8N | 29.3W | ENE | 25 | 7 | diesig | 23.0 | 65 | 1020.9 | 23.1 | 2.5m | NW 13kt |
| 8903 | 2803 | 19.6N | 29.1W | ENE | 24 |  | keine Beob | 22.5 | 59 | 1021.5 | 22.8 | 2.5m | N 13kt |
| 8903 | 2806 | 20.1N | 29.0W | ENE | 24 |  | keine Beob | 22.0 | 53 | 1021.0 | 22.6 | 2.5m | N 8kt |
| 8903 | 2809 | 20.7N | 28.9W | E | 18 | 7 | fast bedkt | 22.0 | 49 | 1023.1 | 22.6 | 2.5m | N 13kt |
| 8903 | 2812 | 21.4N | 28.8W | E | 22 | 7 | fast bedkt | 22.4 | 52 | 1024.3 | 22.4 | 2.0m | N 13kt |
| 8903 | 2815 | 22.0N | 28.7W | E | 17 | 7 | fast bedkt | 22.3 | 52 | 1023.5 | 22.3 | 2.0m | N 13kt |
| 8903 | 2818 | 22.7N | 28.5W | E | 17 | 7 | fast bedkt | 22.2 | 52 | 1022.6 | 22.3 | 1.5m | N 13kt |
| 8903 | 2903 | 24.6N | 28.2W | E | 13 | 9 | keine Beob | 21.8 | 47 | 1024.3 | 21.7 | 1.5m | N 13kt |
| 8903 | 2906 | 25.2N | 28.1W | E | 13 | 9 | keine Beob | 21.2 | 51 | 1023.4 | 21.4 | 1.5m | N 13kt |
| 8903 | 2909 | 25.3N | 28.0W | E | 14 | 7 | fast bedkt | 21.4 | 48 | 1023.5 | 21.5 | 1.0m | NE 3kt |
| 8903 | 2912 | 25.4N | 28.1W | E | 8 | 7 | fast bedkt | 22.1 | 43 | 1023.7 | 21.5 | 0.5m | NW 3kt |
| 8903 | 2915 | 25.4N | 28.1W | E | 11 | 2 | heiter | 21.6 | 52 | 1022.4 | 21.7 | 0.5m | Station |
| 8903 | 2918 | 25.4N | 28.1W | E | 7 | 1 | heiter | 21.6 | 54 | 1022.0 | 22.0 | 0.5m | Station |
| 8903 | 3003 | 26.9N | 26.8W | uml | 1 |  | keine Beob | 20.1 | 60 | 1022.1 | 21.2 |  | NE 13kt |
| 8903 | 3006 | 27.5N | 26.3W | S | 6 | 9 | keine Beob | 19.2 | 66 | 1020.9 | 20.2 | 0.5m | NE 13kt |
| 8903 | 3009 | 28.0N | 25.9W | SW | 6 | 4 | wolkig | 20.0 | 62 | 1020.8 | 20.1 | 0.5m | NE 13kt |
| 8903 | 3012 | 28.5N | 25.4W | SW | 7 | 4 | wolkig | 20.0 | 61 | 1020.8 | 20.4 | 0.5m | NE 13kt |
| 8903 | 3015 | 29.1N | 24.9W | SW | 9 | 6 | wolkig | 20.8 | 60 | 1019.0 | 20.5 | 0.5m | NE 13kt |
| 8903 | 3018 | 29.6N | 24.4W | W | 11 | 7 | fast bedkt | 19.3 | 64 | 1017.6 | 20.5 | 1.0m | NE 13kt |
| 8903 | 3103 | 31.3N | 23.0W | NNE | 8 | 9 | keine Beob | 17.2 | 71 | 1018.5 | 19.3 | 0.5m | NE 13kt |
| 8903 | 3106 | 31.8N | 22.4W | NNE | 11 | 9 | keine Beob | 16.9 | 69 | 1017.8 | 18.8 | 1.0m | NE 13kt |
| 8903 | 3109 | 32.3N | 22.0W | NNE | 6 | 4 | wolkig | 17.3 | 71 | 1018.8 | 18.9 | 0.5m | NE 13kt |
| 8903 | 3112 | 32.9N | 21.4W | S | 6 | 1 | heiter | 18.2 | 70 | 1020.7 | 19.4 | 0.0m | NE 13kt |
| 8903 | 3115 | 33.5N | 20.9W | ESE | 7 | 7 | fast bedkt | 18.2 | 68 | 1021.1 | 19.3 | 0.5m | NE 13kt |
| 8903 | 3118 | 34.1N | 20.3W | uml | 4 | 2 | heiter | 18.8 | 58 | 1021.5 | 19.4 | 0.0m | NE 13kt |
| 8904 | 0103 | 35.7N | 18.8W | SW | 8 | 9 | keine Beob | 17.4 | 66 | 1022.8 | 17.4 | 0.5m | NE 13kt |
| 8904 | 0106 | 36.3N | 18.3W | WNW | 13 | 9 | keine Beob | 16.8 | 77 | 1021.5 | 17.8 | 1.0m | NE 13kt |
| 8904 | 0109 | 36.6N | 17.9W | NNW | 21 | 7 | diesig | 16.3 | 80 | 1022.1 | 17.9 | 1.0m | NE 8kt |
| 8904 | 0112 | 37.1N | 17.4W | NNW | 25 | 8 | bedeckt | 14.9 | 67 | 1024.3 | 17.0 | 2.0m | NE 13kt |
| 8904 | 0115 | 37.5N | 17.1W | NNW | 20 | 7 | fast bedkt | 15.1 | 48 | 1024.2 | 16.9 | 2.0m | NE 8kt |
| 8904 | 0118 | 37.9N | 16.6W | NNW | 19 | 7 | fast bedkt | 14.7 | 48 | 1023.7 | 17.0 | 2.0m | NE 13kt |
| 8904 | 0203 | 39.2N | 15.4W | WNW | 15 | 9 | keine Beob | 13.4 | 48 | 1021.7 | 16.1 | 1.5m | NE 13kt |
| 8904 | 0206 | 39.6N | 14.9W | W | 22 | 9 | keine Beob | 13.5 | 56 | 1018.8 | 15.6 | 2.0m | NE 13kt |
| 8904 | 0209 | 40.0N | 14.5W | NW | 16 | 8 | bedeckt | 12.3 | 67 | 1016.4 | 15.4 | 2.0m | NE 13kt |
| 8904 | 0212 | 40.4N | 14.1W | NW | 26 | 7 | fast bedkt | 12.6 | 57 | 1014.0 | 15.5 | 2.0m | NE 8kt |

| YYMM | DDHH | Latit. | Longit | DDD | FF | N | Wetter | | TLTL | RF% | QNH | TwTw | See | dsvs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8904 | 0215 | 40.9N | 13.6W | WNW | 21 | 7 | fast bedkt | 11.5 | 55 | 1011.2 | 15.2 | 2.0m | NE | 13kt |
| 8904 | 0218 | 41.4N | 13.1W | NNW | 26 | 3 | heiter | 9.9 | 58 | 1009.1 | 15.5 | 2.5m | NE | 13kt |
| 8904 | 0303 | 42.9N | 11.6W | NNW | 18 | | keine Beob | 9.6 | 55 | 1005.6 | 13.9 | 1.5m | NE | 13kt |
| 8904 | 0306 | 43.3N | 11.1W | NNW | 25 | | keine Beob | 10.7 | 52 | 1003.5 | 13.8 | 2.0m | NE | 13kt |
| 8904 | 0309 | 43.8N | 10.7W | NW | 23 | 4 | wolkig | 10.9 | 54 | 1002.9 | 13.7 | 2.0m | NE | 13kt |
| 8904 | 0312 | 44.3N | 10.1W | NW | 11 | 5 | wolkig | 10.5 | 63 | 1002.2 | 13.5 | 1.0m | NE | 13kt |
| 8904 | 0315 | 44.9N | 9.5W | NNE | 20 | 6 | wolkig | 11.7 | 56 | 1001.5 | 13.8 | 2.0m | NE | 13kt |
| 8904 | 0318 | 45.4N | 8.9W | NNE | 26 | 8 | bedeckt | 11.2 | 66 | 1002.5 | 13.4 | 2.0m | NE | 13kt |
| 8904 | 0403 | 46.6N | 7.5W | NNE | 38 | 9 | keine Beob | 10.8 | 48 | 1006.3 | 13.0 | | NE | 8kt |
| 8904 | 0406 | 46.9N | 7.1W | NNE | 38 | 6 | wolkig | 9.4 | 65 | 1005.3 | 12.6 | 3.5m | NE | 8kt |
| 8904 | 0409 | 47.4N | 6.6W | NNE | 35 | 7 | fast bedkt | 6.8 | 73 | 1005.3 | 12.5 | 3.0m | NE | 13kt |
| 8904 | 0412 | 47.9N | 6.1W | NNE | 41 | 7 | fast bedkt | 8.1 | 62 | 1004.4 | 12.1 | 3.0m | NE | 13kt |
| 8904 | 0415 | 48.4N | 5.4W | NNE | 40 | 8 | diesig | 6.6 | 73 | 1002.5 | 11.9 | 3.0m | NE | 13kt |
| 8904 | 0418 | 48.8N | 4.8W | NNE | 36 | 8 | diesig | 7.8 | 58 | 1001.7 | 12.0 | 2.5m | NE | 13kt |
| 8904 | 0503 | 49.9N | 2.4W | NE | 28 | 9 | diesig | 7.6 | 83 | 996.9 | 11.2 | 1.5m | NE | 13kt |
| 8904 | 0506 | 50.1N | 1.4W | NE | 28 | 8 | diesig | 8.7 | 81 | 996.4 | 10.9 | 1.5m | E | 13kt |
| 8904 | 0509 | 50.3N | 0.1W | NE | 24 | 8 | diesig | 6.8 | 91 | 996.6 | 10.7 | 1.5m | E | 18kt |
| 8904 | 0512 | 50.6N | 1.1E | NE | 8 | 8 | diesig | 5.2 | 91 | 996.2 | 10.1 | 0.0m | NE | 18kt |
| 8904 | 0515 | 51.2N | 1.9E | uml | 4 | 8 | diesig | 6.5 | 89 | 996.2 | 10.0 | 0.0m | NE | 18kt |
| 8904 | 0518 | 51.8N | 2.7E | E | 12 | 8 | diesig | 6.5 | 93 | 996.7 | 9.6 | 0.5m | NE | 18kt |
| 8904 | 0603 | 53.4N | 4.8E | E | 15 | | keine Beob | 6.1 | 86 | 998.1 | 8.0 | 0.5m | NE | 16kt |

## 1.2.2 ANALYSIS OF DIMETHYL SULFONIUMPROPIONATE (DMSP) IN MARINE PHYTOPLANKTON

U.Karsten, G.Kirst, D.Meyerdierks

The sulphur-organic compound DMSP has been established in the last few years in a variety of planktonic microalgae and benthic macroalgae. The physiological importance of DMSP as an active osmotic substance was recently demonstrated in many types of green macroalgae. Other biological functions of this compound as a feeding deterrent and as a methyl group donor, are currently being discussed.

DMSP is split into dimethyl sulphide (DMS) and acrylic acid in water under slightly alkaline conditions. DMS is regarded as one of the most important volatile sulphur compounds in marine ecosystems, that is, about 25 % of all sulphur emissions are caused by DMS.

The aim of the investigation was to quantify the amount of DMSP in surface water phytoplankton during a leg from the south to the north Atlantic. The chlorophyll content and also the relationship between the DMSP content and the whole species range was to be investigated as a reference figure and biomass indicator, because, characteristically, the composition of species changes depending upon the climatic zones.

Sampling had to be standardized at the beginning of the cruise. It transpired that the membrane pump which feeds the on-board sea water system was unsuitable for sampling because too many algae were destroyed (microscopic check). Scooping water with a bucket from the ship´s stern proved in comparison to be very effective. Standardized water samples were taken daily at 8.30, 12.30 and 16.30, parallel with Ernst´s group and D. Tanzer (Heumann´s group), and were pre-filtered through a 200 µm mesh.Two 3 litre batches of sea water from each sample were filtered through a Whatman GF/C glass fibre filter for DMSP analysis, and then immediately packed in aluminium foil and frozen at a temperature of -80° C. Similarly, two 3 litre batches of sea water were filtered for chlorophyll analysis and the filter was then frozen in a closed plastic vial at -40° C. 220 ml of sea water were preserved with 4 ml of 37 % formaldehyde solution to establish the organism count and composition of species.

More than 100 samples were taken which are to be examined in the home laboratory. The majority of the samples were scooped from the surface water. In addition, 2 profiles up to a depth of 250 m were sampled.

The filters used for DMSP analysis are incubated for 2 hours with 25 % NaOH in a gas-sealed container (for algae break down and splitting DMSP into DMS and acrylic acid) and the resulting DMS is quantitatively determined using gas chromatography. The filters used for chlorophyll analysis are exracted in plastic vials with 90 % acetone and, after being in a centrifuge, the chlorophyll is photometrically determined. The composition of species and their concentrations are determined microscopically. The results are to be compared with the measurements of the other groups.

Algae concentration was all in all very low. Even in the up-welling areas, where one normally finds high plankton content, population density was much lower than expected. In view of the abundant neuston catches, it can be assumed that algal bloom had already taken place. The very low nutrient levels also support this assumption.

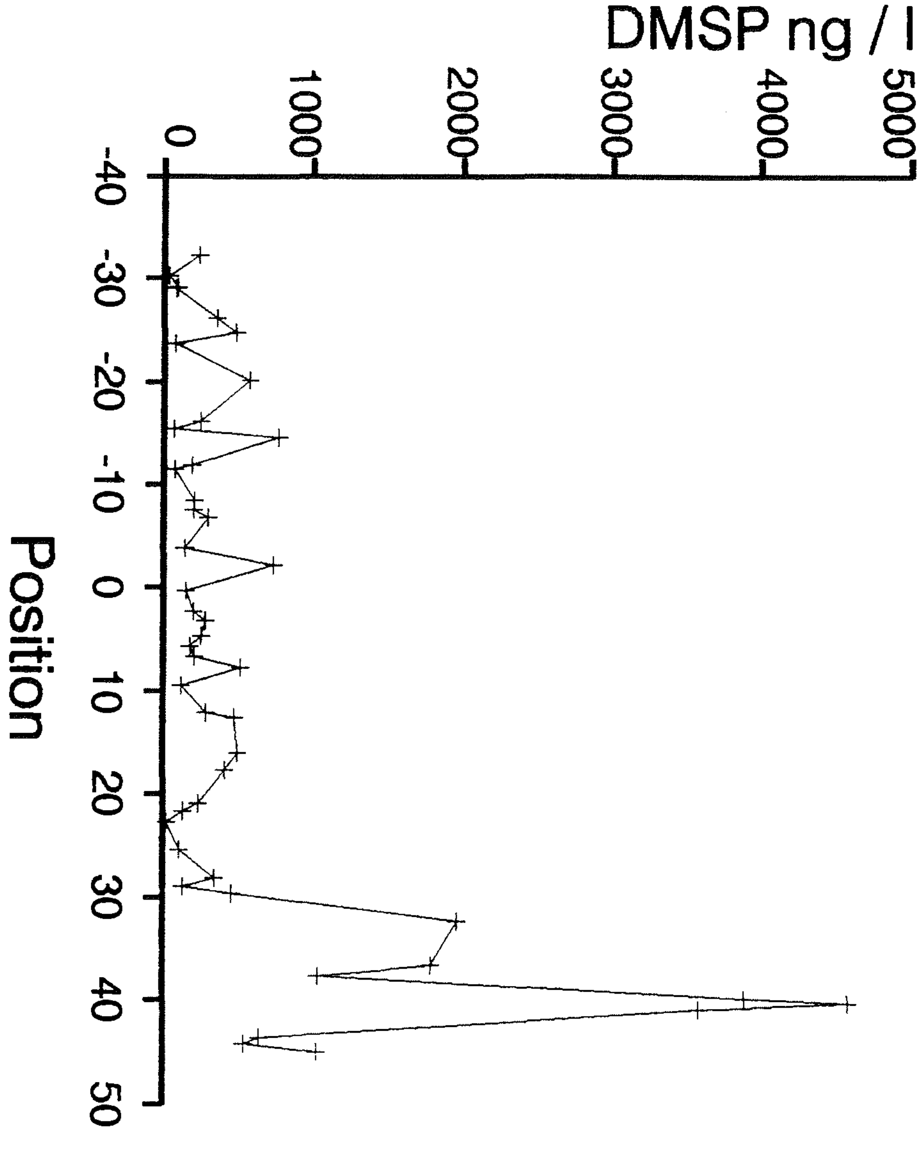



Figure 57: DMSP contents of marine phytoplankton after filtration through GF/C-filters

## 1.2.3 ATMOSPHERIC CARBONYLSULPHIDE (OCS) MEASUREMENTS OVER THE ATLANTIC

H.G.Bingemer, K.Jaeger, O.Schrems

The only natural gaseous sulphur compound in the atmosphere with a lengthy life-time is OCS. Its dwelling time in the atmosphere is estimated to be about 2.5 years. As a consequence of this, OCS is the dominant gaseous sulphur compound in the troposphere. A considerable portion of OCS is reaching the stratosphere. Here, OCS is first of all oxidized into $SO_2$ and this is eventually transformed into $H_2SO_4$. The sulphuric acid, in turn, forms stratospheric sulphate aerosols which affect the balance of radiation and the earth's climate.

Present information indicates that the global distribution of OCS is quite uniform. Originally it was thought that the oceans were the main sink for atmospheric OCS, whereas nowadays they are regarded as being the main source. Its global production rate is estimated to be about 5 Tg/year ($1 Tg=10^{12} g$). OCS is formed via photolysis from dissolved sulphur compounds which are probably of biogenic origin but have not yet been clearly identified. A number of other sources of atmospheric OCS have become known in the last few years:

- microbial production in soil
- the burning of biomass
- $CS_2$ photolysis with ensuing oxidation to OCS

The direct contribution of biospheric processes are at the present time thought to be about 1 Tg/year whereas estimates for anthropogenic emissions move between 1-5 Tg/year. Volcanoes appear to be only of minimal importance as a source of OCS. Processes to remove OCS from the atmosphere are at present not well known. It is assumed that about 1 Tg OCS a year are transported to the stratosphere. A large part of OCS is presumably absorbed by vegetation, although there are no available data concerning this.

Because of the relevance of OCS for the balance of radiation and the earth´s climate, a larger anthropogenic contribution to atmospheric OCS would raise the following important questions:

is there a world-wide trend for atmospheric OCS?

is the inflow of sulphur via OCS into the stratosphere larger than in preindustrial times, and, coupled with this,is compensation for the "greenhouse effect" from stratospheric overcasting observable?

Measurements of atmospheric OCS concentrations over the Atlantic were carried out between latitudes 33° S and 51° N. The air samples were obtained via cryogenic enrichment during which the air´s trace compounds were frozen with liquid argon. Immediately afterwards, a gas chromatographic analysis was carried out using a FPD-detector. The equipment for both air sampling and gas chromatography were installed on the "Polarstern's" upper deck in the air-chemistry container. The sampling was carried out via a Teflon tube (approx: 2 m long) on the starboard fore side of the upper deck, about 20 m above sea-

level. The direct connection of the freezing equipment with the GC system prevented contamination of the samples, as well as possible chemical reactions caused by the samples standing too long. Analyzing the samples at the upper deck has its drawbacks during rough weather because the whole apparatus is sometimes subject to heavy vibration. The air samples (drawn in volume = 3 litres) were taken in a 6 hourly cycle at, all in all, about 100 different geographical positions. The air's $H_2O$ content was removed utilizing a permeation gas dryer before the trace compounds were frozen out.
The air was drawn in at a constant flow rate of 200 ml/min through a glass cold trap filled with silylated glass-wool which was kept in liquid argon. The resulting OCS sample was condensed in a small injection trap and from there injected into the GC-column by means of a hot water bath. The chromatographic separation resulted at 40° C via a Teflon column which was packed with Carbopack B 100 HT. The GC system was calibrated daily utilising a permeation standard as well as gas mixtures of known concentrations.
Our analysis indicates an even OCS distribution in the troposphere in both north and south hemispheres. OCS concentrations in the region of 500-600 ppt are found there. An exact analysis of the measured data will be forthcoming only after including all available meteorological data.

### 1.2.4 MEASURING GASEOUS NITRIC ACID USING THE LASER-PHOTOLYSIS-FRAGMENT-FLUORESCENCE (LPFF) METHOD

A.Kaes, Th.Papenbrock

Gaseous nitric acid in the atmosphere constitutes a stable end product of the so-called NOX chemistry. Whilst the precursory substances, mainly nitrous oxide, are relatively short lived, nitric acid can attain a lifespan of up to 8 days in the atmosphere. This long dwell period can lead to nitric acid being transported with the air masses over large distances. This means, on the other hand, that certain concentrations of nitric acid can be established well away from the area where they are formed.
The LPFF method represents a direct method to quantively establish the prescence of gaseous nitric acid in the air. A laser beam with a wave length of 193 nm splits the $HNO_3$ molecules into two fragments, namely $NO_2$ and OH radicals. During the splitting process, the OH fragments receive a large amount of surplus energy which is given up in the form of radiation. The intensity of this fluorescent radiation at 309 nm is a direct measurement of the nitric acid concentration in the analysed air and constitutes the actual measuring signal. The process is calibrated with synthetic $HNO_3$/air mixtures which are photolyzed in various concentrations in the measuring chamber. The resulting dependence of the fluorescence intensity on the air $HNO_3$ content describes the calibration function, with the help of which the actual $HNO_3$ concentration outside can be determined.

The time required for an analysis using our method for a detectable limit of 30 ppt $HNO_3$ in air is approximately 60 min. per measurement. The purpose of our participation on the cruise from Cape Town to Bremerhaven along the African west coast was - as far as possible - to provide a continuous quantitive analysis of nitric acid concentration in the air. We expected the $HNO_3$ concentration to depend upon the time of day, sunlight intensity as well as geographical position and meteorological parameters.
Another area of work on board was the continuous recording of the ozone concentration about 15 metres above the water surface. A commercial measuring device was used for this (DASIBI MODEL 1008 AH) which was put at our disposal by the Institut für Atmosphärische Chemie der Kernforschungsanlage, Jülich.

Preliminary results

An extensive evaluation of the measurement results will only be possible after some time due to the mass of data available. As a preliminary result we can say:

1. From between latitude 15° S as far as the English Channel, the $HNO_3$ concentration in the outside air was continuously measured. Two hourly measuring periods were arranged in which for the first hour the outside air was sampled, and in the second, pure synthetic air was measured. The concentrations of nitric acid in the air lay mainly between 30 and 150 ppt whereas peaks of about 320 ppt were registered in those sections of the cruise near the African mainland.

2. The ozone measurements extended from latitude 20° S as far as the northern part of Biscay. The actual ozone concentration was continuously registered at 30 second intervals. In the south-north direction, a general rise in the ozone concentration was ascertained.

## 1.2.5 INVESTIGATION OF HEAVY METALS IN SEA WATER, NEUSTON AND MULTI-NET CATCHES

E.Helmers, J.Modersitzki, C.Pohl, M.Schulz-Baldes

Surface water samples and neuston organisms were collected continuously and partly investigated on board for heavy metals, and partly prepared for analysis in the AWI. The horizontal heavy metal distribution is to be correlated with hydrographical, chemical and biological parameters. Various surface currents were encountered on this leg: Benguela Current, South Equatorial Current, Guinea Current, Equatorial Counter Current, North Equatorial Current, Atlantic Recirculation, Canary Current and the Portugal Current. A particular aim was to investigate the correlation of metal concentration in water with the metal content of organisms. Individually selected neuston organisms are to be investigated for their metal inventory and the variation of these data with location.

Investigations into the biogeochemical cycle of heavy metals are to be started with this, in particular into the role of plankton in heavy metal binding, in chemical transformation and in transportation into the deep sea.
In addition, a newly constructed "clean room" container was used and tested for the first time. The 20´ container consists of an outer room containing the air circulation, air filtration, air conditioning installations and a refrigerator and deep freezer and a work room (class 10,000 particles/$m^3$). This room contains in addition a clean bench (class 100 particles/$m^3$), a vent with separate in and out ports, a Milli-Q-pure water apparatus and a work bench.
An aluminium neuston sledge was used for neuston catches, on which 8 nets in 4 groups were mounted. The mouth opening of the nets was 30 x 15 cm. Each group consisted of 2 nets, the top one fished in the range 0 to 8 cm, the lower one in the range 10 to 25 cm below surface. The mesh size was 330 $\mu$m, as in the utilized gauze-net beakers. The catches from both nets were combined. The neuston sledge was trawled twice daily about 10 m to the side of the ship at a speed of 4 kn over a 15 min period, the first time 20 min before sunrise, the second 20 min after sunset.
After the catch, single individuals were isolated under binocular microscopes, grouped under various systematic taxa and deep frozen in pre-cleaned 2 ml Eppendorf vials, PP vials or 50 ml Kautex flasks. After freeze drying and acid digestion, an analysis of lead, cadmium, copper and possibly nickel and zinc will take place in the laboratory with the aid of flameless Zeemann-AAS.
A snorkel system 3 m under the ship´s bottom with a direct pipe to the "clean room" container was originally planned for continuous water sampling. The snorkel could not unfortunately be used with the available, unlockable lid in the hydrographical moon pool due to high vibration.
A fully Teflon 500 ml-water sampler with titanium fittings (Mercos-sampler, HYDROBIOS) was used for water sampling from the bow boom. The Mercos-samplers were used - with the ship stationary - from the bow boom 8 m in front of the ship´s bow, 14 m above the water surface, using a high grade steel winch, a 5 mm Kevlar line and a counterweight covered with synthetic material, and operated in about 1 - 2 m of water depth. For comparison water samples were taken by hand from a rubber dinghy at two stations at a distance of 1 - 2 km from the ship.
For vertical zooplankton sampling, a multinet - 5 nets with 200 $\mu$m mesh size and a mouth opening of 50 x 50 cm - was used. The heave speed was 1 m/sec. In order to prevent metal contamination from the ship and the wire, 10 liter GO-FLO samplers were used for deep water sampling and driven on a Hostalen covered wire.
Both equipments were operated down to 1200 m. In this way two central bodies of water could be sampled in the Angola Basin, the Guinea Basin and the Sierra Leone Basin. In the first place, the South Atlantic Central Water with its warm surface layer and secondly, the water immediately below that, the Antarctic Intermediate Water. For both northerly deep water stations - the Cape Verde and Canary Basins - inflows from the Eastern North

Atlantic Central Water and that under it, the Mediterranean Water, will appear during analysis.
The biomass in the multi-net catches was very small. Copepods, chaetognaths, decapods, euphausiids, fish larvae and hyperiid amphipods were preserved for metal analysis. It was, however, remarkable that especially at depths of 800 - 1200m, large individual copepods and chaetognaths were found.
Anodic stripping voltammetry on a rotating mercury film electrode made it possible to analyse the concentration of cadmium, lead and copper on board the ship in spite of their very low content in the Atlantic water.
The polargraph and cell stand equipment used were types 384B and Rotel 2 from the EG&G PAR company. The cell stand was operated in the clean bench where the samples were also bottled and acidified (40 - 50 ml sea water plus 1 µl HCl suprapure/ml sea water).
Because of their low concentrations, the metals were enriched for 50 minutes on ex-situ-modus generated mercury film. During the following "stripping", the voltage range from -0.85 V to -0.1 V was run at a rate of 6.7 mV/s. The oxidation potential lay atabout -0.76 V for Cd, -0.55 V for Pb and -0.40 V for Cu. After the first and second spiking with a metal standard, the enrichment time was reduced by a half and then by a third.
The remaining samples are to be worked on in the AWI. Furthermore, all samples are to undergo UV photolysis and once again measured. This achieves better resolution of the peaks and suppresses disturbances from DOM.
At 43 stations 450 neuston samples were gathered and assigned to various systematic categories, which are compiled in Table 17.

Table 17. COMPILATION OF NEUSTON ORGANISMS

| Species | no of samples |
|---|---|
| CNIDARIA | |
| Siphonophora | 1 |
| Velella | 12 |
| Physalia | 4 |
| Porpita | 15 |
| other Cnidaria | 2 |
| ACNIDARIA | 1 |
| PLATHELMINTHA | |
| Planaria | 1 |
| ANNELIDA | |
| Polychaeta | 2 |
| CHAETOGNATHA | 4 |

Tab. 17 cont'ed

| Species | no of samples |
|---|---|
| MOLLUSCA | |
| Heteropoda | |
| Pterotrachea | 8 |
| Atlanta | 17 |
| Pteropoda, thecosomat | 31 |
| Pteropoda, gymnosomat | 3 |
| Glaucus | 3 |
| Janthina | 14 |
| Nudibranchia | 2 |
| Cephalopoda | 11 |
| INSECTA | |
| Halobates micans | 17 |
| CRUSTACEA | |
| Isopoda | 8 |
| Copepoda | 26 |
| Pontellidea | 9 |
| Sapphirinidae | 2 |
| Cirripedia | |
| Lepas | 1 |
| Ostracoda | 1 |
| Amphipoda | |
| Hyperiidea | 38 |
| Oxycephalidae | 2 |
| Phronima | 4 |
| Hyperiidea, "lilac" | 6 |
| Mysidacea | 27 |
| Euphausiacea | 19 |
| Decapoda | |
| Natantia | 13 |
| Luzifer | 3 |
| Reptantia | 7 |
| Phyllosoma-Larvae | 3 |
| TUNICATA | |
| Thaliacea | 12 |
| Pyrosoma | 2 |
| VERTEBRATA | |
| Pisces | |
| Myctophida juv. | 19 |
| Exocoetidae juv. | 16 |
| Scomberesox saurus juv. | 26 |
| Coryphaena equiselis juv. | 9 |
| Mola mola juv. | 2 |
| other fish larvae | 17 |

Heavy metal analyses carried out on board with the aid of stripping voltammetry are shown in table 18.

Table 18. CONCENTRATIONS OF CADMIUM, LEAD AND COPPER IN SOUTH AND NORTH ATLANTIC WATERS

| Station | Lat. Degr. +N/-S | Min | Long. Degr. +E/-W | Long Min | Cadmium ng/l | Lead ng/l | Copper ng/l |
|---|---|---|---|---|---|---|---|
| 1 | -31 | 28,5 | 13 | 16,7 | 3,0 | 30,0 | 95,0 |
| 2 | -30 | 13,5 | 10 | 23,1 | 2,3 | | 48,0 |
| 3 | -28 | 59,7 | 9 | 13 | 1,4 | 16,0 | 65,0 |
| 4 | -26 | 16,9 | 9 | 11,5 | 1,7 | 45,0 | 78,0 |
| 5 | -23 | 19,5 | 9 | 9,8 | | | |
| 6 | -20 | 33,5 | 9 | 9,8 | | 28,0 | |
| 7 | -18 | 52,1 | 8 | 14,6 | 4,0 | | 55,0 |
| 8 | -16 | 36,4 | 6 | 28,9 | 3,2 | | 51,0 |
| 9 | -14 | 3,9 | 4 | 31 | | | |
| 10 | -11 | 56,3 | 2 | 55,3 | | | 49,0 |
| 11 | -10 | 55,4 | 2 | 9,1 | 2,8 | | 54,0 |
| 12 | -8 | 45 | 0 | 33 | 2,0 | 19,0 | 58,0 |
| 13 | -6 | 11,5 | -1 | 25 | 3,1 | | 67,0 |
| 14 | -4 | 1,8 | -2 | 59,2 | 2,8 | | 54,0 |
| 15 | -1 | 36,1 | -4 | 48,8 | 3,5 | 10,0 | 65,0 |
| 16 | 0 | 21 | -6 | 24,3 | 1,5 | | 33,0 |
| 17 | 0 | 20,7 | -6 | 26,2 | | | |
| 18 | 0 | 50,1 | -7 | 21,6 | 2,9 | 9,5 | 67,0 |
| 19 | 2 | 3,9 | -9 | 34,4 | | | |
| 20 | 3 | 27,3 | -12 | 8 | 2,2 | 9,3 | 41,0 |
| 21 | 4 | 38,3 | -14 | 19,1 | 1,5 | 8,5 | 51,0 |
| 22 | 5 | 40,4 | -16 | 20,3 | 2,5 | 5,0 | 54,0 |
| 23 | 6 | 28,1 | -17 | 42,6 | 2,3 | 5,1 | 49,0 |
| 24 | 7 | 57,5 | -20 | 27,7 | | | |
| 25 | 9 | 12,8 | -22 | 48,4 | | | |
| 26 | 12 | 8,8 | -28 | 0,1 | 2,7 | 7,0 | 67,0 |
| 27 | 13 | 15,4 | -28 | 1 | | | |
| 28 | 15 | 47,4 | -28 | 0,1 | 4,6 | 7,8 | 58,0 |
| 29 | 18 | 0,5 | -29 | 16,5 | | | |
| 30 | 20 | 27,5 | -28 | 57,3 | 4,3 | 7,7 | 55,0 |
| 31 | 23 | 19,7 | -28 | 27,5 | 4,7 | 29,0 | 59,0 |
| 32 | 25 | 18,5 | -28 | 3,9 | 4,6 | 14,0 | 49,0 |
| 33 | 25 | 55,3 | -27 | 42,4 | 3,6 | 15,0 | 58,0 |
| 34 | 27 | 43,3 | -26 | 6,9 | 3,0 | 23,0 | 87,0 |
| 35 | 30 | 5,5 | -24 | 1,4 | 2,6 | 51,0 | 63,0 |
| 36 | 32 | 1,5 | -22 | 14,7 | 2,4 | 15,0 | 67,0 |
| 37 | 34 | 29,9 | -19 | 56,7 | 2,5 | | 147,0 |
| 38 | 36 | 24,9 | -18 | 8,1 | 2,2 | 18,0 | 62,0 |
| 39 | 38 | 12,8 | -16 | 21,9 | | | |
| 40 | 39 | 43,3 | -14 | 51,2 | | 21,0 | 91,0 |
| 41 | 41 | 45,8 | -12 | 47,2 | | | |
| 42 | 43 | 22,8 | -11 | 4,1 | 6,2 | 26,0 | 60,0 |
| 43 | 45 | 43,5 | -8 | 33 | | | |

## 1.2.6 INVESTIGATION OF INORGANIC AND ORGANIC TRACE COMPOUNDS OVER THE ATLANTIC

N.Rädlein, D.Tanzer

The main emphasis of our tests on inorganic trace compounds was the collection of aerosol samples to analyse the following environmentally relevant heavy metals: thallium, copper, cadmium, lead, zinc, nickel, chrome and iron. For the first time, a five stage impactor was used for the collection of aerosol samples according to size.
Continuous sampling began on 13.3.89 on "Polarstern's" upper deck a day after sailing from Cape Town. The complete aerosol residue on the cellulose nitrate filters (pore size 8 µm) was sucked off at 12 hourly intervals, and parallel to that, the five stage impactor was put into operation, and sea spray was separated before. The aerodynamic diameters of the individual particle fractions include:

| | | |
|---|---|---|
| 1. step: | > | 7.2 µm |
| 2. step: | 3.0 - | 7.2 µm |
| 3. step: | 1.5 - | 3.0 µm |
| 4. step: | 0.95 - | 1.5 µm |
| 5. step: | 0.49 - | 0.95 µm |
| Backup: | < | 0.49 µm |

The separating effect of the impactor was clearly seen in the area where dust from the Sahara entered it (approx: between latitude1° N and 16° N). The large sand particles - up to 1.5 µm - precipitated with a red-brown colour on the first three impactor positions whilst those particles with a smaller aerodynamic diameter were found with a dark brown to black colour on the following positions. Preparation of the samples to establish the total content of the elements thallium, cadmium, lead and zinc were carried out on board "Polarstern" for the mass spectrometrical isotope dilution analysis (MS-IVA) process. The measurement itself as well as finishing the work on the impactor measurements are taking place at the institute in Regensburg. The concentration of the other elements over and above the average values for the earth´s crust - and thereby possible anthropogenic influences - are to be established by determining the content value of the element iron. An indication of aerosol sources is expected from their size distribution pattern in the impactor analysis. Questions of element distribution and element-element correlation in top surface water and in aerosols are also to be investigated in cooperation with the heavy metals work-group of the AWI´s chemistry section.
The aim of further investigations was the quantitative analysis of volatile biogenically formed sulphur and selenium compounds and halogenated hydrocarbons in sea water. The parallel determination of DMS, the most important biogenic sulphur compound, and the halogenated hydrocarbons MeI, MeBr and MeCl should provide information about a possible common formation mechanism. By gas chromatography using a flame

photometric detector, it was possible to continually analyse water samples for volatile sulphur and selenium compounds on board. The compounds were driven out of the water samples (between 10 and 30 ml) with helium, enriched in a cooling trap with liquid nitrogen and separated in a capillary column. The water samples were taken together with the ATP- and DMSP working groups using a bucket from the ship´s stern. Apart from the regular sampling (at 8.30, 12.30 and 16.30), samples were often taken in a two-hourly cycle, and in several depth profiles which were also immediately analysed. Halogenated hydrocarbon analysis will take place in a laboratory at the University of Regensburg according to the same measuring principle but with an electron capture detector. In addition, 55 water samples were shrink-wrapped in glass containers and deep-frozen. At the same time, 60 water samples were cryogenically enriched on Tenax GC on the ship´s upper deck. The analysis which resulted from thermal desorption was partly carried out on board.
Direct gas chromatographic analysis made possible a comparison of measurement results with other groups. A correspondence was revealed with the ATP results from Ernst´s group and the chlorophyll results from Ohm´s group. A comparison with DMSP content - the direct DMS precursor - will take place with the results of the Karsten, Meyerdierks, (Kirst group).
The ascertained DMS concentrations in the top surface water span a range from 30 to 550 ng/l. The highest concentrations were found in the Iberian Basin, in an area in which rich neuston catches of mainly young animals (Schulz-Baldes group) point to a recently present Algal bloom. The sulphur compounds COS, $CH_3SH$, $CS_2$ and DMDS were found as well as the main component, DMS.

## 1.2.7 DETERMINATION OF NUTRIENTS

H.Becker, M.Fütterer, G.Kattner

The nutrients nitrate, nitrite, phosphate and silicate were constantly determined from Cape Town to the English Channel with an autoanalyzer system. The water was sucked up from a depth of about 7 m via the ship´s pure sea water pipe and then pumped into the analysis system. The analyses were carried out in 4-hourly cycles. After each 4-hourly measuring phase, measurements were interrupted in order to calibrate and service the equipment. Results were recorded on a printer, and stored every two minutes.
Furthermore, nutrients were determined from all the various samples from the five deep water stations in order to get an impression of the expanse of the nutrient-deficient surface layer, and in order to be able to carry out a characterization of the bodies of water at the greater depths. As an example, Fig. 58 shows the nutrient distribution in the southern Canary Basin.
The concentration of nitrate and nitrite during the whole cruise was almost below the equipment´s recording level, that is, the nitrogen containing nutrients were used up and thereby limiting phytoplankton growth. The first signs of measurable nitrate

concentrations were detected only between latitudes 41° N - 42° N, which then continuously rose, sometimes sporadically, up to 4 µmol/l, as far as the English Channel.
The phosphate concentrations were similarly very low, but in most cases still measurable. A rise of 0.3-0.4 µmol/l resulted parallel to the nitrate increase.
Silicate showed variations in concentration between 0 and 2 µmol/l during the whole cruise. These variations are possibly related to the various bodies of water in the Atlantic. Only the final evaluation can reveal further details. The data is to be compared and evaluated with the hydrographical results from Ohm´s working group (such as salinity, temperature, chlorophyll and turbidity).

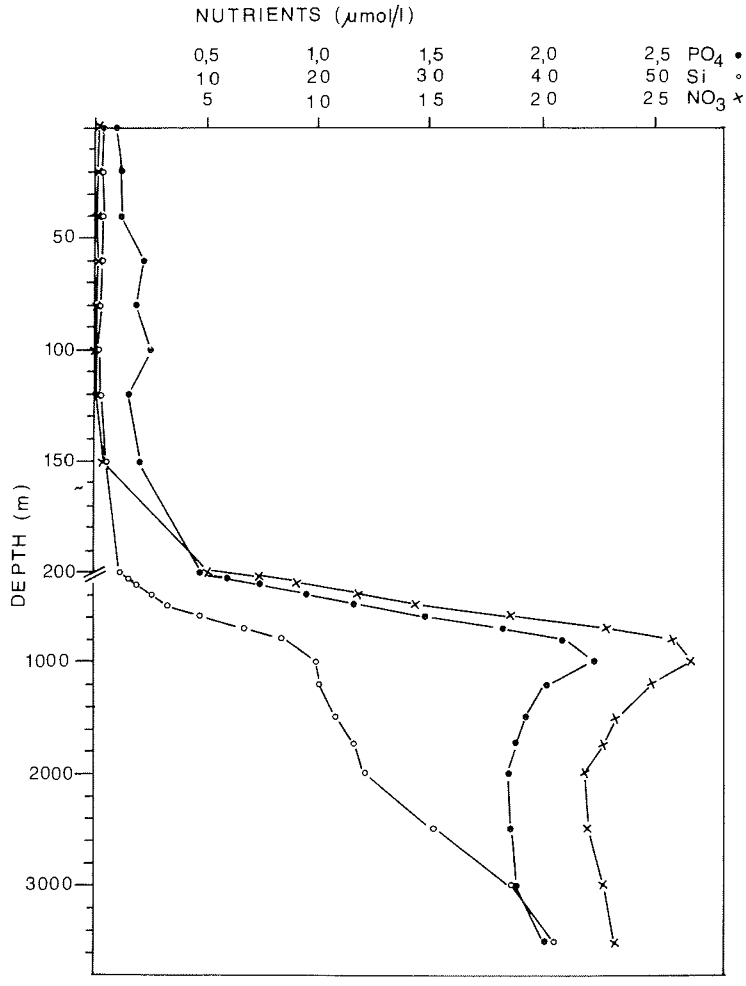



Figure 58: Vertical profiles of nitrate, silicate and phosphate at St. 14/374 (Canary Basin, 25°23'N 28°07'W)

## 1.2.8 ORGANIC TRACE COMPOUNDS IN WATER

W.Drebing, K.Weber

The first two days of the cruise were used for the installation work and equipment testing. The ship's own sea water supply system (Klaus pump/V4A-pipe) was started shortly after sailing and run during the entire cruise to prevent contamination. It was used to supply a continuously operating sea water extraction apparatus. Additionally, two modified Gerard-Ewing samplers were employed for deep water sampling.

Sectional samples of air and surface water were taken from the ocean-atmosphere boundary layer as discrete samples from bottom and intermediate water. Sectional water samples were sucked up at about 5 t/h from a tube on the ship's keel and at full speed of the ship. From this, 6 t were continuously extracted within 12 h with 5 l n-hexane in an extraction cycle of 50 l/h. Sectional samples of air were sucked up at a rate of 75 $m^3$ per hour through a pipe (150 x 20 cm) 6 m above the water surface, also at full speed of the ship. The air sucked up during 12 h was fed through a modified Gerard sampler, used as an exchange column, and brought into distributional equilibrium with 100 l sea water. The sea water - loaded with atmospheric trace compounds - was consecutively and continuously extracted with 5 l n-hexane as above and afterwards fed back as counterflow for the exchange process. Deep water samples were extracted during a 12 hour cycle with 5 l n-hexane. In this case water and extract were covered with argon during extraction in order to prevent contamination from the ship's atmosphere. Rainwater could not be collected in sufficient quantities in spite of staying for a relative long time within the intertropical convergence zone and occasional route changes following satellite pictures and radar observations.

All in all, 7 extracts were prepared from each 6 t of Atlantic surface water, 5 extracts from each 1000 $m^3$ high oceanic air, 4 extracts from Atlantic intermediate water samples (each one 0.4 t at depth 750 to 1000 m) and 6 extracts from samples of Atlantic bottom water (each one 0.4 t at depth 4500 to 5500 m).

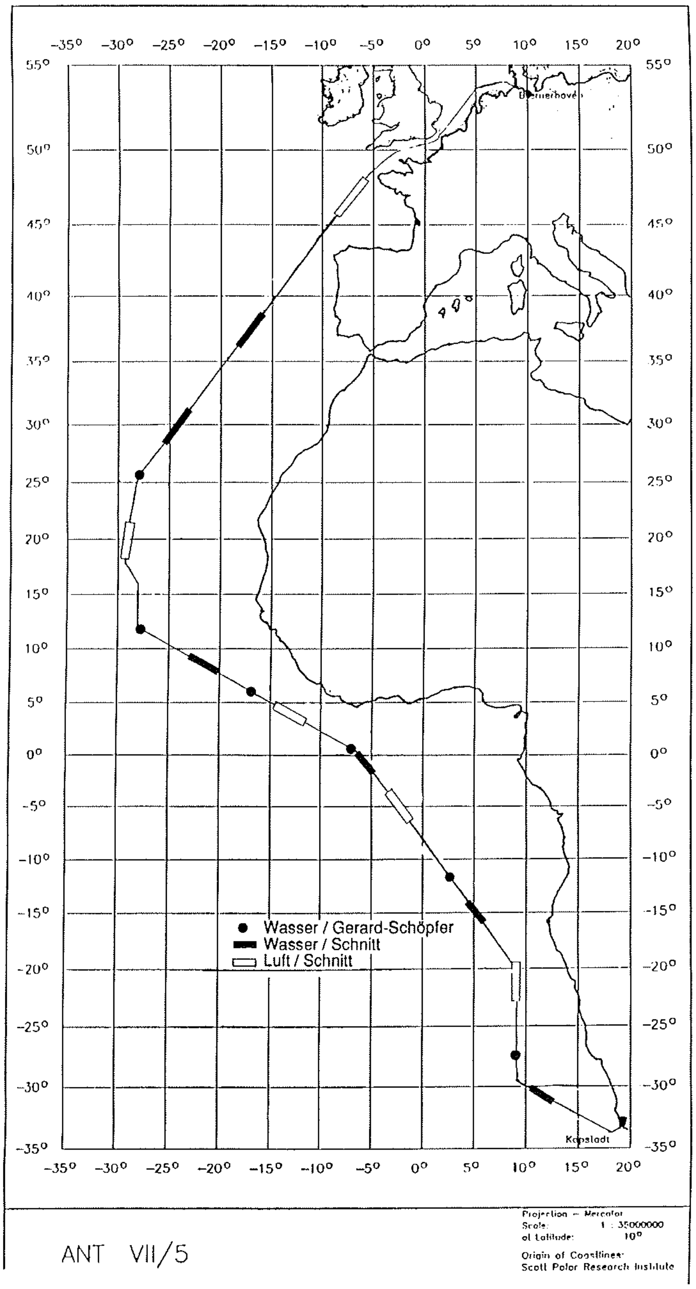



Figure 59: Location and type of sampling for organic trace analysis
● Gerard sampler, water
▬ Sectional sampling, water
▭ Sectional sampling, air

## 1.2.9 ORGANIC TRACE COMPOUNDS IN ORGANISMS

W.Breitschuh, A.Jurr

It was the aim of this cruise to collect material from neuston for xenobiotic compound analyses. Neuston was chosen as representatives of the top water layer, they should reflect an input of trace compounds from the atmosphere through enrichment in their lipids.
Samples were collected for this purpose during the cruise at 43 stations using a neuston sledge. The sledge was trawled for 15 minutes shortly before sunrise and shortly after sunset at a speed of 4 knots. Eight nets with 300 μm holes were fitted onto the sledge so that they fished at about 20-30 cm into the top water column. The content of the 4 net beakers were combined and used for the investigation of organic trace material. The organisms were sorted out immediately after the catch and stored in aluminium foil (pre-cleaned with n-hexane) at -26° C for further analyses.
Samples of copepods were obtained at 29 stations and of hyperiids at 28 stations. In the same way, young fish and fish larvae were generally caught, apart from at the last station.
Simultaneously to the neuston catches, water samples were taken at 32 stations which are to be utilized for a comparison of the concentration of the substances under study in organisms and water. These water samples were taken with the aid of a grade steel pipe from 10 m depth. They were extracted on board with n-hexane, cleaned over aluminium oxide (neutral, 5 % water content) and melted into ampoules. The concluding analyses will be carried out by multi-dimensional gas chromatography in the AWI.
A sample of sufficient quantity and homogenity was preserved in methanol/chloroform for lipid pattern analysis, in order to answer the question whether a connection exists between lipid pattern and the organisms bioaccumulation potential. The processing of these samples will continue in the AWI in cooperation with Kattner´s group.

## 1.2.10 PARTICLE FLUX TO THE SEA FLOOR

D.Hebbeln

The interpretation of events in geological history from the analysis of marine sedimentation demands an exact knowledge of the sedimentary formation process. Seasonal changes of particle flux to the sea floor and, indirectly, the seasonal variability of productivity in the upper surface water is ascertained utilising a time operated sediment trap. The sinking particles from the euphotic zone supplies not only a large part of the material for sediment formation but also influences the remineralization of nutrient salts in the water column and thereby the whole material balance of the sea. Particle flux constitutes the primary nutrient source for deep sea benthos and is simultaneously a precondition for the introduction of environmental signals into the sediment.

In March 1988, a mooring with a sediment trap and a current meter was put into place by the RV "Meteor" in the Benguela Current over the Walvis Ridge. It was successfully recovered on 16.3.89. Due to technical problems, the sediment trap worked for only 2 months so that only a general sample with no temporal resolution for the rest of the time was obtained. Light microscopic and REM preparations were produced on board from the available samples.
A new mooring with 2 sediment traps was put into place at the same position (20°02.8'S, 09°09.3'E, 2196 m depth). The two sediment traps are situated at different depths. The possibility is therefore created to investigate variations in particle flux according to depth. Conclusions about material conversion in the water column can then be made from the differences in the material collected and in connection with remineralization and resolution phenomena. This mooring is to be recovered again in March 1990.

## 1.2.11 MEASUREMENT OF THE OPTICAL PROPERTIES OF WATER

W.Baranski, K.Ohm

Chlorophyll and gelbstoff-fluorescence sensors as well as temperature and conductivity probes were mounted in the hydrographical shaft to analyse the optical properties of sea water in various water masses.
As opposed to those used on cruise ANT VII/1, the probes were improved so that they utilized an earth-free power supply. The outputs could therefore be earthed where required in order to keep electrical disturbance from the ship´s electrics as low as possible. On top of that, each of the fluorescence sensors was given a sensitive measuring range which took into account the expected low concentrations.
A whole series of problems appeared since, above all else, our digital equipment was not compatible with the ship´s INDAS system and, for several further reasons, we had to do without digital recording.
After various attempts, re-wiring the probes allowed relatively interference-free data recording on a multi-channel analogue recorder, even though further unexplained interference appeared. This made the use of the most sensitive ranges almost pointless. The temperature and salinity recordings showed the expected values as they relate to the various bodies of water. The chlorophyll fluorescence which is calibrated in concentration can be correlated from the optical magnitudes with the provisional results of the other working groups (DMS and ATP measurements). The neuston catches are also related with chlorophyll concentrations. The concentrations in the southern hemisphere were near the detection limit of 50 ng/l and only occasionally reached values of 200 ng/l, whereas in the northern hemisphere, an initial maximum of 1.5 µg/l was reached in the Iberian Basin and a further one of 2.75 µg/l at the latitude of Cape Finisterre.

## 1.2.12 DEPTH ADAPTION OF BACTERIAL POPULATIONS

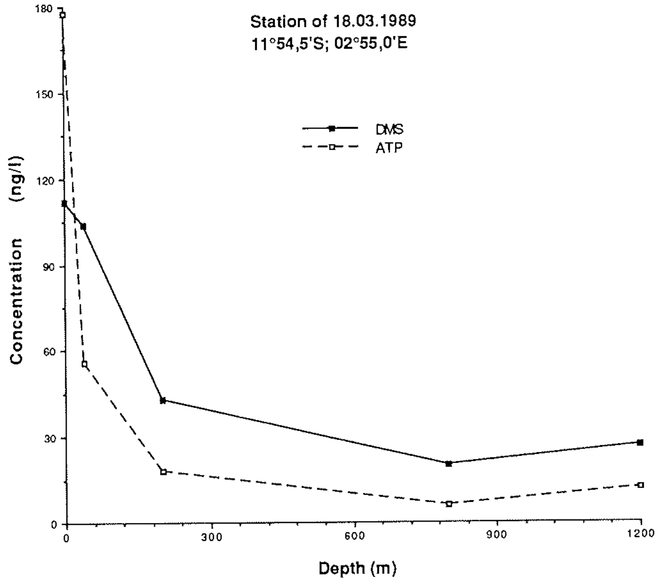
E.Helmke, H Weyland

Information concerning the adaptation of heterotrophic bacterial populations in the deep sea basins of the eastern Atlantic are to be investigated with this project, after bacterial adaptation was ascertained during the "Winter Weddell Sea Projects 86". The investigations serve to answer the question whether the inclusion of hydrostatic pressure is an indispensable prerequisite for the inclusion of the active components of deep sea bacteria. The isolation of barophilic bacteria is attempted in order to determine their potential performance.
It was possible to retrieve samples from the upper surface sediment and the water at sea-floor level at 6 stations on the south-north leg - in the Cape, Angola, Guinea and Sierra Leone Basins, and in the central- and north Cape Verde Basin - from depths of around 5000 m with simultaneous deployment of a "Shipek" earth grab and a deep-sea water sampler, not only under decompressed but also under constant pressure conditions. At the same time, "Gerard" water samplers were deployed at three deep-sea stations. The sampling progressed successfully without exception. The newly developed deep-sea sampler - in service for the first time - proved to be efficient, and the transportation of sub-samples under aseptic and constant pressure conditions for culturing purposes as well as for activity determinations of the population proved to be practicable, even though optimization of the system is necessary.
Cultures were prepared from the decompressed sediment and water samples in solid media and "most probable number" trials in liquid media under simulated deep-sea conditions as well as under atmospheric pressure. Samples were fixed for total cell count determination. Tests were initiated with sediment and water from 2 stations to assess bacterial activity using labelled glutamate and lactate, likewise under simulated deep-sea conditions.
Sub-samples from the water samples taken under pressure were transferred - whilst maintaining the in-situ pressure and low temperature - into various culture media in order to determine the incidence of decompression sensitive barophilic bacteria, and then to isolate them. In addition, sub-samples of water - collected with and without decompression - were supplied with labelled substrate, the later without disrupting the deep sea pressure in order to discern decompression sensitive organisms by the rate of uptake and incorporation.
Because long generation time-spans must be reckoned with under high hydrostatic pressure and low temperatures, the evaluation of culture and activity trials can only take place in the "home" laboratory.
The sediment trap mooring from the University of Bremen was used to expose cellulose and chitin substrate at depths of 600 m and 1600 m on the Walvis Ridge to gather further data concerning bacterial decomposition of particular substrate from this sea area.

## 1.2.13 ADENOSINETRIPHOSPHATE (ATP) AS BIOMASS INDICATOR

Th.Bluszcz, R.Ernst, W.Ernst

Classification of ATP were carried out in water from various depths and at different times of day with the aid of the luciferin-luciferase system. The examinations served to classify microplankton biomass for comparison with measured DMSP concentrations in phytoplankton (the Karsten-Meyerdierks-Kirst group) and with ascertained DMS concentrations in water (the Tanzer-Heumann group). The 400 individual ATP classifications are distributed over surface and deep water and comprise three day´s operations. The water samples were filtered, the filter extracted with boiling tris-buffer and measured after cooling down. Membrane filters (3 µm, 0.45 µm and 0.22 µm) were used for the stepped filtration. In addition, one sample was passed over a 0.22 µm filter. The largest portion of ATP was found on the 3 µm filter. The ATP values were converted with a factor of 250 into biomass carbon.
The biomass values were around the value 15 µg/l from Cape Town as far as latitude 20°S, and rose from here until latitude 2°S to a maximum of 60 µg/l. After a following drop to about 20 µg/l, biomass-C rose by leaps and bounds from 32°N on, and reached values of 100 µg/l at latitude 40°N. With one exeption in the area around the equator, a close correlation exists with the DMS concentrations determined by Tanzer and Heumann´s group, especially with the depth profiles (see Fig. 60 and 61) and with Ohm and Baranski´s chlorophyll-fluorescence measurements.



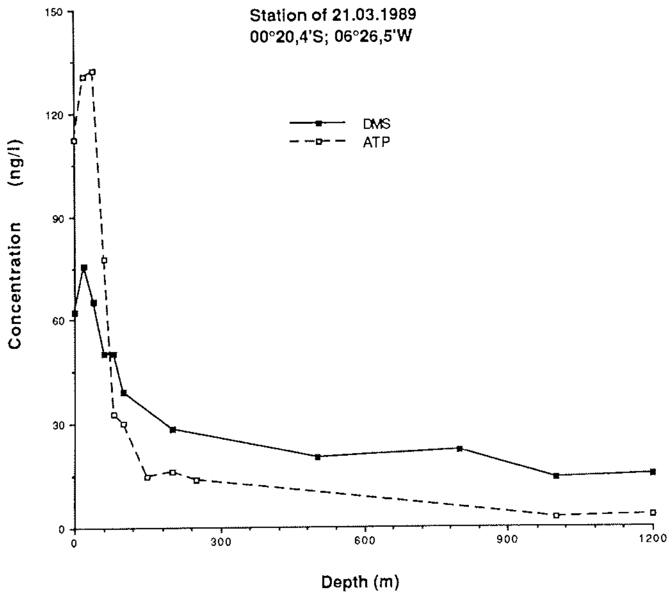
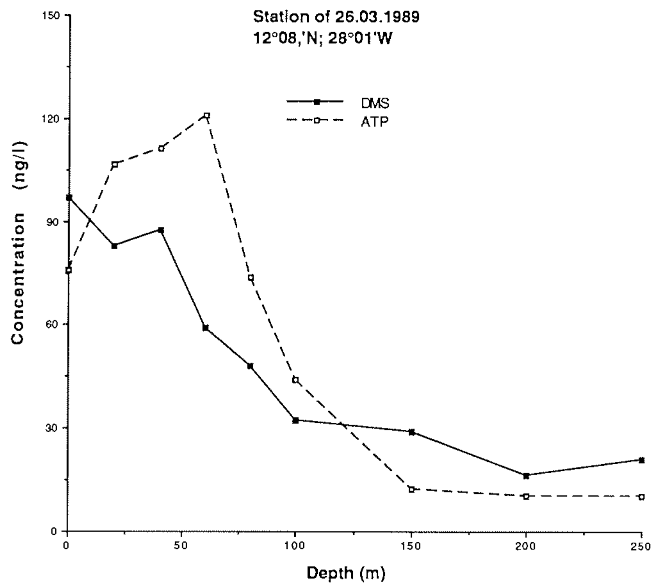




Figure 60: Concentration of DMS in water and ATP in phytoplankton after filtration. (Southern hemisphere)



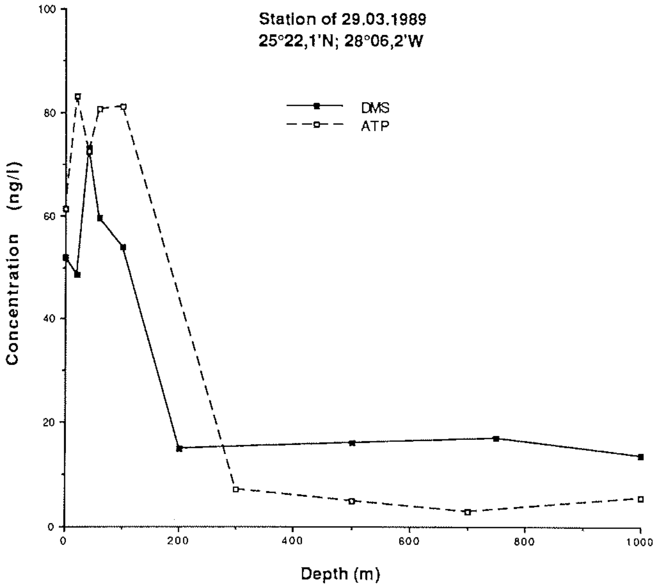




Figure 61: Concentration of DMS in water and ATP in phytoplankton after filtration. (Northern hemisphere)

## 1.2.14 METEOROLOGICAL MEASUREMENTS IN CONTAINERS

H.G.Hill

During ANT VII/5, meteorological measurements in containers were carried out within the framework of the German Weather Service´s investigations into the temperature strain potential in modern transport systems as a result of irradiation and radiation. The results of this project serve to improve the advisory and assessing work of the meteorological service in this area.
The measurement series gathered up until now in Hamburg - in temperate zone radiation conditions - were to be supplemented with measurements in subtropical and tropical climatic zones.
Two containers on the RV Polarstern's funnel deck were fitted out with a number of temperature and humidity sensors. In addition, general radiation and outside air temperature in the area of the container roofs were registered. The recording of measured values took place continuously from 14.3.89 until 5.4.89, and the actual, as well as the average, minimum and maximum values from the previous hour were recorded at hourly intervals on magnetic tape. The measuring interval amounted to one minute.
Provisional data evaluation shows that at a maximum outside temperature of 33° C, temperatures near 70° C were measured inside the containers (see Fig. 62). The at first sight somewhat inhomogenous appearing temperature profiles - during the day, the sensor "roof-10 cm" was significantly warmer than the roof in Container 1, whereas the relationship in container 2 was the reverse (Figs. 63 and 64) - require a thorough analyses. It cannot, however, be ruled out that these results stem from the various locations - outside and inside position, different shade from the ship´s superstructure and so on - especially as similar profile forms were also found during other measurements.
In summing up, it can be established that these measurements are to be seen as a valuable supplement to the Hamburg measurement series. It appears to be desirable to plan similar measurements on a future outward or homeward Polarstern voyage.

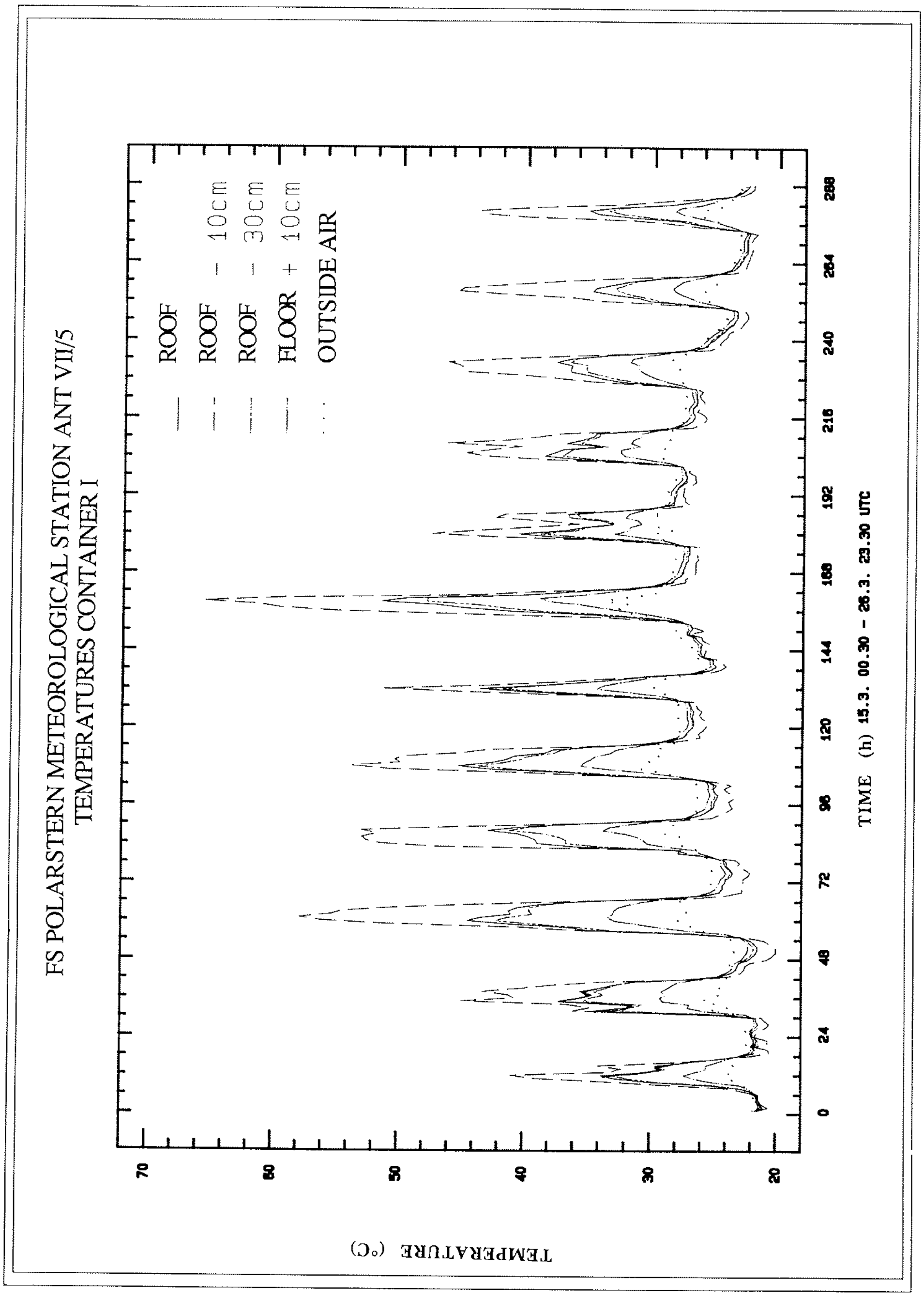



Figure 62: Temperatures measured at various locations in a test container

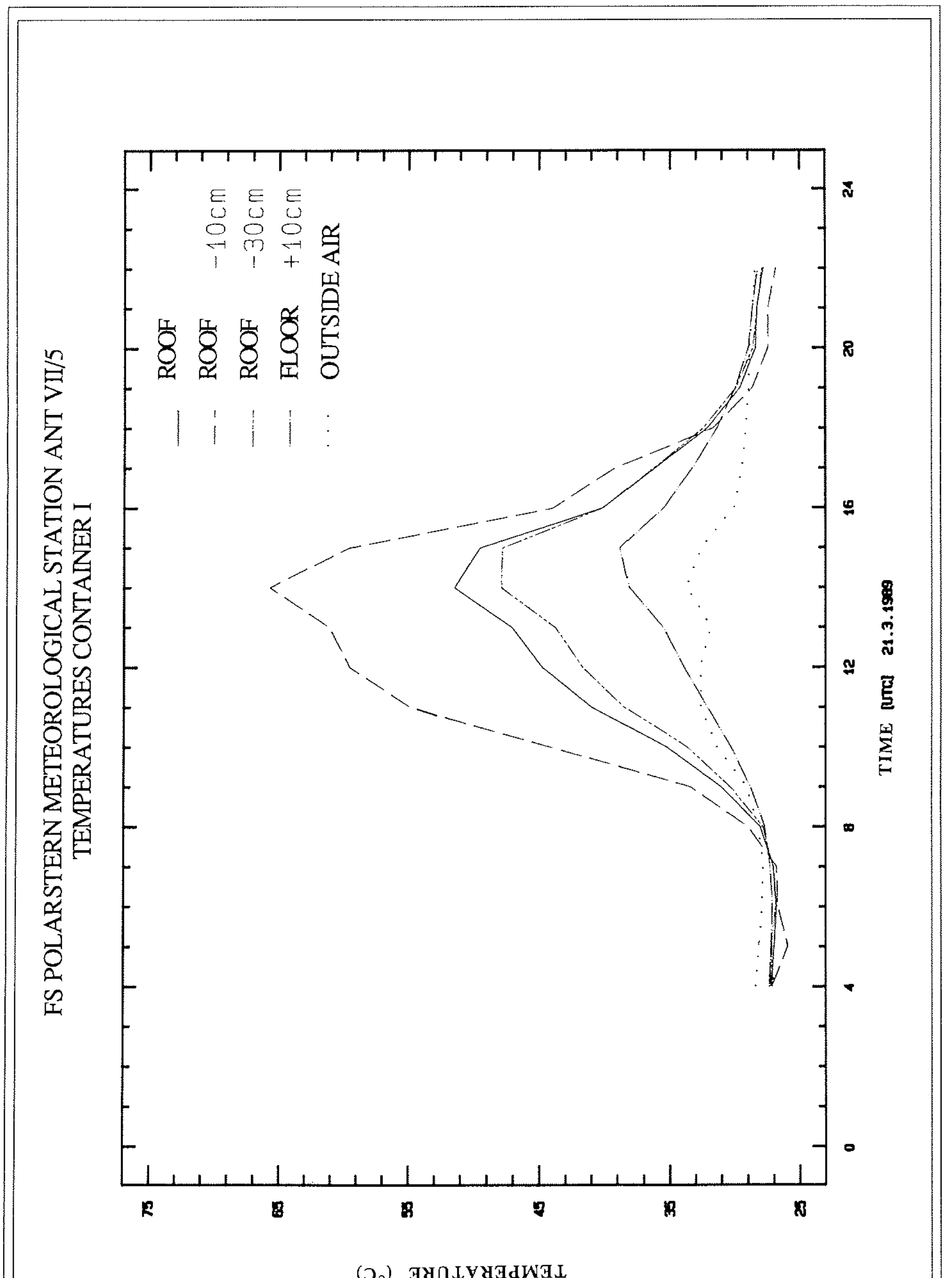



Figure 63: Temperature profile in test container 1 during a daily course

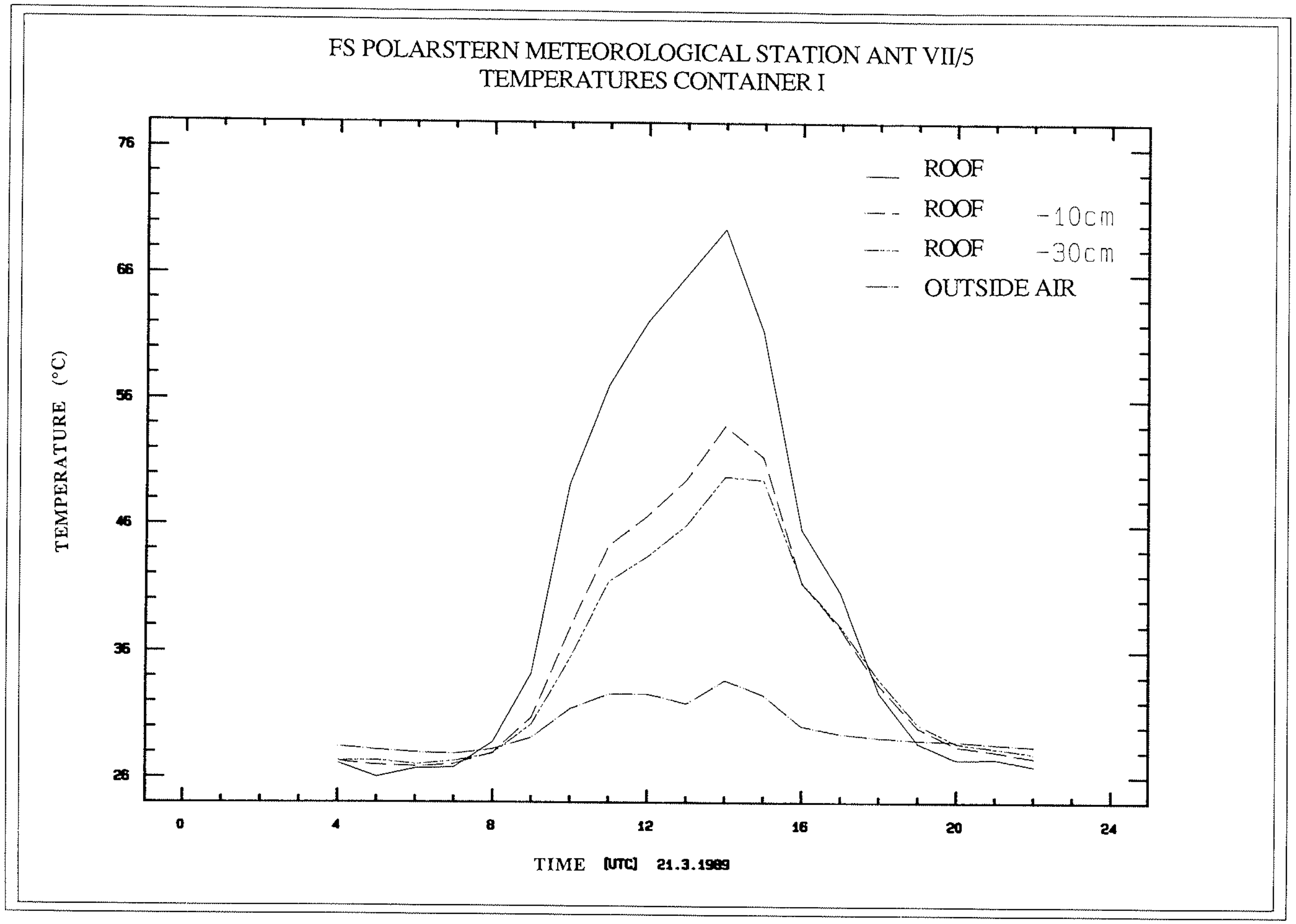



Figure 64: Temperature profile in test container 2 during a daily course

## 1.2.15 MAINTENANCE OF LIVING ANTARCTIC CRUSTACEANS AND MOLLUSCS

M.Klages

Several thousand Antarctic invertebrates were caught alive in the eastern Weddell Sea during EPOS 3 (ANT VII/4) and were taken care of during the homeward voyage of ANT VII/5. There were mainly amphipods, isopods, molluscs, some decapods, krill (*Euphausia superba*) which was already caught during EPOS 1 and was maintained on board since then.
Apart from daily checks on air and water temperatures in the laboratory containers, inspection of salinity, regular water changes and other routine tasks, various aspects of the biology of several amphipod species were thoroughly investigated. Comparative investigations of the feeding behaviour of *Eusirus perdentatus, Epimeria robusta, Paraceradocus gibber* and *Gnathiphimedia mandibularis* furnished interesting results which were evaluated and described on board (Klages & Gutt, in press). Because questions concerning growth rates of selected amphipod species form the main emphasis of future work with these animals, the observed hatch of juvenile individuals from *Epimeria macrodonta, Epimeria equestris* n.sp. (Klages and De Broyer, to be published), *Eusirus perdentatus, Abyssorchomene plebs* and a species of the family Acanthonotozomatidae gains special importance. Measurements of the oxygen consumption of *A. plebs, Abyssorchomene rossi* and *Waldeckia obesa* served to gain initial base data to give an idea of the size of $O_2$ consumption in animals under stress. Because the dry weight determination of the studied animals will take place in Bremerhaven, only consumption rates for each animal are available (90 to 210 nmol $O_2 \cdot h^{-1}$). It is, however, already discernible that the values compared to each other correspond well with aqarium observations.

References:

Klages, M. & J. Gutt (in press): Observation on the feeding observation of the Antarctic gammarid *Eusirus perdentatus* chevreux, 1912 in Aquaria. Polar Biol.

## 1.2.16 MAINTENANCE OF ANTARCTIC FISH (NOTOTHENIOIDEI)

A.P.A.Wöhrmann

During ANT VII/4 (Epos leg 3) various fish species of the suborder Notothenioidei were caught and kept alive in cooling containers at a constant temperature of -1°C (± 0.5°C) under constant light conditions (25 W, red light). Temperature, oxygen saturation (>100%) and salinity (35‰) were measured daily and the water was changed weekly. Once a week feeding experiments were carried out. A total of 34 specimens out of three families (2 x Nototheniidae, 2 x Bathydraconidae, 30 x Artedidraconidae) were successfully transported back to Bremerhaven on board RV

"Polarstern". For a detailed describtion about further research see Johnson et al. in ANT VII/4 cruise report (this volume).

The animals were fed with pieces of fish and with krill (*Euphausia superba*). *Artedidraco orianae* and *A. loennbergii* took only krill. *Trematomus eulepidotus*, *Gymnodraco acuticeps* and *Dolloidraco longedorsalis* refused any food during this experiments. The species *Histiodraco velifer* and *Pagothenia hansoni* seem to be gluttonous generalists. The function of the barbel in the family Artedidraconidae for chemoreception (food detection) is still uncertain.

The swimming behaviour of some species could be observed and photographed during the feeding experiments. Previous observations of Nototheniidae confirmed that their pectoral fins are responsible for slow, continuous swimming, whereas the caudal fins are used only for fast locomotions, e.g. to catch food organisms. Thus morphological and ecological characteristics could be shown for Artedidraconidae as well as for Nototheniidae, indicating the tendency towards a more pelagic way of living. The Antarctic fish kept alive in Bremerhaven will provide unique opportunities for further research. In cooperation with the Universities in Kiel and Stuttgart-Hohenheim, investigations will be carried out on reproduction, ontogenesis, swimming behaviour and physiology.

ANNEX

STATIONSLISTE / STATION LIST ANT VII/5

Abkürzungen / Abbreviations

| | |
|---|---|
| DWS | Pressure retaining water sampler |
| GS | Gerard water sampler |
| HWS | Water sampler (bucket) |
| MN | Multi Net |
| NS | Neuston net |
| RO | Rosette sampler |
| SB | Rubber Boat |
| SG | Shipek grab sampler |
| WSB | Water Sampler (bow boom) |
| WR | Sediment trap |

| Stat. No | Date | Time (GMT) Start | End | Position | | Echo Depth(m) | Gear |
|---|---|---|---|---|---|---|---|
| 14/315 | 13.03.89 | 07.09- | | 32°17,5'S | 14°47,4'E | 3009 | NS z.W. |
| | | | 07.24 | 32°18,5'S | 14°47,9'E | 3010 | NS a.D. |
| 14/316 | 13.03.89 | 10.30 | | 32°04,5'S | 14°25,3'E | 2949 | HWS |
| 14/318 | 13.03.89 | 17.29- | | 31°28,5'S | 13°16,7'E | 3426 | NS z.W. |
| | | | 17.46 | 31°28,2'S | 13°15,5'E | 3428 | NS a.D. |
| | | 17.45 | | 31°28,2'S | 13°15,6'E | 3428 | HWS |
| | | 17.58 | | 31°27,9'S | 13°14,7'E | 3428 | WSB |
| 14/319 | 14.03.89 | 05.01- | | 30°13,5'S | 10°23,1'E | 4661 | NS z.W. |
| | | | 05.18 | 30°13,8'S | 10°21,9'E | 4708 | NS a.D. |
| | | 05.20 | | 30°13,8'S | 10°21,9'E | 4712 | HWS |
| | | 05.27 | | 30°13,9'S | 10°21,4'E | 4717 | WSB |
| 14/320 | 14.03.89 | 10.40- | | 29°37,6'S | 09°10,6'E | 4965 | SG, GS z.W. |
| | | | 14.47 | 29°37,3'S | 09°12,4'E | 4963 | SG, GS a.D. |
| 14/321 | 14.03.89 | 17.38- | | 28°59,7'S | 09°13,0'E | 4994 | NS z.W. |
| | | | 17.56 | 29°01,1'S | 09°14,0'E | 4993 | NS a.D., WSB |
| 14/322 | 15.03.89 | 05.00- | | 26°16,7'S | 09°10,6'E | 4748 | NS z.W. |
| | | | 05.19 | 26°16,9'S | 09°11,5'E | 4752 | NS a.D., WSB, HWS |
| | | 05.21- | | 26°16,9'S | 09°11,5'E | 4751 | NS z.W. |
| | | | 05.38 | 26°17,4'S | 09°12,6'E | 4778 | NS a.D. |
| 14/323 | 15.03.89 | 11.30 | | 24°48,1'S | 09°08,1'E | 4635 | HWS |
| 14/324 | 15.03.89 | 17.34- | | 23°19,5'S | 09°09,8'E | 4702 | NS z.W. |
| | | | 17.54 | 23°19,5'S | 09°11,3'E | 4466 | NS a.D., WSB |
| 14/325 | 16.03.89 | 05.02- | | 20°33,5'S | 09°09,8'E | 1193 | NS z.W. |
| | | | 05.20 | 20°32,3'S | 09°10,1'E | 1368 | NS a.D., WSB |
| 14/326 | 16.03.89 | 07.44- | | 20°04,2'S | 09°10,0'E | 2198 | SB z.W., HWS |
| | | | 09.45 | 20°04,1'S | 09°10,1'E | 2200 | SB alongside, WR 1 a.D. |
| 14/327 | 16.03.89 | 10.01- | | 20°04,2'S | 09°10,2'E | 2205 | WR 2, Anchor- |
| | | | 11.31 | 20°02,8'S | 09°09,3'E | 2196 | weight splipped |
| 14/328 | 16.03.89 | 16.01 | | 18°57,4'S | 08°18,9'E | 4990 | HWS |
| 14/329 | 16.03.89 | 17.38- | | 18°52,1'S | 08°14,6'E | 4996 | NS z.W. |
| | | | 17.55 | 18°52,1'S | 08°13,5'E | 5003 | NS a.D., WSB |
| 14/330 | 17.03.89 | 05.17- | | 16°36,4'S | 06°28,9'E | 5273 | NS z.W. |
| | | | 05.34 | 16°36,5'S | 06°29,8'E | 5271 | NS a.D., WSB |
| 14/331 | 17.03.89 | 11.22 | | 15°26,6'S | 05°34,1'E | 5377 | HWS |
| 14/332 | 17.03.89 | 15.25 | | 14°35,5'S | 04°58,5'E | 5448 | HWS |

| Stat. No | Date | Time (GMT) Start | End | Position | | Echo Depth(m) | Gear |
|---|---|---|---|---|---|---|---|
| 14/333 | 17.03.89 | 18.12- | | 14°03,9'S | 04°31,0'E | 5482 | NS z.W. |
| | | | 18.29 | 14°03,3'S | 04°31,6'E | 5483 | NS a.D., WSB |
| 14/334 | 18.03.89 | 05.26- | | 11°56,3'S | 02°55,3'E | 5526 | NS z.W. |
| | | | 05.43 | 11°55,7'S | 02°55,8'E | 5531 | NS a.D., WSB |
| | | 06.01- | | 11°55,6'S | 02°55,8'E | 5529 | SG z.W. |
| | | | 10.33 | 11°54,9'S | 02°55,1'E | 5531 | SG a.D. |
| | | 07.24 | | 11°55,7'S | 02°55,2'E | 5530 | HWS |
| | | 10.44- | | 11°54,6'S | 02°55,2'E | 5533 | NIS z.W. |
| | | | 12.00 | 11°54,5'S | 02°55,0'E | 5532 | NIS a.D. |
| | | 12.06- | | 11°54,5'S | 02°55,0'E | 5532 | MN z.W. |
| | | | 13.09 | 11°54,4'S | 02°55,3'E | 5530 | MN a.D. |
| 14/335 | 18.03.89 | 15.23 | | 11°29,6'S | 02°35,5'E | 5533 | HWS |
| 14/336 | 18.03.89 | 18.24- | | 10°55,4'S | 02°09,1'E | 5576 | NS z.W. |
| | | | 18.41 | 10°54,7'S | 02°08,6'E | 5575 | NS a.D., WSB |
| 14/337 | 19.03.89 | 05.28- | | 08°45,0'S | 00°33,0'E | 4532 | NS z.W. |
| | | | 05.45 | 08°44,0'S | 00°33,4'E | 5041 | NS a.D., WSB |
| 14/338 | 19.03.89 | 07.24 | | 08°27,8'S | 00°20,7'E | 5370 | HWS |
| 14/339 | 19.03.89 | 11.24 | | 07°36,3'S | 00°19,6'W | 4852 | HWS |
| 14/340 | 19.03.89 | 15.26 | | 06°47,4'S | 00°56,8'W | 4027 | HWS |
| 14/341 | 19.03.89 | 18.32- | | 06°11,5'S | 01°25,0'W | 4341 | NS z.W. |
| | | | 18.49 | 06°10,6'S | 01°24,7'W | 4341 | NS a.D., WSB |
| 14/342 | 20.03.89 | 05.50- | | 04°01,8'S | 02°59,2'W | 4504 | NS z.W. |
| | | | 06.06 | 04°01,0'S | 02°59,8'W | 4511 | NS a.D., WSB |
| 14/343 | 20.03.89 | 07.24 | | 03°46,4'S | 03°07,2'W | 4791 | HWS |
| 14/344 | 20.03.89 | 11.25 | | 03°00,8'S | 03°48,7'W | 4637 | HWS |
| 14/345 | 20.03.89 | 15.20 | | 02°13,0'S | 04°21,4'W | 5112 | HWS |
| 14/346 | 20.03.89 | 18.44- | | 01°36,1'S | 04°48,8'W | 5016 | NS z.W. |
| | | | 19.00 | 01°35,8'S | 04°49,4'W | 5017 | NS a.D., WSB |
| 14/347 | 21.03.89 | 06.01- | | 00°21,0'N | 06°24,3'W | 5385 | NS z.W. |
| | | | 06.18 | 00°21,4'N | 06°25,0'W | 5133 | NS a.D., WSB |
| | | 06.34- | | 00°21,5'N | 06°25,0'W | 5133 | NIS z.W. |
| | | | 07.42 | 00°21,5'N | 06°25,1'W | 5132 | NIS a.D. |
| | | 07.47- | | 00°21,5'N | 06°25,1'W | 5135 | MW z.W. |
| | | | 08.54 | 00°21,3'N | 06°25,2'W | 5128 | MW a.D. |
| | | 09.08- | | 00°21,1'N | 06°25,7'W | 5153 | SG z.W., GS, DWS |
| | | | 13.18 | 00°20,4'N | 06°26,3'W | 5130 | SG a.D. |

| Stat. No | Date | Time (GMT) Start End | Position | Echo Depth(m) | Gear |
|---|---|---|---|---|---|
| 14/347 | 21.03.89 | 09.51- | 00°20,7'N 06°28.0'W | 5129 | SB z.W. |
| | | 10.46 | | | SB a.D. |
| | | 13.36- | 00°20,5'N 06°26,1'W | 5121 | CTD z. W. |
| | | 14.03 | 00°20,6'N 06°25,9'W | 5124 | CTD a.D. |
| | | 14.12- | 00°20,7'N 06°26,2'W | 5082 | NS z. W. |
| | | 14.30 | 00°21,2'N 06°27,2'W | 5120 | NS a. D. |
| 14/348 | 21.03.89 | 16.30 | 00°33,7'N 06°51,3'W | 5127 | HWS |
| 14/349 | 21.03.89 | 19.01- | 00°50,1'N 07°21,6'W | 5146 | NS z.W. |
| | | 19.18 | 00°49,9'N 07°22,4'W | 5139 | NS a.D., WSB |
| 14/350 | 22.03.89 | 06.15- | 02°03,9'N 09°34,4'W | 4654 | NS z.W. |
| | | 06.32 | 02°03,7'N 09°35,5'W | 4653 | NS a.D., WSB |
| 14/351 | 22.03.89 | 08.26 | 02°17,2N 09°57,4'W | 4408 | HWS |
| 14/352 | 22.03.89 | 12.26 | 02°42,9'N 10°46,3'W | 4574 | HWS |
| 14/353 | 22.03.89 | 16.34 | 03°10,5'N 11°38,4'W | 4458 | HWS |
| 14/354 | 22.03.89 | 19.18- | 03°27,3'N 12°08,0'W | 4439 | NS z.W. |
| | | 19.35 | 03°28,0'N 12°08,7'W | 4424 | NS a. D., WSB |
| 14/355 | 23.03.89 | 06.31- | 04°38,3'N 14°19,1'W | 4788 | NS z.W. |
| | | 06.48 | 04°38,1'N 14°20,1'W | 4789 | NS a.D., WSB |
| | | 06.57- | 04°38,2'N 14°20,7'W | 4788 | NS z.W. |
| | | 07.15 | 04°38,6N 14°21,7'W | 4789 | NS a.D. |
| 14/356 | 23.03.89 | 08.26 | 04°45,7'N 14°34,9'W | 4811 | HWS |
| 14/357 | 23.03.89 | 12.30 | 05°14,1'N 15°26,6'W | 4916 | HWS |
| 14/358 | 23.03.89 | 16.23 | 05°40,1'N 16°14,0'W | 4965 | HWS |
| 14/359 | 23.03.89 | 17.02- | 05°42,5'N 16°18,6'W | 4944 | SG z.W, DWS, GS, GS |
| | | 21.30 | 05°40,4'N 16°20,3'W | 4947 | SG a.D. |
| | | 21.36- | 05°40,4'N 16°20,3'W | 4947 | NS z.W. |
| | | 21.54 | 05°40,5'N 16°21,2'W | 4946 | NS a.D., WSB |
| 14/359 | 23.03.89 | 22.03- | 05°40,6'N 16°21,5'W | 4946 | NIS z.W. |
| | | 22.56 | 05°40,4'N 16°21,8'W | 4946 | NIS a.D. |
| | | 23.01- | 05°40,4'N 16°21,8'W | 4946 | MN z.W. |
| | | 23.59 | 05°40,0'N 16°21,8'W | 4945 | MN a.D. |
| 14/360 | 24.03.89 | 06.46- | 06°28,1'N 17°42,6'W | 4860 | NS z.W. |
| | | 07.03 | 06°28,2'N 17°43,5'W | 4859 | NS a.D., WSB |
| 14/361 | 24.03.89 | 17.28 | 07°40,7'N 19°57,5'W | 3992 | HWS |
| 14/362 | 24.03.89 | 19.57- | 07°57,5'N 20°27,7'W | 4148 | NS z.W. |
| | | 20.12 | 07°58,0'N 20°28,6'W | 4147 | NS a.D., WSB |

| Stat. No | Date | Time (GMT) Start End | Position | Echo Depth(m) | Gear |
|---|---|---|---|---|---|
| 14/363 | 25.03.89 | 07.02- | 09°12,8'N 22°48,4'W | 4882 | NS z.W. |
| | | 07.17 | 09°14,6'N 22°49,1'W | 4887 | NS a.D., WSB |
| | | 09.25 | 09°28,6'N 23°16,8'W | 4906 | HWS |
| 14/364 | 26.03.89 | 07.02- | 12°08,8'N 28°00,1'W | 5444 | NS z.W. |
| | | 07.18 | 12°10,0'N 28°00,0'W | 5443 | NS a.D., WSB |
| | | 07.28- | 12°10,3'N 28°00,1'W | 5486 | NIS z.W. |
| | | 08.46 | 12°08,8'N 28°01,3'W | 5488 | NIS a.D. |
| | | 08.48- | 12°08,8'N 28°01,3'W | 5488 | MN z.W. |
| | | 09.45 | 12°08,0'N 28°02,1'W | 5487 | MN a.D. |
| | | 09.52- | 12°07,9'N 28°02,4'W | 5491 | CTD z.W. |
| | | 10.18 | 12°08,0'N 28°01,8'W | 5488 | CTD a.D. |
| | | 10.24- | 12°08,0'N 28°01,8'W | 5490 | SG z.W., DWS, GS |
| | | 15.17 | 12°07,4'N 28°03,6'W | 5487 | SG a.D. |
| 14/365 | 26.03.89 | 17.34 | 12°38,3'N 28°02,1'W | 5430 | HWS |
| 14/366 | 26.03.89 | 20.17- | 13°15,4'N 28°01,0'W | 5314 | NS z.W. |
| | | 20.32 | 13°16,3'N 28°01,0'W | 5313 | NS a.D., WSB |
| 14/367 | 27.03.89 | 07.15- | 15°47,4'N 28°00,7'W | 4957 | NS z.W. |
| | | 07.31 | 15°48,4'N 28°00,5'W | 4960 | NS a.D., WSB |
| 14/368 | 27.03.89 | 13.30 | 16°59,5'N 28°42,3'W | 4868 | HWS |
| 14/369 | 27.03.89 | 17.30 | 17°49,6'N 29°16,6'W | 4950 | HWS |
| 14/370 | 27.03.89 | 20.23- | 18°00,5'N 29°16,5'W | 4641 | NS z.W. |
| | | 20.46 | 18°02,0'N 29°16,3'W | 4565 | NS a.D., WSB |
| 14/371 | 28.03.89 | 07.24- | 20°27,5'N 28°57,3'W | 4905 | NS z.W. |
| | | 07.41 | 20°28,5'N 28°57,1'W | 4888 | NS a.D., WSB |
| 14/373 | 28.03.89 | 20.23- | 23°19,7'N 28°27,5'W | 5542 | NS z.W. |
| | | 20.41 | 23°20,8'N 28°27,3'W | 5548 | NS a.D., WSB |
| 14/374 | 29.03.89 | 07.14- | 25°18,5'N 28°03,9'W | 5423 | NS z.W. |
| | | 07.31 | 25°19,7'N 28°04,1'W | 5421 | NS a.D.,WSB |
| | | 07.42- | 25°20,1'N 28°04,0'W | 5420 | NIS z.W. |
| | | 08.49 | 25°20,1'N 28°05,2'W | 5432 | NIS a.D. |
| | | 08.58 | 25°20,2'N 28°05,0'W | 5532 | MN z.W. |
| | | 09.53 | 25°20,5'N 28°05,3'W | 5555 | MN a.D. |
| | | 10.03- | 25°20,6'N 28°05,0'W | 5562 | CTD z.W. |
| | | 12.29 | 25°21,3'N 28°05,9'W | 5610 | CTD a.D. |
| | | 12.43- | 25°21,4'N 28°05,6'W | 5620 | SG z.W., DWS, GS |
| | | 17.34 | 25°24,2'N 28°07,0'W | 5289 | SG a.D. |

| Stat. No | Date | Time (GMT) Start End | Position | Echo Depth(m) | Gear |
|---|---|---|---|---|---|
| 14/375 | 29.03.89 | 20.28- | 25°55,3'N 27°42,4'W | 5527 | NS z.W. |
| | | 20.45 | 25°56,1'N 27°41,7'W | 5541 | NS a.D., WSB |
| | | 20.53- | 25°56,5'N 27°41,4'W | 5521 | NS z.W. |
| | | 21.11 | 25°57,2'N 27°40,8'W | 5550 | NS a.D. |
| 14/376 | 29.03.89 | 23.29 | 26°22,4'N 27°19,2'W | 5460 | HWS |
| 14/377 | 30.03.89 | 07.02- | 27°43,3'N 26°06,9'W | 5138 | NS z.W. |
| | | 07.20 | 27°44,1'N 26°06,1'W | 5124 | NS a.D., WSB |
| 14/378 | 30.03.89 | 20.14- | 30°05,5'N 24°01,4'W | 5299 | NS z.W. |
| | | 20.31 | 30°06,3'N 24°00,8'W | 5287 | NS a.D., WSB |
| 14/379 | 31.03.89 | 06.51- | 32°01,5'N 22°14,7'W | 5094 | NS z.W. |
| | | 07.09 | 32°02,5'N 22°14,2'W | 5092 | NS a.D., WSB |
| 14/380 | 31.03.89 | 08.25 | 32°16,7'N 22°01,5'W | 5143 | HWS |
| 14/381 | 31.03.89 | 12.30 | 33°04,7'N 21°17,7'W | 5244 | HWS |
| 14/382 | 31.03.89 | 16.32 | 33°52,1'N 20°32,3'W | 5151 | HWS |
| 14/383 | 31.03.89 | 20.00- | 34°29,9'N 19°56,7'W | 5177 | NS z.W. |
| | | 20.18 | 34°30,7'N 19°55,9'W | 5070 | NS a.D., WSB |
| 14/384 | 01.04.89 | 06.27- | 36°23.0'N 18°09,0'W | 5522 | NS z.W. |
| | | 06.45 | 36°24,0'N 18°08,1'W | 5546 | NS a.D., WSB |
| | | 06.56- | 36°24,3'N 18°07,8'W | 5486 | NS z.W. |
| | | 07.12 | 36°25,1'N 18°07,0'W | 5479 | NS a.D. |
| 14/385 | 01.04.89 | 12.30 | 37°12,3'N 17°20,4'W | 4850 | HWS |
| 14/386 | 01.04.89 | 19.45- | 38°12,8'N 16°21,9'W | 5393 | NS z.W. |
| | | 20.02 | 38°13,3'N 16°20,4'W | 5463 | NS a.D., WSB |
| 14/387 | 02.04.89 | 06.16- | 39°43,3'N 14°51,2'W | 5302 | NS z.W. |
| | | 06.34 | 39°44,3'N 14°50,9'W | 5345 | NS a.D., WSB |
| 14/388 | 02.04.89 | 07.30 | 39°52,0'N 14°39,0'W | 5338 | HWS |
| 14/389 | 02.04.89 | 11.30 | 40°27,8'N 14°05,1'W | 5324 | HWS |
| 14/390 | 02.04.89 | 14.30 | 41°01,4'N 13°30,3'W | 4650 | HWS |
| 14/391 | 02.04.89 | 19.37- | 41°45,8'N 12°47,2'W | 5254 | NS z.W. |
| | | 19.54 | 41°46,5'N 12°48,1'W | 5253 | NS a.D., WSB |
| 14/392 | 03.04.89 | 05.58- | 43°22,8'N 11°04,1'W | 3798 | NS z.W. |
| | | 06.15 | 43°24,0'N 11°04,1'W | 3940 | NS a.D., WSB |
| 14/393 | 03.04.89 | 07.50 | 43°38,6'N 10°47,8'W | 4964 | HWS |
| 14/394 | 03.04.89 | 11.30 | 44°18,2'N 10°10,2'W | 4948 | HWS |
| 14/395 | 03.04.89 | 15.29 | 45°02,1'N 09°18,5'W | 5017 | HWS |
| 14/396 | 03.04.89 | 19.28- | 45°43,5'N 08°33,0'W | 4899 | NS z.W. |
| | | 19.44 | 45°44,6'N 08°31,7'W | 4835 | NS a.D., WSB |

PARTICIPATING INSTITUTIONS AND SCIENTISTS ANT VII/5

| | | |
|---|---|---|
| AWI | Alfred-Wegener-Institut<br>für Polar- und Meresforschung<br>Columbusstraße<br>D-2850 Bremerhaven | Baranski, Becker, Bluszcz,<br>Breitschuh, Drebing, Ernst, R,,<br>Ernst, W. Fütterer, Helmers, Helmke<br>Jaeger, Jurr, Kattner, Klages,<br>Modersitzki, Ohm, Pohl,<br>Schrems, Schulz-Baldes,<br>Weber, Weyland |
| DWD | Deutscher Wetterdienst<br>Seewetterdienst<br>Bernhard-Nocht-Str. 76<br>D-2000 Hamburg 36 | Hill, Köhler |
| IPÖ | Universität Kiel<br>Institut für Polarökologie<br>Olshausenstr. 40-60<br>D-2300 Kiel 1 | Wöhrmann |
| RUB | Ruhr-Universität Bochum<br>Physikalische Chemie I<br>Universitätsstraße 150<br>D-4630 Bochum | Kaes, Papenbrock |
| UB | Universität Bremen<br>Postfach 33 04 40<br>D-2800 Bremen | Hebbeln, Karsten, Meyerdierks |
| UR | Universität Regensburg<br>Institut für Anorganische Chemie<br>Postfach 397<br>D-8400 Regensburg | Tanzer, Rädlein |

FAHRTTEILNEHMER / PARTICIPANTS ANT VII/5

| Name | Vorname | Institute | Country |
|---|---|---|---|
| Baranski | Wlodzimierz | AWI | D |
| Becker | Hartmut | AWI | D |
| Bluszcz | Thaddäus | AWI | D |
| Breitschuh | Wolfgang | AWI | D |
| Drebing | Wolfgang | AWI | D |
| Ernst | Ruth | AWI | D |
| Ernst | Wolfgang | AWI | D |
| Fütterer | Meike | AWI | D |
| Helmers | Eckard | AWI | D |
| Helmke | Elisabeth | AWI | D |
| Hebbeln | Dirk | UB | D |
| Hill | Hans-Günther | DWD | D |
| Jaeger | Klaus | AWI | D |
| Jurr | Anke | AWI | D |
| Kaes | Anette | RUB | D |
| Karsten | Ulf | UB | D |
| Kattner | Gerhard | AWI | D |
| Klages | Michael | AWI | D |
| Köhler | Herbert | DWD | D |
| Meyerdierks | Doris | UB | D |
| Modersitzki | Jutta | AWI | D |
| Ohm | Klaus | AWI | D |
| Papenbrock | Thomas | RUB | D |
| Pohl | Christa | AWI | D |
| Rädlein | Norbert | UR | D |
| Schrems | Otto | AWI | D |
| Schulz-Baldes | Meinhard | AWI | D |
| Tanzer | Dieter | UR | D |
| Weber | Kurt | AWI | D |
| Weyland | Horst | AWI | D |
| Wöhrmann | Andreas | IPÖ | D |

SCHIFFSPERSONAL / SHIPS CREW ANT VII/5

| | |
|---|---|
| Kapitän | Jonas, H. |
| 1.Offizier | Götting, H. |
| Naut. Offizier | Varding, I. |
| Naut. Offizier | Weihe, W. |
| Arzt | Dr. Rose, W. |
| Ltd. Ingenieur | Briedenhahn, C. |
| Ltd. Ingenieur | Dietrich, H. |
| 1. Ingenieur | Schulz, V. |
| 2. Ingenieur | Monostori Erret, G. |
| 2. Ingenieur | Fengler, R.-R. |
| Elektriker | Schuster, G. |
| Elektroniker | Elvers, H. |
| Elektroniker | Hoop, K.-J. |
| Funkoffizier | Butz, J. |
| Funkoffizier | Müller, E. |
| Koch | Klasen, H.-D. |
| Kochsmaat | Klauck, F.-M. |
| Kochsmaat | Kröger, H.-J. |
| 1. Steward | Peschke, D. |
| Stewardess | Feigler, M. |
| Stewardess | Hoppe, M. |
| Stewardess | Lieboner, R. |
| Stewardess | Hopp, A. |
| 2. Steward | Fang, S. Y. |
| 2. Steward | Lai, C.-Y. |
| Wäscher | Shyu, T.-S. |
| Bootsmann | Hopp, W. |
| Zimmermann | Kassubeck, P. |
| Matrose | Albrecht, B. |
| Matrose | Arias Iglesias, E. |
| Matrose | Pereira Portela, B. |
| Matrose | Novo Loveira, J. |
| Matrose | Prol Otero, A. |
| Matrose | Meis Torres, M. |
| Lagerhalter | Barth, B. |
| Maschinen-Wart | Fritz, G. |
| Maschinen-Wart | Jordan, G. |
| Maschinen-Wart | Buchas, F. |
| Maschinen-Wart | Reimann, S. |
| Maschinen-Wart | Heurich, E. |