The Expedition ANTARKTIS XV/3 (EASIZ II) of RV "Polarstern" in 1998

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with contributions of the participants

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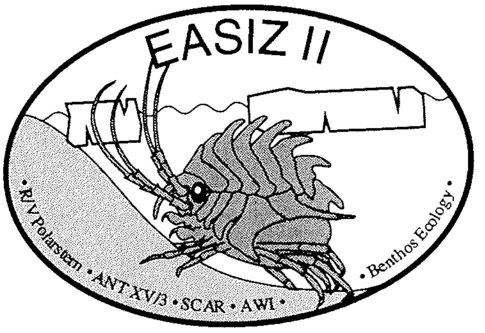

EASIZ II
• R/V Polarstern • ANT XV/3 • SCAR • AWI •
• Benthos Ecology •

1. Introduction

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

The EASIZ (Ecology of the Antarctic Sea Ice Zone) programme of SCAR, planned as a complementary approach to SO-JGOFS and SO-GLOBEC, combines investigations from the shore stations around Antarctica with shipboard work on the shelf and slope. Its terms of reference were approved at the SCAR XIII meeting in Rome (1994):

> "The aim of the EASIZ Programme is to improve our understanding of the structure and dynamics of the Antarctic coastal and shelf marine ecosystem, the most complex and productive in Antarctica, and likely the most sensitive to global environmental change. Particular attention will be paid to those features that make the biology of this ice-dominated ecosystem so distinctive, and to understanding seasonal, interannual, and long-term changes."

During the EASIZ I cruise (ANT XIII/3) in early 1996 RV "Polarstern" worked in the pack-ice zone of the southeastern Weddell Sea, focussing research primarily on the benthos and fish communities. The core projects were a study of iceberg impact on the bottom fauna, and the investigation of the trophic relations between different components of the high Antarctic ecosystem.

The objective of this EASIZ II cruise (ANT XV/3) was to continue the same approach as during EASIZ I, concentrating on few localities ("box concept") and a limited number of joint projects rather than on large-scale sampling. The principal projects to be undertaken included

(i) the effect of iceberg scour on macro- and meiobenthic, and demersal fish, communities. During EASIZ I, recurrent patches of benthic fauna had been found ranging from very poor stages on fresh scours to mature, obviously old stages. However, we needed finer identification and separation of these stages, including the identification of characteristic species, and we need to place them in a temporal sequence, to assess the capacity of recovery (resilience) of these communities. Parallel to these studies, a long-term experiment on benthic colonisation of hard bottoms (tiles) was to be initiated.

(ii) bentho-pelagic coupling in the high Antarctic ecosystem and the role of suspension feeders. Analyses of the food of benthic suspension feeders (hydroids, gorgonians, pennatularians) during EASIZ I had revealed very little connection between the strong rain of larger particles and aggregates sinking to the seafloor in Antarctic summer and the food intake by these organisms. Careful sampling and experiments aboard the vessel, incl. a new incubation technique which accounted for the pico- and nanoplankton food fractions, was to be carried out to learn what kind of food the high Antarctic suspension feeders subsist on. An attempt was to be made also to collect hard-bottom suspension feeders from a shallow (60 m) mound which had been detected by ROV during the former cruise.

(iii) diving and foraging behaviour of Weddell seals in relation to the available food. In the Drescher Inlet, Weddell seals were to be equipped with various instruments indicating their diving frequency and depth, and their intake of pelagic or benthic food. At the same time, food availability was to be studied using different trawls (bottom, benthopelagic, Agassiz) in open water and at the seafloor. During EASIZ I, sampling in the pycnocline had yielded only minute specimens of notothenioid fish whereas former studies on Weddell seal food intake had suggested adult *Pleuragramma* to be the staple food of these seals.

(iv) biodiversity and evolutionary links of the high Antarctic Weddell Sea with the Antarctic Peninsula area (and the Magellan region which had been sampled before). Major gaps still exist in the taxonomic inventory of many groups, and specific sampling by epibenthic sledge and multibox corer was required to account for smaller species, the hyperbenthic fauna above the seafloor, and latitudinal diversity gradients.

In addition to these core projects, studies were to be undertaken, among others, on secondary metabolites and their role in species interactions, carbon and silica storage and flow on the

Weddell Sea shelf and slope, benthic distribution and respiration, ultrastructure and population genetics of benthic fauna, migratory behaviour of crabeater and Weddell seals, physiology of benthic invertebrates, lipid storage of copepods, shelf sources of iron, and the ice platelet layer. All these studies had the common goal of improving the knowledge on organisms, species populations and communities in the Antarctic sea ice zone as well as on the energy flow within and among the different compartments of this ecosystem.

In regional terms, the major part of the EASIZ II expedition was planned to take place in the southeastern Weddell Sea, between Atka and Halley Bay, and the final part was scheduled for the area around King George Island (South Shetland Islands, Antarctic Peninsula) to do some work in the context of the Antarctic-Magellan comparison that could not be completed during "Polarstern" cruise ANT XIII/4.

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

Most groups aboard "Polarstern" during the EASIZ II cruise concentrated on the benthic fauna in the pack-ice zone of the Antarctic continental shelf and slope. Work in the southeastern Weddell Sea centred around the effect of iceberg scouring on benthic communities, the role of benthic suspension feeders, and biodiversity (Figs 1 - 2). The latter was also the principle theme of benthic research around King George Island (Figs 1 and 3) within the context of the Antarctic-Magellan comparison. In addition, the diving and foraging ecology of Weddell seals in comparison with the availability of their food was a major theme of interest during this cruise, and some work was done on the migration of crabeater seals in relation to the prevailing pack ice conditions. The platelet layer underneath the fast ice was subject to a special study undertaken in the Drescher Inlet. Further research included ecophysiological experiments on fish and invertebrates and the collection of material for the study of secondary metabolites, the population dynamics of fish and benthos key species, and studies on ultrastructure of selected taxa.

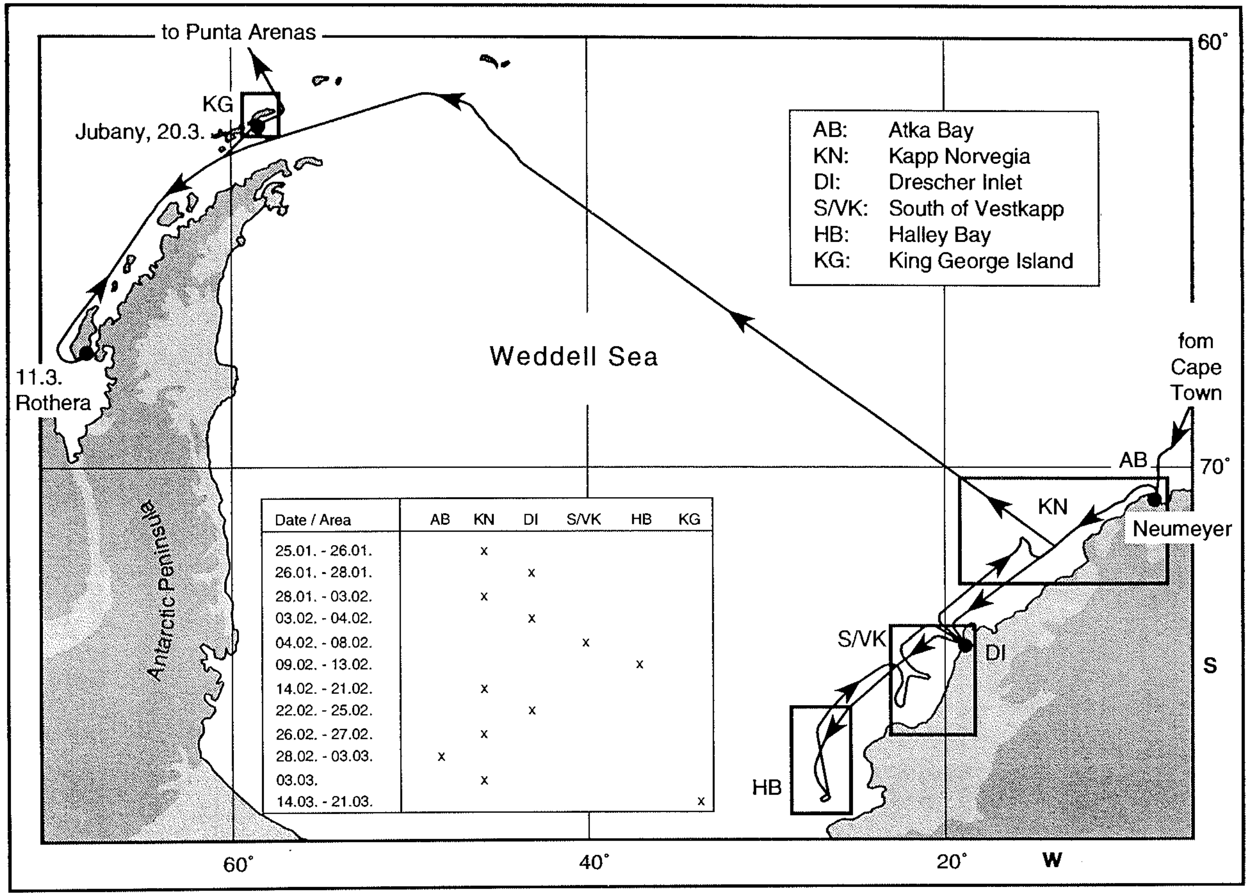
(a) Iceberg scouring and benthic resilience

Former estimates had arrived at the conclusion that about 5% of the Antarctic shelf is affected by iceberg scouring. However, during work at the Auståsen iceberg cemetery north of Kapp Norvegia (approx. 250 to 350 m depth) imaging methods revealed that locally disturbance can be much higher. In this area recent scour marks without any megafauna made up 15% of the observed seafloor, recolonised scours contributed 35%, whereas undisturbed assemblages contributed only 20%. The remainder cannot at present be classified.

Progress has also been made in determining those organisms that are typical of certain stages of recolonisation. Besides colonial ascidians (*Synoicium* sp.) and bryozoans of the *Cellaria* type, which had been identified as early colonizers before, one of the most prominent species in early stages of recolonisation was the gorgonarian *Primnoisis antarcticus* which occurred in high abundances in scour marks. Other indicator organisms of disturbed areas were the stalked sponge *Stylocordyla borealis*, the solitary ascidian *Molgula pedunculata*, the gorgonarian *Ainigmaptilon antarctica*, and the polychaete *Pista* cf. *spinifera* (Terebellidae). The main task in the near future will be to place the various stages of recolonisation into a temporal sequence and to determine and verify the growth of the indicator organisms. Recent progress has been made in this respect using stable isotopes, e.g. with the bivalve *Laternula elliptica* and the bryozoan *Melicerita obliqua.* Studies on *Cellaria* are under way.

Growth of hard bottom dwellers will hopefully be verified in coming years from a load of tiles which were deployed in 4 mounds at 341 m depth off Kapp Norvegia. It is expected that improving ROV facilities should make the location and retrieval of these substrates easier.

The fish community in areas disturbed by icebergs turned out to be significantly less diverse than that of undisturbed areas: In disturbed areas, 19 species were found, with the first two dominants *(Trematomus penellii, T. nicolai)* reaching a numerical share of nearly 70%.



AB: Atka Bay
KN: Kapp Norvegia
DI: Drescher Inlet
S/VK: South of Vestkapp
HB: Halley Bay
KG: King George Island

Date / Area	AB	KN	DI	S/VK	HB	KG
25.01. - 26.01.		x				
26.01. - 28.01.			x			
28.01. - 03.02.		x				
03.02. - 04.02.			x			
04.02. - 08.02.				x		
09.02. - 13.02.					x	
14.02. - 21.02.		x				
22.02. - 25.02.			x			
26.02. - 27.02.		x				
28.02. - 03.03.	x					
03.03.		x				
14.03. - 21.03.						x

Fig. 1: Areas of investigation. Overview.

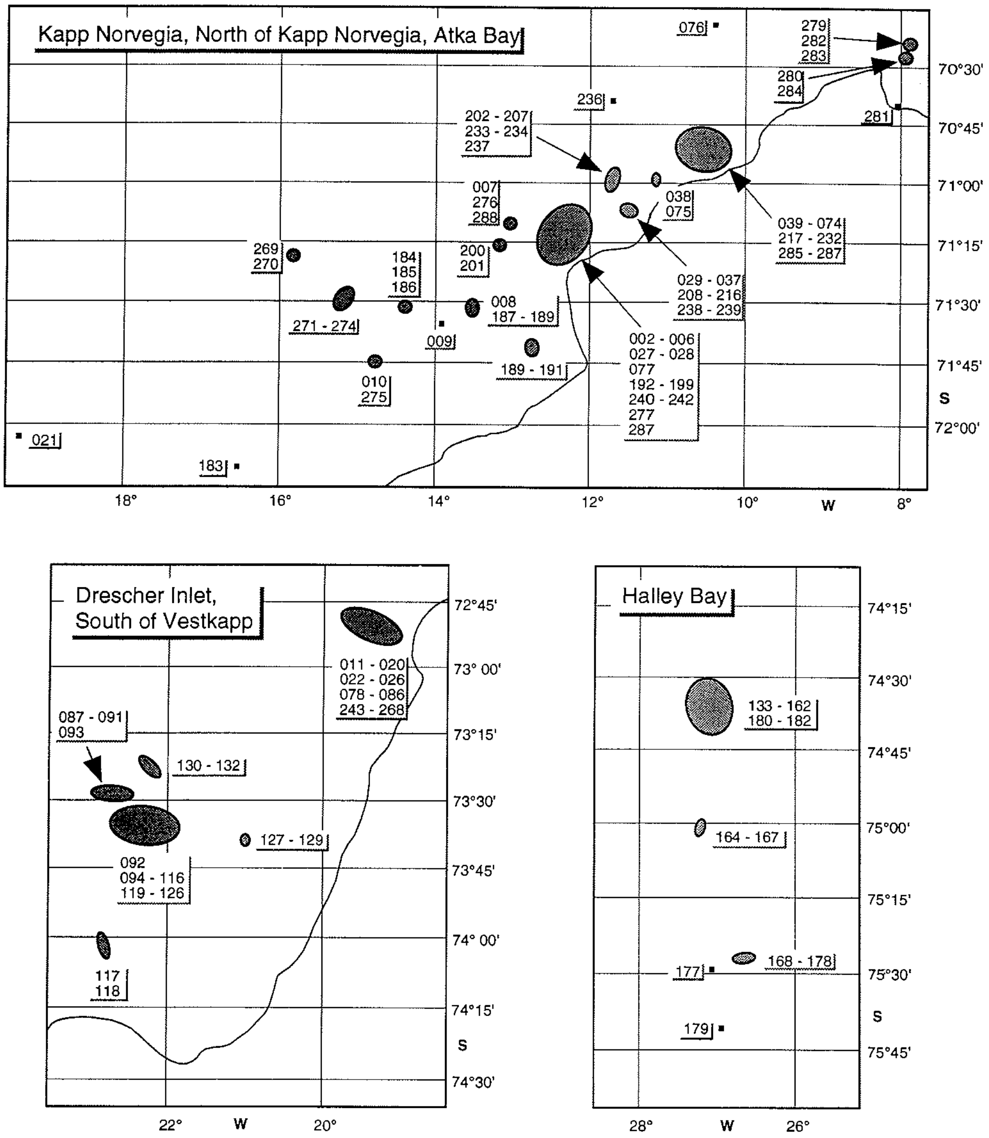


Fig. 2: Areas of investigation. Weddell Sea.

In undisturbed areas, 25 species were recorded, and the 70% mark was reached only with 6 species. In these areas, the fish species *T. scottii* and *Prionodraco evansii* are most common.

(b) Ecology of benthic suspension feeders

The EASIZ II cruise is the one where most species of hydrozoans (72) and anthozoans (63) have been recorded in the Antarctic. An anthozoan group that was intensely studied is the octocorals, mainly the gorgonians and the stoloniferans. Three new genera and species, and an additional two new species, have been proposed of gorgonians which reveal a particularly high species richness in the southeastern Weddell Sea. Stoloniferans were found to be strongly dominant on stones at a shallow (60-70 m) site off Four Seasons Inlet. A community study of this site, which was sampled by means of a 1.6 m^2 videograb, and which is characterized by a surprising species richness despite its coarse sediment, is under way and will be the first study of a shallow hard-bottom community in the high Antarctic Weddell Sea.

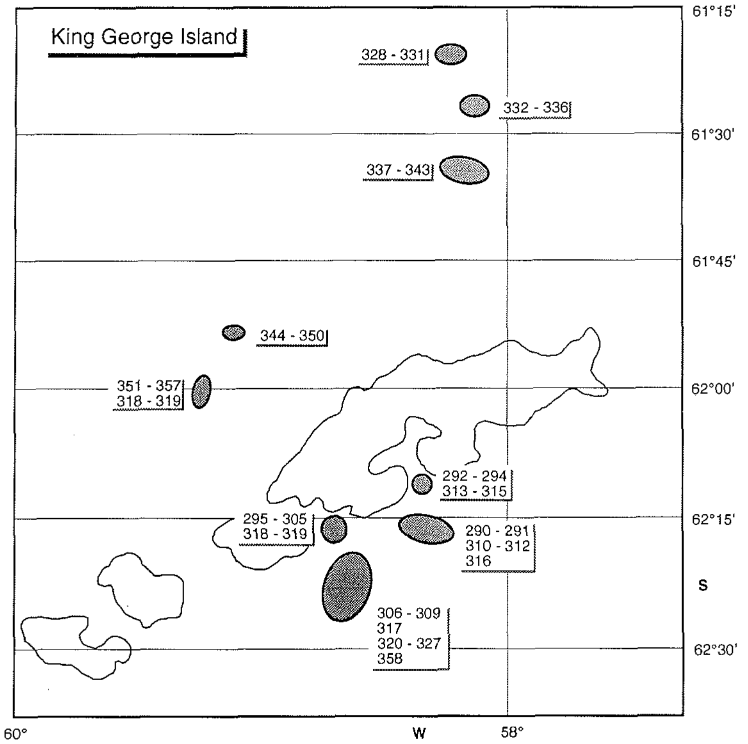


Fig. 3: Areas of investigation. King Georg Island.

Sexual reproduction was extensively studied and quantified in several species of gorgonians and stoloniferans. The number of eggs per mature polyp in several species of gorgonians such as *Ainigmaptilon antarcticus* were of the same order of magnitude as in many Mediterranean, Caribbean, and Pacific species, indicating hight fertility and potential recruitment success. In some female polyps several larvae ready to be released from the polyp were found together with oocites in early stages of development. This finding suggests an extended development period, possibly from early spring to late austral summer, and it could mean that these organisms might be in a continuous reproductive state, which enables them to recruit successfully in, e.g., areas recently disturbed by iceberg scouring. This would explain why *Primnoisis* is always among the earliest dwellers in iceberg scours. Larvae are not pelagic but may function as drift stages.

As during the EASIZ I cruise seemingly no larger particles were taken up by the majority of benthic suspension feeders, predation on the fine (pico- to nanoplankton) fraction was assessed using continuous flow incubation chambers. The suspected use of these very small organisms as food would solve one of the enigmas of Antarctic benthos communities: Which kind of food can maintain very dense communities of benthic suspension feeders in a highly seasonal environment? A great part of the organic input from ice algae, phytoplankton and suspended benthic microalgae sinks from the water column to the bottom, possibly due to low microbial decomposition rates. Both these particles and their associated microorganisms, often resuspended by currents, may represent important food sources for benthic suspension feeders, which would place them as key organisms in Antarctic food webs.

An exception in that it feeds on larger particles is the common benthic hydroid, *Tubularia ralphii,* whose predation rate was estimated at 1790 prey items $m^{-2}d^{-1}$, with a diet consisting entirely of planktonic copepods! This high predatory impact, which resembles that of related species living in temperate waters, should allow fast growth during the austral summer. *Tubularia*, beside the hydrozoan *Silicularia rosea* described from Jubany (which feeds on diatoms), is the only hydrozoan large-particle feeder known hitherto from the Antarctic.

Another exciting finding was the discovery of pigmented cells and pigment concentrations in several cnidarian species. These pigments might be involved in supplying food to animal cells during the austral summer by means of symbiotic associations similar to those known from temperate and tropical regions (e.g., zooxanthellae). Furthermore, it was most likely confirmed that certain cnidarians such as gorgonians and hydrozoans possess biochemical adaptations enabling them to digest macromolecules of plant origin.

(c) Biodiversity

Only preliminary results can be presented at this time due to the fact that many samples have not yet been sorted, and that many smaller-sized taxa require further identification. Those samples that were taken in a quantitative or semi-quantitative way (e.g., multibox corer, multicorer, epibenthic sledge) may finally be used for the study of latitudinal and depth gradients. The megafauna data from imaging methods are used for Arctic-Antarctic comparisons. Divided by groups, the following results are available:

Macroalgae: In several hundred former Agassiz trawl and bottom trawl catches taken since 1979, and in a very large amount of underwater pictures and videos, never a single macroalga had been detected in the Weddell and Lazarev Seas. However during EASIZ II, working at the shallow 60-70 m site off Four Seasons Island, one piece of fresh red alga was found which served as a camouflage to a sea urchin *(Sterechinus* sp.). While we cannot be sure that this alga had grown at this site, we also found several corallinous algae growing on stones.

Meiofauna: From mud samples, 6 meiofauna taxa were obtained. The most dominant taxon were the nematods which comprised 96.4% by number (406 ind. cm^{-3}) of all meiofauna. Tardigrades, the second dominant taxon, accounted for 2.1%, copepods (incl. nauplii) for 1.1%. In sponge spicules 9 meiofauna taxa were found. Abundance of nematodes in this substrate was higher (460 ind. cm-3), however their dominance (52.5%) was less pronounced than in the mud. Crustaceans (copepods, ostracods and nauplii) comprised 46.1% in this substrate. Sponge spicules, which provide interstitial space which is more suitable for meio- than for macrofauna and trap small suspended particles which may serve as food, are considered an important habitat for microfauna.

Molluscs: 83 gastropod and 35 bivalve species were found in the Weddell Sea during the cruise, compared with 93/39 species reported by Hain from that area. For the first time, 4 live specimens of the scallop *Adamussium colbecki* have been reported from the southeastern Weddell Sea, e.g. from Drescher Inlet, and *Laternula elliptica* has been reported for the first time from the 60-70 m shallow site off Four Seasons Inlet.

Polychaetes: Within the 32 families identified until now, species richness seems to be highest in sandy bottoms and lowest in compacted silt and clay sediments. 1 Aphroditidae, 12 Polynoidae and 5 Sabellidae have been identified to species level. Ampharetidae were the most abundant family. Species richness appeared to be lower in areas disturbed by iceberg scouring. The faunal break between shelf/slope and deep sea appears to occur between 1000 and 1500 m in the southeastern Weddell Sea and may be somewhat shallower off King George Island. Deep-sea stations are much less species rich than those taken off the U.S. Atlantic and Pacific coasts. Polynoidae were sampled not only for taxonomic reasons but also to study their reproduction.

Quite a number of specimens, particularly of *Harmothoe spinosa* and related species, were found bearing mature eggs on their backs, under the elytra. Mean egg diameter was 150 um. External brooding is supposed to be short, and larvae hatching from these eggs are likely to be pelagic.

Isopods: 22 larger-sized species have been identified from AGT samples and baited traps. Many small species from deep-sea samples have only been determined to family level. The break between shelf/slope and deep sea was most pronounced at about 1000 m depth for this group. The serolid isopod species *Ceratoserolis trilobitoides* and *C. meridionalis* showed a distinct allopatric depth distribution, with the former occurring at shallower sites and the latter being more common below 850 m depth. Similar results were obtained from baited traps for the aegid isopods: *Natatolana oculata* and the abundant *N. obtusata* were found only at shallower stations, *N. intermedia* was sampled only below 1000 m. At stations with large amounts of big Demospongiae, arcturid species were common whereas serolids and *Glyptonotus antarcticus* were scarce.

Amphipods: At least 179 species of gammaridean amphipods, 2 species of caprellids, and 4 species of pelagic Hyperidea have been collected. Three genera and 38 species are presumably new to science, which would increase the number of species known from the Antarctic by at least 8%. The small Stenothoidae is the family with the largest number of new species, most of them from "unusual" habitats such as shallow-water stone accumulations, which obviously still hold a great potential of undetected species. Of the 130 species that could be identified, 46 species were known from the West Antarctic but only 12 from the Magellan Region. The family Clarencidae has been detected for the first time in the East Antarctic. Commensal amphipods (lysianassids, stegocephalids and stenothoids) have been found in live ascidians, mostly *Ascidia challengeri.* Some stenothoid species were found to be associated with hydrozoans or gorgonians *(Primnoella),* mostly from boulder assemblages.

Leptostracans: Two species (*Nebalia* sp. and *Nebaliella* sp.) were obtained from dredge samples, the latter also from a baited trap.

Decapods: Caridean shrimps were much more common in AGT catches from the southeastern Weddell Sea than around King George Island. The dominance of *Chorismus antarcticus, Notocrangon antarcticus* and *Nematocarcinus lanceopes* and their depth zonation (from shallow to deep water) was confirmed once again. The only other species found were *Lebbeus antarcticus* and *Eualus kinzeri* (in a single specimen).

Megafauna: Agassiz trawl, multibox corer and epibenthic sledge confirmed results from former cruises that the shelf fauna off Vestkapp and Halley Bay is less rich than that off Kapp Norvegia. This may be related to the lower abundance of sponges, but also to the diversifying effect of iceberg scouring on larger spatial scales. On the transects down the slope hexactinellid sponges (*Rossella* spp.) were found down to 1000 m water depth, however in low numbers. At even greater depths, the large epibenthos is dominated by several species of ophiuroids and the shrimp *Nematocarcinus.* Holothurians, echinoids and asteroids were less abundant but occurred regularly. Species richness of the latter group was compared at a number of shelf and slope stations, and found to be surprisingly high.

"Other side of Drake Passage": Sampling on the southern slope of the Drake Passage with different types of gear, which had been planned for "Polarstern" cruise ANT XIII/4 but had to be suspended because of unfavourable weather, was completed during EASIZ II. Sampling was carried out at 5 stations in the open Drake Passage (100 to 2100 m depth) and at 5 stations in the Bransfield Strait (250 to 1500 m depth).

The first results indicate full Antarctic conditions on the southern slope of the Drake Passage, with a particularly rich benthos between 400 and 1000 m depth. However, both in the Bransfield Strait and in the open Drake Passage, the endofauna - especially polychaetes - appeared to be much better developed than in the southeastern Weddell Sea whereas the typical high Antarctic epifauna (in particular, sponges, hard-shelled bryozoans and gorgonians) was largely missing. Errant polychaetes, particularly deep-living Onuphidae, were common on both sides of King George Island whereas sedentary forms (Sabellidae, Terebellidae, Cirratulidae) only abounded in the Bransfield Strait. Algal remains and soft cheilostomatic bryozoans were very common at the shallowest stations (ca. 100 m) both in the Bransfield Strait and the Drake Passage. Large scleractinian single corals occurred frequently in the Drake Passage but were almost missing in the Bransfield Strait. Large gastropods, with the conspicuous species *Aforia magnifica* dominating, were common in the Drake Passage. Contrary to the northern slope of the Drake Passage sampled during ANT XIII/4, not a single reptant decapod was encountered on the southern slope, and stomatopods do not seem to exist here either. Among the echinoderms, ophiuroids were found to be strongly dominant on both sides of King George Island whereas relatively few asteroids occurred in the Bransfield Strait in comparison with the Drake Passage (and the high Antarctic). Crinoids, a very dominant element in the southeastern Weddell Sea, were abundant only off Admiralty Bay but showed a trend of increasing importance in relation to the northern slope of the Drake Passage and, in particular, the Magellan Region.

Fishes: From the bottom trawl (used only in the Weddell Sea) 54 fish species have been identified up to now, 80% of which belong to the suborder Notothenioidea. Within this suborder, *Pleuragramma antarcticum* contributed 51% of all individuals. The only other species with a remarkable numerical dominance was *Macrourus whitsoni* (Macrouridae), with 11% of all fish caught. Below 500 m this species was dominant. A cluster analysis revealed distinct differences in species composition between shallower and deeper (>500 m) samples. Differences between shallower stations were more pronounced than between deep stations.

(d) Chemical ecology, ecophysiology, and autecological research

Several species of nudibranchs and related species were investigated because of their defensive abilities against predators by using secondary metabolites. In feeding experiments it was shown that neither live snails nor tissue pieces from their mantles were eaten by predators. Tests with extracts of nudibranch mantles showed that the defensive chemicals are located in the mantle.

Respiration measurements on benthic species (sponges, cnidarians, and echinoderms) showed that Antarctic animals exhibit low respiration rates compared with species from temperate regions. Oxygen measurements on isolated tissues of octopods proved to be suitable to investigate the cost of protein synthesis as a potential measure of growth. The fractional cost of protein synthesis rose significantly at higher temperatures.

Baited traps were successfully used to catch large numbers of eelpout (Zoarcidae, *Pachycara brachycephalum),* which were transferred to the AWI aquarium both by plane and on "Polarstern". More than 100 specimens are kept alive in the aquarium system.

Pterobranchia (Hemichordata) are a predominantly Antarctic group of sessile, colonial suspension feeders. Material from different life stages and species of *Cephalodiscus* was collected for ultrastructural and cytochemical work and should enable a decision how closely this group is related to the chordates. - Echiurids are part of the endofauna which is rather sparsely developed in the high Antarctic. To live on the presumably poor substrate, the green species *Alosoma belyaevi* has developed an intestine with several compartments, which is 20 times the length of the female worm (males are dwarfs). The alimentary channel of these echiurids will be analyzed for the first time including its contents, which are neatly packed in pellets. - Priapulids are the oldest living fossils among the metazoans. They hardly changed their outer appearance since the Kambrium. The alimentary channel of the large species *Priapulus tuberculatospinosus* will be investigated for the first time. - The scavenging isopod *Natatolana obtusata* was caught in large numbers with baited traps. The isopods had ingested so much food, that they could only lie on their backs. However, after seven weeks only a minute share of the ingested meat had been digested. This indicates that food intake once a year may be sufficient for the survival of these scavengers. Also their alimentary chanal will be analyzed electron microscopically. - The amhipod scavengers *Waldeckia obesa* and the "giant" *Eurythenes gryllus* revealed distinct differences in their alimentary channels between eachother and with *Natatolana.*

Food, mandibles and stomach structures of the three dominant Antarctic decapods *Chorismus antarcticus*, *Notocrangon antarcticus* and *Nematocarcinus lanceopes* were investigated to explain food partitioning (all three species live mainly on benthic invertebrates) and habitat segregation (they are dominant in different depths, however with considerable overlap). Mandibles and stomach filters revealed strong differences among the three species which should be reflected in their diets. An electron microscopic study is under way.

Holothurians have probably developed more connective tissues than any other invertebrate group. A histochemical study is missing, although it might clarify the systematic position of the echinoderms, which by some authors are considered the closest relatives of the chordates. A large material was collected including samples from the deep sea, to tackle this problem.

Morphological characters appearing as differences in sensory organs (eyes and barbels) of the notothenioid fish family Artedidraconidae are helpful in the distinction of species and genera, and may be related to the fast radiation and speciation processes within this group. These seem to result in the avoidance of competition for food. A negative correlation exists between eye size and barbel length. An electron microscopic study of the barbels will answer the question as to the presence of receptors. An analysis of the diet of 36 pelagic and demersal fish species was carried out. 2640 prey items from 92 taxa were found, and a description was made of the position of the fish assemblage in the Antarctic food web.

(e) Diving and foraging ecology of Weddell seals in relation to food availability

Seal and fish biologists cooperated closely in this study which is part of the APIS programme. Weddell seals undertook two types of dives in the Drescher Inlet, orientation dives to various depths and foraging dives, the latter preferably to 50, 150 (pycnocline), and 400 m (seafloor). They showed a preference for pelagic foraging during the night, concentrating on the depths around the pycnocline, and for hauling out during daylight.

Trawling in the pelagial and at the seafloor revealed that fish, above all *Pleuragramma antarcticum*, migrated into water depths around the pycnocline (230 to 130 m) at night whereas they remained close to the seafloor during the day. This behaviour seems to be linked to pelagic feeding as well; at midnight the number of empty fish stomachs was zero. - Weddell seals enjoyed favourable feeding conditions in the Drescher Inlet during austral summer 1998. Sea-ice conditions were quite unusual; during the later part of the season, the fast ice withdrew far into the inlet. The behaviour of the Weddell seals was obviously finely tuned to the vertical migrations of their fish prey. - Several hundred giant petrels shared the pelagic fish with the seals. On one occasion a seal had vomited 230 specimens of *Pleuragramma* which - unless being collected by scientists - would have become an easy prey for the birds.

(f) Abundance and distribution of crabeater seals, and satellite tracking of this species

A total of 3636 seals were counted over an area of 244.4 nm^2 and occurred at a mean density of 23.3 nm^{-2} (only pack-ice fields considered). The proportional contribution, which did not differ from that found in previous censuses, was 95.4% crabeater seals, 0.5% Ross seals, 1.2% leopard seals and 2.9% Weddell seals. The very high mean density of crabeater seals in the eastern Weddell Sea was due to the low pack ice coverage in this area (the few ice fields attracted all the seals), whereas the low mean density (0.38 nm^{-2}) found in the western Weddell Sea was probably an artefact of the relatively small area surveyed and not characteristic of the region. The census returned seal density values which were considerably lower than those recorded in 1968 and 1969, but similar to that found in 1983, also a year with a very strong El Niño as in the present study.

A number of crabeater seals were equipped with satellite transmitters to reveal their migration routes. 12 seals migrated westward and reached an ice covered area at 35°W in the first days of March. Their migratory routes corresponded roughly to a strong branch of the Weddell gyre. Two crabeaters migrated eastward up to 30°E against the coastal current. Their migration route was initially associated with a small band of sea ice near the ice shelf. After having passed 0°

they continued to 30°E in ice free water close to the ice shelf. Maximum distances were 1900 km eastward and approx. 720 km westward during the first four weeks of migration.

(g) Sea ice research

Sediment traps were for the first time successfully deployed under fast ice and revealed a high flux of organic matter underneath the ice. Hydrographic measurements under fast ice did not indicate supercooled water under the ice shelf in February. Platelet layers under fast ice were up to 30 m thick and housed high standing stocks of sea ice algae which attracted many amphipods and copepods. Novel field experiments were carried out to determine biogeochemical pathways and reasons for high production in the platelet layer.

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

"Polarstern" left Cape Town (South Africa) on January 13, 1998 with an international team of 47 marine biologists from 7 European countries, Canada, Korea and South Africa, enforced by 2 meteorologists, 4 helicopter pilots and technicians, 44 crew and 14 guests (Neumayer Station and logistics personnel). Spain and Belgium contributed the largest foreign groups on board.

During the first days of the crossing to Atka Bay (Fig. 1), "Polarstern" encountered moderate winds but a fairly rough sea, which often flooded the aft deck and made it difficult to empty the containers. The second part was quiet, however, and the vessel arrived on schedule in Atka Bay on January 23 to deliver the new overwintering crew, technical equipment and provisions. Many aboard took the chance to visit Neumayer station in bright sunshine by helicopter shuttle. "Polarstern" left Atka Bay the next day and headed along the shelf ice edge, in the coastal polynya, for Kapp Norvegia where it arrived on January 25 (Fig. 2). A couple of moorings and four tile bags destined for hard-bottom recolonization were deployed, and the giant TV grab was tried for the first time in the search for benthic suspension feeders. When there was pack ice around, the two South African seal biologists flew helicopter transects which served a crabeater seal census within the APIS programme.

The vessel then continued to Drescher Inlet, which was reached on March 26 and largely found under ice cover, and the igloo station was unloaded immediately with the support of the helicopters. Before "Polarstern" left the fast ice edge, almost everybody took a walk on the ice and then enjoyed a buffet dinner and punch which the cooks had provided beside the vessel. During the following two nights trawling was carried out in the ice-free outer Drescher Inlet with the benthopelagic trawl, to study vertical migrations of fish in relation to the pycnocline, availability of fish to seals, and fish diet. Only light work was carried out during the day including CTD, bongo, baited traps, and underwater camera. Meanwhile the three scientists at the Drescher station started their field work on seals and the platelet layer underneath the fast ice.

Passing Kapp Norvegia, work on January 29 started off Four Seasons Inlet where an extremely shallow station at 60-70 m depth was sampled successfully by means of the TV grab. The following days, characterized by strong wind, "Polarstern" worked on the iceberg impact question in the Auståsen iceberg cemetery, where large icebergs always provided sufficient shelter to continue working with a set of gears, even under otherwise rough conditions. Imaging methods were employed to distinguish undisturbed areas from those hit by iceberg impact, and sampling was done using quantitative corers and non-quantitative dredges and trawls. The samples, besides yielding information on iceberg impact, also provided material for the suspension feeders and some samples for the biodiversity group.

The first working period at the Auståsen iceberg cemetery ended on February 1, and "Polarstern" returned to Drescher Inlet, picking up two baited amphipod traps on the way and taking a bottom trawl haul off Kapp Norvegia to supply the "secondary metabolite" group with material. February 3 was spent mainly with the second (daylight) fishing in the outer Drescher Inlet, where three bottom trawl hauls were taken, and light accompanying work. The vessel then proceeded to a working area southwest of Vestkapp, where up to February 8 a biodiversity transect and demersal fishing were carried out between 200 (EBS: 400) and 2000 m depth. Up to February 12, the same procedure - again biodiversity and trawling - was applied in an area off Halley Bay station. Some light gear such as amphipod traps, bongo, CTD and photo sledge was also used in the two localities, a short encounter with HMS "Endurance" took place on February 10, and captain, cruise leader, and chief meteorologist payed a short visit to Halley Bay station. The idea of proceeding down to Filchner or even up to 71°S along the Antarctic Peninsula was abandoned due to the little time that would have been left for doing scientific work.

After return to Kapp Norvegia the next phase, between February 15 and 21, was dedicated again to research on iceberg impact and benthic suspension feeders, with the usual change of imaging methods, trawling and coring, and another TV grab shallow station off the Four Seasons Inlet. February 17 was lost completely as a work day because of a gale from which not even the icebergs could provide protection. A second phase in the Auståsen iceberg cemetery led to the successful conclusion of the iceberg impact study also for the fish biologists who were able to use the bottom trawl in the narrow passages between icebergs.

After picking up the amphipod traps and doing some complementary work, "Polarstern" headed towards Drescher Inlet for the third time on the night of February 21, to complete the work on the availability of fish in the inlet and to pick up the three researchers and the station. The fast ice had retreated considerably in the meantime, and the ice edge was at the height of the station (which was located above, on the shelf ice). Fishing with the benthopelagic trawl during daytime ended when the net touched the bottom and was torn to pieces. During the second (night) fishing, a bottom trawl was used with two barrels as floating devices but yielded only very small catches. Inbetween, water pumping outside the inlet had to be interrupted because the weather was about to deteriorate, and the vessel returned to the fast ice edge to recover the station. As helicopter use was impossible, Drescher Station was removed in a great effort via the shelf ice, using Nansen sleds to transport the igloos.

With the igloos, equipment and scientific personnel luckily aboard, "Polarstern" started its return to Atka Bay on February 25. An attempt to do some deep-sea sampling off Kapp Norvegia within the biodiversity approach was only partly successful due to strong swell. One of the moorings deployed when we began our work in the area was retrieved, the second one was not released. An additional AGT provided more suspension feeder material. Atka was reached on February 28 under favourable ice and weather conditions, and loading could be done in one and a half day. After the customary farewell party, "Polarstern" did some final ROV work at a very shallow (60-70 m) station in the innermost part of Atka Bay. On March 1, last year's overwinterers and some "guests" were picked up by helicopter, the amphipod traps were retrieved once more, and the vessel proceeded to Kapp Norvegia where a futile attempt was made to retrieve the "lost" mooring. However, the retrieval of a sediment trap was more successful. Some grease ice was sampled from a zodiac before "Polarstern" headed towards the Antarctic Peninsula.

The crossing of the Weddell Sea was achieved in 9 days under low wind and comfortable sea conditions. Pack-ice in any quantity was encountered only around the tip of the Antarctic Peninsula, where the South African seal biologists could finally resume their census for a few days. The vessel passed King George Island and headed immediately for Rothera Station to deliver some kerosene. Rothera was reached on March 11. While the fuel was pumped ashore, many scientists and crew members visited the station and its surroundings.

"Polarstern" arrived back off King George Island on March 14. As there was too much wind and swell to start sampling in the open Drake Passage, work was initiated in the Bransfield Strait with a transect between 200 and 1500 m, and continued from March 18 in the open Drake Passage (100-2000 m), including AGT, EBS, the photo sledge, the corers, CTD and Bongo (Fig. 3). In the Bransfield Strait, also amphipod and fish traps were deployed. During this work, an inspection of the Dallmann laboratory was made together with Argentinean officials to prepare maintenance work in the next season, and individual scientists payed visits to the Korean and Polish stations in King George Island and to the Spanish station on Livingstone

Island, where the vanishing resources of formalin were filled up. "Polarstern" left King George Island on March 21 after taking up materials and a last group from Jubany which raised the total number of people on board to 121. After a quiet crossing of the Drake Passage the vessel sailed along the Tierra del Fuego east coast and into the Strait of Magellan, to arrive on schedule in Punta Arenas in the night of March 25/26.

1.4 Meteorological Conditions (R. Brauner, H. Köhler)

Kapstadt - Neumayer (13 Jan to 23 Mar)

"Polarstern" left Capetown on the 13-01 at 20:00 hours with light south-easterly winds and a temperature of about 20°C. Near Cape Agulhas windspeed increased up to 6 Bft due to the orographic effect. Then "Polarstern" passed a zone of high pressure with light and variable winds but swell up to 2.5 m initiated by the strong westly winds between 40° and 60°. Near 42° "Polarstern" crossed the Subtropic Convergence and the water temperature decreased from 18°C to 12°C. Then low pressure systems with winds from westerly directions dominated the weather. The wind speed varied between 15 and 40 knots and the wave heights varied between 2.5 and 5 m. When "Polarstern" reached the southern flank of the low pressure systems, the sky was partly cloudy with a moderate south-easterly breeze and temperatures between -1°C and -5°C. On 23-01 "Polarstern" went alongside the iceshelf edge. With temperatures at about -5°C, sunshine and light and variable winds, the logistic work for the Antarctic station Neumayer were completed quickly.

Neumayer - Neumayer (24 Jan to 2 Mar)

On the 24-01 "Polarstern" left Atka Bay with destination Drescher Inlet, where scientists and their equipment were tranported by Helicopter onto the iceshelf edge. From 27-01 until 27-02 scientific work was done near Kapp Norvegia, Vestkapp, Drescher Inlet and Halley Bay.

The weather was dominated by low pressure systems moving across the northern Weddell Sea from the Antartic Peninsula in easterly direction in periods of four to seven days. On the front of the low pressure systems relative warm air with a high humidity streamed in from north-easterly directions mostly accompanied by moderate to strong snowfall. Sometimes fog developed due to the high dewpoints in relation to the cold water. Moderate to strong southerly winds with cold and dry air and good visibilities were experienced at the rear of the low pressure systems. The daily temperatures varied between -4°C and -12°C.

During station work near Kapp Norvegia the easterly geostrophic wind was enhanced due to Katabatic winds. The increase in windspeed reached 2 to 5 Bft. Thus wind forces up to 11 Bft were measured near the Cape. The Katabatic winds could be calculated and forecasted with the ground temperature (sea surface temperature), the temperature on the mountain plateau and the slope of the iceshield. This katabatic effect is shown in Fig. 4 and 5. Fig. 4 shows the frequency of the measured wind forces between 24-01 and 02-02. Fig. 5 shows the frequency of wind direction of all wind forces greater than or equal to 6 Bft (28 kts). It is evident that the greatest frequencies were from east and northeast. For further scientific work at Kapp Norvegia it is important to know that the high gale force activities are "homemade" due to the katabatic effect.

On the 26-02 the scientists from Drescher Inlet and their equipment were transported back on "Polarstern" heading for Atka Bay. From the 28-02 until 02-03 the logistic work was done under good weather conditions.

Neumayer- Rothera- Jubany Base (3 to 21 Mar)

"Polarstern" took course to the Antarctic Peninsula and reached the British Antarctic station Rothera on the 11-03. In the evening, the research vessel left for King George Island. The weather conditions west of the Antarctic Peninsula are very different to the Weddell Sea. Because there are no land masses west of the Antarctic Peninsula, periods between two low pressure systems were about 48 hours. The temporary high pressure influence was short and accompanied by broken stratocumulus cloudiness. The front side of the low pressure systems produced the highest wind speeds, sometimes accompanied by heavy rain- or snowfall. During the scientific work in the lee of the King George Island mountains, the stormy geostrophic north-westerly winds were forced additionally by jet effects and gusts. The wind speed increased by 2 to 4 Bft so that often windforces up to 9 or 11 Bft were observed. The sea developed wave heights between 2 and 5 m. Even during calm days the swell height was never below 2 m. Only in the lee of King George Island was the sea subdued.

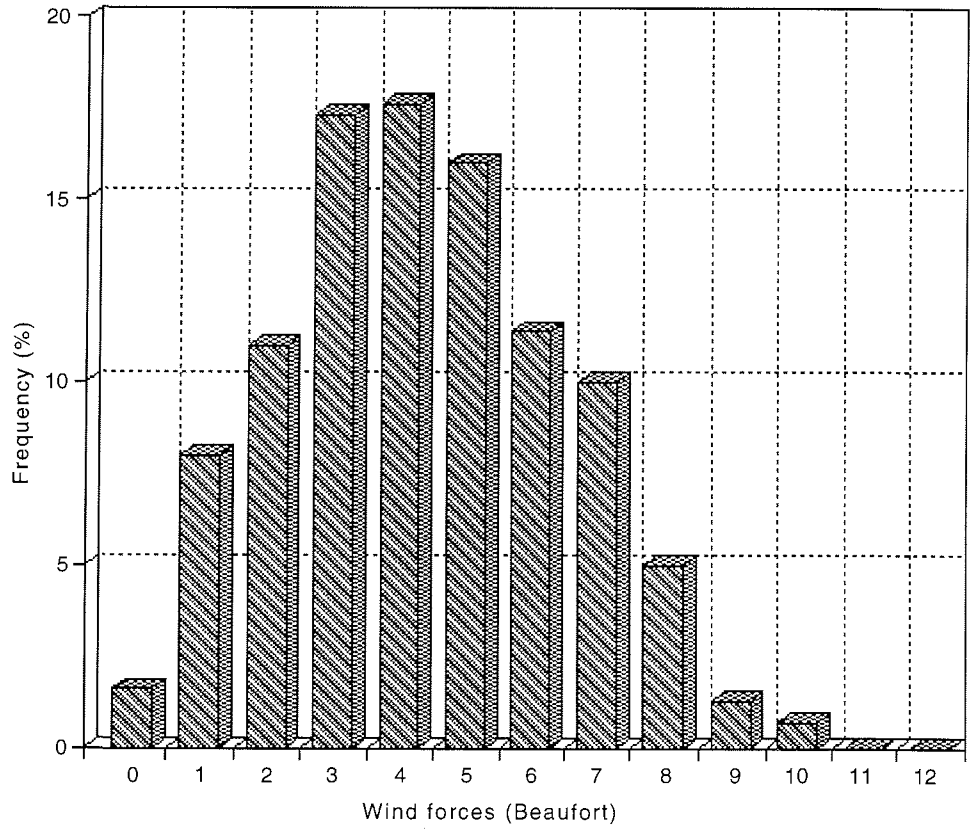


Fig. 4 Frequency of wind forces between 24 Jan and 02 Mar 1998.

Jubany Base - Punta Arenas (21 to 26 Mar)

On the 21-03, "Polarstern" left for Punta Arenas. The weather conditions on the Drake Passage were untypical for the begin of the autumn season with light to moderate winds under high pressure influence. Near the South American continent the westerly winds increased temporarily. The cruise ANT XV/3 ended in the morning of the 26-03 on the anchorage of Punta Arenas

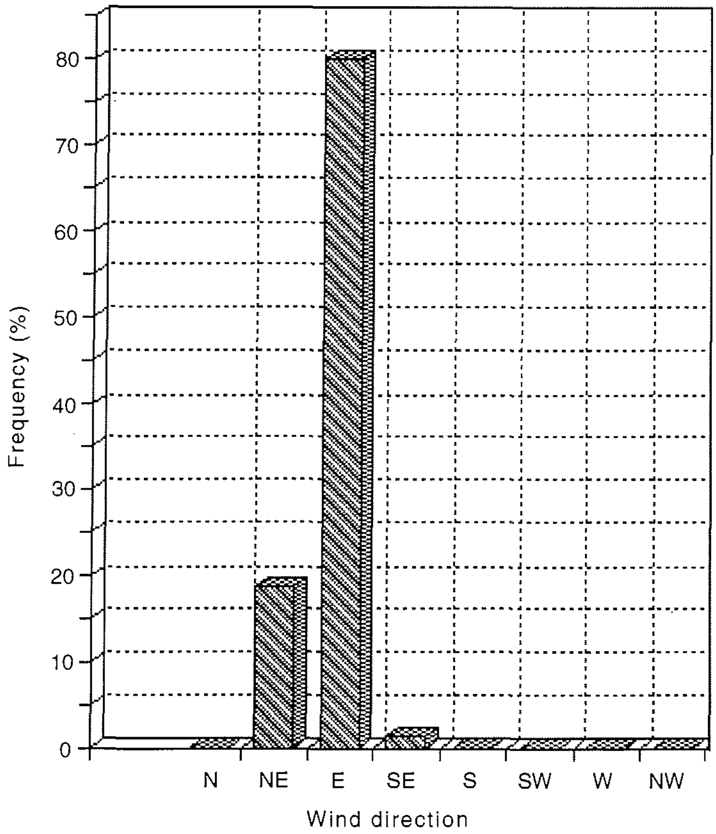


Fig. 5 Frequency of wind directions greater than 28 kts between 24 Jan and 02 Mar 1998.

2. Results

2.1 Benthic Resilience: Effect of Iceberg Scouring on Benthos and Fish

(W. E. Arntz, J. Gutt)

Rationale and general objectives

The resilience of an ecosystem is defined as its capacity to return to a situation identical or similar to that before a significant impact, e.g. by physical disturbance. Worldwide resilience research has recently been intensified because of two reasons which are the background for our general objectives.

- Resilience studies provide general insight into how an ecosystem functions. As the Antarctic shelves are large marine coastal systems that are little affected by man, the investigations carried out here should contribute to a better understanding of the general relationship between natural disturbance and biodiversity. This is one of the most challenging questions in modern ecology because many theories and only few data exist. Models, e.g. the "Intermediate Disturbance Hypothesis" suggested by Connell (1978), predict that an intermediate level of disturbance at intermediate productivity of an ecosystem leads to the highest biodiversity. In fact, a certain pattern of different stages of recolonisation after disturbance can obviosly lead to an increase of diversity at an intermediate spatial scale (Reise 1991, Remmert 1991, 1992).
- The above mentioned approach condensed to the question "which processes affect biodiversity?" can be turned around to "what is the effect of a high or low biodiversity on biological processes in case of disturbance?" Three decades ago there was a general opinion that highly diverse and complex systems should be less susceptible to disturbance because they were considered to have a higher buffer capacity than a system in which only few dominant species may be essential for the functioning of the entire system. However, most simple systems were shown to be quite resilient after natural catastrophes (see, e.g., Boesch and Rosenberg 1981, Arntz and Rumohr 1982, Tarazona *et al.* 1996) whereas more complex systems seem to have greater difficulties to recover (Remmert 1992). At any rate, the knowledge of the role of disturbance can contribute to the development of advanced strategies of nature conservation. This is particularly relevant for the Antarctic since the "Madrid Protocol" to the Antarctic Treaty has come into force.

Unlike plankton and nekton, when the environment is severely damaged most benthic life forms cannot escape and immediately reinvade. Thus, the benthos, in particular the sessile fauna, which is dominant on most of the Antarctic shelf (Arntz *et al.* 1997, Dayton 1990), is presumably very sensitive to both natural and anthropogenic disturbance. Until recently, these benthic communities were considered to be very persistent despite a distinct seasonality of the primary food input. However, intense investigations by imaging methods did not corroborate this picture, and revealed that even the benthos of deeper shelf areas is exposed to locally limited natural catastrophes due to grounded icebergs (Gutt *et al.* 1996). First recolonizing taxa have been identified which may not follow the general tendency of very slow recruitment and growth among Antarctic benthic invertebrates (e.g. Dayton 1994). As to the fish, we know that certain species are adapted to different small-scale habitats in the highly patchy benthos of the Weddell Sea shelf. It is unknown, however, whether the fish fauna shows preferences for disturbed or undisturbed areas. In this context, the question arises why some species occur with high abundances in iceberg scour marks and which ecological role they play in this habitat.

During ANT XV/3, several approaches were taken at different scales because the various components of Antarctic benthos, demersal fish included, may differ considerably in terms of their resilience. The epibenthic megafauna was analyzed by imaging methods (video and still photography) which cover up to two kilometre long transects per station. The macro- and meiofauna from iceberg scours, recovering and undisturbed areas was sampled by a multibox corer. Furthermore, a few bottom and Agassiz trawl catches provided material for detailed studies on the fish fauna and the growth of selected invertebrate pioneer species, and a long-term colonization experiment was initiated using tiles as artificial hard substrates.

Imaging methods play an important role for this approach because of different reasons. As non-invasive methods they provide scientific information which will be of increasing relevance because new international rules of nature conservation have been established in the Antarctic under the "Madrid Protocol". The iceberg scour marks were detected for the first time in the Weddell Sea by the continuous video observations of the ROV. First results about the relevance of this kind of disturbance and a few pioneer organisms have been published (Gutt *et al.* 1997) which includes material for high resolution underwater photography. A video camera mounted on the multibox corer made controlled sampling inside and outside the scour marks possible. Successful fishing without the video observations undertaken beforehand would hardly have been possible.

Our investigations encompassed both disturbed and undisturbed benthic assemblages. They are expected to contribute to a better understanding of Antarctic biodiversity in a global context. Some sessile suspension feeders appear to play an important role as pioneer organisms, thus, this study has a strong relationship with the investigations on the role of suspension feeders (next main chapter).. Moreover, the absolute abundance values will be used, in combination with the results from the respiration measurements, to estimate epibenthic population oxygen uptake and carbon demand.

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2.1.1 Study on Benthic Resilience of the Macro- and Megabenthos by Imaging Methods (J. Gutt, A. Buschmann, J. Dijkstra, W. Dimmler, D. Piepenburg, N. Teixidó)

Objectives

The investigation of macro- and megaepibenthic resilience in the high Antarctic is of special relevance because many species seem to grow extremely slowly. Furthermore, this size fraction of benthic animals can locally be extremely rich in biomass. We already know from previous expeditions (EPOS I and EASIZ I) that approximately 5% of the Antarctic shelf (100-500 m water depth) is affected by iceberg scouring. Moreover, it was evident that a few species from different systematic groups can be extremely abundant in disturbed areas. This finding indicates an early and successful above average recruitment or a fast growth of the respective species. Previous investigations were carried out in two areas off Kapp Norvegia and southwest thereof, with a high abundance of grounded icebergs and on level plateaus without concentrations of icebergs. However, apparently the frequency of iceberg scouring does not differ between these two different situations.

In order to complement the knowledge on the effects of iceberg scouring gained by previous studies we addressed the following objectives:

- Assessment of the spatial extention of disturbed and undisturbed areas in order to estimate the significance of iceberg scouring on a regional scale.
- Identification and structural description of different stages of recolonisation in order to improve our knowledge on the relationship between diversity and disturbance. This includes the:
  - determination of key species in disturbed areas,
  - quantitative inventory of all macrobenthic taxa,
  - assessment of the diversity and evenness inside and outside the disturbed areas.
- Comparison of the structure of the assemblages inside and outside the disturbed areas in order to describe the temporal sequence of the recolonization process, to estimate its velocity, and to increase knowledge about its predictability.

Sampling was concentrated in an area off Auståsen between Kapp Norvegia and Atka Bay, wich had not been investigated under the above mentioned aspects. It is larger (~28 x 9 km) and slightly deeper (~230 m) than previously investigated areas of iceberg concentrations (~180 m deep) but it is part of the same depth zone. Thus, the total material now covers all bottom topographic characteristics of the shelf in water depths of 150-300 m. These include small elevations with comparably steep slopes (e.g. areas of iceberg concentrations off Kapp Norvegia and Four Seasons Inlet), large elevations with smooth slope (e.g. Auståsen), and level plateaus (e.g. southwest of Kapp Norvegia).

For the first time photographs obtained in this study will also be analyzed using the method developed in Landscape Ecology. This method provides a novel set of measures, besides those currently used to describe the communities (such as species composition and cover, or changes in species cover over time). They enable us to tackle problems related to spatial heterogeneity and allow comparisons of spatial patterns and processes across different faunal assemblages. This may be of importance when studying complex systems such as Antarctic communities.

Work at sea

Two different imaging methods were applied (video and still photography) which yield complementary information on epibenthic biotopes and communities. The still camera system (FTS) consists of a vertically oriented camera combined with one or two oblique strobes and provides high-resolution still pictures of the sea bottom. At most stations a series of 100 pictures were taken, each covering approximately 1 m^2 of the sea floor at relatively regular intervals along the transect. The colour slides already developed on board demonstrate that our information on benthic biotopes normally based only on trawl catches or corer samples is increased considerably by this method. The photographs provide "in-situ"-views of epibenthic habitats and will be analyzed to determine the identity, the absolute abundance, and small-scale distribution patterns of epibenthic species. The high optical resolution of the slides, due to the 60 x 60 mm format and to the constant and relatively small distance of the camera to the bottom (1.4 m), will allow the identification of even relatively small epibenthic animals.

The ROV consists of four major components: The vehicle itself is a cube of approx. 80x80x80 cm, equipped with five thrusters, a compass, depth sensor, two video cameras (low light level monocolour, colour), a still camera, lights and strobes which can be tilted. Two laser beams provide a scale in the images by generating points 34 cm apart on the object observed. The vehicle is connected to an underwater winch by a 150 m long floating cable. This winch is connected to the board units by a special cable via a standard ship winch. The cameras and the movement of the vehicle are operated by two joysticks and the video image is observed on line. The vehicle is lowered to the sea floor, docked below the underwater winch. Approx. 20 m above the bottom the vehicle is mechanically released and can operate at a radius of 150 m around the underwater winch, independent of the ship's up and down movement. To achieve straight transects the vehicle and the underwater winch were left suspended and the ship was allowed to drift. The vehicle was only actively engaged in order to avoid obstacles and to attain a very low altitude (approx. 20 cm) above the bottom in order to obtain high resolution images. In addition to the videos, a minimum of 100 still photographs were taken at each station.

All underwater photography and ROV stations, except test stations, are listed in Tables 1-2. Additional information for each station, the region, number of photographs, length of the transects, and the size of the observed areas is also provided.

Preliminary results

The following preliminary results are mainly based on first analyses of the videos. A first view at the photographs supports these findings.

Auståsen (N/KN, principal study area). In contrast to results from former expeditions, we found a high percentage of benthic assemblages which are disturbed to different degrees. The results of a preliminary (!) analysis show that recent scour marks almost without any megafauna make up 15% of the total observed area, recolonised scours 35% and undisturbed assemblages (Fig. 6a) only 20%. The remainder cannot at present be classified. A detailed analysis should show, for at least some of these unclassified areas (30%), if they were formerly disturbed or not. This category includes assemblages for which we have indications that the fauna has been indirectly disturbed, e.g. by a significant change in the current regime close to a grounded iceberg or by an iceberg which drifted only a few metres above the sea floor. The recent scour marks are characterized by different bottom topographic features: slightly roundish to steep elevations mainly at the margin of flat plateaus with or without fine parallel scratch marks, steep embankments or walls. Scour marks were also identified as being recently disturbed if an abrupt and significant change in the fauna was obvious (Fig. 6b). A first stage of recolonisation was defined by having only a poor fauna composed of different taxa or by being dominated by one or two highly abundant pioneer species. One of the most prominent of these species was the gorgonarian *Primnoisis antarctica* which occurred in high abundances only in scour marks (Fig. 6c). Other indicator organisms of disturbed areas were the sponge *Stylocordyla borealis*, the solitary ascidian *Molgula pedunculata*, the gorgonarian *Ainigmaptilon antarcticus*, and the Terebellid polychaete *Pista* spp. A later stage of recolonisation was characterized by a variety of species, which were separated by clear borders with respect to both faunal composition and bottom topographic features. One main argument to include areas in the category of a late stage of recolonization is the absence of large hexactinellid sponges, especially if they occurred fairly regularly in adjacent parts of the transect. In such areas, we occasionally observed a relatively high abundance of small barrel-shaped sponges. Detailed anayses of the images will be carried out at the home institutes in Bremerhaven and Kiel.

Table 1: List of photographic stations.

stn	area	lat. (S) start	long. (W) start	lat. (S) end	long. (W) end	depth (m)	no. of photos	transect length (m)
016	DI	72°51.10'	19°18.32'	72°51.12'	19°18.28'	391-392	34	49
017	DI	72°49.74'	19°23.97'	72°49.45'	19°23.53'	458-457	10	150
020	DI	72°52.92'	19°17.65'	72°51.06'	19°17.89'	373-376	28	248
021	DI	72°51.24'	19°18.96'	72°51.27'	19°18.99'	375-374	10	69
029	N/KN	71°07.39'	11°27.99'	71°07.13'	11°27.30'	64-162	70	810
034	N/KN	71°07.22'	11°28.35'	71°07.37'	11°29.42'	68-110	52	1348
042	N/KN	70°53.98'	10°33.65'	70°54.05'	10°33.11'	260-243	70	450
053	N/KN	70°52.53'	10°30.45'	70°52.59'	10°30.45'	243-240	65	150
056	N/KN	70°53.22'	10°29.20'	70°53.36'	10°29.32'	236-231	71	330
061	N/KN	70°53.38'	10°27.51'	70°53.49'	10°27.55'	242-241	71	340
072	N/KN	70°50.83'	10°31.30'	70°50.80'	10°31.30'	220-225	18	51
073	N/KN	70°49.51'	10°30.26'	70°49.61'	10°30.11'	276-278	53	677
104	S/VK	73°33.91'	22°01.89'	73°33.89'	22°01.64'	600-594	26	120
125	S/VK	73°38.23'	22°11.48'	73°38.20'	22°11.82'	382-387	30	206
173	HB	75°26.75'	26°37.64'	75°26.72'	26°37.60'	226-128	10	73
174	HB	75°26.61'	26°37.39'	75°26.53'	26°37.48'	239-239	30	180
185	KN	71°31.71'	14°22.87'	71°31.73'	14°23.70'	162-160	99	718
191	KN	71°41.76'	12°43.93'	71°41.86'	12°44.64'	241-242	100	820
192	KN	71°13.64'	12°25.36'	71°13.59'	12°25.31'	253-244	90	328
195	KN	71°15.26'	12°20.42'	71°15.30'	12°20.68'	183-176	50	260
200	KN	71°15.37'	13°08.70'	71°15.82'	13°08.08'	154-157	81	1168
211	KN	71°07.30'	11°27.92'	71°07.54'	11°29.36'	77-117	99	1220
215	KN	71°06.40'	11°31.87'	71°06.88'	11°31.99'	167-154	98	1093
218	N/KN	70°50.76'	10°31.15'	70°50.82'	10°30.40'	223-237	101	530
221	KN	70°50.08'	10°35.59'	70°49.70'	10°34.02'	261-270	95	947
226	KN	70°50.44'	10°34.77'	70°50.30'	10°34.39'	249-259	98	646
229	KN	70°50.74'	10°30.82'	70°50.88'	10°30.27'	223-228	93	475
232	KN	70°49.27'	10°28.95'	70°49.21'	10°29.51'	271-273	84	497
239	KN	71°06.23'	11°31.88'	71°05.81'	11°31.83'	190-227	98	1068
240	KN	71°17.97'	12°15.61'	71°17.94'	12°15.94'	177-175	101	320
242	KN	71°16.24'	12°19.76'	71°16.22'	12°19.80'	159-158	97	355
278	N/KN	70°53.39'	10°41.73'	70°53.36'	10°41.20'	279-273	79	468
317	KG	62°21.69'	58°41.25'	62°21.76'	58°40.61'	750-790	41	620
318	KG	62°16.45'	58°42.18'	62°16.49'	58°42.43'	316-372	42	270
319	KG	62°15.71'	58°43.04'	62°15.63'	58°42.99'	224-197	42	175
333	KG	61°26.97'	58°07.87'	61°27.20'	58°07.77'	975-932	43	600
342	KG	61°34.69'	58°06.55'	61°34.76'	58°06.66'	426-425	42	180
350	KG	61°53.26'	59°07.33'	61°53.22'	59°07.14'	219-220	42	240
358	KG	62°00.27'	59°15.38'	62°00.30'	59°15.56'	130-130	42	170
						total:	2405	

Areas: DI: Drescher Inlet, HB: Halley Bay, KN: Kapp Norvegia, N/KN: north of Kapp Norvegia (Auståsen), S/VK: south of Vestkapp, KG: King George Island

Four Seasons Inlet. In front of Four Seasons Inlet there is a steep elevation rising from approx. 200 m to a minimum water depth of 60 m. At this hilltop a transect, videotaped during EASIZ in 1996 by the ROV, was repeated by the still camera in order to apply the landscape method. At the shallowest part of approx. 60 m water depth, large boulders were partly overgrown by Stolonifera (see also 2.2.8). At intermediate water depths different species of sessile suspension feeders (hydrozoans and sponges) were dominant. The detailed analysis must show if these areas are recolonized scour marks. At the deepest parts, a diverse fauna associated mainly with the demosponge *Cinachyra barbata* was disturbed by recent scour marks.

Table 2: List of ROV stations.

stn	area	lat. (S) start	long. (W) start	lat. (S) end	long. (W) end	depth (m)	transect length (m)
019	DI	72°51.21'	19°16.74'	72°51.23'	19°17.77'	385-392	397
040	N/KN	70°52.04'	10°32.40'	70°51.52'	10°34.21'	232-226	939
041	N/KN	70°53.82'	10°33.85'	70°53.94'	10°32.87'	249-238	901
045	N/KN	70°52.15'	10°29.34'	70°52.14'	10°28.97'	233-245	2024
052	N/KN	70°52.34'	10°29.10'	70°52.33'	10°29.73'	247-245	213
059	N/KN	70°53.28'	10°27.80'	70°53.72'	10°27.58'	242-233	936
065	N/KN	70°51.93'	10°32.32'	70°51.89'	10°34.04'	233-228	1205
066	N/KN	70°50.77'	10°30.50'	70°50.99'	10°32.08'	237-231	1064
070	N/KN	70°49.34'	10°28.98'	70°49.61'	10°29.83'	286-273	468
074a	N/KN	70°49.32'	10°28.92'	70°49.30'	10°33.57'	283-279	2664
176	HB	75°27.02'	26°34.51'	75°26.75'	26°33.94'	234-241	646
177	HB	75°28.52'	27°05.49'	75°27.79'	27°07.81'	255-261	1355
178	HB	75°26.83'	26°45.48'	75°27.01'	26°45.92'	223-222	
186	KN	71°31.84'	14°24.03'	71°31.85'	14°25.74'	168-169	1050
190	KN	71°41.57'	12°44.68'	71°41.43'	12°45.82'	238-236	421
193	KN	71°13.56'	12°25.48'	71°13.93'	12°27.53'	258-248	1173
201	KN	71°16.07'	13°10.63'	71°16.20'	13°11.42'	162-166	
213	N/KN	71°07.77'	11°28.19'	71°08.31'	11°28.84'	114-113	1092
219	N/KN	70°50.56'	10°34.97'	70°50.07'	10°35.59'	251-271	882
238	N/KN	71°06.09'	11°31.76'	71°05.95'	11°31.81'	208-229	
281	AB	70°40.25'	08°01.57'	70°40.00'	08°02.41'	67-68	747
285	N/KN	70°47.37'	10°24.83'	70°47.81'	10°26.13'	298-296	904
286	N/KN	70°51.71'	10°45.24'	70°51.58'	10°47.12'	315-309	1048
287	KN	71°13.79'	12°14.93'	71°13.47'	12°13.77'	268-281	872
						total:	21001

Areas. DI: Drescher Inlet, HB: Halley Bay, KN: Kapp Norvegia, N/KN: north of Kapp Norvegia (Auståsen), VK: Vestkapp, AB: Atka Bay

Kapp Norvegia. The fauna at four stations was less disturbed than that off Auståsen. Abundance of hexactinellid and demosponges was less than in the undisturbed areas at Auståsen and Four Seasons Inlet. The fauna was dominated by bryozoans, compound ascidians and occasionally by gorgonians.

Vestkapp. The ROV images from the station in the Drescher Inlet showed a faunal composition which resembled the disturbed association off Kapp Norvegia and north of it. It is doubtful, however, that a large iceberg with a draft of 390 m should have drifted into the inlet. The benthic community photographed south of the Drescher Inlet at 400-600 m was poor compared with the sponge association off Kapp Norvegia. The most prominent faunal element were crinoids with an average abundance of 2 m^{-2} approximately.

Halley Bay. One scour mark was observed at one of the three stations. The undisturbed fauna was much poorer in abundance than in the more northerly areas, especially in terms of sponges. The dominant groups were bryozoans and compound ascidians. At station 177, an unusually high abundance of dead sponges was observed.

Atka Bay. One station in the southernmost part of Atka Bay was sampled because this is one of the extremely rare regions in the southeastern Weddell Sea, where the water depth is less than

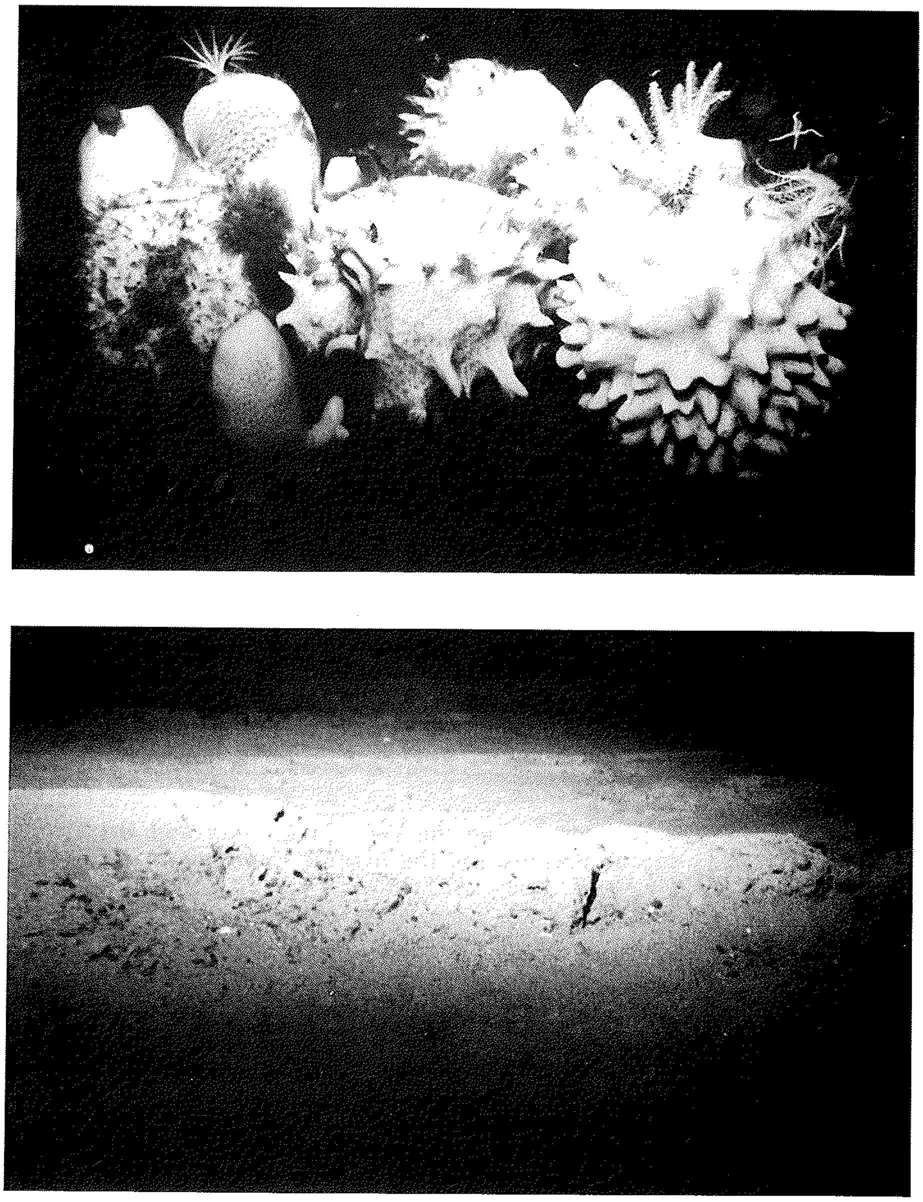

Fig. 6: a) Aggregations of different haxactinellid sponges represent an aerea which has not been disturbed by iceberg scouring for a long time; stn 74.
b) Recent scour marks are characterized by the total absence of the epibenthos and specific small-scale characteristics of the sediment surface; stn 219.

Fig. 6 c) Among the first colonists in a scour mark the gorgonian *Primnoisis antarctica* may be one of the most successful species; stn 59.

100 m. This station was selected to compare results with the other extremely shallow site in front of Four Seasons Inlet. The epifauna was dominated by a broad variety of bryozoans and gorgonians. The giant sea cucumber *Ekmocucumis turqueti* had its highest abundances at this station. This faunal composition is totally different from the site off Four Seasons Inlet. It has more resemblance with a station of approx. 130 m water depth west of Atka Bay sampled during EASIZ I.

2.1.2 Effects of Iceberg Scouring on the Fish Community and the Role of *Trematomus* spp as Predator on the Benthic Community in Early Successional Stages (R. Knust, A. Schröder)

Objectives

Mechanical disturbances of the sea floor, such as demersal trawling or the construction of gas pipelines have a pronounced impact on fish communities. Video imaging of the sea floor in the Weddell Sea showed that in areas which are disturbed by iceberg scouring the fish fauna was obviously different from those areas with an undisturbed benthic community. In areas which were heavily impacted by iceberg scouring and which were in a very early state of recolonization a relatively high abundance of the genus *Trematomus* was observed. In- and exclusion experiments in coastal waters of boreal latitudes showed that epibenthic predators, such as fish and decapods, have a pronounced influence on structuring macrobenthic communities during different successional stages.

In close co-operation with the Zoobenthos Working Group (AWI), the fish fauna in disturbed and undisturbed areas was investigated. Species composition, abundance, biomass of fishes and the food preferences of the dominant fish species were studied to estimate the impact of iceberg scouring on the fish community and to evaluate the role of fishes as predators on the macrobenthic community in early successional stages.

Work at sea

Relative abundance, biomass, and species composition of the fish fauna in disturbed and undisturbed areas were studied based on material from several Otter trawl hauls in a depth range from 250 to 400 m. The handling of the catches is described in detail in chapter 2.4.1. To position the gear in disturbed areas, information from the ROV video imaging was used (see chapter 2.1.1). The amount of large sponges in the catch was used as an indicator for the severity of the disturbances of the sea floor, with a low number or absence of these sponges indicating a high degree of disturbance. Samples for food analyses were taken from the dominant genus *Trematomus*. The animals were killed, the abdominal wall was opened and the total fish was preserved in 10% formalin.

Preliminary results

The analysis of the complete data set from all bottom trawls with multivariate statistical methods (Cluster analysis and Multidimensional Scaling, MDS) showed a clearly different composition of the fish communities in those areas, which had been disturbed by an iceberg scour (Fig. 7 and 8).

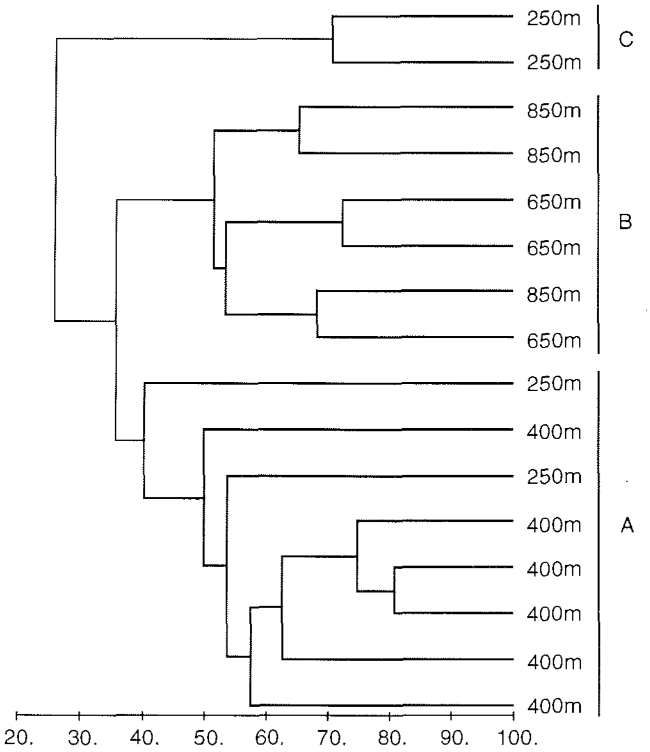

Fig. 7: Dendogram of the fish fauna in the eastern Weddell Sea. Similarity index: Bray-Curtis, Transformation: 4th root, Cluster A: All stns between 250 and 400 m, Cluster B: All stns between 600 and 850 m, Cluster C: Stns in shallow water disturbed by iceberg scouring.

In comparison with two other samples from a water depth of 250 metres, the fish community in the disturbed areas showed a distinctly lower diversity, indicated by the lower number of species and the steeper slope of the cumulative dominance curve (Fig. 8).

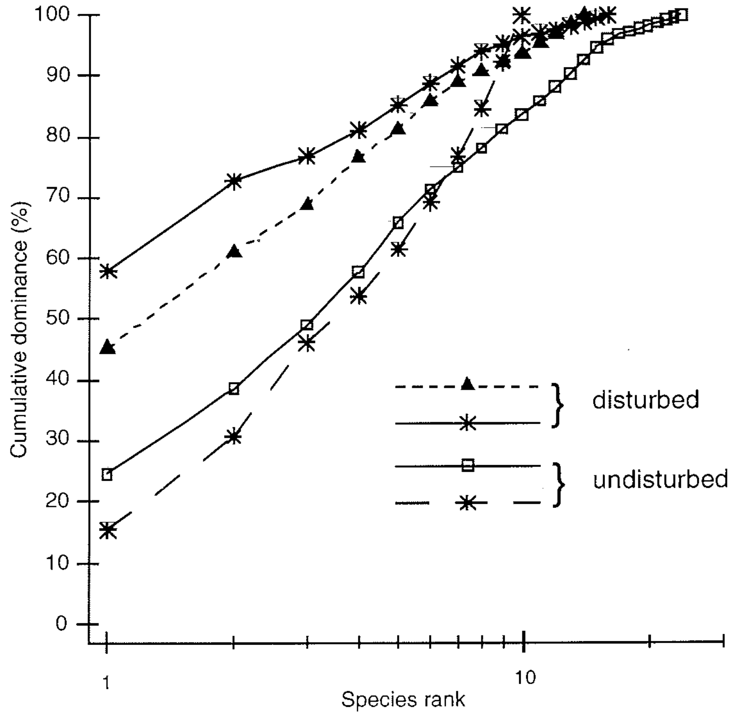

Fig. 8: Cumulative dominance of the fish fauna in disturbed and undisturbed areas in shallow water (250 m).

In the disturbed area 19 species were found and only two species, *Trematomus pennellii* and *T. nicolai* together, had a dominance in abundance of nearly 70%. In the undisturbed area, 25 species were recorded and the 70% mark was reached after 6 species. The dominant species were *T. scotti, Prionodraco evansii, Cryodraco antarcticus, Artedidraco orianae, T. lepidorhinus* and *A. scottsbergi* (Fig. 9). The results demonstrate the significance of iceberg scouring in the shallower areas of the eastern Weddell Sea not only on the invertebrate benthic community but also on the associated fish community of this region.

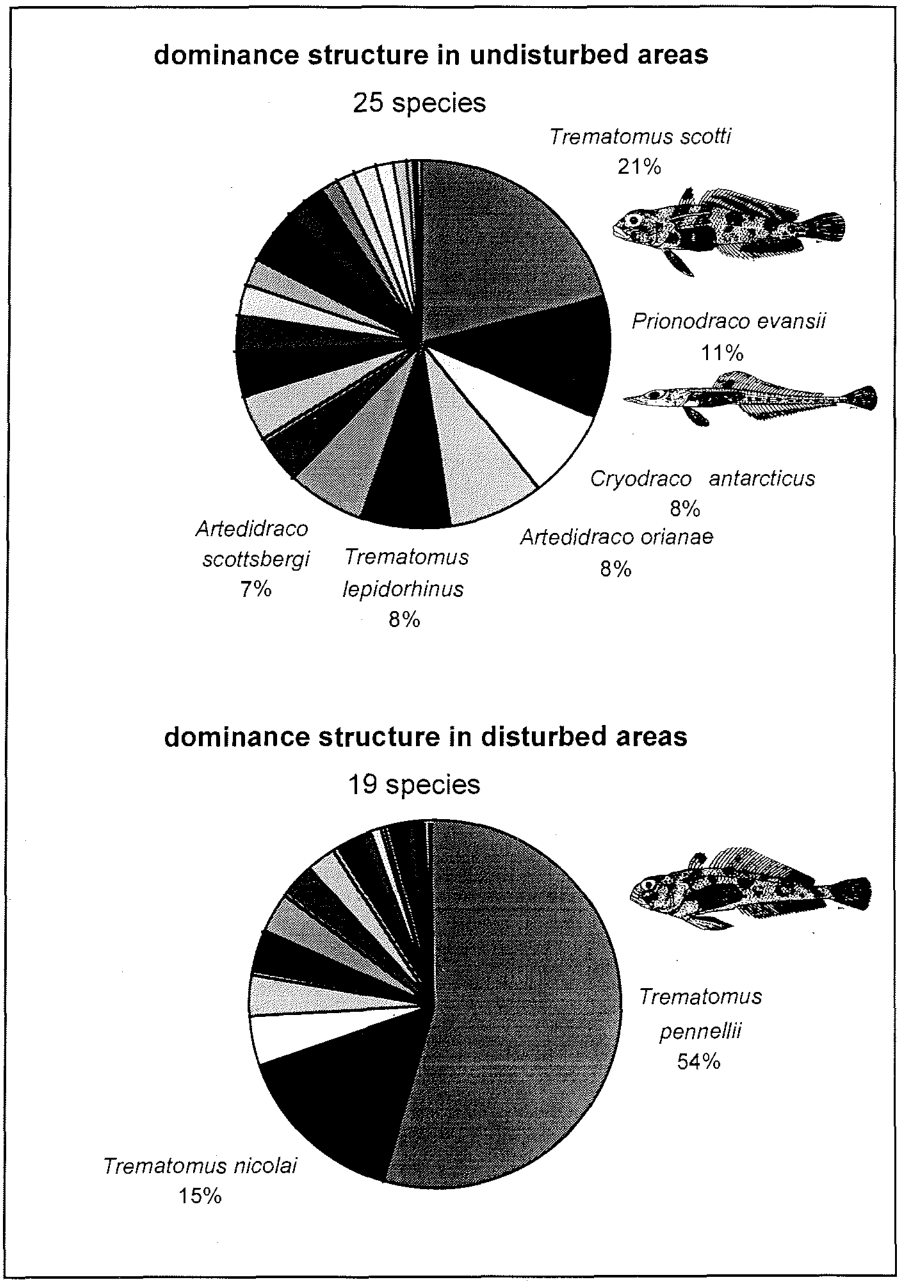

Fig. 9: Dominance structure of the fish fauna in disturbed and undisturbed areas.

2.1.3 Effect of Iceberg Scouring on the Infauna and other Macrobenthos

(D. Gerdes, H. Bohlmann)

Introduction and objectives

During the expedition ANT XIII/3 first attempts were made to sample quantitatively with the multibox corer, guided by an attached UW-videosystem, benthos from disturbed shelf areas off Kapp Norvegia. This area on the southeastern Weddell Sea shelf is particularly suitable for such studies, because it is heavily affected by grounding icebergs and because our knowledge about the rich fauna of this area is substantial due to former AWI benthos research activities there.

Based on our experience from the last expedition the general aim of the planned investigation was to study in more detail the effects of grounded icebergs on benthic assemblages. We expected and had some indication from previous investigations, that vagile forms and juveniles (demersal drift stages) of the macrofauna occur first in fresh scour marks, however, in lower numbers and biomass and less diverse as compared to undisturbed adjacent areas.

The questions to be addressed were:

- what do disturbed areas look like (differences in abundance, biomass, composition)?
- how does recolonisation occur?

Work at sea

During ANT XV/3 the multibox corer with the attached UW video system was successfully deployed at 26 stations along the southeastern Weddell Sea shelf, covering a depth range from 180 to 2415 m. The effects of grounding icebergs on meio- and macrofauna were studied on the shelf in the Kapp Norvegia area, including areas north of the Kapp in front of Auståsen. Transects sampled SW of Vestkapp and off Halley Bay provided quantitative samples and videos for studies of biodiversity, especially of peracarid crustaceans, molluscs, and polychaetes. These stations cover a wide depth range and extend our knowledge of the faunistic inventory of the deeper parts in this part of the Weddell Sea, where up to this cruise only 7 stations had been sampled with quantitative gear. Four stations in front of Potter Cove (Bransfield Strait) and 5 stations in the Drake Passage yielded an additional 78 cores from the Peninsula area where up to now only little work had been done. Table 3 summarizes the station work, showing the number of deployments and number of cores obtained for the different fields of work.

All quantitative samples obtained were sieved over 500 µm mesh size, at 8 stations partly over 300 µm mesh, and preserved in 4% hexamethylene buffered formalin prior to sorting in the labs in Bremerhaven and Hamburg.

Preliminary results

Fifteen multibox corer stations south and northeast of Kapp Norvegia yielded a total of 102 single quantitative cores for abundance and biomass estimates of the macrofauna (79 cores) and meiofauna (23 cores; cf. Table 3). Additionally almost 3 hrs of video material were obtained by means of the attached UW-video system, which gives insight into the distribution of macrobenthos on a broader scale. The video transects varied between 10 to 281 m in length. Five stations (48, 65, 187, 223, 225) yielded 22 quantitative macrobenthos samples obtained directly in iceberg scours. Stns 187 and 225 were taken in ´fresh´ scours with up to 1 m high plough marks without any visible macrofauna on the surface. At stn 187 the small detritivorous amphipod *Ampelisca richardsoni* was found on top of the sediment cores of the multibox corer with up to 8 specimens per core, indicating that the specific bottom topography of scour marks might favour sedimentation and enrichment of fluff, thus creating an optimal feeding ground for these amphipods.

Table 3: Number of stations / cores taken by the multibox corer during ANT XV/3.

Research Field	Stn No.	Number of cores (Macro/-Meiofauna)	Area	Depth Range (m)
Iceberg scour	48, 65, 187, 223, 225	32 (22/10)	KN1)	234 - 273
semidisturbed	63, 68, 69, 230	20 (17/3)	KN	227 - 267
undisturbed	47, 67, 188, 224, 227, 228	50 (40/10)	KN	225 - 360
Biodiversity	136, 137, 146	24 (18/6)	HB2)	1000 - 2011
Biodiversity	91,92,93,112,113,131,132	41 (31/10)	S/VK3)	378 - 2415
Biodiversity	216	02 (2/0)	KN	180
Biodiversity	299, 300, 325, 326, 330, 334, 341, 345, 356	78 (60/18)	PI4)	120 - 2000
Total		247		

1) Kapp Norvegia 2) south of Vestkapp 3) Halley Bay 4) Peninsula

First analyses of the UW video showed that the shelf area north of Kapp Norvegia in front of Auståsen can be regarded as heavily disturbed by grounding icebergs. At shallower depths (down to about 260 m) it was rather difficult to find undisturbed reference stations. During one video transect we several times found the typical dense 'Eastern Shelf Assemblage', dominated by sessile suspension feeders with a rich accompanying fauna, living in isolated patches of only a few square meters. In between such patches we observed more or less disturbed areas; Stn 230 (229 m water depth) is a good example for such a situation. In scour marks, sponges which seem to be especially suited as indicators for disturbance, were absent and motile forms such as crinoids, brittlestars, sometimes caridean decapods (*Chorismus antarcticus* or *Notocrangon antarcticus*?), and fish were quite abundant. At stn 223 the fauna in the scour mark appeared more diverse with some bryozoans and hydrozoans, some asteroids, *Serolis* sp., and pantopods being visible on the videos. In another scour mark with almost no visible macrofauna on the seafloor, which we passed during a 100 m long video transect at stn 188, the only organism occurring quite frequently was the ascidian *Molgula pedunculata.* This species is known to grow rather fast at the Antarctic Peninsula, and the approximately 20 cm long specimens observed in the devastated scour area could have grown up to this size in less than 4 years (pers. com. M. Rauschert). The undisturbed reference stations in front of Auståsen were sampled at greater water depths between 280 to 360 m (cf. Table 3), where iceberg effects are minimized. These stations again showed those diverse, three-dimensional assemblages, which are typical for the undisturbed areas of the Kapp Norvegia shelf.

The combination of sampling and visual check of scour marks turned out to be an excellent method for studies of the impoverished benthic assemblages in such marks, because this technique considers both rarely occurring and as infaunal organisms are considered.

2.1.4 Begin of a Long-Term Experiment of Benthic Colonisation and Succession on the High Antarctic Continental Shelf (W. E. Arntz)

Introduction and objectives

Most ecologists believe that the Antarctic marine ecosystem should be particularly sensitive to disturbance. As reasons for this assumption they usually refer to the prevailing lack of physical and anthropogenic disturbance ("pristine ecosystem") and the specific life strategies of Antarctic organisms ("Thorson's rule"). Both these characteristics are not valid in an absolute sense. Disturbances are quite common in the zones where drifting icebergs scour the seafloor (see preceding reports) or where growlers and brash ice abrade the intertidal and upper subtidal. Among the organisms that live in the Antarctic ecosystem, some take the risk of mass production and rapid dispersal instead of investing - like the majority - in few, well-equipped, often carefully brooded descendants that start reproducing late in their life cycles and grow slowly.

The few colonisation experiments which have been carried out in the Antarctic to date have yielded contradictory results. In McMurdo Sound Dayton (1989) waited 12 years in vain for a colonisation of substrates; however, in the 13th year there was a mass recruitment of many species. Rauschert (1990) managed to retrieve only one of his experimental hard-bottom substrates after an exposure of 3 years off King George Island, however this one was densely colonised with ascidians of considerable size and other fauna. Interestingly, the colonisation of Dayton's and Rauschert's substrates occurred during the "ENSO of the century" 1982-84 which also had strong effects on hydrography, krill and warm-blooded animals in the Antarctic. Both experiments were carried out in the shallow water of the scuba diving zone above 30 m. On colonisation plates exposed at about 600 m Gerdes and Klages (pers. comm.) did not find any organisms after one year.

Perhaps the Antarctic fauna which normally suffers from little disturbance is particularly sensitive (reduced resistance), recolonisation is slow and occurs only occasionally under specific hydrographic conditions, and succession is - due to the retarded growth of many species such as most sponges - a slow process which takes a long time. Compared with communities living, e.g. in temperate latitudes and used to all kinds of disturbance, the return to a mature, complex association may take a much longer time in the Southern Ocean (reduced resilience). These hypotheses seem plausible at least for the deeper benthos below the zone of ice impact, where there is also an opportunity to work experimentally without running the risk that the substrates are destroyed or dislocated by ice after a short time.

Work at sea

For a long-term experiment lasting at least ten years, an area at 341 m depth off Kapp Norvegia was selected (71°35.4-5'S, 13°54.3'W). Hard-bottom substrates (burned tiles without chemical treatment) were exposed in six (3x2) piles of about 1 m^3 each. To facilitate re-encountering of the tiles and to avoid distribution over a wide area, the tiles were left in their bags. During future cruises, ROV series and samples will be taken to follow succession at the site. This experiment will, at the same time, serve the validation of growth of benthic organisms under natural conditions.

References

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Rauschert, M. (1990) Ergebnisse der faunistischen Arbeiten im Benthal von King George Island (Südshetlandinseln, Antarktis). *Ber. Polarforsch.* 76.

2.1.5 Effect of Iceberg Disturbance and Recovery of Meiofauna (H. J. Lee)

Introduction and objectives

Disturbance of the Antarctic shelf by icebergs has a long geographical history. Perhaps the meiofaunal community in this area has been strongly selected for a long period and thus its structure has been optimized for recolonisation from the frequent disturbances.

Our study on the recolonisation of meiofauna in iceberg scours at the coast of Signy Island, where a grounding iceberg was observed and the sediment samples taken by SCUBA diving, shows that the recolonisation of meiofauna does not take longer that 3 months to recover to the initial state in terms of abundance. During the first EASIZ cruise we also took some samples for the investigation of meiofaunal recolonisation in an iceberg scour mark. The preliminary result of those samples showed no clear differences of meiofaunal abundance and community structure between the scour samples and control sites. Up to now a standard method to determine the age of the scour mark has not been found. Therefore it is hard to estimate the resilience of meiofauna in an area where the scouring processes cannot be observed and SCUBA diving is impossible.

Despite the difficulties of estimating the resilience of meiofauna, we are expecting that the close comparison of the meiofaunal communities between disturbed and undisturbed areas will show aspects of the succession of meiofauna and also the functional position of certain meiofaunal groups in a certain degree of disturbance. This information will help to understand not only the recolonisation process of meiofauna but also the different ecological roles of nematod groups. This study will also reveal the impact of iceberg scouring on the meiofaunal biodiversity.

Work at sea

Sediment samples were taken from the continental shelf off Kapp Norvegia by using the multibox corer (MG). For the comparison of functional differences in recolonisation between meio- and macrofauna, the sediment boxes from the same drop of the MG were shared. According to the video image provided by MG, the state of disturbance was categorized into three groups, disturbed, semi-disturbed and undisturbed areas (Table 4). On the basis of this

Table 4: Station list for the biodiversity and iceberg scour studies of meiofauna.

Station	Depth (m)	Gear No.	Location	Station Type	Sediment Type
047	243	MG 1	N/KN	iceberg	bryozoan mat
048	245	MG 2	N/KN	iceberg	bryozoan mat
063	234	MG 3	N/KN	iceberg	sand / silt
064	227	MG 5	N/KN	iceberg	bryozoan mat
067	305	MG 6	N/KN	iceberg	bryozoan mat
090	1557	MUC 1	S/VK	biodiversity	sand / silt
091	1506	MG 9	S/VK	biodiversity	stone / sand / silt
092	993	MG 10	S/VK	biodiversity	sand / silt
093	1985	MG 11	S/VK	biodiversity	silt
131	1944	MG 14	S/VK	biodiversity	sand / silt
132	2415	MG 15	S/VK	biodiversity	silt
135	2021	MUC 3	HB	biodiversity	sand / silt
136	2012	MG 16	HB	biodiversity	sand / silt
137	1521	MG 17	HB	biodiversity	stone / sand / silt
143	1528	MUC 4	HB	biodiversity	sand / silt
146	1021	MG 18	HB	biodiversity	stone / sand / silt
187	255	MG 19	KN	iceberg	sand / silt
223	276	MG 22	KN	iceberg	sand / compact silt
224	273	MG 23	KN	iceberg	
225	278	MG 24	KN	iceberg	silt
227	332	MG 25	KN	iceberg	bryozoan mat
228	298	MG 26	KN	iceberg	sponge spicule mat
230	220	MG 27	KN	iceberg	bryozoan mat
298	239	MUC 5	BI	biodiversity	silt
299	207	MG 28	BI	biodiversity	silt
300	423	MG 29	BI	biodiversity	silt
302	398	MUC 6	BI	biodiversity	silt
306	801	MUC 7	BI	biodiversity	silt
325	805	MG 30	BI	biodiversity	silt
326	606	MG 31	BI	biodiversity	silt
330	2009	MG 32	DP	biodiversity	silt
334	1028	MG 33	DP	biodiversity	silt
340	411	MUC 8	DP	biodiversity	silt
341	429	MG 34	DP	biodiversity	silt
345	218	MG 35	DP	biodiversity	silt
349	226	MUC 9	DP	biodiversity	silt
351	122	MUC 10	DP	biodiversity	silt
356	130	MG 36	DP	biodiversity	silt

category the meiofaunal communities will be analyzed and compared. Samples were treated as described in 2.4.8. The station list for the biodiversity and recolonisation studies of meiofauna is given in Table 4.

The sediment was sliced and preserved on board and will be worked at the home institute to obtain data comparable with former studies.

2.2 The Role of Benthic Suspension Feeders in Antarctic Communities

(J. M. Gili, W. E. Arntz, P. Filipe, P. López, C. Orejas, J. Ros, N. Teixidó)

General introduction and objectives

Antarctic benthic communities are isolated from the ecosystems surrounding the Southern Ocean by the abyssal plain, circumpolar currents, and very low temperatures, which make immigration by exotic species difficult, and particularly by the Polar Front, which blocks dispersal of endemic species. These limiting factors characterize the Antarctic benthic subsystem and set it off from other geographic regions. A multitude of questions remain to be answered, even though a number of studies have been carried out to investigate the role of the Polar Front and the abyssal plains as geographical barriers (Dayton 1990) and the adaptation of organisms to the low-temperature regime (Clarke 1991). Another characteristic feature of the Antarctic benthic subsystem is an exceptionally marked level of seasonality in food availability in the water column. The consequence is that the benthic species may have to adapt to a possible scarcity of food throughout the year, except in summer (Barnes and Clarke 1995), which contrasts with the constant nature of many other environmental factors.

The high degree of seasonality in the supply of fresh food may be a factor conditioning the life strategies of benthic organisms, to the point of limiting their growth and reproductive strength. Benthic suspension feeders are one of the groups most highly susceptible to temporal fluctuations in the available food supply. Generally speaking, these organisms are trophically dependent on the available food suspended in the water column and on the currents for their renewal rate; they must adapt their trophic strategies to the particular characteristics of the Southern Ocean. The apparently discontinuous pattern of food availability can be expected to condition their activity rhythms and metabolisms (Barnes and Clarke 1995). However, from the point of energy requirements, the energy expenditure needed to survive at 0°C is very low: six times less than that needed at 30°C (Clarke 1991), which is practically negligible. For that reason it would appear that these organisms should be able to invest more in growth and reproduction than species dwelling in temperate regions, though this has not been demonstrated for practically any species (Clarke 1991).

A commonly accepted view is that there is a prolonged period of winter lethargy or minimal activity levels lasting for at least six months during the Austral winter (Fenchel 1990). However, recent studies on certain littoral benthic suspension feeders have suggested that the period of inactivity lasts only a few weeks (about two months). This raises the question of what is happening to allow these organisms to feed, and hence remain active, for considerably longer periods than previously thought (Barnes and Clarke 1995). Certain researchers have suggested special adaptations to feeding at low levels of food concentration, or to occasional food abundance followed by long periods of starvation (Arntz *et al.* 1994). Low chlorophyll concentration in the water, which has always been taken as an indicator of food scarcity, is an Antarctic characteristic during most of the year. However, many suspension feeders might use other types of organisms as food sources, namely, microplankton (bacteria, ciliates, and flagellates), which has recently been shown to play a much more important role than expected in complementing the diet and meeting energy demands in many species of suspension feeders. The possible role of this portion of the "fine fraction" of organic matter in the diet of Antarctic suspension feeders is an open question.

The apparent scarcity of fresh food supply for Antarctic suspension feeders during the greatest part of the year as a factor conditioning the growth of such organisms, contrasts with the large assemblages of suspension feeders that exist on the continental shelf off Antarctica (Gutt and Starmans in press). Three-dimensional communities with large biomasses are dominated by bryozoans, sponges, gorgonians, and echinoderms (Gerdes *et al.* 1992), and must have specialized not only in slow growth and reproduction and low productivity (Arntz *et al.* 1994), but also in a feeding strategy capable of maintaining such communities all year round. A possible way of specialization could be the phytoplankton-based diets observed in certain hydrozoan species, even though Hydrozoa are clearly adapted to capturing large amounts of zooplankton (Gili and Hughes 1995). Other examples are the consumption of phytoplankton by sponges and crinoids, organisms that use to specialize more on other types of diet (e.g., sponges on bacteria, Reiswig 1975). The possible role of sediment resuspension has also been reported, which points to the possibility that there may be differences between shallow and deep areas, or between those exposed to or sheltered from currents. Given the high food value of sediments even on deep bottoms (Smith *et al.* 1996) this is a way worth exploring.

A series of issues relating to existing knowledge of communities of Antarctic suspension feeders are of high interest and are one of the key subject areas in the EASIZ Programme:

- Have suspension feeders adapted to another type of diet than that reported for each group of such organisms in temperate regions, thus enabling them to exploit the distinct food resources available in Antarctic waters? What food resources are available?
- In view of the short time (in geological terms) that has elapsed since the last glaciation, is it possible that benthic suspension feeders may not yet have had sufficient time to make the necessary adaptations enabling them to successfully exploit the large concentrations of phytoplankton during the Austral summer? Or have they instead merely adapted to a strategy of surviving on low resources during the winter?
- What other environmental mechanisms, such as resuspension, may increase the potential capture of food items, and how have suspension feeders adapted to irregular fluctuations in food availability?

The general objectives of the cruise are based on two preliminary experiments carried out by the members of the research team.

- Studies on the trophic ecology of benthic suspension feeders in the Mediterranean have been under way for the past six years. Those studies have demonstrated that the life cycles and ecological strategies of some of the studied species are more strongly conditioned by food availability than by other environmental or biological factors. At the same time, species capable of capturing large prey items such as zooplankton have been shown to be capable of consuming microplankton to satisfy their energy balance.
- Recent studies carried out in Antarctic waters have yielded a hydrozoan species that feeds basically on resuspended benthic diatoms, which contrasts with the diets of other species in that same group, based chiefly on zooplankton. At the same time, dissection of hundreds of zooids from different species of suspension feeders on the last "Polarstern" ANT XIII/3 survey did not yield any prey items of any size in the contents. Subsequent electron microscopy detected a variety of small particles in the stomach contents, the nature and source of which remain unknown. They may be particles or accretions of particles of organic matter from decomposition processes taking place in the sediment through the action of as yet undetected decomposers or other organisms.

The specific objectives are:

- To identify benthic suspension feeders, namely cnidarians and bryozoans, and to study their distribution and abundance both in function of geographical area and depth.

- To observe reproduction variability at the colony level (between polyps of the same colony), population level (between colonies in the same community), and community level (between geographic areas and in different periods within the same area).
- To determine experimentally the natural diet and prey capture rate and to ascertain which portion of the fine fraction is most important in the diet of each species.
- To confirm whether certain species have biochemical adaptations enabling them to digest macromolecules of plant origin.
- To determine the biochemical nature and characteristics of possible food sources in the surface layer of the sediment.
- To analyze the stoichiometric composition of colonies of various species and to relate it to different life strategies; to evaluate intraspecific variability in colony composition in different geographic areas, within the same community, and within the same colony.

2.2.1 Abundance and Distribution of Benthic Hydroids in the Weddell Sea

Objectives

The main objective during the ANT XV/3 cruise has been to raise a complete list of the hydroid species collected with the purpose of increasing the knowledge of the hydroid fauna of the area. At the same time, the identification, quantification and description of the spatial pattern of the hydroid taxocoenosis (like the ones of benthic cnidarians) has been considered the first step to know the role of suspension feeders in the shallow Antarctic benthic communities.

Work at sea

All species and the major part of colonies collected by different gears (TV Grab, AGT, D, BPN, MG) have been sorted on board. The major part of hydroids from 35 samples (stations) have been identified at the species level during the cruise and a set of 7 species have been labelled and separated for further identification in the laboratory. In all samples each species was quantified considering the total number of colonies or polyps in several cases, such as individual polyps of athecates, although only the TV Grab allows a quantitative approach of species density and abundance. The depth range considered was between 50 and 800 m.

Preliminary results

A total of 3457 colonies have been sorted and labeled, and around 72 species of hydroids have been recognized (Table 5). Very small colonies, mainly epibionts of other hydroids, were not completely identified during the cruise, and back home they will increase at least by 10% the species recorded for the ANT XV/3 cruise. It is worth mentioning that the athecate species represent the 19% of all species collected, especially because this group is poorly known in Antarctic waters, and is scarcely reported in the papers already published on the Antarctic hydroid fauna. The number of species collected on this single cruise is high if it is compared with the numbers reported by previous species records from biological sampling expeditions in the Antarctic. The following list tries to summarize some general information on several expeditions in order to compare them with the ANT XV/3 records:

- Swedish Subpolar Expedition 1901-1903 (South Shetland, Bellingshausen Sea; Antarctic and Subantarctic): 51 species reported
- Terra Nova Expedition 1910-1913 (Ross Sea and New Zealand; Antarctic and Subantarctic): 82 species reported

- Australasiatic Antarctic Expedition 1911-1914 (Commonwaelth Bay; Antarctic): 38 species reported
- Norwegian Antarctic Expedition 1927-1928 (South Shetland, South Georgia; Antarctic and Subantarctic): 46 species reported
- Soviet Antarctic Expedition 1955-1958 (South Shetland, Weddell Sea; Antarctic and Subantarctic): 51 species reported
- XII French Expedition 1964-1965 (Adelie Land; Antarctic): 51 species reported
- Antártida 8611, 1995 (Scotia Ridge Area; Antarctic): 32 species reported

Table 5: Hydrozoans collected during the ANT XV/3 cruise. Numbers indicate the total number of colonies (in some species the number of polyps) counted in each sample.

Species Stn No.	04	05	06	27	30	31-33	36	44	50	58	62	71	77	78	223
Abietinella operculata (Jäderholm 1903)	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Acriptolaria conferta (Allman 1877)	-	-	-	-	-	-	-	-	-	-	40	-	2	-	-
Billardia subrufa (Jäderholm 1904)	7	2	3	7	-	1	-	21	11	-	3	2	4	2	-
Campanularia hicksoni (Totton 1930)	-	-	-	-	-	4	129	-	-	-	-	-	-	-	-
Campanularia subantartica (Millard 1971)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campanulina chilensis (Hartlaub 1905)	-	-	-	-	-	220	-	-	-	-	-	-	-	-	-
Coryne tubulosa (M. Sars 1855)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eudendrium antarcticum Totton 1930	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eudendrium rameum (Pallas 1766)	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eudendrium sp. 1	7	-	-	1	-	-	-	-	-	-	13	-	-	-	-
Eudendrium sp. 2	-	-	-	6	-	148	40	-	-	-	-	-	-	-	-
Eudendrium sp. 3	-	-	-	6	-	1	-	18	-	-	-	-	-	-	-
Eudendrium sp. 4	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-
Filellum antarcticum (Hartlaub 1904)	4	1	1	100	-	-	-	2	1	-	-	-	-	-	-
Halecium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Halecium antarcticum (Vanhöffen 1910)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Halecium delicatulum (Coughtrey 1876)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Halecium jäderholmi (Vervoort 1972)	-	-	-	1	-	-	1	-	1	2	-	-	3	-	-
Halecium ovatum (Totton 1930)	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Halecium pallens (Jäderholm 1904)	-	-	1	-	-	-	75	1	-	-	-	-	2	-	-
Halecium secundum (Jäderholm 1904)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Halecium tenellum (Hincks 1861)	-	-	-	10	-	2	-	-	-	-	-	-	100	-	-
Hebella sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydractinia sp.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Hydractinia sp. 1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hydractinia sp. 2	-	-	-	-	-	4	8	-	-	-	-	-	-	-	-
Hydractinia sp. 3	-	-	-	-	-	2	5	-	-	-	-	-	-	-	-
Hydrodendron arborea (Allman 1888)	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-
Lafoea dumosa (Fleming 1820)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Lafoea fruticosa (M. Sars 1851)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Opercularella sp.	3	-	1	100	-	-	-	-	-	-	-	-	100	-	-
Oswaldella antarctica (Jäderholm 1904)	-	-	3	3	3	102	43	-	-	-	2	3	-	-	-
Oswaldella bifurca (Hartlaub 1904)	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Oswaldella billardi (Brigss 1938)	7	-	-	-	-	-	-	-	-	2	-	2	1	-	-
Oswaldella delicata (Peña *et al.* 1997)	-	-	-	3	-	-	-	-	-	-	-	-	-	-	
Oswaldella elongata (Peña *et al.* 1997)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oswaldella gracilis (Peña et al., 1997)	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Oswaldella rigida (Peña *et al.* 1997)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perigonimus antarcticus (Hickson and Gravely 1907)	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-
Schizotricha glacialis (Hickson and Gravely 1907)	-	-	-	-	-	-	-	-	10	-	-	-	-	-	6
Schizotricha turqueti (Billard 1906)	-	-	-	6	-	2	-	-	25	-	3	-	2	-	-
Schizotricha unifurcata (Allman 1883)	-	-	1	-	-	-	-	-	4	-	2	-	2	-	-

Table 5 continued.

Species Stn No.	04	05	06	27	30	31-33	36	44	50	58	62	71	77	78	223
Selaginopsis affinis (Jäderholm 1904)	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-
Selaginopsis juncea (Vanhöffen 1910)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selaginopsis vanhoeffeni (Peña and Garcia 1994)	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Sertularella glacialis (Jäderholm 1904)	-	-	-	-	-	-	-	-	-	-	4	-	1	-	-
Sertularella jeodiae (Totton 1930)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sertularella polyzonias (Linné 1767)	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sertularella spiralis (Hickson and Gravely 1907)	-	-	-	-	-	-	-	4	-	-	-	-	100	-	-
Sertularella tuba (Totton 1930)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Stauretheca antarctica (Hartlaub 1904)	-	-	-	-	-	-	-	-	3	1	1	-	3	-	-
Staurotheca compressa (Briggs 1938)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staurotheca dichotoma (Allman 1888)	1	3	-		-	-	-	-	2	-	-	-	2	1	-
Staurotheca pachyclada (Jäderholm 1904)	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-
Staurotheca plana (Peña *et al.* 1997)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staurotheca stolonifera (Hartlaub 1904)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Stegella grandis (Hickson and Gravely 1907)	-	1	3	3	-	-	-	2	-	-	1	-	4	-	-
Symplectoscyphus antarctica (Hartlaub 1900)	-	-	-	-	-	-	-	-	-	-	-	-	100	1	-
Symplectoscyphus biformis (Jäderholm 1903)	-	-	-	-	-	-	-	-	-	-	22	-	2	-	-
Symplectoscyphus confusus (Totton 1930)	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-
Symplectoscyphys curvatus (Jäderholm 1917)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Symplectoscyphus elongatus (Jädelholm 1904)	1	-	-	4	-	-	-	2	5	-	6	8	-	4	-
Symplectoscyphus epizooticus (Totton 1930)	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
Symplectoscyphus filiformis (Allman 1888)	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-
Symplectoscyphus naumovi (Blanco 1969)	3	1	20	-	-	-	-	-	-	-	-	-	2	-	-
Symplectoscyphus plectilis (Hickson and Gravely	-	-	-	-	-	1	-	-	-	2	-	-	21	-	-
Symplectoscyphus pulchella (Jäderholm 1905)	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Symplectoscyphus spiralis (Hickson and Gravely	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Tubularia ralphii (Bale 1884)	-	-	-	6	-	406	-	-	-	-	-	-	-	-	-
Zygophylax armata (Ritchie 1907)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zygophylax unilateralis (Totton 1930)	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-

The most recent list of the Antarctic hydroid fauna has been published by Stepanjants (1979), where she describes and discusses about 148 species. More recently, in Arntz *et al.* (1997) a personal communication of A. Svoboda is mentioned with a more actualized species number of almost 201% of the 72 species identified during the ANT XV/3 cruise, representing new records for the Weddell Sea. Considering the preliminary data mentioned above, the present cruise is the one in which most species have been recorded; there could be two possible explanations for this. The first one is because the Weddell Sea is one of the Antarctic areas where the hydroid fauna is less known, and the second is due to the fact that this area is one of high species richness, perhaps the highest that can be found in the Southern Ocean. The description of an important number of species from samples collected in this area by Peña-Cantero and colleagues (e.g. Peña Cantero *et al.*, 1997a,b) corroborates this diversity assumption, even though these authors worked with material collected during several cruises from the same stations.

Sampling was performed in four geographic areas: Kapp Norvegia, Halley Bay, Vestkapp and Drescher Inlet. The highest species richness has been found in Kapp Norvegia (Fig. 10), it should be metioned, however, that the major part of samples have been obtained there. As a preliminary impression it could be also pointed out that Kapp Norvegia is a very rich area due to the variety of assemblages and environmental conditions. A careful study of other zoological groups, such as anthozoans, wich are also very rich in this area (see below), must be performed to confirm the high animal diversity of the Kapp Norvegia area. As an example the extremely patchy specific distribution of the hydroid species is shown in Fig. 11. Although different sampling gears have been used, the differences between samples are clear. The major species number found in TVG as compared to the AGT sampler could be due to the fact that all samples have been sorted and studied from the first gear.

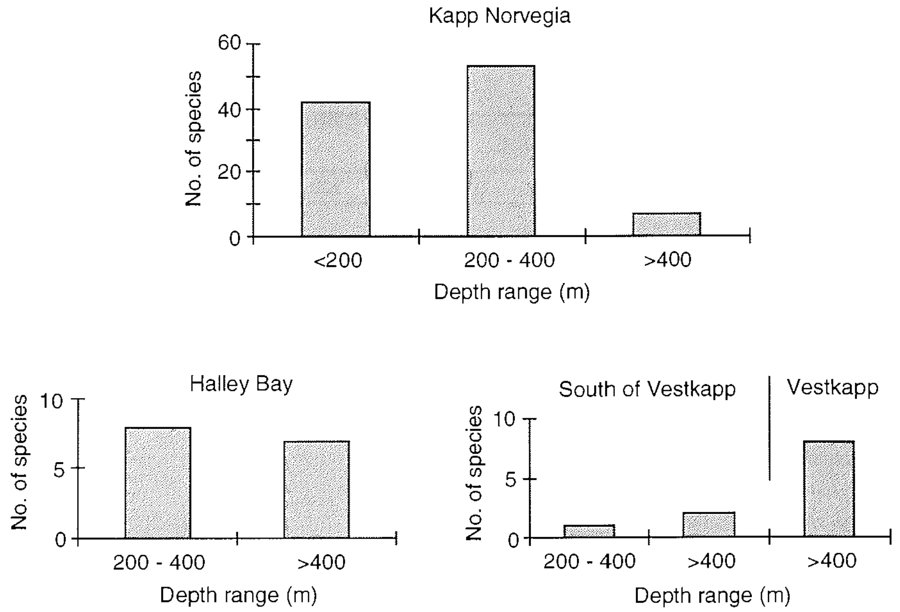


Fig. 10: Number of species of Hydroidea as a function of depth in Kapp Norvegia, Halley Bay and Vestkapp, Weddell Sea. Catches have been pooled for the depth ranges considered.

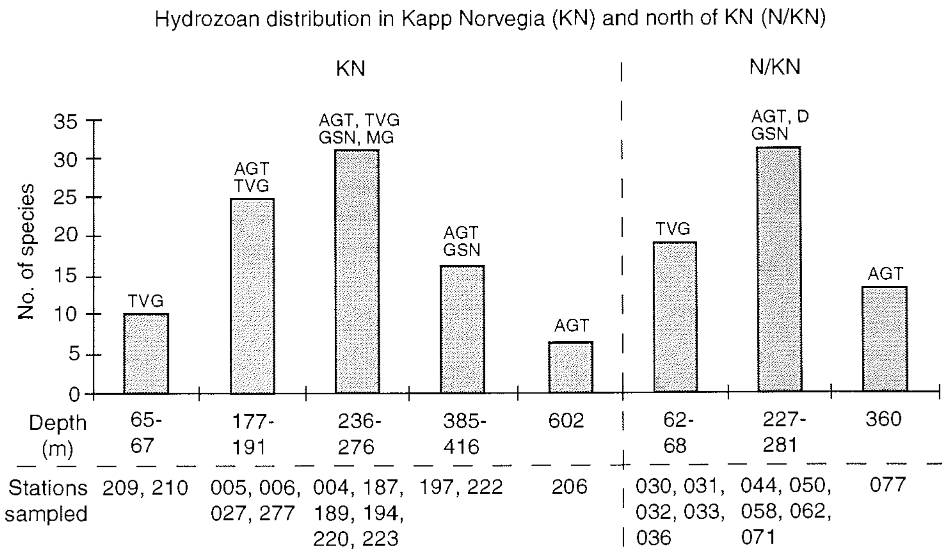


Fig. 11: Number of species of Hydroidea at the different stations sampled in Kapp Norvegia, Weddell Sea.

A first overview of the bathymetric distribution of the hydroid species collected (Table 6) shows that the great majority of species have been found in the range between 100 and 200 m depth, and until 400 m for all the species.

Table 6: Bathymetric distribution of the 72 species of Hydrozoa collected during the EASIZ II (ANT XV/3) "Polarstern" cruise.

Species depth (m)	50	100	150	200	300	400	500	600	700	800
Coryne tubulosa	—	—								
Eudendrium sp. 4	—	—								
Eudendrium antarcticum	—	—								
Hydractinia sp. 1	—	—								
Hydractinia sp. 2	—	—								
Hydractinia sp. 3	—	—								
Hydrodendron arborea	—	—								
Lafoea fructicosa	—	—								
Oswaldella gracilis	—	—								
Perigonimus antarcticus	—	—								
Symplectoscyphus pulchella	—	—								
Tubularia ralphii	—	—								
Eudendrium sp. 2	—	—	—							
Eudendrium sp. 3	—	—	—	—						
Campanularia hicksoni	—	—	—	—	—					
Campanulina chilensis	—	—	—	—	—					
Oswaldella antarctica	—	—	—	—	—					
Schizitricha turqueti	—	—	—	—	—					
Lafoea dumosa	—	—	—	—	—	—				
Halecium ovatum	—	—	—	—	—	—				
Halecium tenellum	—	—	—	—	—	—				
Synplectoscyphus biformis	—	—	—	—	—	—				
Billardia subrufa	—	—	—	—	—	—	—	—		
Symplectoscyphus plectilis	—	—	—	—	—	—	—	—		
Halecium jaederholmi	—	—	—	—	—	—	—	—		
Eudendrium rameum	—	—	—	—	—	—	—	—	—	—
Halecium pallens	—	—	—	—	—	—	—	—	—	—
Symplectoscyphus spiralis		—	—							
Hebella sp.			—	—						
Hydractinia sp.			—	—						
Oswaldella bifurca			—	—						
Oswaldella delicata			—	—						
Staurotheca plana			—	—						
Filellum antarcticum			—	—	—					
Schizotricha glacialis			—	—	—					
Opercularella sp.			—	—	—	—				
Schizotricha unifurcata			—	—	—	—				
Sertularella glacialis			—	—	—	—				
Symplectoscyphus naumovi			—	—	—	—				
Oswaldella billardi			—	—	—	—	—			
Stegella grandis			—	—	—	—	—			

Table 6 continued.

Species	depth (m) 50	100	150	200	300	400	500	600	700	800
Symplectoscyphus elongatus			━	━	━	━	━	━		
Selaginopsis affinis			━	━	━	━	━	━	━	━
Abietinella operculata				━						
Campanularia subantartica				━						
Eudendrium sp.1				━						
Halecium antarcticum				━						
Oswaldella elongata				━						
Oswaldella rigida				━						
Selaginopsis juncea				━						
Sertularella jeodiae				━						
Staurotheca compressa				━						
Staurotheca stolonifera				━						
Symplectoscyphus confusus				━						
Symplectoscyphus filiformis				━						
Sertularella tuba				━	━					
Zygophylax armata				━	━					
Acriptolaria conferta				━	━	━				
Sertularella polyzonias				━	━	━	━	━		
Sertularella spiralis				━	━	━	━	━		
Staurotheca pachyclada				━	━	━	━	━		
Symplectoscyphus curvatus				━	━	━	━	━		
Staurotheca antarctica				━	━	━	━	━	━	
Staurotheca dichotoma				━	━	━	━	━	━	━
Zygophylax unilateralis				━	━	━	━	━		
Halecium secundum					━					
Symplectoscyphus antarctica					━					
Symplectoscyphus epizooticus						━				
Selaginopsis vanhoeffeni						━				
Halecium sp.							━			

This depth zone corresponds to the deeper part of the continental shelf where the vertical organic flux is most intense. Iceberg scouring is likely to occur frequently in the upper and only occcasionally in the lower part of this zone (see 2.1.1). Considering the colony size and shape and the pattern of growth for all the recorded species, several morphotypes and ecological strategies can be recognized at first view:

- Erect colonies, mainly polysiphonic and dichotomously ramified, which grow on stones of different sizes and where a net of encrusting hydrorhizae develop. Several species such as *Oswaldella antarctica* were very abundant in some samples and probably form dense population patches. The erect species can form colonies of more that 50 cm height.
- Massive colonies forming dense bushy concentrations, on several occasions like cushions, up to 20 cm in diameter. Species like *Symplectoscyphus biformis* and *Sertularella spiralis* belong to this group and in several samples were very abundant, growing on organic substrata such as bryozoan colonies.
- Encrusting-erect colonies forming small trees of not more than 10 cm high. Species of this group form very few ramified hydrorhiza running on small

stones or on the surface of other benthic sessile animals. Species belonging to this group are, for example, most of the species of the genera *Halecium* and *Eudendrium*.

- Encrusting species with small polyps arising from encrusting hydrorhiza which are spread on the surface of stones, sponges, shells of molluscs, etc. The species of the genus *Hydractinia* belong to this group.
- Epibiont colonies, mainly of small size, no more than 3 cm, growing on the axis of gorgonians, hydrocaules of other hydroids, etc. Species such as *Campanularia hicksoni* or *Halecium delicatulum* belong to this group.

2.2.2 Ecology of Anthozoans in the Weddell Sea

Objectives

The benthic communities are dominated in many shelf Antarctic areas by sesile suspension feeders such as sponges, cnidarians and bryozoans which develop rich communities (Arntz *et al.* 1994). The ecology of these communities has been little studied and many aspects of their biology are virtually unknown. Suspension feeders are able to form dense populations on the continental shelf and in some cases even on abyssal bottoms, though the communities of the Antarctic can perhaps be considered paradigmatic. These communities are dominated by species whose larvae have short planktonic stages, and they make up one of the largest aggregations of biomass and density of benthic organisms yet known. All these deep-dwelling communities of suspension feeders consist of organisms with long life spans, which means that they are highly structured, mature communities. One of the most important components of Antarctic suspension feeder communities are the anthozoans, mainly gorgonians which contribute with a great biomass (Gerdes *et al.* 1992) and dense populations (Gutt and Starmans 1998). One of the main objectives of the EASIZ II cruise was to undertake a general study of this group, mainly centered in the Octocorallia species. The study was focused on different aspects related with the species composition and abundance, their feeding biology, the study and quantification of reproduction and some preliminary aspects of their growth patterns in the Weddell Sea.

2.2.2.1 Taxonomy and Distribution

Work at sea

From the present cruise, 63 anthozoan species have been collected, most of them identified to the species level (Table 7). These have been sampled from 50 stations, and more than 2000 colonies or individuals were preserved for further studies (histological, reproductive biology, taxonomy...).

In order to study the distribution and abundance of gorgonians on bottoms of the Weddell Sea, images from videotransects filmed with ROV (Remotely Operated Vehicle) were observed along two transects at Stns 193 and 281, in Kapp Norvegia and Atka Bay, respectively. The videotransects were divided in representative sample units (30 seconds) during 15 minutes approximately, and all the colonies of gorgonians present were visually identified to the lowest taxonomic level possible. The results on number of colonies per time were transformed into a distance scale.

Table 7: Anthozoans collected during the ANT XV/3 cruise. Numbers indicate the total number of colonies (for Actinaria numbers of polyps) counted in each sample.

Species stations	04	05	06	27	31	33	35	36	39	44	50	58	60	62	68	71	77	78	82	84	88	89	95	97
Actiniaria sp.	-	-	-	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Actiniaria sp. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Actiniaria sp. 2	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	16	1	-	3	-	-	-	-	6
Actiniaria sp. 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	4
Actiniaria sp. 4	-	-	-	-	-	-	-	-	-	-	1	-	-	4	-	2	-	-	-	-	-	-	1	-
Actiniaria sp. 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actiniaria sp. 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actiniaria sp. 7	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	8	-	10	2
Actiniaria sp. 8	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actiniaria sp. 9	-	-	-	-	-	-	-	-	-	4	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Actiniaria sp. 10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	4	-	11	4	-	-	7	-
Actiniaria sp. 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	4	2	-	-	1	-
Actiniaria sp. 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Ainigmaptilon antarcticus (Molander 1929)	-	-	-	-	-	-	-	-	-	11	9	3	-	-	-	17	-2	-	-	-	-	-	-	-
Ainigmaptilon sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ainigmaptilon virgularoides (Molander 1929)	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	16	-	-	-	-	-	-	-	-
Alcyonium sp.	-	-	-	-	1	-	-	3	2	-	2	-	1	6	-	4	6	-	2	-	-	-	-	1
Amphilaphis grandiflora (Kükenthal,1912)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	-	-	1	-	-	-	-
Caryophyllia antarctica (Marenzeller 1904)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	1
Caryophyllia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Clavularia cf. *frankliniana* (Roule 1902)	-	-	-	1	4	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dasystenella acanthina (Wright & Studer 1889)	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-	9	5	7	14	3	-	-	2	3
Echinisis spicat (Hickson 1907)	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	2	5	-	-	-	-	-	1	-
Fannyella rossii (Gray 1873)	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	6	1	-	-	-	-	-	-
Fannyella spinosa (Thomson & Bennet 1931)	-	-	-	-	1	-	-	-	-	-	-	1	-	11	-	3	26	-	-	-	-	-	-	-
Flabellum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Flabellum curvatum (Moseley 1881)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Flabellum flexuosum (Cairns 1982)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fungyacyathus marenzelleri (Vaughan 1906)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Gardineria antarctica (Gardiner 1929)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3
Haloclaviidae sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hormathiidae sp. 1	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	1	1	-	1	-	-	-	-	-
Hormathiidae sp. 2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	-	-	-	-	-	-	-	-
Hormathiidae sp. 3	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	1	-	-	-	1	-	-	-	-

Table 7 continued.

Species Stations	04	05	06	27	31	33	35	36	39	44	50	58	60	62	68	71	77	78	82	84	88	89	95	97
Hormathiidae sp. 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Hormathiidae sp. 5	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-
Inflatocalyx infirmata (Verseveldt & Bayer 1988)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Isosicyonis alba (Studer 1878)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	8
Javania antarctica (Gravier,1914)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Mopsea elongata (Roule 1908)	-	6	6	9	-	-	-	3	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Mopsea sp. 2	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mopsea sp. 3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mopsea sp. 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Primnoella sp. 1	1	1	-	-	3	4	-	-	-	-	9	1	-	-	-	1	-	-	-	-	-	-	-	-
Primnoella sp. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-
Primnoella antarctica (Kükenthal 1907)	3	-	1	6	-	-	-	-	-	1	7	-	-	2	-	1	-	-	2	-	-	-	1	-
Primnoella vanhoeffeni (Kükenthal 1909)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Primnoidae n. gen. 1	-	-	-	-	-	-	1	1	-	-	1	-	-	-	9	-	-	-	-	-	-	-	-	-
Primnoidae n. gen. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	4	1	3	-	1	-	-
Primnoidae n. gen. 3	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-
Primnoisis cf.*mimas* (Bayer & Stefani,1987)	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Primnoisis antarctica (Studer 1879)	3	3	3	1	-	-	2	-	7	6	37	1	-	2	-	4	11	-	-	-	3	-	-	-
Primnoisis formosa (Gravier 1913)	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	5	2	-	-	-	-	-	-	-
Tenuisis microspiculata (Molander 1929)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thouarella sp. 2	-	-	-	-	-	-	-	-	-	5	35	2	-	35	-	19	40	-	2	1	2	-	-	-
Thouarella aff.*versluisy* (Kükenthal 1907)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thouarella sp. 1	-	-	-	-	-	-	-	-	1	-	28	-	-	1	-	23	49	-	-	-	-	-	-	-
Thouarella sp. 3	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	2	13	6	1	5	-	-	-	-
Tokoprimno n. sp.	5	-	-	-	-	-	-	-	-	2	2	2	2	3	-	10	4	-	-	-	-	-	-	-
Umbellula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Umbellula lindahli (Kölliker 1874)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	3	-	1	-	6	-
Umbellula magniflora (Kölliker 1880)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	2	8	2

Preliminary results

Faunistic and taxonomic contributions. From the 63 anthozoan species collected in the ANT XV/3 cruise, 35 belong to the Octocorallia, and 28 to the Hexacorallia. Within the octocoral species there were one Stolonifera, two Alcyonacea, 29 Gorgonacea, and 3 Pennatulacea. The hexacoral species can be divided in 20 Actiniaria and 8 Scleractiniaria. All actiniarian specimens were been relaxed with menthol and fixed in formalin 6% for further histological studies; worth mentioning, however, is the relatively high number of species collected and the wide bathymetric range registered, from 150 to 1400 m.

The 8 scleractinians collected have been previously reported from the Weddell Sea (Cairns 1982), but bathymetric data are interesting to understand the limits of distribution of these species.

Among the octocoral specimens, the material of the stoloniferous *Clavularia* cf. *frankliniana* will be useful to launch a comparative study of this ill-defined genus with other material preserved in different museums and institutions. One of the alcyonarian species collected in the present cruise, *Inflatocalyx infirmata*, is recorded for the first time since its original description. The present material, together with some colonies collected during the cruise ANT XIII/3, is much more abundant that that used by the original authors, and will be used in the redescription of this species to explain the variability of the colony shape and sclerite dimensions in different parts of the polyps and colony.

The pennatulacean colonies belong mainly to *Umbellula magniflora* and *U. lindahli*. These species have often been confused and considered as synonyms by several authors. Pasternak (1962) described the Antarctic and Subantarctic species of this genus, and clearly distinguished both forms as different species. In the last revision of the living genera of pennatulaceans, both forms seem to be included as one cosmopolitan species under the name *U. lindahli*. The colonies collected during the ANT XIII/3 and ANT XV/3 cruises will be used in a comparative biometric study, and the characters used to separate these species will be evaluated.

The gorgonacean octocorals have been the most interesting material from the faunistic and taxonomic points of view. All the species belong to the families Primnoidae (20 species) and Isididae (9 species), and some old taxonomic problems may be solved from the careful study of the collected specimens. The position of the species presently included in the genus *Ainigmaptilon* will be discussed; as a preliminary impression, at least two of the five species recognized by Bayer (1950) may be the result of the scarce knowledge in the variability of the different characters used in the identification of these species, and they may be considered young synonyms of other previously described taxa. The genus *Primnoella*, recently divided in *Primnoella* and *Convexella* by Bayer (1996), is still in need of an urgent revision. The erection of *Convexella* only improves the position of three of the 14 species previously adscribed to *Primnoella*. According to the generic character used in Primnoidae, the genus *Primnoella* may be subdivided in at least 7 different genera, but much more material from different museums should be consulted and revised before changing the present not convincing taxonomic status of the species included in *Primnoella*. The genus *Thouarella*, recently revised by Brito (1993), is another example of confusion and continuous mistakes in the literature; the species *Thouarella* variabilis should remain in our opinion, including more than one species form, and the abundant material from this cruise will be used for comparative purposes with those deposited in different institutions. New taxa will be described to be included in the family Primnoidae; it is worth mentioning the future proposition of three new genera and species, and two additional new species in the same family, one of them in the genus *Primnoella* (s.l.), and the other in *Tokoprimno*.

Geographical and bathymetric distribution. Four geographical areas have been sampled with different sampling efforts: Kapp Norvegia, Halley Bay, Vestkapp, and Drescher Inlet. The Kapp Norvegia area was caracterized by the highest values in species number (Fig. 12), followed by Vestkapp (Drescher Inlet), Halley Bay and south of Vestkapp.

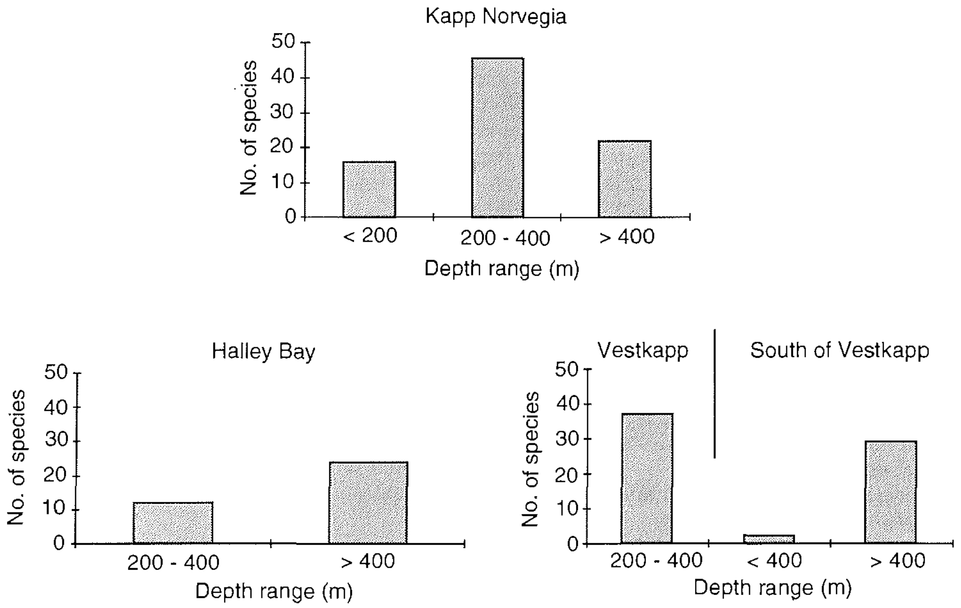


Fig. 12: Number of species of Anthozoa as a function of depth in Kapp Norvegia, Halley Bay and Vestkapp, Weddell Sea. Catches have been pooled for the depth ranges considered.

In each of these areas, the bathymetric distribution of species was quite different. In Kapp Norvegia, where the depth range between 200 and 400 m presented almost 50 anthozoan species, this high species number may also be related with a greater sampling effort. Below 400 m depth, the species number was slightly higher than that in shallow waters (< 200 m). In Halley Bay the most diverse anthozoan fauna was found below 400 m.

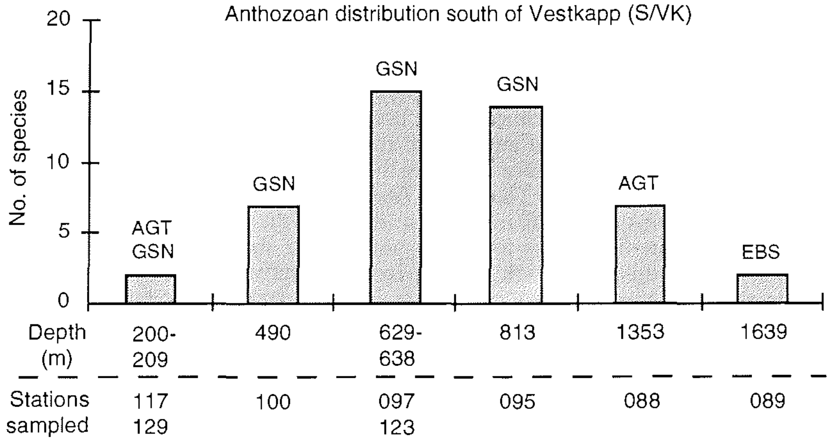


Fig. 13: Number of species of Anthozoa at the different stations sampled south of Vestkapp, Weddell Sea.

A more pronounced situation is observed south of Vestkapp (Figs. 12 and 13). There is a progressive increase in species numbers between 200 (SVK-1) up to 600 (SVK-3) m depth, and later a decrease down to 1350 m. The last sample, SVK-6 (about 1600 m) was obtained with a more selective method, the epibenthic sledge; for this reason, comparisons will not be made.

As to the bathymetric distribution of the 63 anthozoan species collected (Table 8), several comments may be made. In general, a wide bathymetric range is shown by most of the species, like *Dasystenella acanthina*, *Umbellula magniflora*, Primnoidae n. gen. 2, or *Thouarella* sp. 2. Shallow water (< 200 m depth) species contributed about 12% of the total, including the stolonate octocoral *Clavularia* cf. *frankliniana*, gorgonians like *Mopsea elongata*, and Primnoidae n. gen. 1. Almost all species (nearly up to 90% of the total) were found between the depth ranges of 200 to 400 m; some species present in this depth band, however, are also distributed down to the deep sampled zones (about 1600 m). Thus, the high presence values the deep stations (> 400 m) off Halley Bay and south of Vestkapp may be explained by the wider bathymetric distribution of these species.

Distribution of the most abundant gorgonians along ROV transects. The preliminary results derived from ROV images provided us with complementary quantitative data on the gorgonian species distribution and a rough comparison of the faunistic composition between these two selected transects. It is also possible to detect species assemblages and ecologically relevant information from these images.

Stn 281 (64 m depth) was a particularly rich area, considered as an undisturbed community dominated by benthic suspension feeders. Stn 193 (256 m depth) was considered a first stage of recolonisation with presence of scour marks. Number of colonies and frequency distribution were calculated at both stations. The results show a distribution structure with several peaks for both transects. This confirms a tendency for some species (e.g. *Thouarella* spp.) to aggregate and thus produce a contagious distribution (Figs 14 and 15). The presence of *Thouarella* spp. seems to increase the chance that another species will occur in the same area.

The distribution of species at the two transects shows that there is a pool of common species (*Thouarella* spp., *Primnoisis antarctica*, *Primnoella* sp. and *Dasystinella acanthina*) but with different predominance. The presence of *Thouarella* spp. is of special importance, because it provides the macroscopic distribution pattern of the deep transect (Fig. 14) compared with the shallow transect (Fig. 15), where the combination of three species, *Thouarella* spp., *D. acanthina* and *Fannyella rossii*, is what produces the distribution pattern and abundance of gorgonians.

The shallow transect had a higher number of species, due to the presence of *F. rossii* and *F. spinosa*, than the deeper one, with *Ainigmaptilon antarcticus*. From this preliminary analysis we can consider that the presence of *Primnoisis antarctica* and of *A. antarcticus* is a good indicator of the first stages of recolonisation, *P. antarctica* acting as a key species due to its abundance and frequency of occcurrence. On the other hand, *Fannyella rossii* and *F. spinosa* can be considered indicator species for late stages of recolonisation or for undisturbed communities.

In this study we observed videotransects in an attempt to examine the community structure of these areas. Photosampling and videosampling have been used successfully in studying community characteristics (Gutt *et al.* 1996). They are non-destructive methods which allow us the study of the structure and dynamics of benthic antarctic ecosystems.

Table 8: Bathymetric distribution of the 63 species of Anthozoa collected during the EASIZ II (ANT XV/3) "Polarstern" cruise.

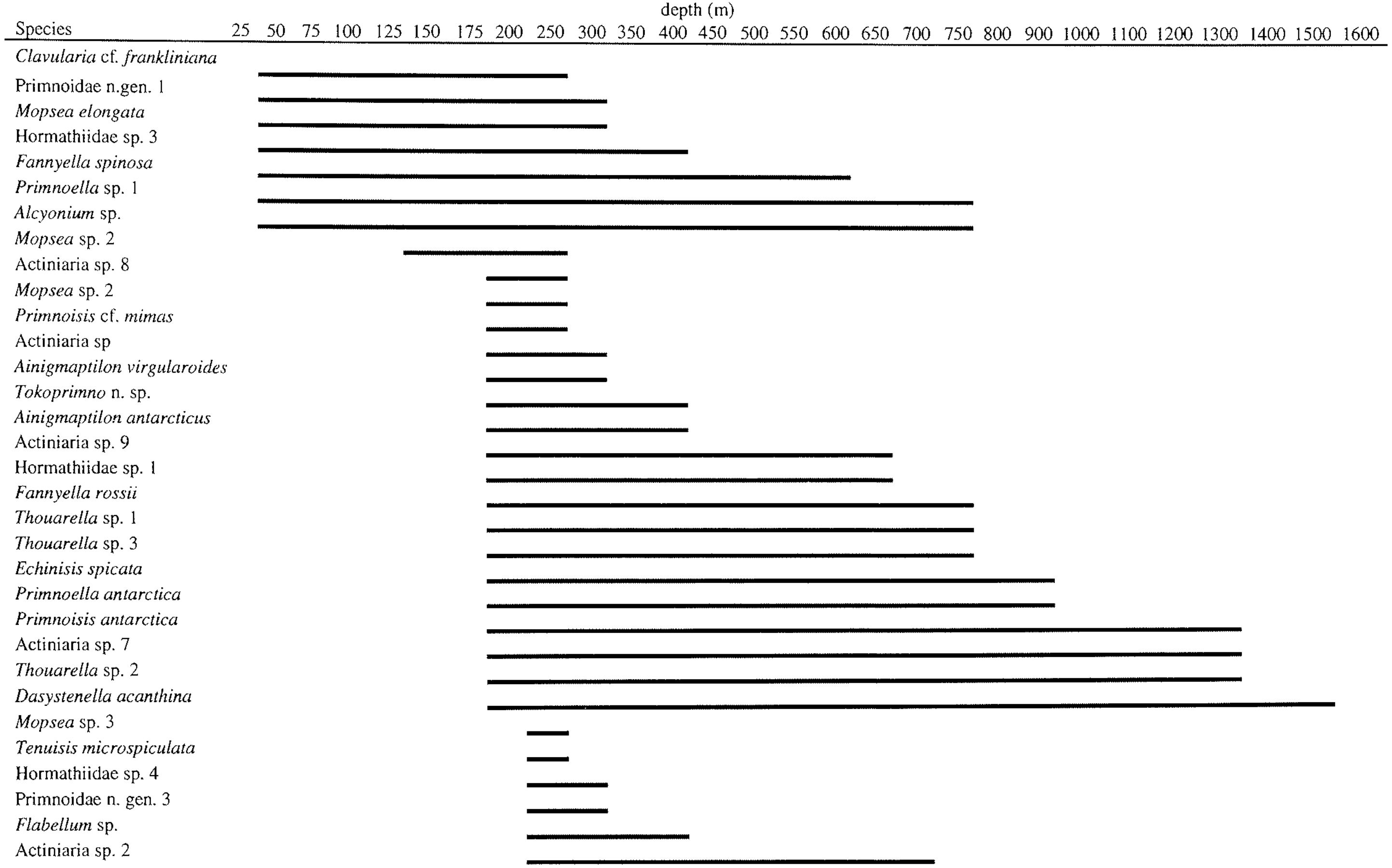
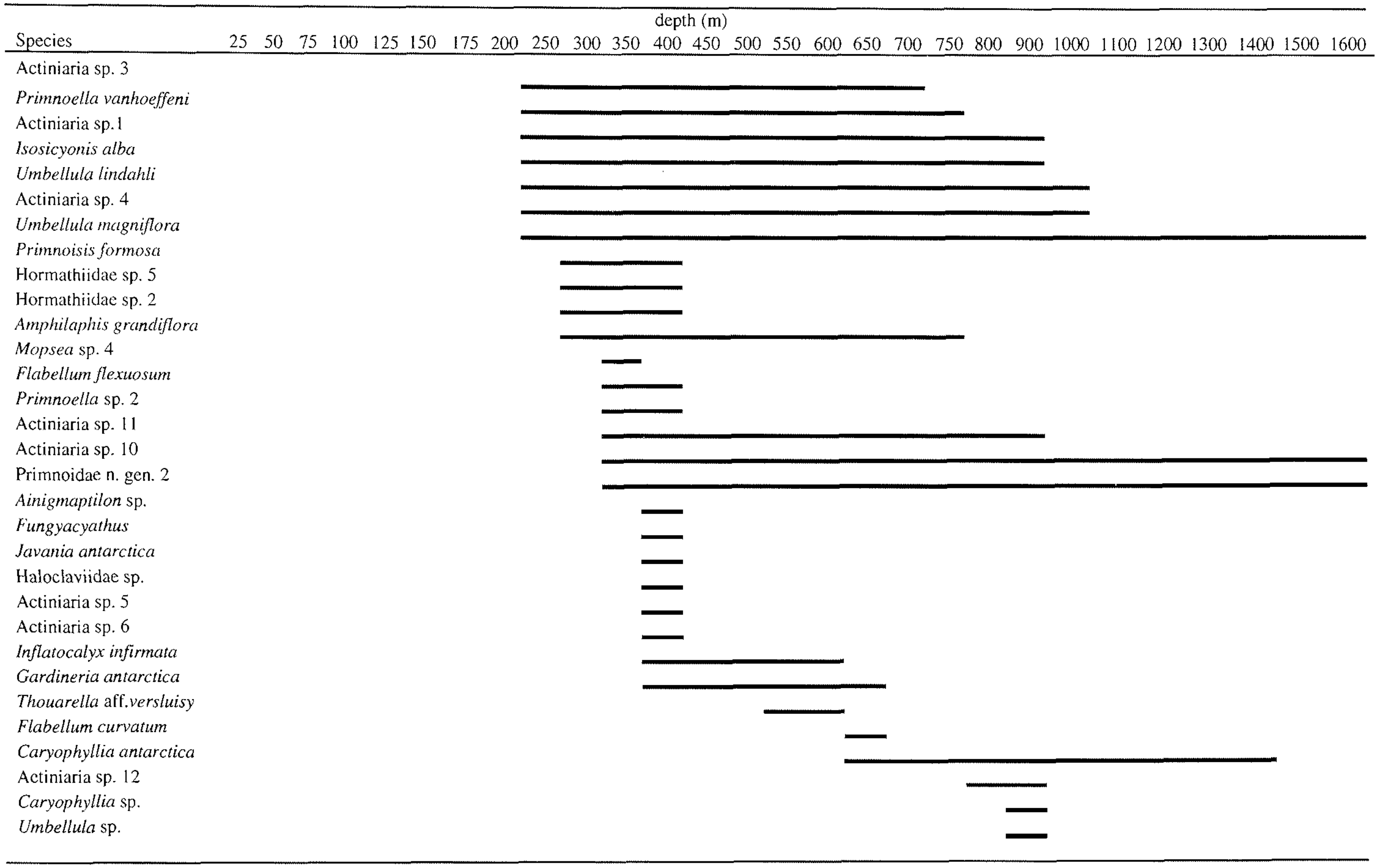


Table 8 continued.



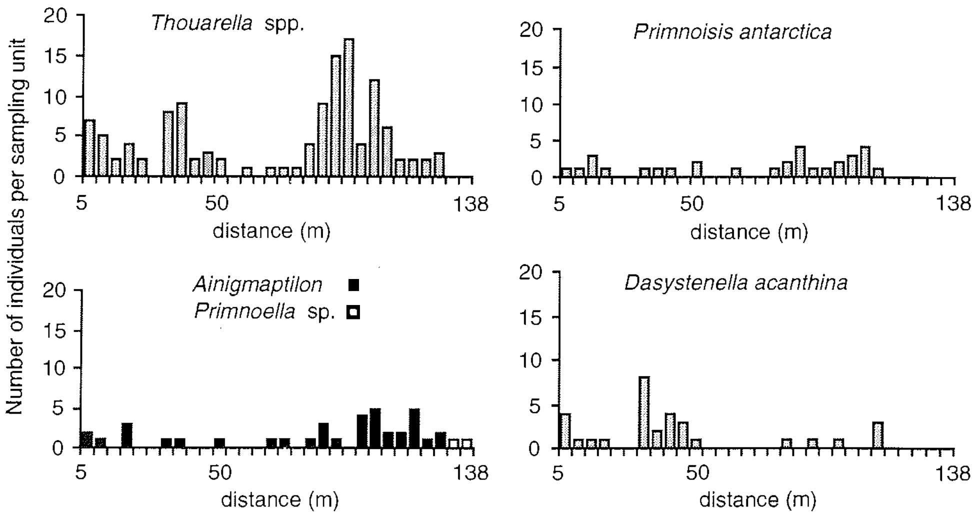


Fig. 14: Distribution of the most abundant gorgonian species along a ROV transect at Kapp Norvegia (stn 193, 256 m depth).

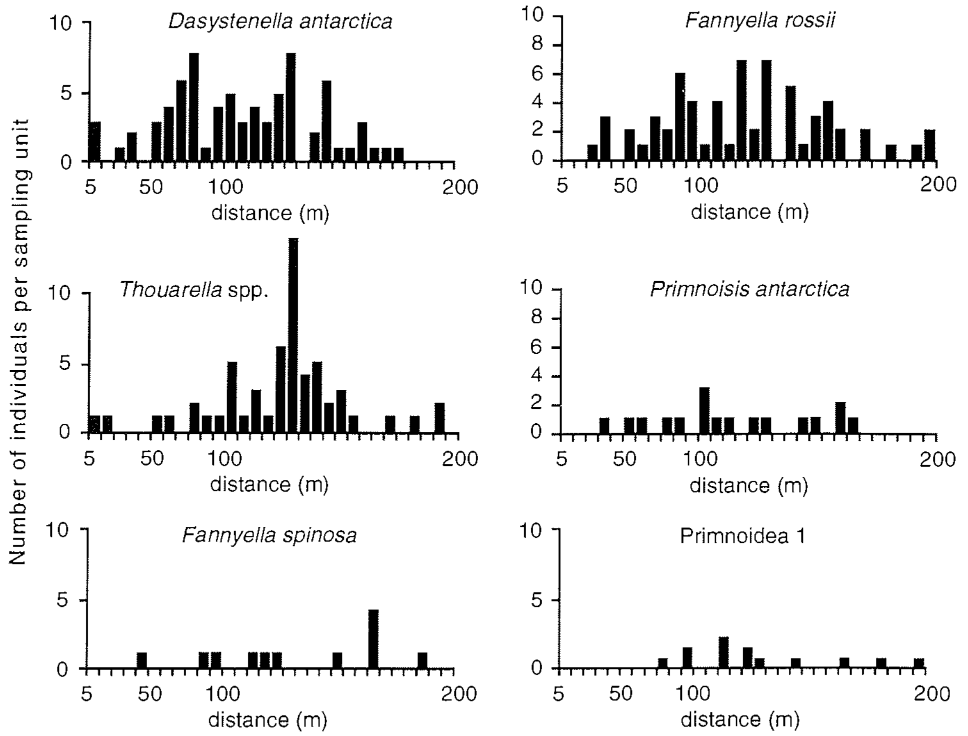


Fig. 15: Distribution of the gorgonian species along a ROV transect at Atka Bay (stn 281, 64 m depth).

2.2.2.2 Growth of Antarctic Octocorals

Objectives

To estimate the age of some benthic communities subjected to periodic disturbance, such as iceberg scouring in the Antarctic, and then to establish successional patterns of recovery from disturbances in these ecosystems, are two of the open questions in marine benthic ecology. One approach is to use structural parameters such as species diversity. But also absolute age measurements of the species themselves have to be taken into account. As some species of gorgonians (e.g. *Primnoisis antarctica*, *Ainigmaptilon* spp.) seem to be more frequent on recently disturbed bottoms, and others (e.g. *Fannyella* spp.) seem to be indicators of more mature successional stages, there is an interest in knowing whatever age markers can be confidently used. Other anthozoan species such as the encrusting stoloniferans probably grow faster than gorgonians. The study of their spatial pattern of polyp size and distribution at colony level provide an excellent material to understand their age and growth.

Work at sea

Three samples were taken with a TV Grab which covers an area of 1.82 m^2 (cf. also report 2.2.8). All colonies growing on the stones sampled were noted, and their polyps counted for further quantitative analysis. All colonies were checked to determine their sex by examinig the gonads (if present), under the light microscope. Selected colonies showing a well characteristic radiate growth from the settlement site of the planulae, which is the origin of the colony, were studied to determine radially the polyps size classes, distribution of the polyps in the colony, and the different reproductive effort among central, medial and distal polyps. The work protocol has been as follows:

Per stone:

- Measurement, identification and photography of the stone;
- Counting numbers of colonies;
- Counting polyp number per colony (and total number of polyps per stone).

Per identifiable colony (up to 20 per sample):

- Defining three colony areas (central, medial and distal) (Fig. 16);
- Pick 5 polyps per area and measure anthostele height, number and diameter of eggs or spermatic cysts; alternatively, identify sex;
- Measure distance between polyps in the three defined areas (5 counts).

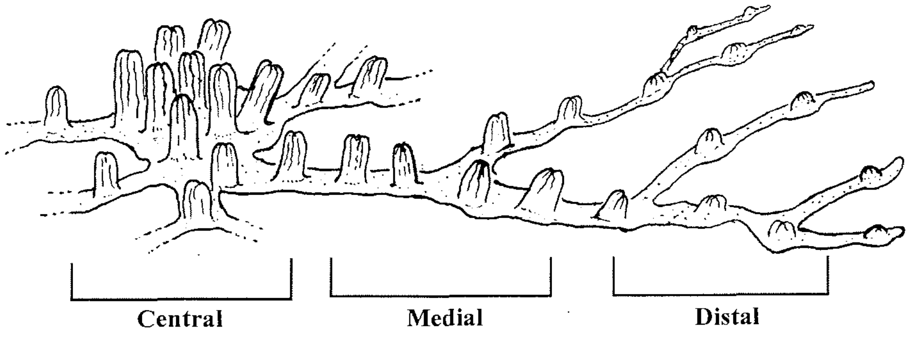


Fig. 16: Habitus of a colony of *Clavularia* cf. *frankliniana* with the three zones considered in this study.

Preliminary results

Examininig roughly one third of the preserved polyps, the mean number of colonies m^{-2} was found to be 30.8; the mean number of polyps colony^{-1} was 94.9, and the mean number of polyps m^{-2} 2920.9. The three considered areas differ in polyp height, number of eggs or spermatic cysts, and mean distance between polyps (Table 9 and Fig. 17) as well as in egg and cyst diameter (Fig. 17).

Table 9: Male and female reproductive data of *Clavularia* cf. *frankliniana*.

Polyp	Polyp size (mm)	male cyst number	male cyst diameter (mm)	Distance between polyps (mm)
Central 1	4.90	41	0.24	1.45
Central 2	4.48	12	0.27	0.90
Central 3	4.48	16	0.20	2.45
Central 4	3.84	15	0.28	1.00
Central 5	2.24	28	0.21	1.00
Medial 1	4.64	20	0.26	2.20
Medial 2	2.56	0		1.80
Medial 3	1.60	0		1.35
Medial 4	1.44	0		1.85
Medial 5	0.64	7	0.20	1.40
Distal 1	3.36	20	0.25	3.10
Distal 2	1.12	0		3.10
Distal 3	1.60	0		3.35
Distal 4	1.76	7	0.23	3.30
Distal 5	0.80	0		2.25

Polyp	Polyp size (mm)	male cyst number	male cyst diameter (mm)	Distance between polyps (mm)
Central 1	2.88	12	0.33	1.25
Central 2	3.04	7	0.38	0.80
Central 3	3.84	7	0.36	1.10
Central 4	3.36	8	0.26	0.55
Central 5	4.64	11	0.41	2.05
Medial 1	3.20	14	0.31	3.45
Medial 2	3.36	0		4.40
Medial 3	3.04	4	0.21	2.55
Medial 4	3.04	10	0.29	2.20
Medial 5	2.40	1	0.28	1.10
Distal 1	1.92	0		2.40
Distal 2	1.60	0		4.60
Distal 3	1.28	0		2.80
Distal 4	0.80	0		3.90
Distal 5	1.60	0		2.20

This suggests that the older polyps (central part of the colony) are more involved in reproduction whereas the distal ones are responsible for the greater part of colony elongation and growth. The growth and shape of the *Clavularia* colonies are directly influenced by the space available on the stones. Thus, on bigger stones with free surfaces typical radiate colonies were found. In these cases the oldest and youngest polyps are easily to distinguish. On the other hand, on smaller stones, circular stolons are produced at different levels, and they result in a membranose colony; moreover, young polyps may be generated in all parts of the colony, without any defined pattern.

Growth marks in Antarctic gorgonians. One of these markers could be growth marks of hard parts which would have to be surely matched to years or whatever other clear-cut period of growth (seasonal or other). The hard stems of gorgonians seem to be a good material to be studied in search of growth rings, and several stems from *Ainigmaptilon antarctica*, and *Primnoisis antarctica* species will be surveyed for these structures at home.

Growth pattern in *Clavularia* cf. *frankliniana*. *Clavularia frankliniana* Roule, 1902 is a common stoloniferous octocoral that lives in shallow Antarctic waters. This species forms stolonate or membranous encrusting colonies depending on the disponibility of space. It is a common species that grows on stones, tubes of polychaetes, and hydroids. *Clavularia frankliniana* can develop dense populations such as the ones described in Explorer's Cove (Ross Sea) with a mean number of 7.3±0.8 colonies and 1337.3±233.1 polyps m^{-2} (Slattery and McClintock 1995). The colonies have an extensive network of stolons and produce new polyps continuously throughout the austral spring-summer period (29.4±37.6 new polyps colony^{-1} month^{-1}; Slattery and McClintock 1997). In the laboratory, the stolon growth was estimated at 1.2±0.4 cm month^{-1}, which represents a colony life span of at least 4.5 years (Slattery and McClintock 1997).

The finding of a large number of specimens of the stoloniferan *Clavularia* cf. *frankliniana* during the ANT XV/3 cruise has provided an opportunity to study the distribution, colony features, reproduction and food of this species, in order to improve our knowledge of its growth patterns and the distribution of the reproductive effort as a function of the polyp's age.

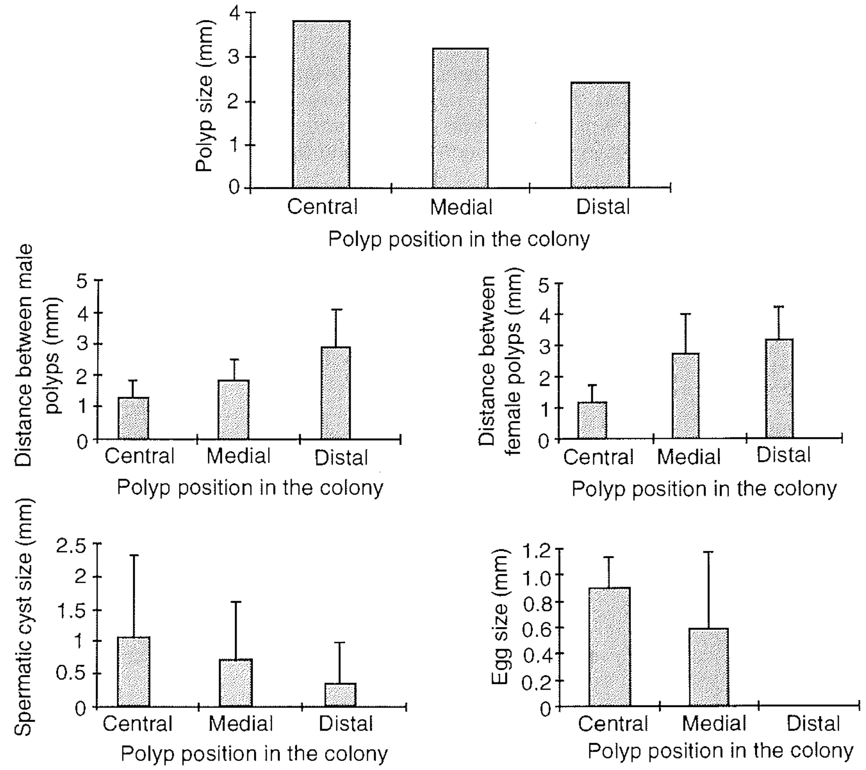


Fig. 17: *Clavularia* cf. *frankliniana*. Polyp size in the three zones considered (above), distance between polyps in the three zones considered and in male and female colonies (middle), and size of spermatic cysts and eggs (below).

2.2.2.3 Reproduction in Antarctic Octocorals

Introduction and objectives

Describing the reproductive biology of Antarctic gorgonians will allow the comparison of their reproductive effort with other geographical areas and to evaluate the reproductive strategies which will provide a better understanding of their life history traits. In this general framework, three main lines of work have been developed in this cruise.

- Firstly, a comparison of the potential reproductive effort was made in three different ramification patterns in gorgonians, and its distribution along the established morphotypes.
- Secondly, one gorgonian species, Ainigmaptilon antarcticus, was selected to evaluate its sexual reproductive strategy in different geographical areas in the Eastern Weddell Sea, and for a temporal comparison with the results from the previous cruise ANT XIII/3.
- Finally, Clavularia cf. frankliniana, which has a very different colonial growth form, was selected to compare the distribution of the reproductive effort along their stolonate colonies in relation to the age of their polyps.

Work at sea

Comparative study on ten gorgonian species. Colonies of ten gorgonian species were collected from GSN, AGT and TVG, and fixed in 4% formalin for their comparative study. These gorgonian species were selected and sorted according to three morphologic ramification patterns: unbranched (*Ainigmaptilon antarcticus*, *Primnoella* sp., and Primnoidae n. gen. 1), dichotomous (*Mopsea elongata, Fannyella rossii, F. spinosa*, and Primnoidae n. gen. 2), and "bottle brush" (*Tokoprimno* sp., *Thouarella* sp. 2, and *Dasystenella acanthina*). In each ramification type, 3 different portions were considered: the basal, medial, and distal parts (Fig. 18).

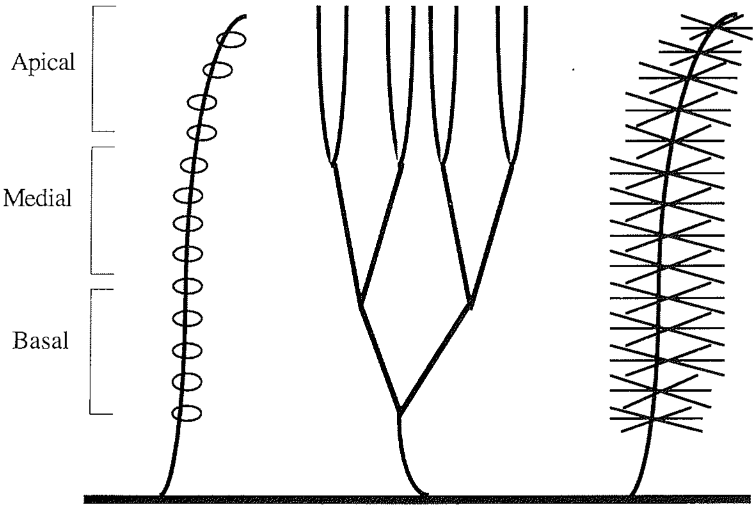


Fig. 18: The three morphotypes of gorgoniens considered in this study; from left: unbranched, dichotomous and "bottle brush".

Ainigmaptilon antarcticus. The reproductive study on *Ainigmaptilon antarcticus* has been done as part of a comprehensive study of this species comprising feeding, growth and morphological surveys. Among the colonies sampled, 10 complete and undamaged ones were selected at random. Each colony length was measured and two polyp leaves from its basal, medial and distal portions were removed for study (see Tables 10 - 12). Polyp and egg numbers per polyp leave were counted. The length and width of 60 polyps were measured as well as the diameter of 100 eggs. The same procedure was used to study 10 colonies of *Ainigmaptilon antarcticus* from a previous cruise (EASIZ I cruise, ANT XIII/3). The data obtained will be analyzed and integrated at home.

Clavularia cf. *frankliniana.* Colonies of this octocoral have been studied to know the sex ratio and the reproductive effort in different parts of their colonies: older (central), younger (distal) and intermediate (central) polyps. Polyps were dissected under the stereomicroscope, and the number and size of eggs or larvae were recorded for each polyp. To determine differences among the three morpho types in the female polyp's fecundity (number of gonads produced per polyp) as a function of the polyps position within the colony, 10 colonies of each species per sampling station were selected and measured. Additionally, a portion of the samples was fixed in glutaraldehyde for examination by electron microscopy. At least three different areas have been surveyed at least three times (at the beginning, in the middle, and at the end of the cruise). A minimum of 50 polyps from each of the basal, medial and apical zones of each colony have been analyzed.

Preliminary results

Comparative study on ten gorgonarian species. According to the three branching patterns studied, some preliminary results may be commented (Table 13). In all types, polyp size varied in the same way, the distal polyps being always the bigger ones in the colony. The number of eggs per polyp varied quite differently in the three morphotypes. In unbranched gorgonians the reproduction was mainly produced in the central and distal parts of the colony, whereas in dichotomous ones this process was located clearly at the distal fragment. Finally, in the "bottle brush" colonies the reproductive effort was evenly distributed along the colony length, with higher values at the basal and central portions of the colony. The maximum egg diameter varied from about 500 µm in unbranched and dichotomous colonies, to more than 1.5 mm in "bottle brush" colonies.

Comparing Antarctic gorgonians with the features and patterns of reproduction already described for other species from different geographical areas (e.g. Pacific, Caribbean, Mediterranean), some trends may be commented (Table 14).

The number of offspring per year is generally related to environmental characteristics and tends to be higher in temperate and climatically less stable regions than in the tropics. This places the Antarctic environments in an intermediate position between temperate and tropical areas, with a low number of eggs per polyp, and two clear seasonal periods. The latter tendency is common in other groups of invertebrates, and has been already reported (Arntz *et al.*, 1994).

Ainigmaptilon antarcticus. As a first approach to the reproductive biology of the species, it seems to be clear that the distal portion of the colony is the most actively growing zone whereas the eggs are bigger in the medial part of the colony and more abundant than in therest. The most important and consistent pattern that has been observed is that there seem to be two eggs cohorts, which would mean that this animal could have a continuous reproductive state.

Clavularia cf. *frankliniana.* Of the 64 examined colonies, 11 were male (with a mean polyp number of 149.1 polyps colony^{-1}), 29 female (115.0 polyps colony^{-1}), and 24 not developed (70.3 polyps colony^{-1}). The sex ratio found was 1:2.5. The reproductive effort in the different parts of the colony is shown in Table 9.

Table 10: Polyp and egg size in one basal polyp-leaf of *Ainigmaptilon antarcticus*.

Stn: 049 Colony fragment: basal Colony length: 41 cm Leaf: 2 Polyp number: 105 Egg number: 478

Polyp	Length (mm)	Width (mm)	Polyp	Length (mm)	Width (mm)
1	1.411	0.747	31	1.577	0.830
2	1.577	0.830	32	1.328	0.747
3	1.328	0.747	33	1.328	0.664
4	1.411	0.664	34	1.411	0.664
5	1.328	0.747	35	1.577	0.830
6	1.328	0.664	36	1.245	0.581
7	1.328	0.664	37	1.577	0.830
8	1.660	0.913	38	1.245	0.664
9	1.245	0.664	39	1.245	0.664
10	1.245	0.581	40	1.660	0.830
11	1.826	0.830	41	1.494	0.830
12	1.494	0.747	42	1.328	0.747
13	1.577	0.830	43	1.494	0.830
14	1.660	0.747	44	1.577	0.830
15	1.411	0.747	45	1.660	0.830
16	1.494	0.747	46	1.660	0.830
17	1.660	0.747	47	1.245	0.664
18	1.660	0.830	48	1.162	0.581
19	1.411	0.747	49	1.411	0.747
20	1.245	0.664	50	1.494	0.747
21	1.660	0.830	51	1.494	0.747
22	1.577	0.747	52	1.411	0.664
23	1.577	0.830	53	1.577	0.747
24	0.830	0.830	54	1.411	0.664
25	1.494	0.747	55	1.411	0.747
26	1.577	0.830	56	1.660	0.830
27	1.660	0.747	57	1.411	0.664
28	1.328	0.747	58	1.328	0.581
29	1.494	0.747	59	1.660	0.830
30	1.328	0.664	60	1.660	0.747

Egg	diameter (mm)	Egg	diameter (mm)	Egg	diameter (mm)
1	0.332	34	0.249	67	0.415
2	0.332	35	0.249	68	0.249
3	0.249	36	0.166	69	0.166
4	0.166	37	0.166	70	0.166
5	0.166	38	0.166	71	0.166
6	0.166	39	0.166	72	0.249
7	0.249	40	0.166	73	0.166
8	0.415	41	0.166	74	0.249
9	0.249	42	0.166	75	0.415
10	0.249	43	0.249	76	0.166
11	0.166	44	0.083	77	0.415
12	0.249	45	0.249	78	0.332
13	0.166	46	0.166	79	0.498
14	0.166	47	0.166	80	0.249
15	0.249	48	0.083	81	0.166
16	0.166	49	0.249	82	0.166
17	0.249	50	0.166	83	0.249
18	0.332	51	0.249	84	0.249
19	0.249	52	0.166	85	0.332
20	0.332	53	0.249	86	0.249
21	0.249	54	0.166	87	0.332
22	0.249	55	0.166	88	0.332
23	0.166	56	0.166	89	0.166
24	0.166	57	0.249	90	0.415
25	0.166	58	0.166	91	0.166
26	0.415	59	0.166	92	0.166
27	0.415	60	0.166	93	0.249
28	0.332	61	0.166	94	0.166
29	0.249	62	0.249	95	0.166
30	0.332	63	0.249	96	0.166
31	0.249	64	0.249	97	0.249
32	0.166	65	0.166	98	0.166
33	0.249	66	0.249	99	0.166
				100	0.166

Table 11: Polyp and egg size in one medial polyp-leaf of *Ainigmaptilon antarticus*.

Stn: 049 Colony fragment: midle Colony length: 41 cm Leaf: 2 Polyp number: 182 Egg number: 793

Polyp	Length (mm)	Width (mm)	Polyp	Length (mm)	Width (mm)
1	0.747	0.415	31	1.826	0.996
2	1.328	0.664	32	1.494	0.747
3	1.660	0.747	33	1.577	0.830
4	1.494	0.747	34	1.411	0.747
5	1.660	0.747	35	1.577	0.830
6	1.494	0.830	36	1.577	0.830
7	1.494	0.830	37	1.577	0.747
8	1.577	0.830	38	1.411	0.747
9	1.660	0.830	39	1.328	0.747
10	1.245	0.664	40	1.328	0.747
11	1.494	0.747	41	1.411	0.747
12	1.660	0.830	42	1.411	0.830
13	1.162	0.581	43	1.411	0.747
14	1.743	0.830	44	1.411	0.747
15	1.660	0.830	45	1.494	0.830
16	1.494	0.830	46	1.577	0.830
17	1.411	0.830	47	1.577	0.830
18	1.328	0.747	48	1.494	0.913
19	1.577	0.747	49	1.245	0.664
20	1.660	0.913	50	1.577	0.913
21	1.494	0.830	51	1.328	0.747
22	1.494	0.747	52	1.411	0.747
23	1.494	0.747	53	1.660	0.830
24	1.328	0.747	54	1.660	0.830
25	1.411	0.747	55	0.830	0.581
26	1.494	0.747	56	1.411	0.747
27	1.411	0.830	57	1.411	0.913
28	1.577	0.830	58	1.494	0.830
29	1.494	0.747	59	1.494	0.913
30	1.245	0.747	60	1.162	0.747

Egg	diameter (mm)	Egg	diameter (mm)	Egg	diameter (mm)
1	0.498	34	0.498	67	0.664
2	0.415	35	0.415	68	0.664
3	0.415	36	0.249	69	0.664
4	0.581	37	0.249	70	0.498
5	0.332	38	0.249	71	0.415
6	0.249	39	0.249	72	0.415
7	0.332	40	0.166	73	0.249
8	0.498	41	0.332	74	0.332
9	0.415	42	0.166	75	0.332
10	0.498	43	0.166	76	0.249
11	0.332	44	0.415	77	0.166
12	0.249	45	0.332	78	0.249
13	0.166	46	0.249	79	0.332
14	0.332	47	0.664	80	0.498
15	0.166	48	0.498	81	0.249
16	0.249	49	0.166	82	0.498
17	0.332	50	0.166	83	0.332
18	0.166	51	0.249	84	0.166
19	0.166	52	0.664	85	0.166
20	0.249	53	0.664	86	0.249
21	0.166	54	0.664	87	0.415
22	0.249	55	0.498	88	0.249
23	0.249	56	0.498	89	0.249
24	0.664	57	0.249	90	0.664
25	0.747	58	0.249	91	0.664
26	0.415	59	0.249	92	0.747
27	0.249	60	0.581	93	0.332
28	0.415	61	0.498	94	0.498
29	0.664	62	0.332	95	0.249
30	0.498	63	0.166	96	0.332
31	0.249	64	0.249	97	0.249
32	0.249	65	0.332	98	0.498
33	0.332	66	0.415	99	0.415
				100	0.332

Table 12: Polyp and egg size in one apical polyp-leaf of *Ainigmaptilon antarticus*.

Stn: 049 Colony fragment: apical Colony length: 41 cm Leaf: 1 Polyp number: 75 Egg number: 242

Polyp	Length (mm)	Width (mm)	Polyp	Length (mm)	Width (mm)
1	1.660	0.830	31	1.660	0.747
2	1.660	0.830	32	1.660	0.830
3	1.494	0.747	33	1.743	0.747
4	1.494	0.747	34	1.660	0.747
5	1.411	0.747	35	1.660	0.830
6	1.494	0.747	36	1.660	0.830
7	1.328	0.747	37	1.494	0.830
8	1.411	0.747	38	1.328	0.747
9	1.494	0.747	39	1.494	0.747
10	1.328	0.664	40	1.494	0.830
11	1.494	0.747	41	0.747	0.581
12	0.830	0.581	42	1.494	0.830
13	1.328	0.830	43	1.743	0.747
14	1.245	0.664	44	1.494	0.830
15	1.411	0.830	45	1.660	0.664
16	1.660	0.830	46	1.660	0.747
17	1.743	0.830	47	1.328	0.830
18	1.660	0.747	48	1.328	0.747
19	1.577	0.747	49	1.494	0.747
20	1.494	0.747	50	1.245	0.581
21	1.577	0.747	51	1.494	0.747
22	1.494	0.747	52	1.245	0.664
23	1.577	0.747	53	1.411	0.747
24	1.245	0.747	54	1.411	0.747
25	1.577	0.747	55	1.411	0.747
26	1.660	0.747	56	0.747	0.415
27	0.913	0.664	57	1.162	0.581
28	1.660	0.830	58	1.660	0.830
29	1.660	0.830	59	1.494	0.747
30	1.660	0.830	60	1.743	0.913

Egg	diameter (mm)	Egg	diameter (mm)	Egg	diameter (mm)
1	0.332	34	0.166	67	0.249
2	0.166	35	0.166	68	0.166
3	0.332	36	0.249	69	0.332
4	0.249	37	0.166	70	0.581
5	0.415	38	0.415	71	0.415
6	0.415	39	0.498	72	0.415
7	0.498	40	0.415	73	0.332
8	0.747	41	0.332	74	0.249
9	0.498	42	0.664	75	0.332
10	0.498	43	0.415	76	0.332
11	0.498	44	0.332	77	0.498
12	0.664	45	0.664	78	0.415
13	0.332	46	0.830	79	0.332
14	0.332	47	0.747	80	0.249
15	0.415	48	0.747	81	0.249
16	0.415	49	0.415	82	0.166
17	0.249	50	0.249	83	0.166
18	0.332	51	0.249	84	0.166
19	0.166	52	0.581	85	0.249
20	0.249	53	0.249	86	0.332
21	0.249	54	0.249	87	0.664
22	0.581	55	0.332	88	0.332
23	0.747	56	0.249	89	0.747
24	0.664	57	0.415	90	0.249
25	0.581	58	0.332	91	0.332
26	0.166	59	0.332	92	0.332
27	0.332	60	0.332	93	0.415
28	0.664	61	0.249	94	0.581
29	0.498	62	0.332	95	0.332
30	0.415	63	0.249	96	0.249
31	0.332	64	0.166	97	0.249
32	0.332	65	0.415	98	0.332
33	0.332	66	0.249	99	0.332
				100	0.166

Table 13: Comparison of some parameters related with reproduction in three Antarctic gorgonian morphotypes.

		Unbranched	Dichotomous	”Bottle brush”
	apial	1.52	1.77	3.00
Polyp size (mm)	medial	1.48	1.52	1.60
	basal	1.30	1.04	1.60
	apial	2.47	1.20	1.66
Eggs polyp^{-1}	medial	3.10	0.46	2.66
	basal	0.19	0.08	2.66
	apial	400	410	1530
Egg diameter (μm)	medial	520	510	830
	basal	250	350	940

Table 14: Comparison of some reproduction data in different gorgonian species (from Coma *et al.*, 1995).

Species	Mode of reproduction	Fertilization	Max. oocyte diameter (μm)	No. of eggs per mature polyp	Geographic area
Corallium rubrum	Internal	Internal	300-330	3-6	Mediterranean
Eunicella singularis	Internal	Internal	-	4	Mediterranean
Paramuricea clavata	Surface brooding	Internal	400-500	13	Mediterranean
Muricea californica	Internal	Internal	700	1.6	NE Pacific
Muricea fruticosa	Internal	Internal	600	3.8	NE Pacific
Plexaura homomala	External	Internal	315-640	2	Caribbean
Plexaura A	External	Internal	500-600	1.9	E Pacific
Pseupterogorgia bipinnata	External	External	-	7	Caribbean
P. elisabethae	Unknown	-	-	7	Caribbean
Briareum asbestinum	Surface brooding	Internal	600-900	2.3	Caribbean
Ainigmaptilon antarcticus	?	?	740	3.4	E Weddell Sea
Primnoidae n. gen. 2	Internal	Internal	1700	1.5	E Weddell Sea
Dasystenella acanthina	Internal	Internal	1670	1.1	E Weddell Sea

According to these provisional data, the oldest polyps were most involved in the reproduction of the colony, followed by the medial ones, while distal polyps did not participate in reproduction (female colonies) or had a low contribution (male colonies).

Additional observations about the reproduction of *C. frankliniana* concerned the late stages in which larvae remain in the polyp cavity. In some female polyps several larvae ready to be released from the polyp were found together with oocytes in early stages of development. This fact suggests a long reproductive period, perhaps from early spring to late austral summer.

2.2.2.4 Defensive Strategies in Antarctic Octocorals

Objectives

Mechanical defenses like a high amount of calcareous sclerites are common in octocorals. However, recent publications have shown the importance of various secondary metabolites as defensive agents against predation and fouling (Paul 1992). The selective pressures in old and extreme ecosystems like Antarctica are consistent with those required for the evolution of chemical defenses in a wide range of phyla (e.g. McClintock and Baker 1997).

Some rare octocorals show extremely low concentration of sclerites, and sometimes they are completely absent. In these cases fleshy structures are surprisingly exposed to the environment and to predators, epibionts, etc. Among the octocoral species identified during the ANT XV/3 cruise, three to this description; moreover, an abundant mucose secretion was present during the manipulation of the specimens. The possible presence of bioactive secondary metabolites in this mucus which might contain defensive chemicals will be checked. For comparative purposes, other well spiculated octocorals will be also investigated to check for the presence of bioactive molecules and to test the scope of their possible deterrent activity (feeding deterrence, toxicity, antifouling activity, etc.).

Table 15: Cnidarian samples for further analysis.
id = idem, SM = secondary metabolite analysis, a = apial, m = medial, b = basal.

Date	Station	Sample No.	Freezing (no. of specimens)	Glutaral-dehyde	Stoichiometry	Freezing SM
28-01	027	52	*Primnoisis antarctica* (1)	id (?)		
			hydrozoan sp. (2)	id (?)		
30-01	044				*Ainigmaptilon antarcticus* (1)	
30-01	050	58	*Ainigmaptilon antarcticus* (2)	id	id	
			Primnoisis antarctica (1)	id	id	
			Thouarella sp. 2 (2)	id	id	
			hydrozoan sp. (1)	id	id	
31-01	063	84	*Thouarella* sp. 3 (2)	id	id	
			Fanniella spinosa (1)	id (2)	id	
			hydrozoan sp. (1)	id (2)	id	
02-02	077	119	*Amphilaphis grandiflora* (1)	id	id	
			Rosgorgia australis (1)	id	id	
			Selaginopsis vanhoeffeni (1)	id	id (3)	
03-02	078	137	*Rosgorgia australis* (1)	id	id	
04-02	088					*Umbellula magniflora* (2)
05-02	095					*Umbellula magniflora* (1)
07-02	117					*Umbellula magniflora* (5)
07-02	120					*Umbellula magniflora* (1)
08-02	129	218	*Billardia subrufa* (1)	id	id	
11-02	150	222	*Umbellula lindahli* (2)	id	id (2) (122)	*Umbellula lindahli* (2)
11-02	154					*Umbellula lindahli* (2)
12-02	168	252	*Ainigmaptilon antarcticus* (2)	id	id (1)	*Umbellula lindahli* (2)
15-02	189					*Umbellula lindahli* (1) *Ainigmaptilon antarcticus* (5)
16-02	194					*Ainigmaptilon antarcticus* (26)
16-02	197	282	*Fanniella rossii* (1)	id	id	
			Fanniella rossii (2)	id	id	
			Fanniella rossii (3)	id	id	
		283	*Fanniella espinosa* (4)	id	id	
			Fanniella espinosa (5)	id	id	
			Fanniella espinosa (6)	id	id	
19-02	222	314	*Ainigmaptilon antarcticus* (1)	id	id (a,m,b)	*Thouarella* sp. 3 (3) *Fannyella rossii* (30) *Fannyella spinosa* (45) *Dasystenella acanthina* (15)
			Ainigmaptilon antarcticus (2)	id	id (a,m)	
			Ainigmaptilon antarcticus (3)	id	id (a,m,b)	
27-02	276	276 (318)	*Primnoisis antarctica*	id		id
			Fanniella spinosa	id	id	*Ainigmaptilon antarcticus*
			Schizotricha glacialis (1)	id		*Primnoisis antarctica* (14)
			Schizotricha glacialis (2)	id		

Work at sea

Selected octocoral colonies according with the above commented criteria were frozen at -27 °C. A first group includes mucus-secretor octocorals (*Ainigmaptilon antarcticus*, *Umbellula magniflora*, and *U. lindahli*), in which mucus obtained by decantation and whole specimens were separately preserved. A second group of colonies were frozen for comparative purposes (*Fannyella rossii*, *F. spinosa*, *Dasystenella acanthina*, and *Primnoisis antarctica*). In Table 15 a complete list is given of the species, number of colonies preserved, and stations where they were collected. The sample analyses will be carried out at the University of Cádiz and at the AWI in Bremerhaven.

2.2.3 Role of the "Fine Seston Fraction" in the Cnidarian Feeding Ecology: Experiments with Natural Diet

Objectives and methodology

Studies with natural and artificially-added prey items have shown that cnidarians, especially gorgonians, are able to ingest particulate matter, and theoretical studies have also shown mechanisms for small particle capture in suspension feeders (e.g. Shimeta and Jumars 1991). However, most feeding studies involve mainly the examination of gut contents, as was done during the first EASIZ cruise ("Polarstern" ANT XIII/3). This method is useful in the study of large prey items (usually over 50 µm), but it can underestimate the numbers of small, soft-bodied prey because they leave no recognizable remains. Planktonic communities are dominated by nanoplankton (<20 µm) and picoplankton (<2 µm); most of their components would not be recognizable after having been ingested. Within these groups are the main contributors to marine productivity and biomass, such as small phytoplankton and microbial organisms. Despite this, little is known about the role of these organisms in the diets of benthic suspension feeders (but see for example Ribes 1998). The principal objective was the study of the natural diets of several benthic cnidarians focused on three main questions:

- What planktonic taxa do gorgonians and hydroids feed on?
- What is the capture rate on these taxa?
- What is the role of benthic suspension feeders which capture small particles in the Antarctic microbial food web?

A modified prototype incubator developed by the ICM (Barcelona) has been employed to study the diets of benthic suspension feeders. The incubator consists of a chamber in which the colony is placed, and an empty chamber that does not house any colony (blank). In order to refill the chambers and associated container (60 l), water was collected as close to the bottom as possible by means of a rosette of oceanographic bottles. Specimens for these experiments had to be in the best possible condition for survival on board the ship, so they had to be collected by means of TV Grab, and occasionally by Agassiz trawl. The chambers and all necessary material and instrumentation were installed in a cool room container equipped for operation at Southern Ocean ambient temperature. Water samples were filtered and the filtrate stored in liquid nitrogen or frozen at -30°C. Capture rates are to be calculated as decreasing concentration levels for bacteria, flagellates, ciliates, and phytoplankton in the water samples.

Work at sea

Predation on the fine fraction (picoplankton to microplankton) will be assessed using continuous flow incubation chambers placed on cool container following the methodology developed by Ribes (1998). The potential prey items in this fraction included: heterotrophic bacteria, eukaryotic picoplankton, ciliates, and phytoplankton (diatoms and dinoflagellates).

The incubation chambers (one with organism and one control) were made from cilindric pieces of UV-transparent plexiglass approximately 5 l in volume. Each closed chamber was connected to a pump that recirculated sea water through it at a speed of 3.3 l min^{-1} (this flow becomes turbulent inside the chambers). Predation will be calculated from decrease in prey concentration in the cnidaria chamber relative to the control chamber. Colonies were kept in the cool container with not filtered water until used in incubation experiments. At the beginning of each experiment, a colony was placed on the organism chamber. Colonies were allowed to expand fully before the experiment started. After this acclimation time, both incubation chambers were closed and water samples of 2000 ml (initial water samples) were collected from both chambers. After 6 hours for four experiments and 8 hours for two of each species, water samples were collected again (final water samples).

To quantify heterotrophic bacteria 2 ml water samples were preserved for flow cytometry by standard protocols and stored in liquid nitrogen and after that at -120°C. The samples are then unfrozen, stained with SYTO13 (Molecular Probes) at 1.6 µM (diluted in DMS), let 15 minuts to stain in the dark and run through a flow cytometer. Samples will be analyzed using a bench machine FACScalibur of Becton and Dickinson with a laser emitting at 488 nm. Samples are run at Low speed (approx. 12 µl min-1) and data are adquired in log mode until around 10000 events have been adquired. Bacteria are detected by their signature in a plot of Side scatter (SSC) vs. FL1 (green fluorescence). The settings are adapted for each sample as the populations and their fluorescence may change a lot from sample to sample; Settings that works for us are: FSC: E02, SSC: 400, FL1: 511, FL2: 475, FL3: 590, Threshold at FL1-H: 72). The quantification of pico plankton will be made under epifluorescence microscopy, the sizes of each picoplankton groups will be determined also under epifluorescence microscopy by measuring between 200 and 400 cells of each group.

To quantify phytoplankton and ciliates, 350 ml water samples were preserved with acid Lugol (10% final concentration). Subsamples of 100 ml will be allowed to settle and observed with an inverted microscope using the Utermöhl technique. Dominant groups of diatoms and dinoflagellates will be quantified in this study. A color CCD video camera connected to a VCR will be attached to the microscope to record images of the organisms for measurement. The video images will be digitized and measurements will be made using the image analysis program NIH image. From each subsample, the diameters of 20 individuals of the most common diatom and dinoflagellate groups will be measured and the volumes will be estimated from their ellipsoidal or cylindrical shape.

Depletion rates of the fine fraction will be calculated from the equations based on the computation of the grazing coefficient g (time^{-1}):

$$g = kc - kg$$

$$k = \ln (C1 / C0) / (t1 - t0),$$

k (time^{-1}) is the estimated prey growth rate computed for the control chamber (k_c) and for the gorgonian chamber (k_g). C_0 and C_1 are the prey concentrations in the chamber at the initial time t_0 and at the final time t_1.The clearance rate F (volume swept clear colony^{-1} time^{-1}) is computed:

$$F = V\, g / n$$

where V is the volume of the chamber and n the number of individuals (colonies or polyps). Finally, the ingestion rate I (prey ingested individual^{-1} time^{-1}) is:

$$I = F\, C$$

where C is the average prey concentration during the experiment, to be calculated as follows:

$$C = (C_0 [\exp \{(k\text{-}g)(t_1\text{-}t_0)\} - 1])/\{(k\text{-}g)(t_1\text{-}t_0)\}$$

Predation on each kind of prey will be tested for the hypothesis that k_c is higher than k_g. Then, the null hypothesis is H_0: $k_c = k_g$ and the alternative hypothesis H_1: $k_c > k_g$. This design tests the significance of the differences through a one-tailed Wilcoxon test.

The feeding response (i.e. the changes in ingestion rate as a function of changes in food concentration) will be described by means of a hyperbolic function. Ingestion rate and food concentration will be expressed in prey biovolume per hour and per liter respectively, in order to standardize the data for all prey items. The equation will be fitted using log-transformed ingestion rates to reduce variance at high food concentrations.

Carbon and nitrogen contents of prey items will be estimated using literature conversion factors. For phytoplankton, volume will be converted to carbon and nitrogen weight using the equations:

$\text{pg C cell}^{-1} = 0.109 \times [\text{biovolume } (\text{mm}^3)^{0.991}]$ and,
$\text{pg N cell}^{-1} = 0.0172 \times [\text{biovolume } (\text{mm}^3)^{1.029}]$
For ciliates, volume will be converted to carbon weight using the equation:
$\text{pg C cell}^{-1} = 0.19 \times \text{biovolume } (\text{mm}^3)$,
and volume will be converted to nitrogen weight using the equation:
$\text{pg N cell}^{-1} = 0.026 \times \text{biovolume } (\text{mm}^3)$.

Preliminary results

A total of 24 incubation experiments were carried out on different days. The cnidarians used for the feeding experiments are three species of gorgonians: *Primnoisis mimas, P. antarctica, Primnoella sp.*, and one hydroid, *Oswaldella antarctica.* The analysis of all water samples obtained in the experiments wil be done at home.

2.2.4 Prey Capture in One Species of Hydrozoa and of Stolonifera

Objectives

Hydroids are generally assumed to be carnivores that capture zooplankton prey by means of the nematocysts on their tentacles. Examination of the enteron contents shows that the diet of hydroids is typically dominated by small zooplankters although they show a wide spectrum of food, from very small prey (such as bacteria and diatoms) to adult copepods and other planktonic organisms (Gili and Hughes 1995). Contrary to what was expected, the major part of the guts of several species of hydroids examined during the ANT XIII/3 EASIZ I cruise appeared almost empty. This could be due to the fact that only species with very small polyps, such as Plumularians, were studied during that cruise. During the ANT XV/3 cruise, *Tubularia ralphii* Bale, 1884, was collected at the shallow stations off Four Season Inlet, where this species, together with *Oswaldella antarctica* (Jäderholm 1905), was the dominant species growing on small stones. *T. ralphii* is a common Antarctic species, mainly distributed in shallow areas where it can attain densities of over 2300 polyps m^{-2} (Stepanjants 1979; Haswell Archipelago, Davis Sea). The objective of this part of the ANT XV/3 cruise was to determine the prey type and number of *T. ralphii* based on their natural diet and the study of the gut contents. Our purpose was to get a first approach to the predatory impact of a benthic hydroid in the Antarctic, where a peculiar feeding behaviour was reported in the hydroid *Silicularia rosea* Meyen, 1834, which mainly ingests benthic diatoms.

Anthozoans are another group of benthic cnidarians for which the capture has been demonstrated of a wide spectrum of prey, ranging from dissolved organic matter to other benthic organisms. Like in hydroids, very little information is available about anthozoan feeding in Antarctic communities, and the polyps of species belonging to this group were also observed empty during the first EASIZ cruise. One of the more common species collected in shallow areas during the second EASIZ cruise was the stoloniferan *Clavularia frankliniana.* This species forms encrusting colonies covering, in some cases, a great part of the stones studied for *Tubularia ralphii. C. frankliniana* is a common Antarctic species and has a fast growth, which may be similar to the growth rate of hydroids. Simultaneously with the hydroid species, the gut contents of the stoloniferan polyps were analyzed in order to get the first data on the natural diet of one Antarctic anthozoan species.

Work at sea

The samples (two) were taken with a TV Grab which covers an area of 1.82 m^{-2}. Of the total of 413 hydrocladia of *Tubularia ralphii* growing on stones, 147 brought polyps, and were dissected under the microscope on board. All preys in the enteron were counted, determined to taxa level (mainly copepods, both adults and juveniles) and measured. Prey biomass wet weight was estimated using the relationship betwen length and biomass of Mediterranean copepods (Coma *et al.* 1994) to get a preliminary account. Three samples of copepods collected during the ANT XV/3 cruise have been frozen in order to calculate the dry weight based on Weddell Sea zooplankton and improve the data calculation. Dry weight was converted to carbon weight using the general ratio for zooplankton C:DW = 0.4-0.5. Gut contents were extrapolated to daily rates of intake by assuming a digestion time of 6 hours (Gili and Hughes 1995).

Prey capture rates, expressed as the number of prey items captured per polyp and day, were calculated using the equation:

$$N = \sum_{t=0}^{D} C - [(C * t)/D] \qquad \text{or} \qquad C = N\,[\sum_{t=0}^{D} 1-(t/D)]^{-1}$$

C = no. of prey captured $polyp^{-1}$ h^{-1}; N = prey items $polyp^{-1}$; t = time (h); and D = digestion time (h).

This means that, for example, a feeding rate of 100 items per hour would result in 300 items being seen in the enteron; 100 recently eaten, 80 still visible after one hour digestion, 60 visible after two hours digestion, 40 after 3h, 20 after 4h, and none after 5h in a species with 5 h of digestion of its prey. This is a somewhat inaccurate method, since the digestion time would depend on the size of the particles and their resistance to digestion, but in *T. ralphii* the 90% of prey items belongs to one group, Copepods, and this is the most appropiate way such a calculation could be made.

The first feeding approach for the stoloniferan *Clavularia frankliniana* was done by analyzing the gut contents of 50 polyps of two different colonies and stones.

Preliminary results

In *Tubularia ralphii* 90% of the prey items were copepod adults and juveniles (see Table 16). Other prey items observed were copepod eggs and remains of organic matter which we could not identify. 70% of the dissected polyps contained prey. The relationship between polyp size and number of prey captured per polyp shows a significant correlation, but not with prey size (Fig. 19). This means that big polyps can capture a wide range of prey, including small ones, while small polyps capture less prey and always smaller. This species shows a more opportunistic feeding behaviour than that observed in a congeneric species, *Tubularia larynx*, from the North Atlantic, in which the big polyps capture mainly big prey items.

The estimated mean prey number per polyp is 4.2 (with a maximum of 32 preys in a single polyp). This means 15.78 prey items per polyp and day (2.17 µg $polyp^{-1}$ day^{-1}). Considering a density of 113.46 polyps m^{-2}, the total predatory impact of *Tubularia ralphii* could be estimated at 1791.49 prey items m^{-2} day^{-1} (247.1 µg $polyp^{-1}$ day^{-1}). In Table 17 the general information about the prey capture and predatory impact calculated for different species of hydroids following the same methodology as that for *T. ralphii* is shown. Even though the biomass transformation of the prey capture must be considered with caution until the size/biomass ratio of Antarctic copepods will be available, the predatory impact of *T. ralphii* is obviously not different from that observed for other species from temperate waters. We can hypothesize that during summer, the Antarctic colonies of *T. ralphii* can develop dense colonies which probably remain in the form of stolons during winter (such as has also been observed in other hydroid species in temperate and warm waters, Gili and Hughes 1995), or else the species can change its diet. Both hypotheses need much information on what happens with the shallow Antarctic

Table 16: Number, size and type of prey items observed in 147 polyps of *Tubularia ralphii* collected during February 1998 in Four Seasons Inlet (Weddell Sea, Antarctica).

Polyp	Polyp size (µm)	Number of prey items	Mean prey size (µm)	Type of prey
1	2240	14	420	Copepoda
2	1920	8	420	Copepoda
3	1280	2	600	Copepoda, organic matter
4	1280	0	-	-
5	1120	1	600	organic matter
6	800	0	-	-
7	960	0	-	-
8	960	2	480	Copepoda
9	1120	0	-	-
10	1600	4	420	Copepoda, organic matter
11	2240	6	600	Copepoda
12	1280	2	600	Copepoda, organic matter
13	2300	10	480	-
14	500	0	-	-
15	1200	3	480	Copepoda
16	1600	3	610	Copepoda, organic matter
17	1400	0	-	-
18	2720	9	720	Copepoda, organic matter
19	1280	1	600	Copepoda
20	1920	5	720	Copepoda
21	800	14	360	Copepoda, invertebrate eggs
22	960	7	480	Copepoda
23	2400	8	600	Copepoda
24	1600	0	-	-
25	2240	12	420	Copepoda
26	1120	0	-	-
27	2240	12	630	Copepoda
28	1280	4	570	Copepoda
29	1920	10	480	Copepoda
30	1920	6	420	Copepoda
31	1600	3	840	Copepoda, organic matter
32	2240	18	540	Copepoda
33	2880	16	720	Copepoda
34	1920	8	690	Copepoda
35	1280	0	-	-
36	2400	8	840	Copepoda
37	1760	9	840	Copepoda
38	2080	0	-	-
39	2240	7	660	Copepoda
40	1920	8	480	Copepoda, organic matter
41	2240	11	480	Copepoda, invertebrate egg
42	1280	2	720	Copepoda
43	2240	9	480	Copepoda, organic matter
44	2080	5	480	Copepoda
45	1280	2	420	Copepoda
46	1920	4	450	Copepoda, organic matter
47	2240	5	360	Copepoda
48	1920	0	-	-
49	1280	5	420	Copepoda, organic matter

Table 16 continued.

Polyp	Polyp size (µm)	Number of prey items	Mean prey size (µm)	Type of prey
50	1120	2	270	Copepoda, organic matter
51	1120	2	420	Copepoda
52	1120	0	-	-
53	1440	4	480	Copepoda, organic matter
54	1920	3	960	Copepoda, organic matter
55	1440	0	-	-
56	1280	3	480	Copepoda
57	2240	5	480	Copepoda
58	1280	1	660	Copepoda
59	1120	0	-	-
60	2400	7	660	Copepoda
61	1920	7	720	Copepoda
62	1440	3	720	Copepoda, organic matter
63	1800	5	456	Copepoda
64	2300	32	72	Copepoda, invertebrate egg
65	1800	1	180	Copepoda
66	2400	8	60	Invertebrate egg
67	2400	11	360	Copepoda, invertebrate egg organic matter
68	1500	7	120	Copepoda, organic matter
69	3100	12	540	Copepoda
70	2200	24	420	Copepoda
71	1300	0	-	-
72	1900	0	-	-
73	2200	10	480	Copepoda, invertebrate egg
74	1400	0	-	-
75	2200	11	420	Copepoda, invertebrate egg
76	1600	4	510	Copepoda, organic matter
77	2400	8	480	Copepoda
78	2200	0	-	-
79	1400	0	-	-
80	1400	2	440	Copepoda
81	1280	0	-	-
82	1280	8	480	Copepoda
83	1280	0	-	-
84	1280	6	480	Copepoda, organic matter
85	12	5	480	Copepoda, organic matter
86	1400	0	-	-
87	500	1	240	organic matter
88	1400	8	360	Copepoda
89	1600	0	-	-
90	1280	2	400	Copepoda, organic matter
91	1280	0	-	-
92	500	0	-	-
93	960	2	480	Copepoda
94	1920	5	420	Copepoda, organic matter
95	960	0	-	-
96	960	0	-	-
97	2240	6	420	Copepoda
98	2400	8	480	Copepoda

Table 16 continued.

Polyp	Polyp size (µm)	Number of prey items	Mean prey size (µm)	Type of prey
99	960	0	-	-
100	1120	2	570	Copepoda
101	960	0	-	-
102	1120	0	-	-
103	1600	4	450	Copepoda
104	1920	4	600	Copepoda
105	960	0	-	-
106	960	1	660	organic matter
107	1120	0	-	-
108	1120	3	420	Copepoda
109	1120	1	480	Copepoda
110	1920	5	720	Copepoda, organic matter
111	960	0	-	-
112	2560	12	600	Copepoda
113	2240	2	600	Copepoda
114	1600	0	-	-
115	1920	0	-	-
116	2080	6	450	Copepoda
117	1280	0	-	-
118	1120	2	660	Copepoda, organic matter
119	1280	0	-	-
120	800	1	480	organic matter
121	1120	0	-	-
122	1440	5	600	Copepoda
123	1120	3	420	Copepoda
124	1120	2	450	Copepoda, organic matter
125	1440	3	420	Copepoda
126	2400	8	570	Copepoda
127	1600	2	660	Copepoda
128	1280	0	-	-
129	1440	2	480	Copepoda
130	2240	6	5100	Copepoda
131	2080	3	660	Copepoda
132	1440	2	600	Copepoda, organic matter
133	2400	14	480	Copepoda
134	1120	0	-	-
135	1920	6	540	Copepoda
136	960	1	720	organic matter
137	1120	2	480	Copepoda
138	1600	4	540	Copepoda
139	1600	0	-	-
140	2880	18	480	Copepoda
141	1600	4	480	Copepoda, organic matter
142	1280	3	480	Copepoda
143	960	0	-	-
144	960	1	600	organic matter
145	1440	0	-	-
146	2240	6	480	Copepoda
147	960	1	420	Copepoda

Table 17: Trophic features analyzed for seven species of hydroids following the same experimental methodology.

	Silicularia rosea	*Nemalecium lighti*	*Campanularia everta*	*Eudendrium racemosum*	*Tubularia larynx*	*Obelia geniculata*	*Tubularia ralphii*
Geographic area	King George Is. (South Shetland Is.)	Panama (Caribbean Sea)	Catalonia (NW Mediterranean)	Catalonia (NW Mediterranean)	Scotland (NE Atlantic)	Arauco Gulf (SE Pacific)	Weddell Sea (Antarctic)
Polyp size (mm)	0.4	0.3	0.25	0.6	1.0-1.2	0.3	0.7-1.2
Habitat	Tide pools	Sublittoral	Sublittoral	Sublittoral	Sublittoral	Sublittoral	Continental Shelf
Growth form	reptant	reptant	reptant	erect	erect	reptant/erect	reptant/erect
Life cycle	no medusa	no medusa	with medusoid form	no medusa	with well developed medusa	with well developed medusa	with well developed medusa
Dominant prey (mean % of the diet)	Diatoms (95) Eggs (2) Tintinnids (1)	Diatoms (32) POM (21) Invertebrate larvae (20)	POM (88) Copepod eggs (7) Copepod nauplii (2)	Copepod eggs (28) Copepod adults (22) Invertebr. larvae (10)	Copepod eggs (28) Copepod adults (22) Cladocera (21)	Faecal pellets (48) Copepod eggs (29) Diatoms (17)	Copepods adults and juveniles (90)
Mean prey size ± SD and range (μm)	38.6 ± 0.32 (9.7, 436.5)	50 (5, 325)	54.8 (6, 110)	350 (40, 1050)	710 (520, 930)	47.7 (20, 420)	521.4 (60, 1480)
Observed mean ± SD (maximum) prey no. hydranth^{-1}	61.2 ± 6.7 (818)	3.5 (14)	4.4 (8)	2.5 (9)	3.4 (26)	9.3 (40)	4.2 (32)
Estimated mean prey number hydranth^{-1} day^{-1}	225.8	39.6	18.6 26.1**	5.4	36.0**	124.2**	15.7
Estimated mean prey number m^{-2} day^{-1}	4.4×10^6	3.97×10^5	4.3×10^5	1.2×10^5	4.5×10^5	3.2×10^6	1.7×10^3
mg C removed m^{-2} day^{-1}	66	6	6.4	12	225	48	98.8
Prey biomass hydranth^{-1} day^{-1} (in μg)	0.18	2.4	0.3	0.4	8.5	28.1	2.1
Diel mass-specific ingestion rate (in %)	12.6	141.4	19	39.1	89.9	113.2	27.8

* Maximum prey number observed.

** Prey capture during reproductive period.

communities of the Weddell Sea during winter. In other areas, this species can survive all year, provided it has at least two somatic generations of polyps (Stepanjants 1979).

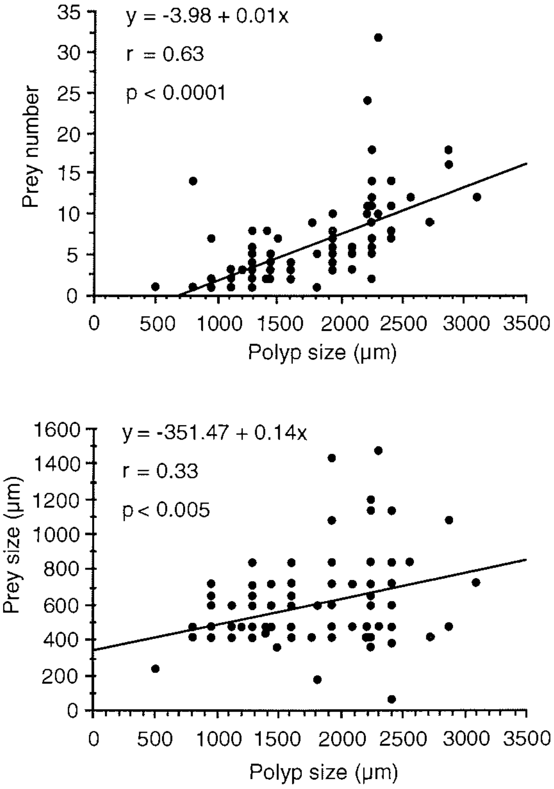


Fig. 19: *Tubularia ralphii.* Relationship between polyp size and number of prey items (above), and polyp size and prey size (below).

The colonies of *Clavularia* frankliniana show different prey items than in *Tubularia ralphii.* Only 45% of the polyps dissected had prey in their stomach. The diet was composed by benthic organisms such as Foraminifera, Nematoda, benthic diatoms, etc (Table 18). This kind of diet is quite frequent in the massive and encrusting anthozoans such as alcyonarians and actiniarians. The polyps of the stoloniferans are probably located very close to the substrate and they capture the prey from the layer closest to it. This kind of diet represents a good adaptation to catch prey that is resuspended by currents and moving around the tentacle crown of *Clavularia frankliniana.*

Table 18: Number, size and type of stomach items observed in 50 polyps of *Clavularia frankliniana* collected during February 1998 in Four Seasons Inlet (Weddell Sea, Antarctica).

Polyp	Number of prey items	Type of prey	Size of prey (µm)	Polyp	Number of prey items	Type of prey	Size of prey (µm)
1	2	Sponge spicules	360	26	6	Diatoms (3)	180
		Anthozoa larvae	360			Diatoms (2)	640
						Nematoda	840
2	0	-	-	27	0	-	-
3	0	-	-	28	0	-	-
4	0	-	-	29	4	Diatoms (3)	180
						Mollusca (juv.)	360
5	0	-	-	30	3	Diatoms (2)	180
						Sea urchin spine	900
6	1	Foraminifera	264	31	0	-	-
7	0	-	-	32	3	Diatoms (2)	180
						Nematoda	2240
8	3	Nematoda	288	33	0	-	-
		Diatoms	96				
		Invertebr. larvae	840				
9	0	-	-	34	4	Diatoms (3)	180
						Invertebr. larvae	480
10	0	-	-	35	0	-	-
11	7	Diatoms (5)	180	36	0	-	-
		Mollusca juv.	360				
		Nematoda	840				
12	7	Foraminifera	180	37	3	Diatoms (2)	180
		Diatoms (6)	180			Invertebr. larvae	540
1.	0	-	-	38	6	Diatoms (5)	180
						Nematoda	1080
14	5	Diatoms (3)	180	39	0	-	-
		Invertebr. larvae	480				
		Nematoda	840				
15	2	Invertebr. larvae	360	40	0	-	-
16	0	-	-	41	3	Diatoms (2)	180
						Nematoda	1020
17	6	Diatoms (4)	160	42	0	-	-
		Diatoms (2)	640				
18	0	-	-	43	0	-	-
19	4	Diatoms (3)	180	44	4	Diatoms (2)	180
		Sea urchin spine	1200			Mollusca (juv.) (2)	420
20	0	-	-	45	0	-	-
21	3	Sponge spicules	420	46	2	Diatoms	480
		Diatoms (2)	180			Nematoda	720
22	0	-	-	47	2	Invertebr. larvae	480
23	0	-	-	48	0	-	-
24	4	Diatoms (3)	180	49	4	Diatoms (3)	180
		Mollusca (juv.)	360			Foraminifera	300
25	0	-	-	50	0	-	-

2.2.5 Respiration in Gorgonians

Objectives

In order to study contrasting ecological strategies and life histories of benthic suspension feeders, the energy budget of some cnidarian species should be estimated. An important part of this study was devoted to know the respiration rates of these animals. With this aim we developed some respiration experiments to ascertain the oxygen consumption rates of some species from the Weddell Sea.

Work at sea

Respiration experiments were done on three species of Gorgonacea. The oxygen uptake was determined using an experimental setup made up by a respirometer with a variable volume depending on the volume of the specimens. After the experiment the water volume was measured. A control chamber was used as an indicator of possible oxygen variations not due to the gorgonian colony. Four respirometers were used at the same time, one as control and the other three as experimental chambers. The oxygen concentration was recorded continuously using oxygen optodes (Holst *et al.* 1997).

The measuring principle of the O_2 optode is based on the ability of the oxygen to act as a dynamic fluorescence quencher that decreases the fluorescence quantum yield of an immobilized fluorophore. The fluorophore is excited by blue light with a defined short wavelength, and a red luminiscent light is emitted by the fluorophore. In the presence of O_2 the intensity of the luminiscent light decreases in a predictable way due to the quenching process.

Respiration was estimated from several measurements with the same animals. Water inside all the chambers was totally renewed when the oxygen concentration decreased until 20% from its initial level. Water renovation was carried out by means of a peristaltic pump connected to the chambers. The respiration rate was estimated as the decrease in oxygen concentration in the gorgonian chamber during the period of each experiment.

Preliminary results

The oxygen consumption is part of the metabolic "output" of the animals together with the excretion, growth and the reproductive effort. The metabolic rate of an organism is usually assessed by measuring its oxygen consumption. This is affected by numerous factors, both endogenous, such as body weight, level of activity, stress, reproductive state, feeding, and also external, such as temperature, salinity and photoperiod.

Early studies of the respiratory rates of polar ectotherms suggested that they had a higher oxygen consumption than might be expected from the extrapolation to polar temperatures of respiratory data for temperate-water organisms (Clarke 1983).

The relation between oxygen consumption and oxygen concentration in water is of importance in showing to what extent consumption is dependent on diffusion (and hence is affected by concentration), and how far consumption may be related to the type of metabolism (aerobic or anaerobic) which is in operation.

Respiration has been measured in a number of other gorgonians (Sebens 1987), but rates have not been expressed in units which can be used for comparative purposes. Some studies on pennatulids showed that the rate of oxygen consumption is dependent on, and limited by, the oxygen concentration. Studies with some cnidarian species showed that the oxygen consumption was generally directly proportional to oxygen concentration, except in the case of contracted specimens. Cnidarians seem to have low metabolic rates when expressed in terms of wet weight, as a result of the high proportion of water or skeletal material in their wet weight. When expressed in relation to the organic content the respiratory rates of cnidarians approach or even exceed those of some other aquatic invertebrates.

The data analysis will be done at home, but some preliminary data have been obtained. These are presented as a first comparison between oxygen consumption rates from different gorgonian species from different places (Table 19).

Table 19: Oxygen consumption rates of four gorgonian species.

Species	Geographical area	O_2 consumption ($ml\ O_2\ h^{-1}\ colony^{-1}$)
Plexaura flexuosa	Panama, Pacific Ocean	0.09
Paramuricea clavata	Spain, Mediterranean Sea	0.02
Primnoisis antarctica	Weddell Sea, Antarctica	0.007
Ainigmaptilon antarcticus	Weddell Sea, Antarctica	0.14

2.2.6 Histological and Biochemical Support of Ecological Observations

Objectives

Seasonal input of organic matter has been considered one of the main factors regulating the benthic production in Antarctic benthic communities, which are organized around the nature, abundance, and predictability of these inputs and their utilization (Dayton 1990). For benthic suspension feeders, the winter period has long been considered one of starvation because the low levels of water column production impose a seasonal resource limitation (Clarke 1988). If winter energy costs are really low they could be met from the normal tissue lipid and protein content. But recent observations on continuos activity rhythms all the year round in several species of suspension feeders show that probably the traditional view of winter starvation may have to be revised (Barnes and Clarke 1995).

Biochemical composition (lipid, protein and carbohydrate) of tissues may contribute to understand if cnidarian colonies collected during the late Antarctic summer store large reserves for the next winter or not. At the same time, seasonal species such as several hydroids could store lipids in the stolons which remain as 'hibernation' structures. One of the objectives of this cruise is to analyze the basical biochemical composition of a set of selected species of suspension feeders to contribute to the general idea explained above, and relate the tissue composition to different life strategies. The evaluation of intraspecies variability in colony composition, in different geographical areas, within the same community, and within the same colony will be also carried out.

Work at sea

Trophic potential of sediments: To determine the nature and characteristics of possible food sources in the surface layer of the sediment, which might be resuspended by water motion and used by filter feeders, and to ascertain whether these food sources are related to phytoplankton settling or due to in situ microbial activity, surface sediment samples at different locations and depths have been taken wherever undisturbed sediment columns were obtained by samplers. At each sampling site, the following samples were taken, by means of TVG, MUC, GKG (MBC), and MG samplers:

- 2-3 samples (1 ml) to be frozen and later analyzed for bacteria; counts will be determined under epifluorescence microscopy and the rest of the sample will be qualitatively studied under the SEM.
- 1 sample (1 ml) to be frozen and later analyzed for stoichiometric composition of proteins, carbohydrates, and lipids;
- 3 samples (3 ml) to be preserved in acetone and further analyzed for chlorophyll and other photosynthetic pigments;

- 1 sample (3 ml) to be preserved in formaline and immediately observed under the microscope for microalgae identification.

Gastric cell morphology: Pieces of several colonies have been preserved in glutaraldehyde as a means to prepare histological sections to study the ultrastructure with TEM.

Enzymatic analysis: To confirm whether certain species have undergone the biochemical adaptations enabling them to digest macromolecules of plant origin, some colonies have been frozen for liquid gel electrophoretic analysis of the presence of such enzymes as amylases and laminariases and for spectrophotometric analysis of enzymatic activity levels (NAD^+ and $NADP^+$).

Biochemical composition of colonies: To analyze the stoichiometric composition of colonies of various species and to relate this composition to different life strategies, the stoichiometric composition of colonies of the principal cnidarian species will be determined by means of analysis such as those mentioned above. Colonies have been frozen for subsequent analysis in the laboratory.

Pigment study: Several hydrozoan colonies collected in the most shallow samples (60-250 m depth) presented a dark (brown or green) colour; after their microscopical observation on board, we think that this colour could be due to pigment concentration in the ectodermal cell layer. To test the possibility that these pigments could represent something more than a colour structure for Antarctic hydroids, several samples have been frozen to - 80°C and several have been preserved in acetone for posterior pigment recognition and analysis of structure. The possibility that these pigments could be associated to algal cells and supply to the animals' photosynthetically produced DOC is very interesting, although it seems not to agree with the depth were the hydroids live and with some major principles of plant-animal symbiosis. Nevertheless, this possibility should only be rejected after a careful analysis of the pigment characteristics and the histological structure of hydroid cells.

All the sample analyses will be carried out at the Institut de Ciències del Mar and at the University of Barcelona.

Preliminary results and discussion

The work done during the cruise is summarized in the sample list of Tables 5 and 20. It is generaly accepted that Antarctic benthos utilizes very efficiently the organic input from the water column production (Dayton 1990). At the same time, this organic input plays an important role in determining the abundance, diversity and biomass of benthic communities. While there are some places where the organic input creates pockets of rich potential food for benthic organisms, the organic carbon content of Antarctic sediments tends to be rather low (Warnke *et al.* 1973). Nevertheless, Antarctic benthic communities are characterized by high densities and biomass of epifaunal, sometimes also infaunal organisms (Arntz *et al.* 1994). In several review papers emphasis is put on the low rates of growth and secondary production of benthic organisms (e.g. Picken 1985), despite the fact that the Antarctic plankton systems are obviously capable of supporting great populations of whales, penguins, seals, etc. This has been termed by several authors the "Antarctic paradox".

The organic input to the benthos of the high Antarctic Wedell Sea has its origin in the primary production by ice algae, phytoplankton and benthic microalgae, the macroalgae being absent due to the lack of shallow environments. This means that many benthic organisms, such as suspension feeders, must be adapted to take profit of this organic input of plant origin even if it is not great. Recent studies have pointed out that diatoms can be an important food source for sponges, brittle stars and hydroids (Arntz *et al.* 1994). However animals such as hydroids that mainly eat zooplankton and other benthic animals (such as larvae), to be able to digest plant material (as has been demonstrated in some tropical benthic cnidarians; Fabricius *et al.* 1995),

Table 20: Sediment samples for further analysis.

Date	Stn	Gear	Pigments *	Stoichio-metry *	Micros-copy *
25-01	006	TVG	110	13	
			111	18	
			115	38	
28-01	027	TVG	122	07	
			114	01	
			117	01	
30-01	047	MG	118	03	
			125	31	
			128	42	
				43	
30-01	048	MG	100	29	
			101	30	
			116	34	
01-02	067	MG	103	10	108
			107	16	
			121	37	
04-02	090	MUC	106	9	A
			123	40	
			134	49	
		(fluff)	109	44	113
04-02	092	MG	119	02	A
			124	25	
			136	39	
04-02	093	MG	228	11	237
			231	14	
			235	17	
08-02	131	MG	230	08	120
			234	19	
			238	46	
08-02	132	MG	133	182	C
			137	187	
			207	197	
09-02	135	MUC	212	04	135
			214	15	
			236	35	
09-02	136	MG	127	12	
			138	26	
			227	32	
09-02	137	MG	203	06	112
			205	33	
			225	47	
10-02	143	MUC	139	22	D (fluff)
			200	28	
			200A	50	
10-02	144	MUC	210	20	
			215	27	
			233	41	
10-02	146	MG	102	24	
			131	45	
			218	48	
11-02	158	TVG	130	160	
	(700m)		211	168	
			213	198	
15-02	187	MG	204	143	129
			219	175	
			232	180	
19-02	223	MG	104	170	
			132	176	
			301	179	
			316	192	
19-02	224	MG	304	05	
			321	189	
			323	190	
				191	
19-02	225	MG	302	155	
			307	178	
			310	184	
				195	
20-02	227	MG	305	21	
			317	169	
			319	172	
20-02	228	MG	303	173	
			315	174	
			320	186	
				194	
20-02	230	MG	300	154	
			312	165	
			322	185	
				199	
21-02	241	GKG	338	200	
			339	204	
			340	211	
				233	

* sample numbers

would require enzymes such as amylases and laminariases. For this reason cnidarians were in principle believed to be unable to assimilate substances of plant origin and to lack these enzymes in their metabolic pathways.

To confirm whether certain species do indeed possess biochemical adaptations enabling them to digest macromolecules of plant origin, we will use histochemical methods, together with ultrastructural techniques enabling the knowledge of how the cnidarian gastric cells ingest the particles and food items. Cnidarians have two kinds of digestion: extracellular and intracellular (Bouillon 1995), probably to facilitate the quick assimilation of food items. This probably explains the high prey capture rates observed in hydrozoans. The observation of digestive vacuoles containing complete prey items such as bacteria and diatoms is also the best proof that confirms the assimilation of the different prey items by the species used for the feeding experiments.

Another important aspect of the organic input to the benthos is the strong seasonality of the surface production that sinks to the bottom. This organic sedimented material is believed to play an important role in the nutrition of benthic sessile animals during winter. Resuspension and transport to the different Antarctic basins create a tremendous organic influx to benthic communities. The availability of this organic input must be in great part due to the low microbial decomposition rate, itself due to the low bacterial growth rates (White *et al.* 1984). Microbial composition and biomass seem to be high and complex in some areas and could represent an important food source for benthic suspension feeders, as has recently been demonstrated for inland lakes and tropical areas (Ribes 1998). Despite the importance for benthic production of the organic input to the benthos through sedimentation, the trophic potential of sediments is still almost unknown in the Antarctic (Dayton 1990).

2.2.7 Distribution, Abundance and Growth of Bryozoa

Introduction and Objectives

Antarctic Bryozoa are a main component of suspension feeder communities, and their taxonomic and life strategies diversity have been stressed by, among others, Zabala *et al.* (1996), who worked on material obtained during "Polarstern" cruise ANT XIII/3. During cruise ANT XV/3 we have collected bryozoan colonies at nearly every station and with nearly all sampling gears (see sample relation), but in particular we have obtained specimens which may allow us to answer interesting questions on benthic ecosystem recovery after major disturbances (such as iceberg scouring):

- Identify growth marks which can be related to seasonal-anual cycles, with the aim to date scour marks by means of the age of some of their inhabitants. Melicerita obliqua has been screened to see if their conspicuous marks show a general pattern which can be related to external seasonal factors (such as summer abundance of food), but the preliminary results do not seem to confirm this hypothesis. More work has to be done with abundant and entire colonies, such as only vertical grabs can sample.
- Bryozoan assemblages on hard substrates, i.e., boulders ranging in size from very small to ca. 1 m^{-3}, have been specially sought, because the stability of these boulders can be assumed to be directly related to their size and the bryozoan (and other phyla, such as cnidarians) assemblages on them should because of greater substrate stability. It is hypothesized that the differing, successive stages of secondary succession after iceberg scouring disturbances will be characterized by communities differing also, among other things, in their degree of maturity , and thus the relative age could be roughly estimated from the knowledge of their component assemblages.

Work at sea

The bryozoan samples will be taken to Barcelona and afterwards studied by M. Zabala. The following samples were taken:

TVG	004, 005, 027, 060, 129, 170
AGT	006, 039, 044, 050, 058, 063, 077, 088, 103, 141, 184, 189, 194, 197, 264, 276, 338
GKG (MBC)	057
D (MT)	172
FTS (BT)	072, 078, 082, 098, 100, 123
GSN	095, 097, 150, 154, 167, 168

2.2.8 Study of the Hard-Bottom Fauna on an Underwater Hilltop at 60-70 m Depth (with the collaboration of J. Dijkstra)

Objectives

During EASIZ I (1996), the remotely operated vehicle (ROV) obtained an interesting video transect while ascending an underwater hilltop located off Four Seasons Inlet (NE of Kapp Norvegia). The top was only 55-60 m deep. Extreme shallow water areas such as these are very scarce in the southeastern Weddell Sea. Usually the shelf ice covers the seafloor to a depth of 150-200 m.

The principal goal of this research was to obtain samples from the shallow water boulder fauna of the high Antarctic Weddell Sea in order to learn about its species composition and community structure. Furthermore, these samples were used for aquarium experiments with suspension feeders. Finally, the intention was to check Hain's (1990) hypothesis that boulders in the high Antarctic are often colonized by brachiopods which are occupying the space taken by bivalves in other areas.

On the hilltop large rounded boulders appeared to carry hard-bottom fauna. As no samples from such shallow sites, nor from other hard bottoms, seem to exist from the Weddell Sea, stones were to be taken with a very large bottom grab to recover the fauna in good condition.

Materials and methods

As no depths shallower than 60 m were encountered at the 1996 position (71°07.1-.3'S, 11°28.1-.5'W), stones were sampled between 64 and 75 m depth using a 1.82 m^2 TV-guided sampler ("TV grab") of the Geologic-Palaeontological Institute of Kiel University. This grab is equipped with a video camera and four lamps (24V/150W) allowing the operator to detect and sample specific locations. Closing and opening of the TV grab is done by hydraulic pressure. Samples were taken when a larger number of boulders covered with epifauna appeared on the video screen. The operator would attempt to close the grab from a position slightly above the seafloor in order to avoid deep penetration into the sediment.

The TV grab was not successful in collecting large boulders. However, intermediate stones and pebbles were obtained between 10 and 470 cm^2 surface area and small pebbles with the underlying coarse sand from 5 grabs. Coarse sand samples without colonized stones were collected from 3 additional grabs.

Colonized stones and pebbles were numbered and photographed individually on deck, and the remaining material was lumped in a "rest sample". In total we obtained 41 individual stone and pebble samples (Table 21) and 8 rest samples (to be evaluated at the respective institutes). The latter contained fauna that was washed from the stones in the respective grabs, as well as coarse sand fauna from the surroundings of the stones. Both fauna from the stones and pebbles and from the rest samples were sorted on board. The fauna from the 41 stones was immediately classified to the lowest possible taxonomic level (cf. Table 21). Fauna which could not be classified to species was given to specialists on board who will complete identification at their home institutes. All fauna was preserved in 4% buffered formalin.

Table 21: Species and their abundance found on the stones (shallow stations off Four Seasons Inlet).

Station No.	30											33									
Stone No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Porifera	1		1		1		1		1						1				1		
Tubularia ralphii (Hyd)	36	12	10	48	6		100	38	10	26	8				6						12
Oswaldella antarctica (Hyd)	10			1		5					1			12	40		9		1	1	6
Eudendrium antarcticum (Hyd)																					
Eudendrium sp. 2 (Hyd)	50	10		8		35	5		1					1					4		6
Eudendrium rameum (Hyd)																					
Billardia subrufa (Hyd)																	1				
Campanulina chilensis (Hyd)																					1
Perigonimus antarcticus (Hyd)																					12
Symplectoscyphus pulchella (Hyd)				1		3															
Symplectoscyphus biformis (Hyd)																					
Symplectoscyphus plectilis (Hyd)																					1
Hydrodendron arborea (Hyd)															1	1					
Hydractinia sp. 3 (Hyd)															2						
Halecium tenellum (Hyd)		2																			
Lafoea fructicosa (Hyd)																					
Halecium ovatum (Hyd)																					
Halecium tenellum (Hyd)																					
Coryne tubulosa (Hyd)																					
Campanularia hicksoni (Hyd)																				90	3
Hydractinia sp. 2 (Hyd)																	2				1
Primnoella sp. 1 (Ant)										2		3							1		
Primnoisis sp. (Ant)																					
Fannyella spinosa (Ant)										1											
Primnoidea n. gen. (Ant)																					
Clavularia frankliniana (Ant)	319	405	397	231	34		123	33	306	137	57				14	2	8	5	280	4	42
Alcyonium spp (Ant)													1								
Hormathia sp. 2 (Ant)																					
Philobrya cf. *quadrata* (Mol)	2	1						1													
Laternula elliptica (Mol)	1																				
Trochidae sp. 1 (Mol)	5																				
Lepetidae sp. 1 (Mol)	1	2	1	1		2		1													
Toledonia sp. (Mol)		3	1					1													

Table 21 continued.

Station No.	30											33									
Stone No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Capulus subcompressus (Mol)																1	1				
Rissoidae sp. a (Mol)	1																				
Rissoidae sp. b (Mol)																					
Admete sp. 2 (Mol)																					
Marseniopsis sp. (Mol)					1																
Doto sp. 2 (Mol)															5						
Philine alata (Mol)																					
Ostracoda																					
Polynoidae (Pol)																					
Serpulidae (Pol)			1																		
Spionidae (Pol)																					
Spirorbidae (Pol)																					
Syllidae (Pol)															1						
Terebellidae (Pol)															3						
Notasellis cf. *sarsi* (Iso)																					
Isopoda sp. unidet. (Iso)															1						
Joerysis sp. (Iso)																					
Munna cf. *antarctica* (Iso)																					
Austrofilinis cf. *furcatus* (Iso)																					
Tanaidacea sp. 1																					
Tanaidacea sp. 2	2															1					
Ischyroceridae (Amp)																					2
Stenothoidae (Amp)	10	1												7	1	1					
Stenothoidae sp. A (Amp)																					
Stenothoidae sp. B (Amp)																					
Atylopsis sp. (Amp)																					
Cumacea																					
Insecta								1*													
Pantopoda	1								1						1					1	
Nematoda	28				5										169	4					1
Bryozoa	1				1														1		
Sterechinus (Ech)		1			1			1													
Holothuroidea (Ech)																					

* The insect (order Thysanoptera) belonged to the cosmopolitan agricultural pest *Limothrips cerealinum* (Dr. R. zur Strassen, pers. comm.)

Table 21 continued.

Station No.	209	210																		
Stone No.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Porifera																				
Tubularia ralphii (Hyd)																				
Oswaldella antarctica (Hyd)	1	15	4	2	5		3	12		5	2	14	6	3	3	7		2		
Eudendrium antarcticum (Hyd)	6					1			3						5					
Eudendrium sp. 2 (Hyd)																				
Eudendrium rameum (Hyd)								54		6										
Billardia subrufa (Hyd)	6																			
Campanulina chilensis (Hyd)																				
Perigonimus antarcticus (Hyd)																				
Symplectoscyphus pulchella (Hyd)																				
Symplectoscyphus biformis (Hyd)										1										
Symplectoscyphus plectilis (Hyd)																				
Hydrodendron arborea (Hyd)	1																			
Hydractinia sp. 3 (Hyd)	2	1								5										
Halecium tenellum (Hyd)																				
Lafoea fructicosa (Hyd)	6												1							
Halecium ovatum (Hyd)	1																			
Halecium tenellum (Hyd)																				
Coryne tubulosa (Hyd)					2															
Campanularia hicksoni (Hyd)					32															
Hydractinia sp. 2 (Hyd)																				
Primnoella sp. 1 (Ant)	2	1	1						1			1		1		1				
Primnoisis sp. (Ant)				1																
Fannyella spinosa (Ant)																				
Primnoidea n. gen. (Ant)									1						1					
Clavularia frankliniana (Ant)		944	300	240	554	534	509		306		27	136	11	155	8	93	341	235	168	415
Alcyonium spp (Ant)																				
Hormathia sp. 2 (Ant)	1																			
Philobrya cf. *quadrata* (Mol)																				
Laternula elliptica (Mol)																				
Trochidae sp. 1 (Mol)		2					1								1	1				
Lepetidae sp. 1 (Mol)	1	1							1				1		1		1			
Toledonia sp. (Mol)																				

Table 21 continued.

Station No.	209	210																		
Stone No.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Capulus subcompressus (Mol)																				
Rissoidae sp. a (Mol)		1		1	4										5					
Rissoidae sp. b (Mol)								1												
Admete sp. 2 (Mol)					5											1				
Marseniopsis sp. (Mol)	1																			
Doto sp. 2 (Mol)																				
Philine alata (Mol)	1																			
Ostracoda		1			1															
Polynoidae (Pol)					1															
Serpulidae (Pol)		1																		
Spionidae (Pol)		1	1		1	1									8					
Spirorbidae (Pol)															1					
Syllidae (Pol)	1			1				1	1		1		2	1	1					
Terebellidae (Pol)																				
Notasellis cf. *sarsi* (Iso)					1								3			1				
Isopoda sp. unidet. (Iso)					1								1							
Joerysis sp. (Iso)						1														
Munna cf. *antarctica* (Iso)								1					1							
Austrofilinis cf. *furcatus* (Iso)					1															
Tanaidacea sp. 1	1				1	2	1						1		1					
Tanaidacea sp. 2					2				1						2					
Ischyroceridae (Amp)																				
Stenothoidae (Amp)		5		7	23	1	11	89	4		7		54	1	18	4				
Stenothoidae sp. A (Amp)		4		2	3		1	17			3		9		25	4				
Stenothoidae sp. B (Amp)		3			5		1	14			5		5		12	1				
Atylopsis sp. (Amp)															1					
Cumacea							3													
Insecta																				
Pantopoda	1		1		3		1			1			1							
Nematoda	41	5	3	2	12	5	12	3		7			5		9	2				
Bryozoa	1					1	1	1	1		1	1	1			1				
Sterechinus (Ech)		7	2	2	3		2					5				3	1	1		
Holothuroidea (Ech)																				

Preliminary results and discussion

Species Compositon: The epifauna living on the stones and pebbles and in the coarse sand was surprisingly rich. Up until now, of those occurring on the stones, a total of 65 taxa, 20 of them hydrozoans, have been identified, although at very different levels (Table 22).

Table 22: Abbreviated list of taxa on 41 stones. Total: 65 taxa on stones only.

- Porifera indet.
- Hydrozoa 20 spp.
- Anthozoa 7 spp.
    - Gorgonaria 4
    - Stolonifera 1
    - Alcyonaria 1
    - Actiniaria 1
- Mollusca 12 spp.
    - Bivalvia 2
    - Prosobranchia 7
    - Opisthobranchia 3
- Polychaeta 6 families
- Ostracoda indet.
- Amphipoda 3 spp. + 2 fam.
- Isopoda 5 spp.
- Tanaidacea 2 spp.
- Cumacea indet.
- Pantopoda indet.
- Nematoda indet.
- Bryozoa indet.
- Echinoidea 1 sp.
- Holothuroidea indet.

The most important sessile species were the stoloniferan *Clavularia frankliniana* and the hydrozoan *Oswaldella antarctica*. They had a presence of 80.5 and 61%, respectively (Table 23).

Table 23: Frequency of occurrence (F.O.) of 8 most common taxa and total number (T.N.) on 41 stones.

	F.O.	T.N.
Clavularia frankliniana (Stolonifera)	33/41	7368 (Pol.)
Oswaldella antarctica (Hydrozoa)	25/41	171 (Col.)
Amphipoda (Stenothoidae)	17/41	357 (Ind.)
Nematoda	17/41	313 (Ind.)
Eudendrium spp. (Hydrozoa)	13/41	135 (Pol.)
Tubularia ralphii (Hydrozoa)	12/41	312 (Pol.)
Prosobranchia (Lepetidae)	12/41	14 (Ind.)
Sterechinus sp. (Echinoidea)	12/41	29 (Ind.)

Pol. = polyps, Col. = colonies, Ind. = individuals

Other important sessile species were the hydrozoans *Tubularia ralphii* and *Eudendrium* spp. Among the motile organisms, the most important groups were Amphipoda Stenothoidae (2 spp), Nematoda, the sea urchin *Sterechinus* sp., and small limpets (Lepetidae). The gorgonians were mostly represented by single colonies of 4 species.

Although at this time many taxa could only be identified to a crude level, it is observed that the stone community contains many species which are either missing or scarce in the eastern Weddell Sea soft-bottom communities. Stones that were taken with the bottom or Agassiz trawls at greater depths (i.e. stones which were surrounded by soft bottoms) contained a completely different fauna. This fauna was mostly dominated by encrusting species (bryozoans and sponges) and sometimes contained large numbers of brachiopods (see former cruise reports from the Weddell Sea: Arntz *et al.* 1990), which, in these cases, seemed to replace the bivalves (Hain 1990). This was not, however, the case in the shallow water stone community found off Four Seasons Inlet, which is characterized by a genuine hard-bottom fauna. Apparently, the soft sediment at greater depth restricts the colonization of stones by hydrozoans, gorgonians, and other erect colonial animals.

Community structure: The stone community was found to be structured in various levels:

- Encrusting fauna, to be divided into a sessile and an erect component.

  C. frankliniana is a rapidly growing opportunistic species which forms a system of creeping stolons that tightly cling to the stones. Bryozoans occur as occasional patches. The stolons produced by *O. antarctica* and *T. ralphii*, as well as the single erect colonies of various hydrozoan and gorgonarian species, provide a three-dimensional structure which serves as a shelter and substratum for a multitude of meio-and macrofaunal species. Most of them seem to live within the net of stolons of the hydrozoans, but some live among the colonies of the hydrozoans and the epibiontic hydrozoans forming a second storey on the base specimens.

- Fauna living on, within or below the encrusting species.

  The fauna living on, within, or below this encrusting fauna (except *C. frankliniana*) is dominated by small stenothoid amphipods (2 spp) and relatively large nematodes, however, many other taxa have been found as well (see Table 21).

- Free-living fauna on the stones.

  The principal element of the free-living species was the sea urchin *Sterechinus* sp., which covered a very wide size range from 2 to about 50mm. It is accompanied by small green limpets (Lepetidae), other prosobranch gastropods, and syllid polychaetes. These taxa are independent of the three-dimensional structure mentioned under (b).

- Inhabitants of the coarse sand which underlies the stones.

  A number of taxa seem to live on or in the very coarse sand under the stones, including small bivalves and gastropods. All fine material seems to have been removed from this sediment by the currents, yet in contrast to what might be expected, its faunal content is high. Part of it may have been swept from the stones on their way up to the ship.

Although we did not manage to "grab" the big boulders which we saw on some video sequences, the stones and pebbles brought up by the TV grab shed some interesting light on this shallow community. Telling from the coarse sand between the stones, there must be considerable current velocities on this hilltop. The smaller stones probably change their position even where there is no iceberg impact which profoundly disturbs the whole community (it is likely that the hilltop as such was formed by massive iceberg impact). The gorgonians may be dwelling on stones which are partly embedded in the sediment (Fig. 20), and thus offer less space but more stable conditions, whereas the stoloniferans and hydrozoans may represent pioneer species which will colonize whatever rock space becomes available by physical disturbance. Hydrozoans normally reveal rapid growth (Gili and Hughes 1995) and in direct

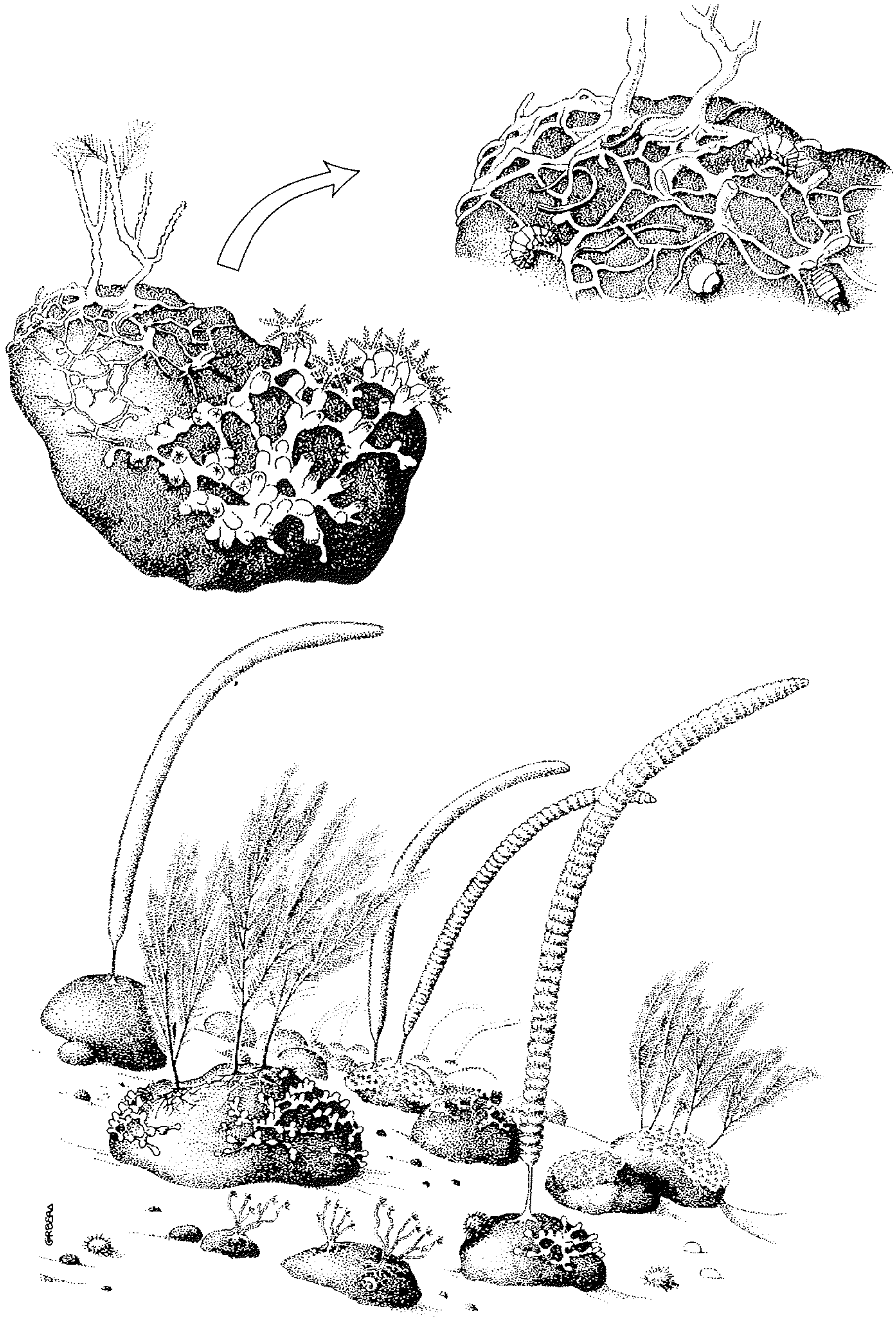


Fig. 20: Epibenthic assemblage on hard substratum at the 60 - 70 m deep hilltop of Four Seasons Inlet.

comparison have been demonstrated to grow much faster than gorgonians (Coma *et al.* 1998). As the hydrozoan pioneer species offer a three-dimensional structure which provides shelter and retains seston, they are colonized by a multitude of small species. As can be seen from Fig. 21,

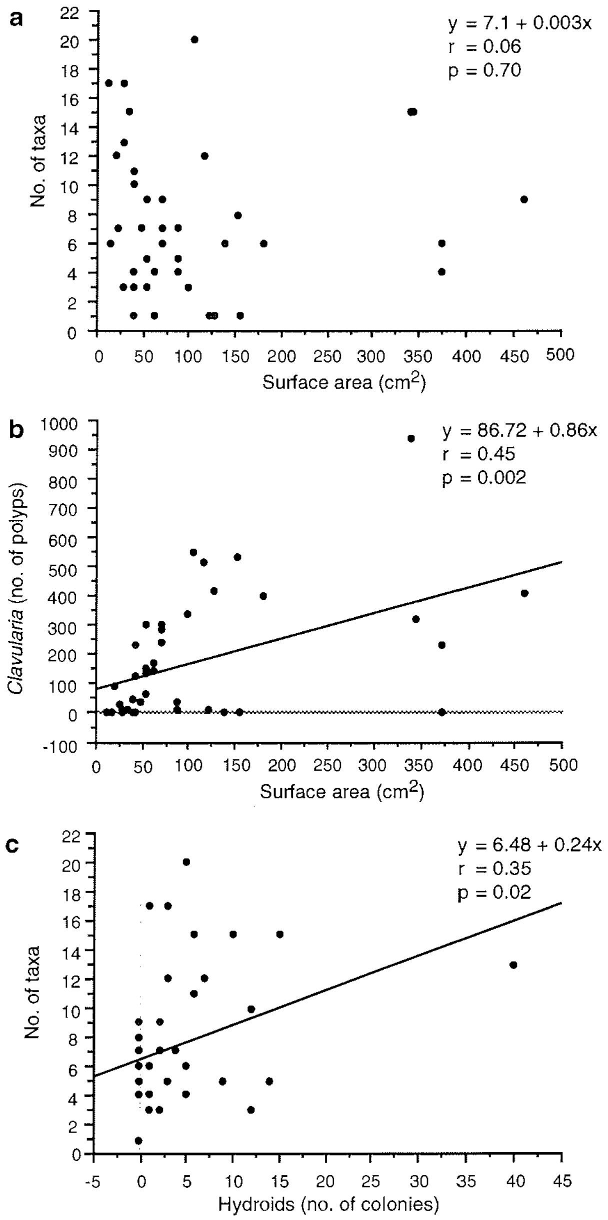


Fig. 21: Relationships between stone size and number of all taxa living on the stones (a), between stone size and number of *Clavularia* polyps (b), between number of hydroid colonies and number of all taxa on the stones (c).

the total number of species is independent of the stone size, but is strongly related to the number of hydrozoan colonies which produce the stolons.

If the hydrozoans prove to be younger than the gorgonians, the early "pioneer community" has a much higher diversity than the late "stable community". This has parallels in rocky shore communities and exposed sand beaches where early diversification may give way to later monopolization by single species (Dayton 1971), but is contrary to the normal successional development on sublittoral and shelf soft bottoms (Rosenberg 1976).

What remains unclear in this context is the role of the coarse sand on which the stones are lying. It seems to be richer in species than coarse sand bottoms normally are. Perhaps the stones provide shelter, and the spaces between the sand grains can be colonized by interstitial meiofauna which serve as food for part of the macrofauna. In this context it may be important to note that the shallowest silty bottoms in this area (around 200 m) have a very tight texture and contain little macrobenthic endofauna (Hilbig pers. comm.).

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2.2.9 Preliminary Observations on Distribution, Biology and Feeding Ecology of some Suspension Feeding Polychaetes in the Eastern Weddell Sea (M. C. Gambi)

Introduction and objectives

Polychaetes, one of the most abundant and diversified groups of benthic organisms also in the Antarctic shelf communities, show also a large variety of feeding habits and strategies and are included at many levels of the benthic food web. Among the trophic types, suspension feeding has independently evolved in different families of these marine worms. They include both active filter feeder forms (that generate their own feeding current), such as Sabellidae and Serpulidae, which generally live inside permanent tubes that protrude from the sea bottom, and feed through a highly modified projection of the head (branchial crown); and facultative suspension feeders that can switch their trophic behaviour from deposit to suspension feeding according to the hydrological conditions, mainly to the load of the suspended material. There are some representatives of this latter strategy in the Nereidae, Chaetopteridae, Spionidae, Oweniidae and Terebellidae. Active suspension feeding may be considered as "life in a nutritionally diluted environment", and most suspension feeders possess low energy pump systems, which include the crown of sabellid and serpulid polychaetes, that enable continuous feeding at low rates, rather than discontinuous and high rates, and which efficiently retain small suspended food particles (Riisgard and Larsen 1995). The bio-ecological adaptations of such filter feeders forms to the unique polar hydrological and energetic regime are still poorly known and represent one of the crucial points to clarify the so-called "paradox of the polar benthos". Studies on the distribution, biology and feeding ecology of suspension feeder polychaetes in the Southern Ocean are lacking. The EASIZ I campaign on the Shelf of the Eastern Weddell Sea (ANT XIII/3, January-March 1996), revealed the occurrence of dense populations of some polychaete filter feeders belonging to Sabellidae: *Perkinsiana littoralis* and *Perkinsiana borsibrunoi* (Giangrande and Gambi 1997). These species were second only to some species of Polynoidae concerning their frequency and number of individuals collected (Gambi 1997).

The research programme focussed on the following aspects of the bio-ecology and feeding behaviour of the above mentioned species, as well as of the other occasional and less abundant suspension feeding polychaetes collected in the samples:

- distribution and abundance patterns;
- population structure (size-frequency distribution) and reproductive biology;
- gut content analysis and size spectrum of the preyed items;
- feeding behaviour, such as time spent in feeding and filtration rate (this last point by means of laboratory observations and experiments).

Work at sea and in the laboratory

Suspension feeding polychaetes were mainly collected, together with the other polychaetes and benthic organisms in general, by means of Agassiz trawl (AGT), bottom trawl (GSN), and TV grab (TVG), and occasionally with the small dregde of M. Rauschert (D). After collection most of the worms (the entire ones with undamaged branchial crowns) were placed in aerated aquaria in the cool room. Some of the worms, especially those somewhat damaged by the sampling, were immediately fixed in 4% formol or checked under the microscope for other kinds of analyses. In case of a female, part of the eggs were mounted in permanent slides (Faure's liquid) for measurement of the egg diameter and egg size frequency distribution; whereas the body tissues were preserved in absolute alcohol for the analysis of some DNA markers for both molecular phylogenetic and population genetic analyses. In case of a male, the tissues were preserved in 6% glutaraldheyde for electron microscopical analysis of the sperm ultrastructure. Furthermore, in some worms the gut content was extracted, before fixation, and permanent slides (in Faure's liquid) were prepared for analysis of the composition of the gut material under the light micoscope. The occurrence and relative abundance of the various items has been estimated and scored by mean of a semi-quantitative codex (see Table 24).

Table 24: List and sizes of items occurring in the guts of the six studied species of polychaete suspension feeders.

Species		*Perkinsiana littoralis*	*Perkinsiana borsibrunoi*	*Myxicola* sp.	*Euchone* sp.	*Demonax* sp.	*Serpula narconensis*
No. individuals analyzed		8	7	3	8	8	8
Food items	Size (µm)						
POC, amorphous organic material	2	++	++	++	++	++	+
diatoms (single cells)	300	++	++	++	++	+	++
diatoms (colonies)	150	++	++	++	++	+	++
dinoflagellates	100	+	+	++	+	-	-
cists of dinoflagellates	120	+	+	-	+	-	0
silicoflagellates	30	0	0	0	0	-	-
globigerins (foraminifers)	250	+	+	0	0	-	-
radiolarians	30	-	-	0	0	0	0
tintinnids	300	+	+	-	+	+	+
ciliates	400	-	0	0	0	0	0
larval stages	120	-	0	0	0	0	0
exuviae of crustaceans	-	0	-	0	-	-	-
fecal pellets (copepods)	200	0	0	0	-	-	+
harpacticoid copepods	500	-	-	0	-	0	0
commensal copepods	500	0	-	0	0	0	0
sediment grains	200	+	+	-	-	++	+
spicules of sponges	2000	+	+	-	+	+	-
sclerite of gorgonians	-	-	0	0	0	0	0
detritus of macroalgae	1200	0	0	0	+	+	+

0 = absent, - = scarcely present, + = common, ++ = very abundant

The population structure of some species was estimated by measuring the tube diameter; this parameter was used because it was easy to measure also in living specimens. The relationship between tube diameter (measured about 1 cm below the tube opening) and width of the worm (1st segment) was tested for *Perkinsiana* spp. From material sampled during the previous EASIZ I expedition also the relationship between crown length and body length was estimated for both species of *Perkinsiana*, since this seemed to be a good parameter to measure for evaluation of size of individuals recorded in the ROV videos and photos.

The worms reared in the aquaria have been maintained at quite low light intensity, and were allowed to climatize for a few days (changing the water every two days) to get used to behavioural observation on feeding. Three kinds of observations and experiments were performed: a) behaviour and irrigation movement inside the tube; b) time spent in suspension feeding; c) feeding rate estimates. Behaviour and irrigation inside the tube was studied in some specimens of *Perkinsiana littoralis* of suitable size that were gently displaced by their natural tubes and inserted in glass Pasteur pipettes. The time spent in feeding was studied by observing the position of the crown, assuming that if the crown was expanded outside the tube the worm was in a feeding state. Three crown positions were recognized: crown expanded outside the tube (F or feeding), crown inside the tube (W or withdrawal), crown outside the tube but not expanded, or half inside and half outside the tube (sW) (this latter position was therefore considered as a non-feeding state). The different series of observation, with several worms each time, lasted between 7 and 12 hours. In this time interval the selected group of worms were checked for crown position every half hour. This time interval was chosen after two hours of continuous observations in which the animals showed a very constant behaviour and slow changes. Feeding rates were estimated by means of forced grazing experiments in smaller aquaria and on single or max. two animals. Three small aerated aquaria were filled with filtered sea water. Worms for the experiment were selected of suitable size with respect to the size of the aquaria and allowed to climatize for at least one day inside the aquaria before the experiment. A known volume of water with high concentration of the pelagic Antarctic diatom *Thalassiosira antarctica* (cultured in the cool room and kindly provided by C. Orejas), was added to the filtered sea water to reach a maximum of 2 liter solution in each of the aquaria. Water samples (2 ml) were then taken at the beginning of the experiment (To) and at different times. Each sample was preserved in 2% formalin. The reduction in the concentration of the diatoms, as a function of time, allows to calculate the clearance rate (F) according to the formula: F = (V/nt) ln (Co/Ct) (Riisgard and Ivarsson 1990), where Co and Ct are the diatom concentrations at time 0 and t, respectively, n is the number of worms in each aquarium (from 1 to max. 2 at time), and V the known volume of water (2 l). The concentrations of diatoms in the preserved water samples will be measured at the Stazione Zoologica of Naples (Italy).

Preliminary results

Distribution. A total of 6 species of filter feeding polychaetes were collected: *Perkinsiana littoralis*, *P. borsibrunoi*, *Euchone* sp., *Myxicola* sp., and a still undetermined genus *Demonax* sp., all belonging to Sabellidae, while *Serpula narconensis* belongs to Serpulidae. Data on species depth distribution, abundance, size and some reproductive traits are summarized in Table 25. The most abundant taxa were the two *Perkinsiana* species that together accounted for a total of 782 individuals. This number is much higher respect to that found in the previous cruise (EASIZ I) were a total of 315 individuals of both species (197 *P. littoralis* and 118 *P. borsibrunoi*) were sampled. In most of the stations of the present cruise, however, the two species have not yet been sorted out and their abundances are therefore cumulated (Table 25). They occurred in 28 samples, and were collected with various type of gears (AGT, GSN and TVG) within a wide depth range from about 100 m (stn 214) to 800 m (stn 095) (Table 25). It is interesting to note that in case of sampling with the GSN, most of the individuals have been collected not from the bottom material inside of the catch, but from the sides of the net, with the tube entangled in the meshes. Both species show also quite a patchy distribution being relatively abundant (more than 50 individuals) only at a few stations (120, 168, 189, and 277). This fact

Table 25: Abundance, frequency, depth range, size and some reproductive features of the six species of polychaete suspension feeders collected.

	Perkinsiana littoralis	*Perkinsiana borsibrunoi*	*Myxicola* sp.	*Euchone* sp.	*Demonax* sp.	*Serpula narconensis*
No. individuals	782*		10	14	104	24
Frequency**	28*		3	6	5	9
depth range (m)	100-800*		200	75-400	65-200	200-800
size range (cm)***	3-12*		1-4	3-7	3-5	1-3
sex	gonochoric	gonochoric	gonochoric	gonochoric	gonochoric	-
reproduction	free spawner	free spawner	brooder	free spawner (?)	free spawner (?)	-
egg size (µm)	30-300	30-200	500-600	200	400	-

* data pooled for the two species of *Perkinsiana* ** total no. of stations: 39
*** body length (crown excluded)

has been noted also during the previous cruise, however, this pattern may be biased by the different sampling tools utilized and by the different amount of bottom material sampled at each station.

The other polychaete filter feeders showed quite a scattered distribution. *Euchone* sp. occurred from 75 m to about 400 m depth, while *Myxicola* sp. occurred only in 3 samples at 200 m depth (Table 25). This latter species is unique in having a typical mucous tube and in feeding at the sediment surface with the inferior side of the crown lying on the bottom. *Demonax* sp. was relatively abundant at only two stations: 212 (TVG at 65 m depth, 86 specimens) and 277 (AGT at 180 m depth, 27 specimens). This taxon seems to be related to shallow waters and was, in fact, one of the most abundant taxa found at stn 212 which represents the shallowest sample up to date obtained in the Eastern Weddell Sea. The tubes of all specimens collected at this station were heavily encrusted with coarse sand, gravel and small pebbles, fractions that dominated in the sediment. Finally, the serpulid *Serpula narconensis* occurred from 200 to 800 m depth. This species has a characteristic calcareous tube and can reach quite large dimensions, however the specimens found were all relatively small (1-3 cm in length, Table 25).

Reproductive biology and population structure. Observations on reproductive biology and population structure of the two *Perkinsiana* species have been initiated on the material collected during the previous EASIZ I expedition (ANT XIII/3) (Gambi *et al.* submitted), and have been complemented with the material collected during this cruise. Both species are gonochoric and eggs occurred in individuals belonging to all size classes identified (Fig. 22). Oocyte diameter was found to vary in *P. littoralis* between 30 µm to up 300 µm (eggs nearly mature), while in *P. borsibrunoi* between 30 µm and 200 µm (Table 25). In both species eggs are pale pink and are present only in the abdomen on both sides of the worm's coelomic cavity. The size-frequency distribution of eggs in both species suggests that the oogenesis is not synchronized among the individuals, as each specimen showed a different modal class. As regards the populations structure, the relationship between tube diameter and worm width for *Perkinsiana* spp. was highly significant ($r = 0.96$; $P < 0.01$) (Fig. 23). Correlation between body length and crown length (Fig. 24) was also relatively high for *P. littoralis* ($r = 0.87$, $P < 0.01$) and lower, but still quite good, for *P. borsibrunoi* ($r = 0.79$; $P < 0.01$). Thus this parameter, more easily measurable form video or photos, can be considered for both species a good descriptor of size. The size-frequency distribution (based on tube diameter) was estimated only in those stations where more than 50 individuals were sampled (Fig. 25). It is interesting to point out that at both stations 120 and 189, the populations are represented only by a few size classes. At stn 189 in particular, the high quantity of relatively small specimens collected probably all belong to *P. littoralis.* At stns 168 and 277 the populations were better structured, and many more size-classes were represented. At stn 120 the lack of small size-classes can be due to the sampling method (GSN) that selects only relatively large animals. At stn 189, the pattern observed indicates, on the contrary, the presence of a relatively young population derived from a single or a few recruitment events in a habitat probably relatively empty to allow mass colonization by suitable species. This station was in fact sampled in an area highly disturbed by iceberg scouring (Gutt pers. comm.). *Perkinsiana* spp. may therefore form characteristic facies of re-colonization in disturbed areas. However, one cannot exclude that a high predation pressure on larger *Perkinsiana* specimens may influence the observed figure at stn 189. Some reproductive features have been observed also for the other less abundant Sabellidae species collected. *Euchone* sp. was gonochoric, with eggs present only in the abdomen, with a maximum diameter of 200 µm. The *Demonax* sp. was also gonochoric, with a sex ratio close to 1:1. Females showed quite large eggs, around 400 µm in diameter (Table 25), and of a bright pink colour. The size-frequency analysis of eggs showed a typical bimodal distribution. This may indicate a synchronized oogenesis and the emission of different egg cohorts in various spawning events. The population structure of this species was also studied by measuring tube diameter at the two stations where it was relatively abundant (212, TVG and 277, AGT). The species showed a well structured population at stn 212 (Fig. 26), while at stn 277 smaller size classes were lacking probably due to the sampling method.

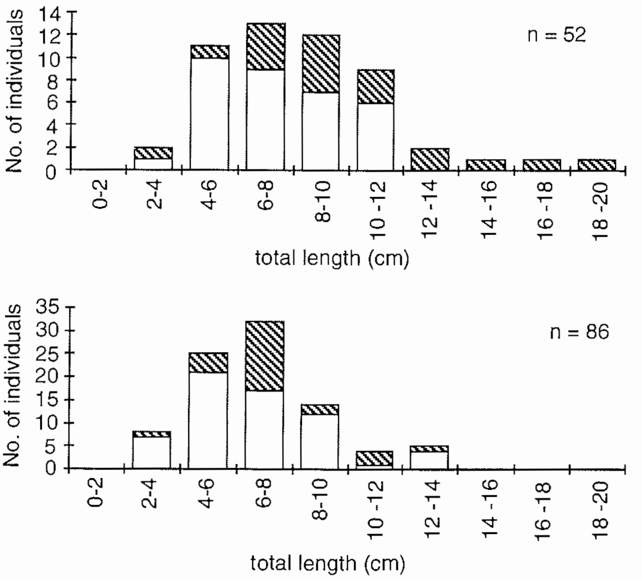


Fig. 22: Size-frequency distribution of *Perkinsiana littoralis* (above) and *P. borsibrunoi* (below) collected during the ANT XIII/3 cruise in 1996 (EASIZ I), with the indication of the specimens bearing eggs at various stages of development (shaded).

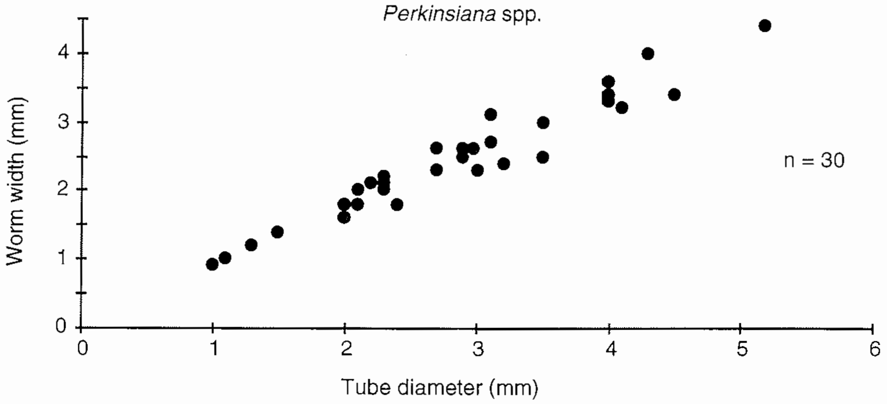


Fig. 23: Relationship between tube diameter and worm width of *Perkinsiana* spp. ($r = 0.96$ ($P < 0.01$).

Finally, from a biological point of view, the most interesting species was *Myxicola* sp., one female of which was found brooding a large amount of larvae within the branchial crown. The incubation habit has not been reported for the genus *Myxicola* (Rouse and Fitzhugh 1994), and may be related to the unique environmental conditions of the Antarctic waters. *Myxicola* sp. is also gonochoric, and the other females observed were bearing large eggs, nearly ready for deposition in the branchial crown, around 500-600 µm in diameter (Table 25) and with a bright orange-reddish colour. The brooded larvae were also orange and of about 700-750 µm in length, they had a round-pointed prostomium with a well developed prototroch and two ocular spots. Below the prototroch the first segment was slightly swallow and without setae. The following four segments were bearing two small capillary, slightly limbate setae each. No uncini were present. The pigidium was rounded and with two very small ocular spots. Since this was the only stage observed, it cannot be excluded that the larvae may have a short pelagic phase before metamorphosis.

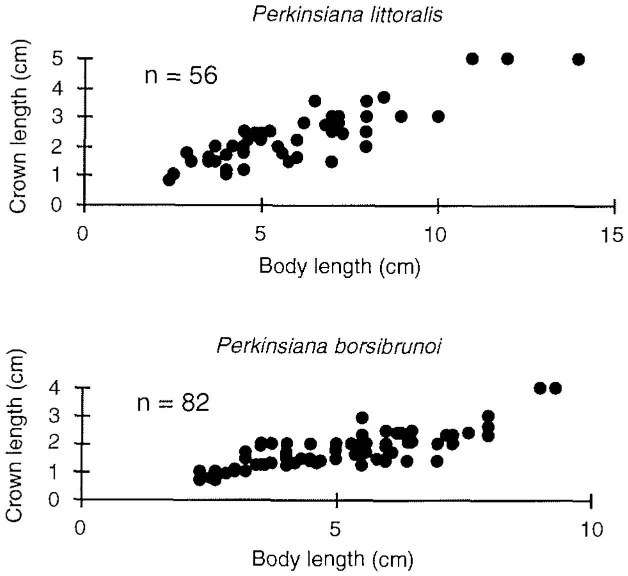


Fig. 24: Relationships between crown length and body length in *Perkinsiana littoralis* ($r = 0.87$, $P < 0.01$) and *P. borsibrunoi* ($r = 0.79$, $P < 0.01$).

Feeding ecology and behaviour. Behaviour inside the tube was observed only in two specimens of *Perkinsiana littoralis*. Other specimens were placed inside a pipette-glass tube as well, but most of them were not able to survive the stress of handling and died in a few days. *P. littoralis* do not fit completely the tube, the body is relatively flat, especially the posterior part of the abdomen, and leave more space inside the tube for water circulation. Irrigation movements were not continuous or constant but occurred when air circulation in the aquarium was closed and therefore oxygen probably decreased to a low level to stimulate irrigation. Irrigation in fact, is performed in many sabellids to increase oxygen uptake (Giangrande 1991). Each irrigatory cycle lasted about 50-55 seconds. As in other Sabellinae, the activity involved only the abdomen, except the last segments. The irrigatory swelling travels headwards. A low number of posterior segments start to swallow slightly and this "wave" is slowly propagated to the upper segments, up to the beginning of the thorax. Here the swallow is mantained for a few seconds and then the body relaxes backwards and a new cycle is starting. The specimens inside

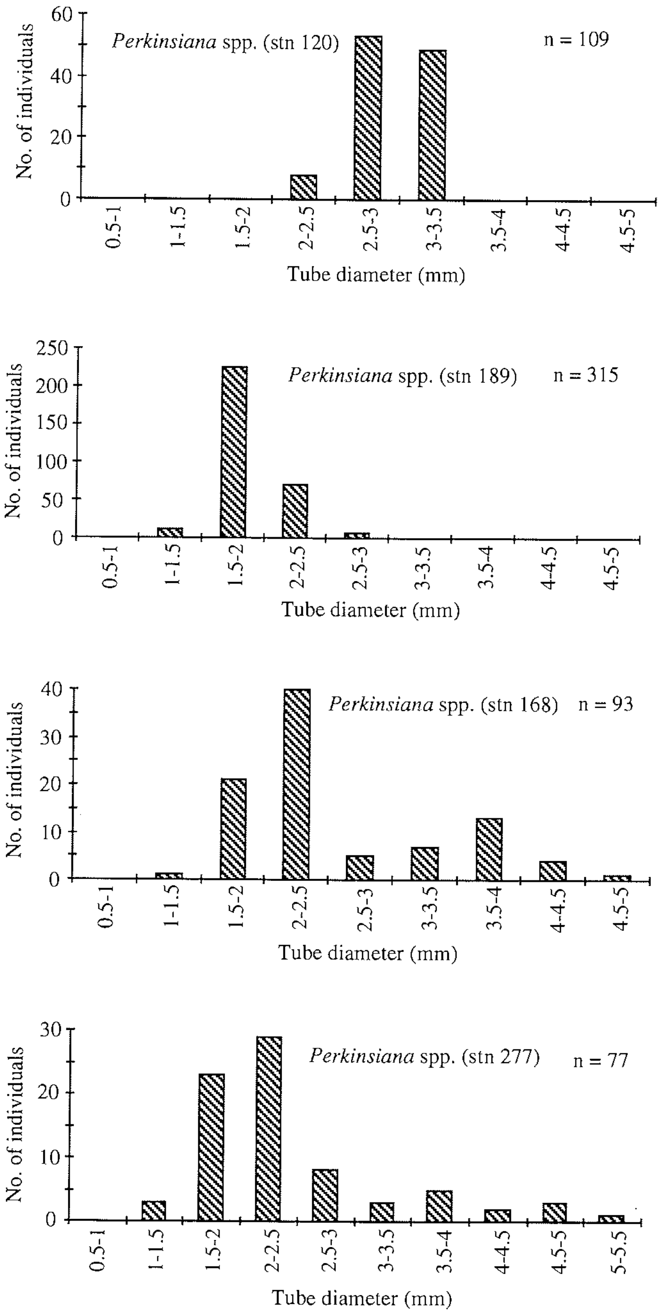
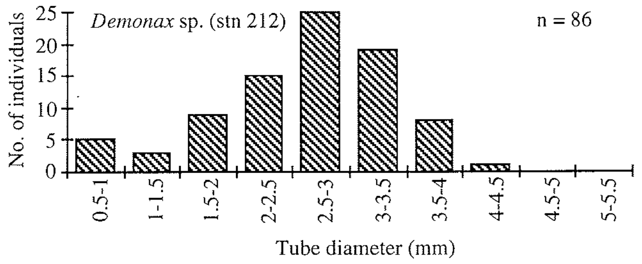


Fig. 25: Size-frequency distribution of *Perkinsiana* spp. populations.



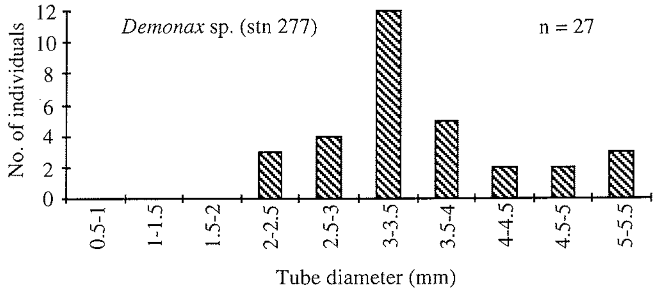


Fig. 26: Size-frequency distribution of *Demonax* sp. populations.

the glass tubes were able to survive for over a month and showed also a pattern of feeding activity which was comparable with that of the specimens in their natural tubes (see Table 26).

Table 26a: Short-term pattern of feeding activity of *Perkinsiana littoralis*.
F = feeding; W = withdrawal (not feeding); sW = half withdrawal (not feeding).

Time (h) Worm no.	0		1		2		3		4		5		6		7		8		9		10		11		12
1	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		
2	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		
3	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	W	F	F	W		
4	F	W	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		
5	F	F	F	W	W	F	F	F	F	F	F	F	F	F	F	W	F	F	F	F	F	F	F		
6	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		
7	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		
8	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F		
9	F	F	F	F	F	F	sW	F	F	F	F	F	F	sW	F	F	F	F	F	F	F	F	F		
10	F	F	F	F	F	F	F	F	W	W	W	W	W	W	sW	F	F	F	F	F	F	F	F		
11	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
12	sW	sW	sW	W	W	W	W	sW	F	sW	sW	sW	F	F	W	W	W	W	W	W	F	F	W	W	W
13	F	F	F	W	W	F	F	F	F	F	F	F	F	W	W	W	F	sW	sW	F	F	sW	sW	W	sW
14	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	W	F	F	F
15	W	sW	sW	sW	sW	sW	sW	sW	F	W	sW	sW	sW	sW	sW	sW	sW	F	W	sW	sW	sW	F	sW	sW
16	F	sW	sW	sW	F	W	sW	F	F	sW	F	F	sW	F	F	F	F	F	F	F	F	F	sW	F	W
17	-	-	-	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
18	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
19	F	F	F	F	F	F	F	F	F	F	F	sW	F	F	F	F	F	F	F	F	F	F	F	F	F
20	F	F	F	F	F	F	F	F	F	F	F	F	F	F	W	W	W	F	F	F	F	F	F	F	W

Table 26a continued.

Time (h)	0		1		2		3		4		5		6		7		8		9		10		11		12
Worm no.																									
21	F	F	F	F	F	F	F	F	F	F	F	F	W	F	F	F	F	F	F	F	F	F	F	F	F
22	-	-	F	F	F	sW	F	F	F	F	F	F	W	W	W	W	F	F	F	F	F	F	F	F	F
23	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
24	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	sW	sW	F	F	F	F	F	F	F
25	F	W	W	W	F	F	F	F	F	F	F	F	F	F	F	W	W	W	F	F	F	F	F	F	F
26	sW	sW	sW	sW	sW	sW	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
27	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	sW	sW	sW	sW	sW	sW	sW	F	F
28	sW	F	F	F	F	F	W	sW	sW	W	F	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW
29	W	sW	F	F	F	F	F	F	W	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
30	F	F	F	F	F	F	F	F	F	F	F	W	F	F	F	F	F	F	F	F	F	F	F	F	F
31	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	W	W	sW	sW	sW	sW	F	F	F
32	W	W	W	F	F	sW	F	F	F	F	F	F	W	W	W	W	W	W	W	W	W	W	W	W	W
33	W	W	W	W	F	F	F	F	sW	sW	sW	sW	W	WF	F	F	sW	sW	sW	sW	sW	sW	F	W	W
34	F	F	F	F	F	F	F	F	F	F	F	F	F	W	W	W	W	W	W	W	W	F	F	F	F
35	W	F	F	F	F	sW	sW	sW	sW	F	W	W	F	F	F	F	F	F	F	F	F	F	F	F	F
36	W	sW	F	W	W	W	W	sW	F	F	F	F	F	F	F	F	F	F							
37	F	W	W	W	W	W	sW	F	W	W	sW	sW	sW	sW	sW	sW	sW	sW							
38	sW	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W							
39	F	F	F	F	F	F	F	F	F	F	W	W	sW	sW	sW	sW	sW	sW							
40	sW	F	F	sW	sW	F	sW	sW	sW	sW	sW	sW	sW	sW	F	F	F	F							
41	F	F	F	sW	F	F	F	F	F	F	F	F	F	F	sW	F	F	F							
42	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W							
43	sW	W	sW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
44	sW	sW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
45	W	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW							
46	sW	F	F	F	F	F	F	F	F	F	F	sW	F	F	F	F	F	F							
47	W	W	W	W	W	F	sW	sW	sW	sW	W	sW	W	W	F	F	W	W							
48 *	W	sW	F	F	sW	sW	sW	sW	F	F	F	F	sW	F	F	F									
49 *	F	F	F	F	F	F	F	F	F	F	F	F	W	W	W	W									

* = glass tube

Table 26b: Short-term pattern of feeding activity of *Perkinsiana borsibrunei.*

Time (h)	0		1		2		3		4		5		6		7		8		9		10		11		12
Worm no.																									
1	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	sW	F	F	F	F	F	F	F		
2	W	W	W	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
3	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	W	W	W
4	F	F	F	F	F	F	W	W	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
5	sW	sW	F	F	F	W	F	F	F	W	F	F	F	W	W	W	W	W							
6	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
7	sW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
8	sW	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
9	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
10	F	F	F	F	F	F	F	F	F	F	F	F	F	W	F	F	F	F							
11	W	W	W	W	W	W	F	F	F	F	F	F	F	F	W	W	W	W							

Table 26c: Short-term pattern of feeding activity of *Euchone* sp.

Time (h)	0		1		2		3		4		5		6		7		8		9		10		11		12
Worm no.																									
1 (1st day)	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W		
1 (2nd day)	W	sW	sW	sW	sW	sW	sW	sW	sW	F	F	F	F	sW	W	W	W	W	W	W	W	sW	sW	sW	sW
1 (3rd day)	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F							
2	W	W	sW	sW	sW	W	W	W	W	W	W	W	W	W	W	W									
3	F	sW	sW	W	W	W	W	W	W	W	F	sW	F	W	W	F									
4	F	F	F	F	F	F	sW	sW	sW	sW	sW	sW	W	sW	sW	sW									
5	W	sW	F	F	F	W	F	W	sW	W	W	sW	F	sW	sW	sW	F	F							
6	W	W	W	W	W	W	W	W	sW	F	W	W	sW	sW	sW	W	W	W							
7	W	sW	F	W	W	W	W	W	W	F	W	W	W	F	W	F	W	F							
8	F	W	F	F	F	F	W	W	W	F	W	F	F	F	W	F	F	W							

Table 26d: Short-term pattern of feeding activity of *Demonax* sp.

Time (h)	0		1		2		3		4		5		6		7		8		9		10		11		12
Worm no.																									
1	F	F	F	F	F	F	F	F	sW	F	F	sW	sW	WF	F	F	F	F	F	F	F	F	F		
2	W	W	W	W	sW	sW	W	F	W	W	W	W	W	W	W	W									
3	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F									
4	W	W	W	sW	W	W	W	sW	sW	F	F	sW	W	W	W	sW									
5	F	F	F	F	F	F	W	F	F	F	F	sW	sW	sW	sW	F									
6	F	F	F	F	F	F	F	F	F	F	sW	sW	sW	F	sW	sW									
7	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F									
8	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F									
9	F	F	F	F	F	F	F	F	F	F	W	F	sW	F	F	F									
10	F	F	F	F	F	F	F	F	W	W	W	W	W	W	sW	F									
11	F	F	F	sW	sW	sW	F	F	F	F	F	W	W	F	F	F									
12	F	F	F	F	F	F	F	F	F	F	F	F	F	sW	F	F									
13	F	F	F	F	F	F	W	sW	sW	sW	sW	W	W	sW	F	F									
14	F	F	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW	sW									
15	F	sW	F	F	F	F	F	F	F	sW	sW	sW	sW	sW	sW	sW									
16	F	F	sW	F	F	W	sW	sW	F	F	F	W	sW	sW	W	sW									
17	sW	sW	sW	F	F	F	F	F	F	F	F	sW	sW	F	F	F	F	F							
18	sW	sW	sW	F	F	F	sW	F	F	F	F	F	F	sW	F	F	F	sW							
19	F	sW	sW	F	F	F	sW	F	F	F	F	F	sW	sW	F	F	F	F							

The pattern of time spent in feeding has been estimated for the two *Perkinsiana* species, as well as for *Euchone* sp. and *Demonax* sp. (Table 26). The numerous observations conducted on *P. littoralis* demonstrated a high degree of variability among individuals. The time that each specimen spent in extension or retraction (withdrawal) of the crown is very idiosyncratic. Some specimens may filter continuously for long periods (up to 12 hours), while others show quite an irregular pattern where filtering is interrupted for relatively long periods of withdrawal (from half an hour to 4-5 hours). Only relatively few specimens remained long periods withdrawn (up to 12 hours). On the average, the species spent around 30% of the time in withdrawal (1123 observations on 49 specimens). *P. borsibrunoi* showed a less variable pattern with more individual filtering for long periods, or alternating the feeding with shorter periods of crown retraction (from half an hour to 2-3 hours); the species on the average spent only around 14% of its time in withdrawal (224 observations on 11 specimens). *Demonax* sp. showed a pattern as irregular as that of *P. littoralis*, and spent on the average 36% of time in withdrawal (317 observations on 19 specimens). Finally, *Euchone* sp. showed an opposite trend to the previous species. Most of the individuals observed spent long periods in withdrawal (on the average 71.5% of time), and relatively short periods of filter feeding (28.5%) (186 observations on 10 specimens). One large individual (no. 1 in Table 26), observed for several days, spent long period in continuous filtering (up to 8 hours), but this was followed by long withdrawal time.

Other species of Sabellidae are reported to spend from 10% to 30% of their time withdrawn (Giangrande 1991 and references herein). Thus, the *Perkinsiana* species fall within this range, while *Demonax* sp. and *Euchone* sp. showed higher values. An explanation for this pattern could be oxygen is not limiting, not even when the crown is retracted in the tube, so withdrawal time can be increased to reduce the risk of predation.

A long-term study on feeding activity conducted at Signy Island on a species most probably belonging to one of the two *Perkinsiana* species here studied (Barnes and Clarke 1995, indicated there as *Potamilla antarctica*), demonstrated that those sabellids cotinue filtering all year around, except for short periods in July-August. The short-term observations made during the cruise on both *Perkinsiana* species suggest a more complex and variable behaviour, at least at the individual level. However, the relatively short time of observation (12 hours) may be not suitable to detect the presence of a possible pattern in feeding time.

Gut content analysis has been conducted on some specimens of all the six collected species (Table 24). A relatively large spectrum of items was represented in the gut; the most abundant and frequent items, occurring in all species, were POC (particulate organic matter), pelagic diatoms and dinoflagellates, tintinnids (protozoans) and sediment grains. To this general pattern, some differences among the various species can be pointed out as regards the occurrence of other items or the relative proportion of the above mentioned common ones. Both species of *Perkinsiana* show the occurrence of many other items, among wich the most interesting are copepods of benthic origin (harpacticoid and commensals, that are most probably taken by resuspension of bottom material in the water column), as well as pelagic foraminifers (globigerins). *Myxicola* sp. showed the lowerst diversity of items, being the material of bottom origin (sediment grains, spicules), as well as the tintinnids, very scarcely represented, while diatoms and dinoflagellates were dominant. *Euchone* sp. showed a pattern similar to the *Perkinsiana* species, and interestingly in this species plant detritus of macroalgal origin was found. Such detritus was also detected in *Demonax* sp. and *Serpula narconensis*. This fact is not totally surprising, since in one of the shallowest station sampled (Dredge sample 037 at 114 m depth) a small fragment of a living red macroalga was found attached to a small sea urchin *Sterechinus* sp. These findings raise doubts whether macroalgae are really non-existent in the area. In *Demonax* sp. and *S. narconensis* a much lower proportion of dinoflagellates was observed, whereas especially in *Demonax* sp. a larger amount of sediment grains and spicules of sponges occurred. In terms of the dimensions of the preyed items, a large spectrum of sizes was represented (Table 24). Species of relatively large dimensions (several cm) suchs as the two *Perkinsiana*, *Euchone* sp. and *Demonax* sp. may take organisms (e.g., copepods or diatoms) up to 500 µm, and some spicules of sponges or fragments of macroalgal detritus were up to 1-2 mm in length.

This preliminary analysis provided evidence of a wide range of preys and sizes captured and, thus, a low selectivity of food intake for both species of *Perkinsiana* and for *Euchone* sp. Conversely *Myxicola* sp. showed a higher degree of selectivity. The scarcity of dinoflagellates recorded in *Demonax* sp. and in *Serpula narconensis* could be due to both rejection of this kind of prey or to their absence in the water column at the stations where they have been sampled. In general, most of the studied species seem to ingest any kind of material that is suspended (or resuspended) in the water column. These results are quite different from what it is generally known for polychaete filter feeders that are considered poorly efficient and to prey only upon POC material or very small phytoplankton (Dales 1957). Antarctic species seem to be more efficient and to profit of any item available during the favourable summer season. However, only from the analysis of the gut content it is not possible to establish which kind of items are actually consumed by the worm and not simply ingested and passed unexploited through the gut.

Acknowledgements

I wish to thank all colleagues who provided me with material for laboratory experiments, and those who helped in the identification of gut content items. Thanks are due to C. Orejas for providing the diatom cultures for feeding-rate experiments, and to M. Rauschert for taking some nice photos of sabellids.

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2.3 Studies at the Drescher Inlet: Seals, Fish, Sea Ice and Hydrography

General objectives

The Drescher Inlet, a funnel shaped 20 km long crack in the Riiser Larsen Ice Shelf, is flanked by floating ice cliffs of up to about 30 m above and 150 m below the sea surface. The topography of the inlet is somewhat irregular with water depths ranging from 360 m to 430 m and the sea bed extends for unknown distances under the ice shelf. The area is characterized by large changes in the physical environment as strong gales and swell induce ice break up which is most intensive during late summer. When the fast ice cover recedes, large numbers of Weddell seals and crabeater seals haul out at the ice edge and at tidal cracks in the inner parts of the inlet. During that time, masses of organic material such as seal and penguin faeces and ice algae are released into the water column from the melting brash and platelet ice, an attractive food source for zooplankton, amphipods and krill especially in the surface layers. This again attracts pelagic fish and finally krill and fish feeding predators, the crabeater and Weddell seals. Knowledge of the trophic relationships between the top consumers and their prey and their ecological interaction with other biological key components and physical processes is fundamental for an improved understanding of the high Antarctic shelf marine ecosystems.

To gain new insights into of the seals' underwater environment, studies on the diving and foraging behaviour of Weddell seals (chapter 2.3.1) and migratory and diving behaviour of crabeater seals (chapter 2.3.2) are closely linked to studies on the role of algae communities in platelet ice for pelagic and benthic consumers (chapter 2.3.6), to the studies on vertical biomass distribution and diurnal migratory behaviour of pelagic fish (chapters 2.3.4 and 2.3.5), and to studies on the distribution and abundance of pack ice seals carried out by census surveys with helicopters of RV "Polarstern" (chapter 2.3.3). Here we present the preliminary results of the three working groups.

2.3.1 Diving and Foraging Behaviour of Weddell Seals (J. Plötz, H. Bornemann)

Objectives

The studies on Weddell seals are part of the EASIZ (Ecology of the Antarctic Sea Ice Zone) programme of SCAR closely linked to the APIS (Antarctic Pack Ice Seals) programme initiated by the SCAR-Group of Specialists on Seals.

Weddell seals are excellent divers highly adapted to reside in the coastal fast ice zone, a dynamic ecosystem that is strongly influenced by the seasonal ice break off. The primary objective was to investigate, during days of continuous recordings, the seals' diving and feeding activities using different types of electronic data loggers. A unique opportunity of this study is to compare the dive records of the seals with hydrographic events under the fast ice of the inlet (CTD-profiles provided by Dieckmann and Thomas, see chapter 2.3.6) and with data on the vertical biomass distribution and diurnal migratory pattern of pelagic fish (chapter 2.3.4) obtained by bentho-pelagic trawling in the same study area. Another important goal is to identify the seals' individual haulout periods. Knowledge of diurnal haulout patterns is important when adjusting estimates of seal abundance calculated from airborne censuses (chapter 2.3.3).

Work at Drescher Inlet

The study on Weddell seals was done in stages spread out over three weeks. From 7 to 13 February, calm and sunny weather contributed to the development of a stratified pycnocline at about 150 m. The period from 14 February onwards until the end of our field campain on 23 February was characterized by an intensive ice break up and mixing of the upper water layers (see chapter 2.3.6).

The Weddell seals were immobilized to achieve a reliable attachment of the logging devices. We used a combination of ketamine, xylazin, and diazepam. The initial doses of the drugs were administered by Telinject-blowpipe darts to minimize the seals' defence and flight responses. Thus, undue stress to the animals is prevented and the risk of adverse reactions to the anaesthesia reduced. Maintenance of immobilization, which lasted for 1.5 - 3 h, was achieved by small additional doses of ketamine and/or diazepam administered by hand. The mixture of ketamine, xylazine and hyaluronidase described as "Hellabrunner Mischung" (HM) contains 500 mg xylazin + 400 mg ketamin + 150 I.U. hyaluronidase. Seals were drugged with either one (body weight: 250 - 350 kg), two (350 - 450 kg), or three (450 - 550 kg) shots of 4.0 ml HM /seal. We reversed the anaesthesia by administration of the antidote yohimbine (0.5 mg/kg).

Preliminary results

We equipped 31 Weddell seals and got back 19 loggers of which 3 had failed. The remaining 16 loggers provided profiles of about 4,000 dives. Dive and haulout records were obtained for periods of up to 14 days. Most of the 16 data records overlapped by many days. The haulout behaviour of seals was affected by the ice situation. Under stable ice conditions they showed a fairly uniform haulout pattern with periods of about 8 to 14 hours at daylight. This regular pattern was somewhat disturbed during the intensive ice break up. During that time the seals dived, without interruption, for periods of 3, 4 and even 6 days. Seals did not necessarily haul out every day, and when on the ice, they again preferred the daylight hours around noon but for short periods of 3 to 6 hours. The majority of both pelagic and bottom dives lasted for about 20 min. It is of particular interest that the longest dives of more than 1 hour were made to about 150 m depth, and not (as expected) to the sea bottom at about 400 m. The maximum record of one pelagic dive was 78 min.

An explanation for the seals' ongoing diving activites during the ice break off might be that (as described above) masses of organic material released from the melting brush and platelet ice provided an attractive food source for zooplankton, that again attracted fish and finally the seals. Fig. 27 gives an example of a series of foraging dives to the three most preferred depth layers,

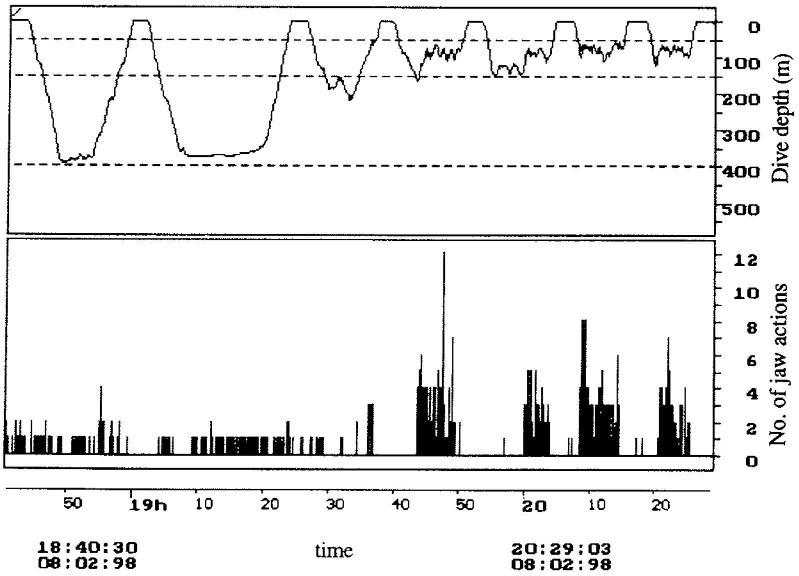


Fig. 27: Example of benthic and pelagic feeding dives of a Weddell seal. Note the increase of jaw action signals (below) of up to 12 mouth openings per 8 sec measuring interval during pelagic diving between the 50 and 150 m depth layer indicated by dotted lines.

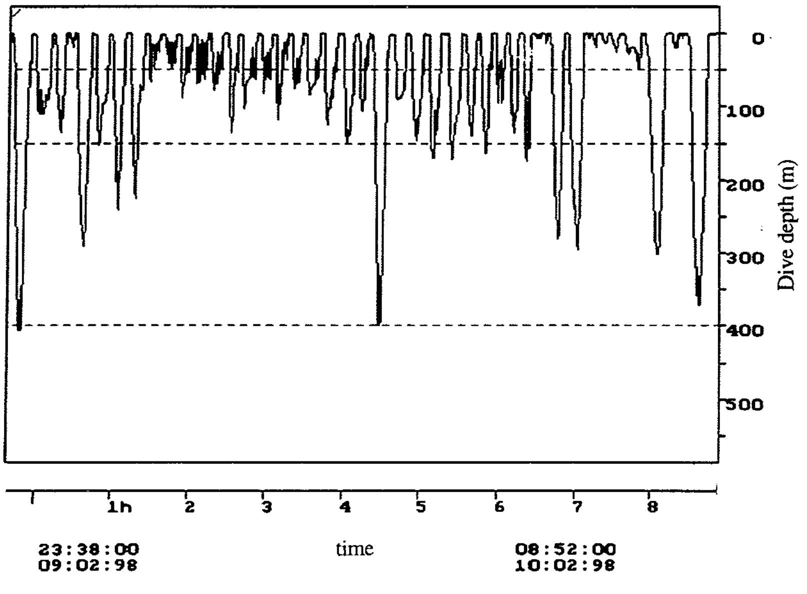


Fig. 28: Example of a typical dive pattern of a Weddell seal. The progressive change in dive depth may reflect the seal's response to vertical migration in fish.

i.e. 50 m, 150 m and 400 m. During benthic diving the seal opened its mouth mostly once per 8 sec-measuring interval. A significant increase in jaw action (up to 12 signals per 8 sec) coincided with the seal's switching from benthic to pelagic dives. These signals of feeding events (or at least prey catch trials) were most intensive within the 50 to 100 m pycnocline depth, where Knust *et al.* (chapter 2.3.4) caught a high biomass of vertically migrating *Pleuragramma antarcticum* followed by *Anotopterus pharao*, a pelagic fish predator.

Another characteristic feature of the feeding dives of Weddell seals is the pattern of a progressive change in the maximum dive depths (Fig. 28). During nighttime most foraging activities occurred in the pycnocline depth between 50 and 150 m. We infer that this typical pattern of an arch-like dive profile reflects the seal's response to vertical migration in fish, a phenomenon that was also observed in *Pleuragramma antarcticum* and *Anotopterus pharao* caught by pelagic night hauls (Knust *et al.*, chapter 2.3.4). As far as we know, this is the first record of vertical migratory behaviour in both the Weddell seal and Antarctic fish.

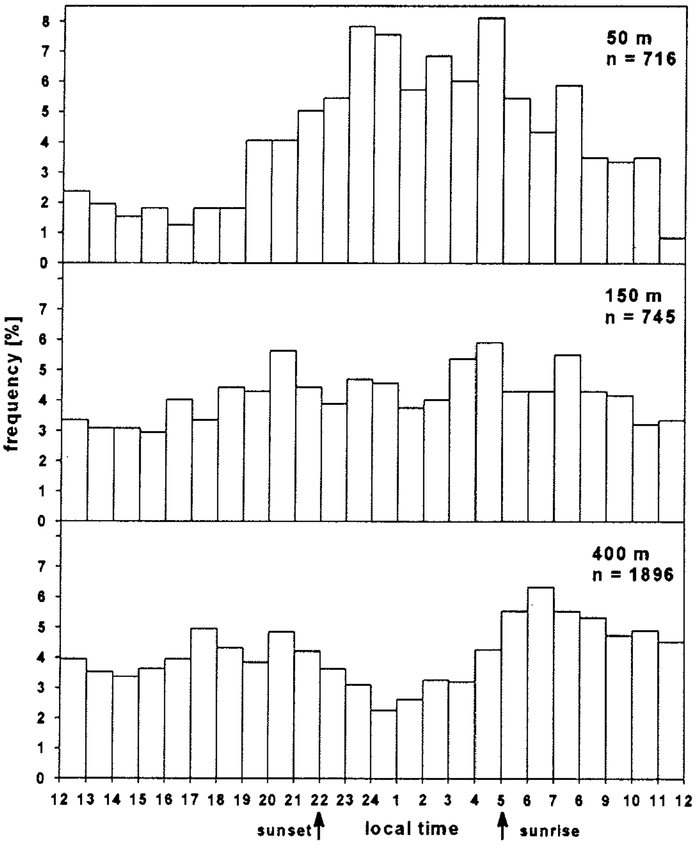


Fig. 29: Frequency distribution of the depths of dives (n = 3357) against time of day. The dive records of 16 Weddell seals were placed into three depth categories.

Fig. 29 represents an overview of most of the dive records obtained. A total number of 3357 dives was roughly categorized into the seals' three preferred depth ranges of 50 m, 150 m and 400 m. The percentage frequency distributions of these dives indicate an increase of pelagic dives during nighttime with a distinct maximum in the 50 m water layer, a broad maximum in the 150 m layer and a minimum of night dives to the sea bottom at about 400 m depth.

2.3.2 Satellite Tracking of Crabeater Seals (H. Bornemann, J. Plötz)

Introduction and objectives

The studies on crabeater seals are part of the international APIS (Antarctic Pack Ice Seals) programme of the SCAR Group of Specialists on Seals. Next to the seal census surveys (see Bester and Odendaal, see chapter 2.3.3) a key element of this programme is to determine seasonal movements, haulout and diving behaviour of crabeater seals by using Satellite-linked Dive Recorders (SDR). To obtain a comprehensive picture of the seals' behaviour in their three-dimensional environment these data need to be interpreted in the context of both biological and physical parameters of the seals' marine environment. The data will be related to information on prey dynamics, ice characteristics and distribution, water column physics and ocean currents by using the information system SEPAN (see below). The data will also provide haulout correction factors to improve the accuracy of the seal census design.

Work at Drescher Inlet

Immobilization of the crabeater seals has been done as described above (see chapter 2.3.1). Crabeater seals were drugged with lower doses of 2 - 3 ml HM, which were supplemented by 2 - 3 ml ketamine (100mg/ml). Body length and girth measurements were taken. We equipped 15 crabeater seals (Table 27) with satellite-linked dive recorders (SDR) between 28 Jan and 6 Feb 1998. The SDRs (SDR T6, Wildlife Computers, USA) are designed to provide at-sea locations through the Service ARGOS system (CLS / Service Argos, France) during the seals' foraging migrations. While at sea the SDRs also process data on the seals' diving behaviour in the form of histograms. These histograms are encoded into messages and transmitted to polar-orbiting satellites. The accessed data provide both the horizontal extent of the seals' migration and the vertical distribution of their dive depths.

Table 27: Tracking periods of crabeater seals and last locations (20.03.98) during EASIZ II.

No.	Sex	Start	End	Last location
1	M	28-01-98	04-03-98	71.961° S, 33.247° W
2	M	29-01-98	05-02-98	73.611° S, 38.257° W
3	F	29-01-98	29-01-98	72.877° S, 19.131° W
4	M	01-02-98	01-02-98	No data
5	M	01-02-98	18-02-98	71.926° S, 27.855° W
6	M	01-02-98	*	
7	M	01-02-98	*	
8	M	01-02-98	*	
9	F	02-02-98	*	
10	M	03-02-98	*	
11	M	03-02-98	14-03-98	70.416° S, 37.236° W
12	M	03-02-98	13-03-98	72.344° S, 44.679° W
13	M	04-02-98	06-02-98	72.830° S, 19.844° W
14	F	04-02-98	*	
15	M	06-02-98	21-02-98	67.108° S, 14.889° W

F = female M = male *still transmitting (20-03-98)

Preliminary results

The animals left the Drescher Inlet between 1 and 5 days after they had been equipped with SDRs. During the first two weeks the seals migrated in different directions. The migratory routes of seals appear to be related to the unusually low sea ice cover of 1 - 3 tenths along the eastern Weddell sea coast between 0 and 25° W (Fig. 30; see chapter 2.3.3).

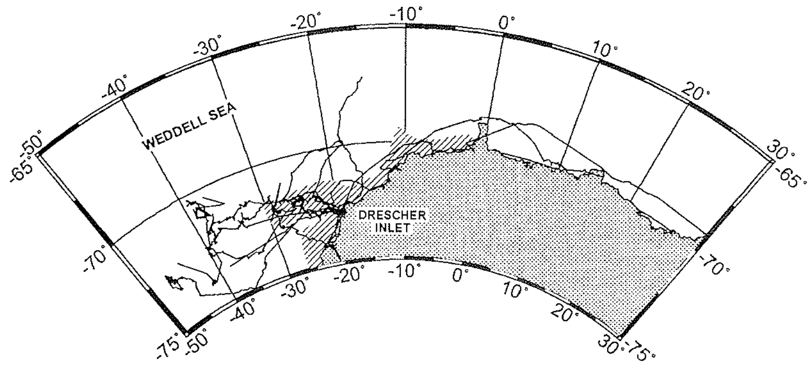
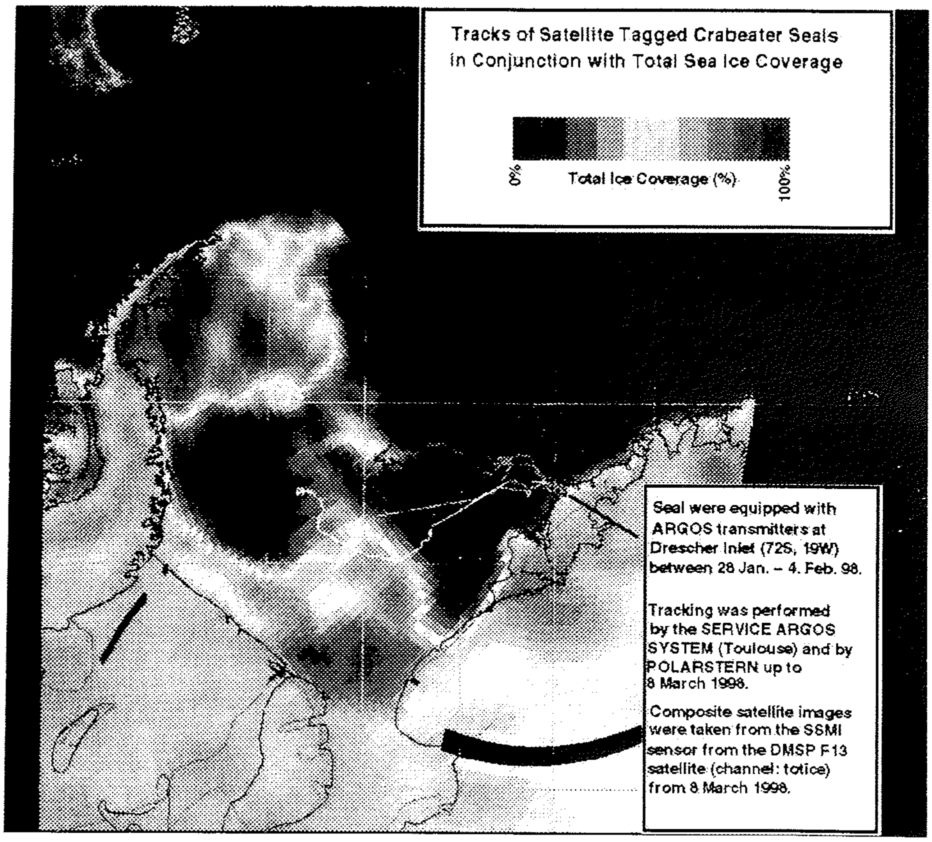


Fig. 30: Migration routes of satellite tracked crabeater seals until 8 Mar in conjunction with the sea ice cover on 30 Jan 1998 (hatched area). Tracks started between 28 Jan and 06 Feb 1998.

One male and one female migrated eastward up to 30° E. Their migration route was initially associated with the small band of sea ice near the ice shelf. After passing 0° W they continued to 30° E in ice free water adjacent to the ice shelf. Twelve crabeater seals migrated westward, and reached an ice covered area at 35° W at the beginning of March where they remained. The migratory routes of the westward moving animals correspond roughly to a strong branch of the Weddell Gyre whereas the eastward moving seals had to swim against the coastal current. Maximum distances reached were 1900 km eastward and approximately 720 km westward. Satellite images (Figs 31 - 32) give the tracks of the crabeater seals in conjunction with the total ice cover of the Weddell Sea for 8 and 20 March Data of ice concentration are derived from the Special Sensor Microwave/Imager (SSM/I) of the DMSP F13 satellite. The data were processed on board "Polarstern" by G. König-Langlo.

The average period the seals remained inside the Drescher Inlet between 28 Jan and 9 Feb 1998 was 2 days (Min 1, Max 5). During this time a total of 3221 dives were recorded. The location and dive data were transmitted from the SDRs via ARGOS satellites, the receiving station in Toulouse (France), and the AWI (ARGOS-data adminstration by L. Sellmann, Bremerhaven) to the "Polarstern" for analyses. This data transfer can be done in a minimum of 6 hours allowing an almost "online" pursuit of the seals' behaviour. The frequency distribution of dive depths is presented in Fig. 33. Next to the absolute maximum for the 10 m bin (minimum depth to be considered a dive = 6 metre) a further two relative maxima exist for the 40 m and the 150 m bin. These depths closely correlate with hydrographic features, e. g. thermo- and pycnocline layers in 50 and 150 m. The relative maxima of the frequency distribution of dive depths of 40 m and 150 m coincide with the preferred dive depth of the Weddell seals in the pelagic zone although the ratio of dives between the two depth ranges is quite different. The proportion of dives below 150 m represented a value of less than 1.5% of all dives. The overall distribution of dive depths confirms the crabeater seals' preference of shallow depths less than 50 m (>75% of all dives). However, a trimodal distribution of dive depths has not been reported for the crabeater seal yet and might be due to the special hydrography of the Drescher Inlet (see chapter 2.3.6).



Seal were equipped with ARGOS transmitters at Drescher Inlet (72S, 19W) between 28 Jan. – 4. Feb. 98.

Tracking was performed by the SERVICE ARGOS SYSTEM (Toulouse) and by POLARSTERN up to 8 March 1998.

Composite satellite images were taken from the SSMI sensor from the DMSP F13 satellite (channel: totice) from 8 March 1998.

Fig. 31: Composite satellite image of total ice cover (8 Mar 1998, gray-scale coded) and tracks of 15 satellite tagged crabeater seals.

Bengtson and Stewart (1992) found a distinct diel pattern of dive timing and depth related to possible predator avoidance behaviour by the crabeater seals' principal prey, Antarctic krill. We observed a similar pattern for both the crabeater and Weddell seals. Fig. 34 shows the diel pattern of dive depths of all crabeater seals divided into 6 hourly blocks. Dives to 10 m where almost independent of the time of day and can be classified as travelling or ice associated dives (after Bengtson and Stewart 1992). Dives summarized in the 20 m bin and the 40 m bin show clear dependencies on the time of day. In both bins the two blocks between 18 and 6 hours show distinct maxima and also contain the periods of dusk and dawn. This was principally true for the few dives in the 30 m bin. Below 40 m this relationship changed showing deeper dives to be more frequent in the two blocks between 12 - 18 and 6 - 12 hours. This clearly indicates that dive depth is a function of daytime and of hours with high solar elevations. These cyclic variations of light levels in the water column are likely to trigger both the vertical migration of the seals and their prey (see chapters 2.3.4 and 2.3.5).

All location and diving behaviour data will be entered into the information system SEPAN (Sediment and Paleoclimate Data Network) of the Alfred Wegener Institute (Diepenbroek *et al.* 1996). SEPAN contains selected data from WOCE and JGOFS as well as the GEBCO charts. The Atlas of the Southern Ocean (Olbers *et al.* 1992) is incorporated and will enable us to analyse our data in relation to a fine-meshed network of hydrographic data (e.g. CTD-profiles).

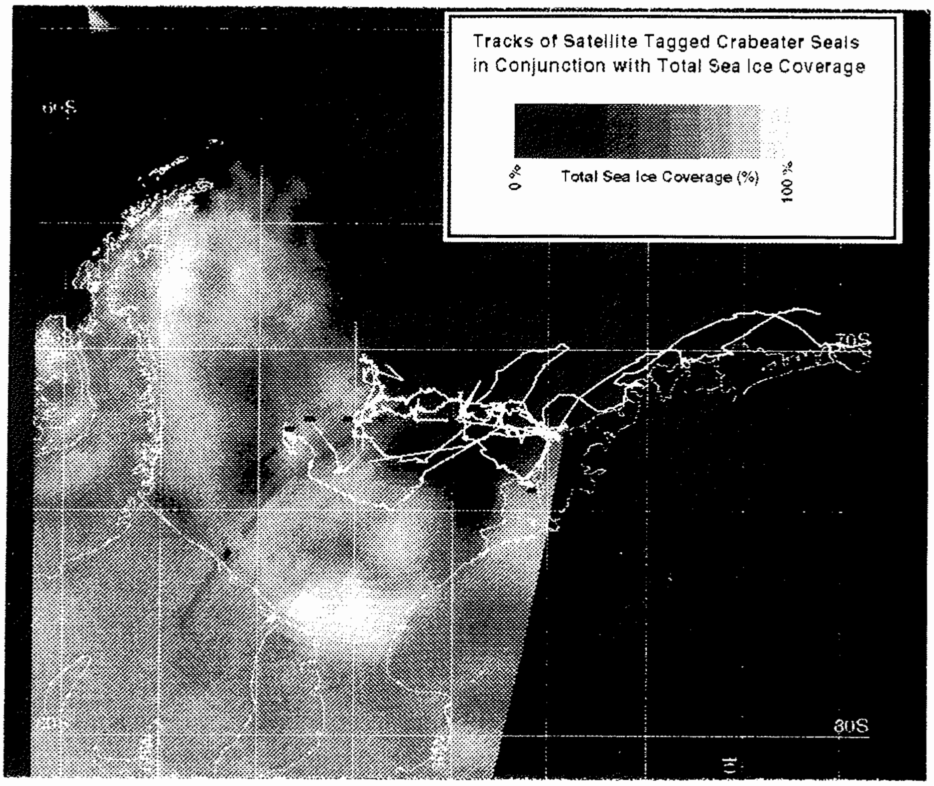


Fig. 32: Composite satellite image of total ice cover (20 Mar 1998, gray-scale coded) and tracks of 9 satellite tagged crabeater seals. Last locations between 14 and 18 Mar are marked with a circle. SDRs which had failed until 08 Mar are not included.

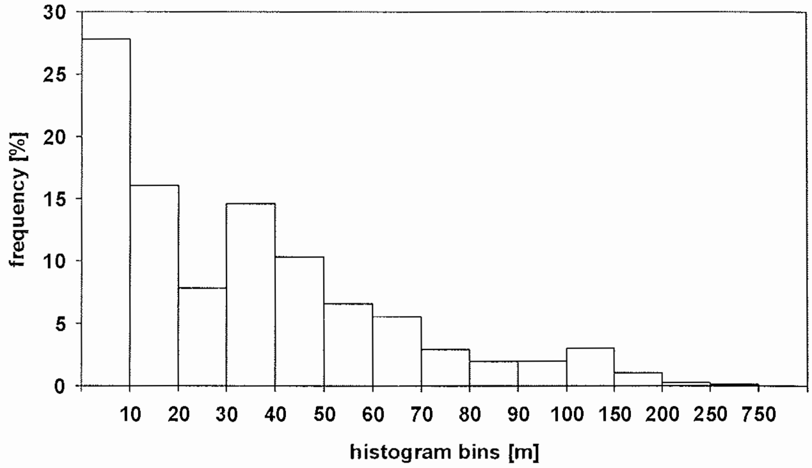


Fig. 33: Frequency distribution of maximum dive depths (n = 3221) of 15 crabeater seals at Drescher Inlet (72° 52'S 19° 26'W) from 28 Jan - 09 Feb 1998.

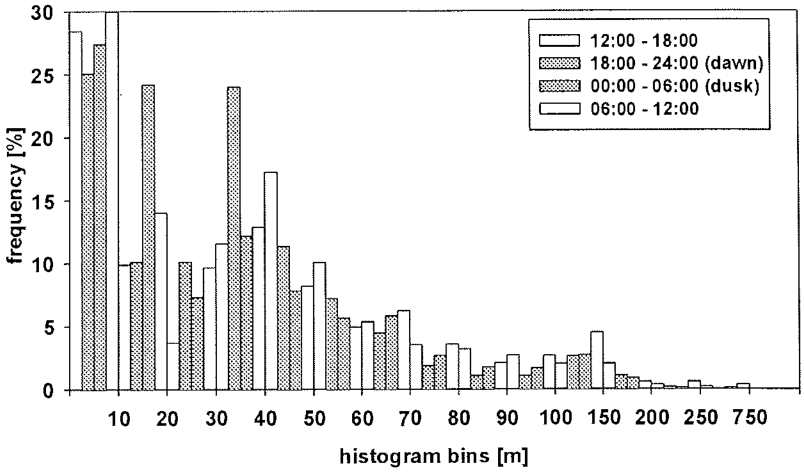


Fig. 34: Diel pattern of the frequency distribution of maximum dive depths (n = 3221) of 15 crabeater seals at Drescher Inlet (72° 52'S, 19° 26'W) divided into 6 hourly blocks from 28 Jan - 09 Feb 1998. The grey bars include the periods of dusk and dawn.

Acknowledgement

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2.3.3 Abundance and Distribution of Antarctic Pack Ice Seals in the Weddell Sea (M. N. Bester, P. N. Odendaal)

Introduction

As a group that occupy the pack ice and fast ice zones of Antarctica, crabeater seals (*Lobodon carcinophagus*), Ross seals (*Ommatophoca rossii*), leopard seals (*Hydrurga leptonyx*) and Weddell seals (*Leptonychotes weddellii*) are among the dominant top predators in the Southern Ocean ecosystem and the fluctuations in their abundance provide a potential source of information about environmental variability. The perceived decline in crabeater seal numbers over part of their range between the late 1960s and 1983 and the unknown current status of the four pack ice phocid seal species, resulted in a recommendation by the SCAR Group of Specialists on Seals (GSS) that a continent-wide census of Antarctic seals be undertaken.. The Antarctic Pack Ice Seals (APIS) Program was formulated by the SCAR GSS to consider the functional significance of ice-breeding seals in the Southern Ocean and to investigate seals' interactions with other top level predators and environmental factors. To this end a collaborative, circumpolar survey was planned as part of APIS to obtain data on Antarctic pack ice seal abundance and distribution.

Objectives

The present study was undertaken to:

- assess the density, species composition, and possible change in the status of pack ice seals within the Weddell Sea and to reconcile it with pack ice conditions and other environmental parameters;
- complement a study into the migratory and feeding behaviour of pack ice seals at the Drescher Inlet in the eastern Weddell Sea, and
- apply and evaluate the distance sampling methodology (line transect sampling) adapted to aerial censuses of pack ice seals.

Methods

Aerial censuses were flown alternating between a single engined Bell Long Ranger II and a twin engined Bölkow Blohm (BO) 105 helicopter operating from the RV 'Polarstern'. The ship remained largely in a coastal polynya at the continental shelf zone in the eastern Weddell Sea, and its daily positions were determined by the requirements of fishery/benthos/biodiversity related research programmes, the relief of the Neumayer Station (70°36'S, 08°22'W) and the setting up of a field camp at the Drescher Inlet (72°52'S, 19°26'W). The pack ice surveyed from 23 January - 22 February 1998 extended in patches from 08°09'S longitude (Atka Bay) to 26°51'S longitude (Halley Bay) along the coast, an area largely devoid of pack ice as shown by satellite imagery (0-3 tenths ice coverage). Surveys 1-3 were initially flown at a groundspeed of 80 kns and at an altitude of 300 ft as determined by radar altimeter. Difficulty to establish species identity resulted in surveys 4-15 being flown at a groundspeed of 60 kns and an altitude of 200 ft. Censuses 14 & 15 were executed as the ship transited the northernmost part of the pack ice in the western Weddell Sea before rounding the tip of the Antarctic Peninsula into the Bransfield Strait. All censuses were flown within the midday haulout period for crabeater seals extending from 11:00-15:30 local apparent time. Surveys 1 - 3 were also used to train the inexperienced starboard observer (only census data collected by the senior observer were used) and to establish and refine cockpit protocols and test equipment.

Seals lying on either side of the helicopter were counted by two observers sitting in the back row passenger seats, one each at the port and starboard side windows. In-flight times and GPS positions were recorded at the beginning and end of each transect leg, at intervals (9-15 minutes) along the transects, and whenever a change in the course direction was effected. Observations were recorded in 3 min time frames, each frame representing a sample unit identified as to time and location, measured as to area, and containing all observational data and related information. The starboard observer classified ice coverage (in tenths) and the proportional contribution of brash and four differently sized ice floes (cake, small, medium, large) for each time frame following standardized procedure.

Sighting bars, affixed with suction cups to each of the side windows, were used to measure the perpendicular distance at which seals, or groups of seals, were seen from each side of the helicopter. Strips of tape stuck to the plexiglas windows outlined the positions of the sighting bars which allowed their exact positioning at each census. Sightings were limited to an angle of 30° from the vertical at the level of the eye of each observer, which creates an obscured strip (bin 0) of approximately 230 ft wide under the helicopter(s) at an altitude of 200 ft. Distances were measured in intervals defined by physical marks on the plexiglass sighting bars which represented 10° vertical angle intervals. Six intervals were thus created, the first five intervals (bins 1-5) of which represented widths of 53, 71, 108, 204 and 587 ft respectively on the ice on either side of the helicopter at 200 ft altitude, with the innermost angle (30° from vertical) being treated as the centerline of the transect by each observer, and the outermost bin 6 stretching to the horizon. Finally, at the conclusion of the eastern Weddell Sea surveys, flagged marker poles were laid out, perpendicular to the wind direction, demarcating the theoretical bin widths determined by measured steps on the ice shelf at Neumayer Station. The sighting bars were validated for each observer in his seating position in the Bell helicopter hovering at 200 ft altitude in a 13 m/s (26 kns) head wind.

Survey design was dictated by the extent of the pack ice in the area, the position of the ship in relation to the available pack ice during the mid-day census window, and the helicopter used for the survey. Adjusted density estimates were obtained using the DISTANCE (Version 2.1) program and the probability functions of detecting seals in bins 1-6 were calculated after each survey, or groups of surveys, for each observer independently to guide his search protocol. For initial comparison (this report) with previous surveys where it was assumed that all seals were counted in a narrow strip on either side of the aircraft, unadjusted density estimates for the 1023 ft (0.1682 nm) strip (bins 1-5) on either side of the helicopter were calculated.

Overall pack ice coverage (in tenths) in the Weddell Sea at various stages during the census period were taken from the routine sea ice analysis maps provided by the National Ice Center, Washington. Additionally, the area covered by pack ice was calculated from satellite pictures received directly on board the RV 'Polarstern'. These calculations are based on cloud and light independent information from the Defence Meteorological Satellite Project (DMSP) satellite F13, channel SSM/I (Special Sensor Microwave Imager) TOT_ICE.

Preliminary Results

A total of 15 censuses were flown during the period 23 January - 22 March over an area of 244.20 nm2 in the area bounded by 07°08' and 45°33' West longitude (Table 28).

Table 28: Seal numbers (brackets) and densities (seal/nm^2) recorded during serial transect censuses of pack ice in the Weddell Sea in 1998.

Census	Date	Time period	Frames	Area per census (nm^2)	Crab-eater	Ross	Weddell	Leopard	Unid.	Total	Long. West
1	23-01	15:07-15:42	10	10.10	4.27 (43)	0.70 (7)	0.00 (0)	0.00 (0)	0.10 (1)	5.07 (51)	7°08'-8°37'
2	24-01	11:57-12:59	17	16.70	4.03 (66)	0.37 (6)	0.13 (2)	0.00 (0)	1.47 (24)	6.00 (98)	8°08'-9°25'
3	25-01	11:39-13:06	21	21.70	0.36 (8)	0.09 (2)	0.19 (4)	0.09 (2)	0.14 (3)	0.88 (19)	11°50'-13°40'
4	27-01	11:59-12:43	24	12.60	0.80 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.80 (1)	19°30'-20°12'
5	01-02	12:19-13:36	36	18.90	3.04 (58)	0.05 (1)	0.52 (10)	0.05 (1)	2.81 (52)	6.48 (122)	10°33'-11°33'
6	03-02	11:40-11:50	8	04.30	2.10 (9)	0.70 (3)	0.00 (0)	0.47 (2)	0.70 (3)	3.97 (17)	19°29'-20°06'
7	06-02	11:30-12:28	30	17.80	10.66 (189)	0.00 (0)	1.07 (18)	0.17 (3)	1.18 (21)	13.08 (231)	22°41'-24°26'
8	15-02	12:07-13:49	34	15.70	5.90 (98)	0.00 (0)	2.42 (39)	0.70 (15)	2.48 (34)	11.59 (186)	13°01'-14°57'
9	19-02	12:27-13:34	22	08.10	39.74 (281)	0.09 (1)	1.32 (7)	0.74 (5)	3.74 (26)	45.63 (320)	10°31'-11°28'
10	19-02	14:13-14:58	14	06.00	21.61 (140)	0.00 (0)	0.14 (1)	0.00 (0)	2.03 (13)	23.79 (154)	11°26'-12°20'
11	20-02	12:29-13:44	62	26.80	93.64 (2078)	0.03 (1)	0.32 (10)	0.36 (8)	1.65 (44)	96.01 (2141)	10°19'-13°18'
12	21-02	11:51-12:19	16	07.20	24.10 (182)	0.00 (0)	0.43 (4)	0.36 (3)	1.86 (15)	26.75 (204)	12°07'-12°40'
13	22-02	11:47-12:49	36	17.80	25.71 (458)	0.00 (0)	0.60 (10)	0.12 (2)	1.89 (33)	28.31 (503)	18°22'-20°03'
14	07-03	11:01-12:28	27	30.30	0.09 (3)	0.00 (0)	0.13 (4)	0.09 (3)	0.11 (3)	0.43 (13)	44°16'-45°33'
15	07-03	12:48-14:08	23	30.30	0.71 (22)	0.00 (0)	0.06 (2)	0.03 (1)	0.00 (0)	0.80 (25)	43°45'-44°58'
Total			320	244.20	21.16 (3636)	0.06 (21)	0.53 (111)	0.22 (45)	1.33 (272)	23.31 (4085)	7°08'-45°33'

Visibility profiles. Combining censuses 1-3 (flown at 300 ft altitude with one observer) on the one hand, and censuses 4-15 (flown at 200 ft altitude) on the other hand for the portside and starboardside observers separately, the pack ice seals (combined totals of all four species) had a decreasing detection probability with distance from the line of flight. Due to the low numbers encountered, separation of Weddell, Ross and leopard seals was not justified. Separating censuses according to the helicopter used produced the same result, while the combination of individual censuses serially (both observers separately, irrespective of which helicopter was used) to attain a minimum sample size of 200 seals counted for each observer (censuses 4-8, 9 & 10, and 12 & 13 combined) suggested that rarely were some seals not seen in Bin 1. Predetermined bin widths checked out correctly when ground truthed.

Pack ice characteristics. During the period 13 January - 3 March 1998, pack ice was virtually absent in the eastern Weddell Sea as shown by satellite imagery. Patches of largely open pack ice, predominantly composed of brash, cake ice, and sometimes small floes, were present along the seaward end of a large polynya which stretched almost continuously from Atka Bay in the northeast to Halley Bay in the southwest. The patches of pack ice occasionally reached the ice shelf. Winds and/or currents compacted, dispersed or shifted the available pack ice as evidenced by its changed characteristics upon revisitation of particular sites e.g. Drescher Inlet, Kapp Norvegia and the Auståsen Iceberg Cemetery (see Table 28). The 6-7 day traverse of the Weddell Sea from Atka Bay to the tip of the Antarctic Peninsula passed through the northern end of a well defined, approximately 167 780 nm^2 area of pack ice on 7 March 1998. The near absence of pack ice in the eastern Weddell Sea may be a periodic event, but it is entirely different from previous recorded surveys in the area at an equivalent time. A strong El Niño event has manifested itself in the winter of 1997 and the scientific community has been cautioned that 1997/98 would be an anomalous season/year. The current absence of pack ice in the eastern Weddell Sea, and relatively small area of cover in the western Weddell Sea, supports this view.

Species composition. A total of 3636 (95.4%) crabeater seals, 21 (0.5%) Ross seals, 45 (1.2%) leopard seals and 111 (2.9%) Weddell seals were observed in bins 1-5 on the pack ice during a total of 1356.57 linear nm (244.2 nm^2) of transect line censused. A total of 272 seals were not identified to species. Mixed groups were not identified during aerial surveys although they may occur. For example, on 25 February 1998 all four phocid species were seen together on a small floe of broken out fast ice within the Drescher Inlet, the leopard seal lying a bit apart from the others.

A subadult male southern elephant seal, *Mirounga leonina,* on a small ice floe within a small area of closed pack, was seen from the ship in Atka Bay on 28 February 1998. Southern elephant seals frequently visit Antarctic waters a source being Marion Island (46°54'S, 73°35'E) from where an adult female was tracked to the eastern Weddell Sea in 1996. At least four adult male Antarctic fur seals were encountered hauled out singly in the pack of moderate coverage in the northwestern Weddell Sea between 63°04.3'S, 43°53.0'W and 62°13.6'S, 45°47.8'W. Seen on the only day (7 March 1998) that the ship traversed pack ice in the region, they were between 92 - 144 nm from the nearest hauling out site of Antarctic fur seals at the South Orkney Islands (60°44'S, 45°02'W).

The percentage species composition found in the present study was remarkably similar to those from other surveys taken over a similar period (mid-January to mid-February) in the eastern Weddell Sea. The increased presence of Weddell seals in the pack ice is not surprising since most of the available fast ice, the preferred habitat of the species, has broken out in the survey area. After the breeding season there is a movement of Weddell seals into the pack ice away from the coast, found throughout the pack they were nearly always single, although densities are probably higher closer to land or fast ice. Similarly, Weddell seals were particularly abundant (25% of positively identified seals) during census 8 on 15 Feb, probably as a result of the disappearance of fast ice in the vicinity. Proportionally fewer Ross seals were counted than in the earlier shipboard surveys. A ready explanation would be that the abundance of Ross seals has declined. However, the low number of Ross seals is in concordance with a progressive decline in Ross seal numbers from east to west off Dronning Maud Land. In previous studies almost no Ross seals were encountered in the Weddell Sea.

Density estimates. The mean density of seals (unadjusted counts) encountered are shown in Table 28. Since all counts were done during the period 11:01 - 15:42, primarily from 12:00 - 13:00, they need not be time corrected for the maximal haulout of crabeater seals. At a mean density of 21.16 seals/nm^2 over an area of 244.20 nm^2, it is the highest densities on record for crabeater seals except for the small (85 nm^2) shipboard 1983 survey (58.89 nm^2) in the inner pack of the western Weddell Sea. In the present study a crabeater density of 93.64/nm^2 was recorded over a 26.8 nm^2 area in census 11 (Table 28). Although a maximum density of 95.7/nm^2 in a 1.1 nm^2 area was previously recorded, densities of up to 411.7/nm^2 were reached in an equivalent 1.07 nm^2 area during census 11 (present study). Furthermore, our estimates are conservative since the emphasis was on distance sampling to enable correction of counts for seals missed during the census, and not on counting all seals within the strips (bins 1-5).

The very high densities recorded in the eastern Weddell Sea (this study) are a consequence of the drastically reduced ice cover, the inverse relationship between cover and seal densities, and the tie between seal densities and areal distribution of the ice pack. Highest values were returned for cabeaters, Weddell, and with the exception of the 1983 survey, leopard seals too. Ross seal densities were the lowest on record for the area, although not many were expected to be found given their paucity during previous surveys.

Population size and distribution. An estimation of population sizes of pack ice seals for the Weddell Sea is difficult. In the present study, extrapolation from the small area (60.6 nm^2) surveyed in the main body of pack ice in the western Weddell Sea where very low densities (mean = 0.38/nm^2) of crabeater seals were found (Table 28), translates to an undoubtedly underestimated 63 757 individuals. However, including all areas surveyed (244.20 nm^2), extrapolation of numbers of the most numerous crabeater seals (21.16/nm^2) to the estimated 167 780 nm^2 pack ice area present in the (western) Weddell Sea on 7 Mar, gives an inflated total of 3 550 225. The mean of the two estimates is 1 806 991 crabeater seals, a result not dissimilar to the 1 525 392 estimated for 1983, based upon a mean density of 4.28 crabeaters/nm^2 (subtotal air-ship) extrapolated to a total pack ice area of 356 400 nm^2. In contrast, extrapolation of 10.38 crabeaters/nm^2 to 281 340 nm^2 pack ice area in 1968, and 12.22 crabeaters/nm^2 to 390 600 nm^2 pack ice area in 1969, the respective totals come to 2 241 324 and 2 780 868 crabeater time corrected for maximal haulout. This was considered a drastic population decline over the intervening 14 years, although there may have been a change in the distribution of seals, either because of a movement from one area to another, or because of a new pattern of local distribution.

The very high densities of crabeater seals counted in census frames while adjacent areas in the same pack were practically devoid of seals (see previous section), seen together with the ice seeking behaviour of satellite tracked crabeater seals, also during the current study (Bornemann and Plötz, chapter 2.3.2), suggest that pack ice seals could keep track of shifting/diminishing pack ice, are patchily distributed, and that all available pack ice was not utilised despite its paucity. Furthermore, seal densities have been shown to be inversely related to the area of pack ice available for haulout, and with the dramatic decrease in the width of the pack ice during early summer, seals apparently move over vast distances to stay within the retreating pack. This would suggest that, with the exception of seals in transit between ice fields, those found present in the pack ice are representative of the population in the area. Undoubtedly, population estimates for crabeater seals in the pack ice need to be adjusted (increased) to account for a fraction of between 20% and 60% for the local apparent time period 11:00-12:00 of crabeater seals not hauled out on the ice. However, assuming a consistent pattern of hauling out behaviour between years, the results from different years (unadjusted for seals hauled out but missed during censuses), time corrected for maximal haulout, are comparable.

Both 1983 and 1998 are El Niño years, and despite the large difference in the area covered by pack ice in a comparable region (western Weddell Sea) in the two years (356 400 nm^2 versus 167 780 nm^2), offset by the differences in crabeater seal densities (means of 1.42-9.41/nm^2

versus 0.38-27.46/nm^2), the censuses returned values considerably lower than those in 1968 & 1969. This suggests that 1983 and 1998 were either exceptional years or that the presumed decline in crabeater seal numbers has continued, or they have failed to recover in any measurable way. Given the uncertainties in the present study, it is impossible to decide which is the more likely scenario.

Crabeater and leopard seals usually occur principally throughout unconsolidated pack, favouring broken ice dominated by cake and small floes, and Ross seals appeared to prefer deeper pack ice areas. Others have, however, found no statistically significant indication that seals preferred any particular parts of the pack ice as in the present study. Neither was the general picture of leopard seals being largely present near the retreating outer edge with the advance of summer manifested in the present study. They were found present in most censuses, in all parts of the small extent of pack ice, and even hauled out on the fast ice at Drescher inlet (J. Plötz pers. comm.), behaviour which was perhaps due to the paucity and patchiness of the pack.

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2.3.4 Vertical Distribution and Diel Migration Pattern of the Pelagic Fish Community in the Drescher Inlet (R. Knust, A. Schröder, A. Lombarte, I. Olaso)

Introduction and objectives

Former studies on the diving and feeding behaviour of seals in the Drescher Inlet showed that feeding activities were most intense in the pycnocline between 150 and 250 m of the water column (see chapter 2.3.6). The composition, distribution, density and the size spectra of possible prey, however, are still unknown. The aim of this study was to determine the vertical migration behaviour, vertical distribution, relative abundance and species richness of the pelagic fish community near the ice shelf and in the Drescher Inlet. The research was closely linked to the parallel investigation of the Seal Working Group (Drescher Campaign 1998).

Work at sea

To get information on diel migration patterns of fish in the pycnocline 7 trawl hauls were taken between 14:00 and 05:00 during two nights and one day. The depth range of the pycnocline was measured by CTD profiles before and after fishing (see sampling scheme in Table 29). To characterize differences in the vertical distribution of the fish community between night and day, 3 hauls were taken during day time around noon and 3 hauls during night around midnight. Three depth strata have be sampled according to the first CTD profile (Table 29). All catches on the ground were done with an otter trawl (GSN), all pelagic trawls were done with a benthopelagic trawl (BPN), with the exception of the last two hauls when due to a broken BPN, the samples were taken with a modified bottom trawl. The trawling depth was controlled by a net sensor system. After trawling the fish were sorted and identified to species level. Length and weight were measured and representative samples of otoliths of *Pleuragramma antarcticum* were taken for later growth analyses.

Table 29: Sampling scheme for the investigation of the pelagic fish fauna in the Drescher Inlet.

Time (h)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05
Depth																				
30-70	o											o								
150-250					xo						x			x	xo		x	x		x
Seafloor			o				o									o				

o = Samples for vertical distribution (day - night difference)
x = Samples for vertical migration pattern in the pycnocline (150-250 m)

Preliminary results

In total 11 species were caught in the pelagic zone. The fish community was strongly dominated by *Pleuragramma antarcticum* with a dominance in biomass of 70%, followed by *Anotopterus pharao* with a dominance of 20%. Biomass and abundance of all other species were significantly lower and most of these species were represented by juveniles or larval stages only. The species are listed in Fig. 35.

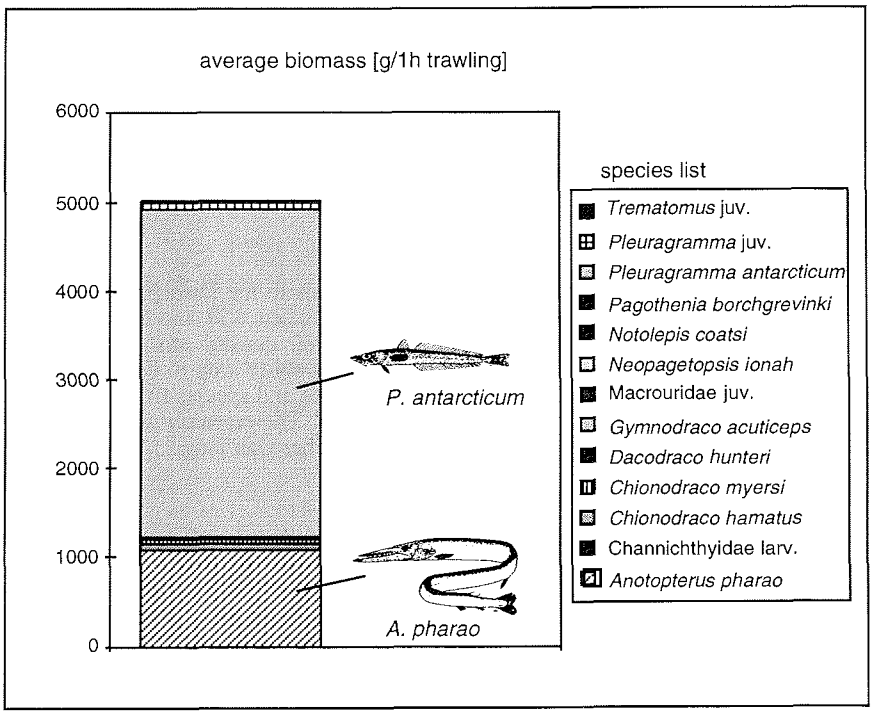


Fig. 35: Biomass and dominance structure of the pelagic fish community in the Drescher Inlet.

The water temperature and salinity regime of the Drescher Inlet is characterized by a stable pycnocline in a water depth between 130 and 230 m. In times with low wind another pycnocline occurred between 30 and 50 m, which was not very stable and disappeared during storm events (see CTD profile Fig. 45-46). The vertical distribution of *Pleuragramma antarcticum* shows a high biomass of adult and juvenile *P. antarcticum* in this unstable pycnocline during day time.

In the stable pycnocline below the biomass data were very low during day time (Fig. 36), but both dominant species, *Anotopterus pharao* as well as *P. antarcticum* showed a distinct diel vertical migration behaviour. The biomasses of both species in this pycnocline were significantly higher around midnight than during day time (Fig. 37).

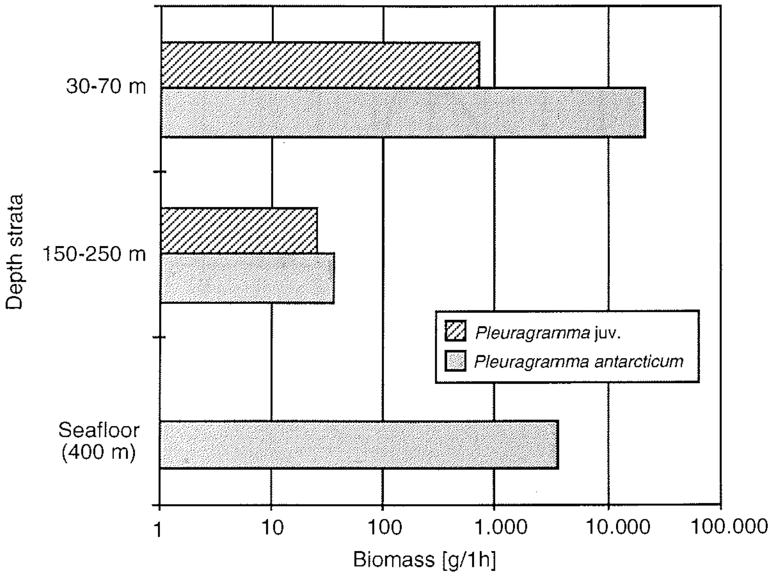


Fig. 36: The vertical distribution of *Pleuragramma antarcticum* in the Drescher Inlet during day time.

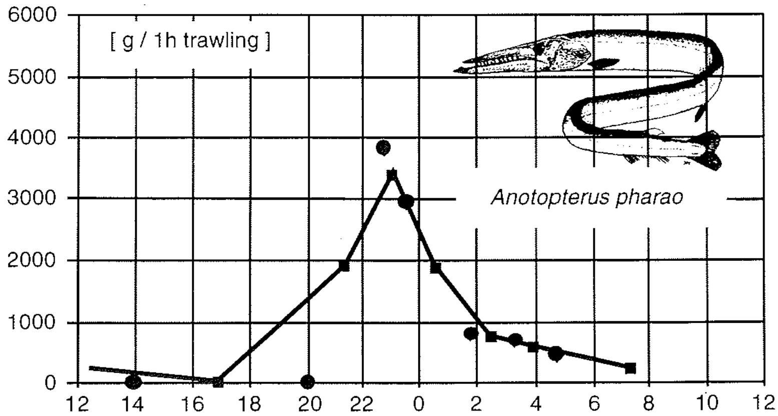


Fig. 37a: Vertical migration pattern of *Anotopterus pharao* in the pycnocline (150 - 230 m) of the Drescher Inlet.

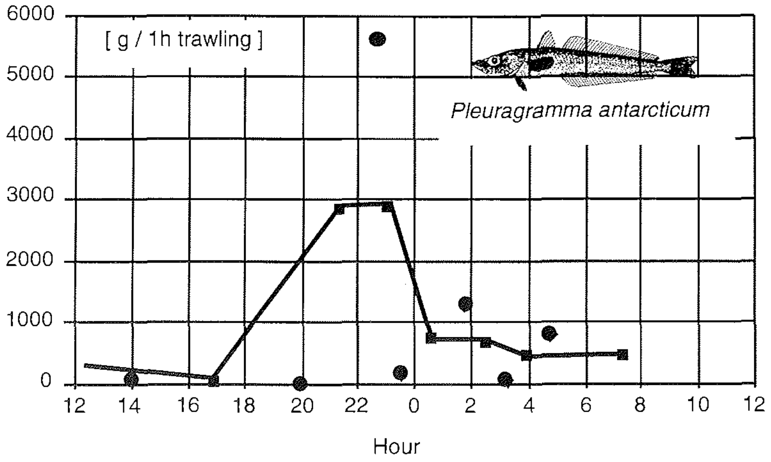


Fig. 37b: Vertical migration pattern of *Pleuragramma antarcticum* in the pycnocline (150 - 230 m) of the Drescher Inlet.

2.3.5 The Pelagic Fish Food Web (I. Olaso)

In the Antarctic ecosystem studies on fish have been carried out in relation to the pelagic food web (Hubold 1983, and others). These authors point out that in the pelagic fish community of the high Antarctic small specimens of *Trematomus* and channichtyids, and the herring like Antarctic silverfish *Pleuragramma antarcticum are* dominant. Together with the krill, these fish are the food base of marine nekton such as cephalopods, predatory fish, and warm blooded predators such as birds, whales and seals that carry out feeding migrations. The latter feed on midwater fish of which the Antarctic silverfish is the most important.

This study presents data on the characteristics of food of this pelagic species. We also studied the diet of other fish that ascend in the water column to feed on pelagic food, and which are the potential prey of seals, such as the demersal channichthyids, some nototheniids (Plötz 1992) and midwater fish like Notolepidae, Anotopteridae and the genus *Dissostichus.*

Objectives

The overall objective is to determine feeding patterns of the most important species of the pelagic fish community, which would allow us to estimate the energy flow through this community. The trophic ecology of the main fish species was investigated focussing on the following specific objectives:

- Food composition of the dominant species of pelagic fish by depth, size of predator and geographical areas
- Change in diet with size of predator
- Overlap in diets
- Position of pelagic feeders in the food web
- Relationships between fish predator size and prey size
- Diel feeding pattern of Antarctic silverfish

Work at sea

The fish samples for diet studies were collected from virtually every haul of the bottom trawl (16 GSN), benthopelagic trawl (8 BPN), and Agassiz trawls (14 AGT; see the characteristics of stations in Table 33, chapter 2.4.1). The standard length (cm) of all fishes sampled were measured, they were sexed and the maturity stage was determined according to a 5 stage scale (Kock and Kellermann 1981). At each station it was attempted to sample at least 10 stomachs containing food, however in some cases stomach contents had been regurgitated due to pressure changes. For this reason the state of the gall bladder was examined (Robb 1992) to separate empty stomachs from those which had regurgitated food shortly before being caught. Stomachs which contained food which was ingested during the haul (the gall bladder had not been used) were considered empty.

Stomach contents were analyzed on board ship. The volume of stomach contents was measured using a trophometer, which consisted of several different sized half cylinders (Olaso and Rodríguez-Marín 1996). Fish, crustaceans and molluscs were identified by species, but other groups were combined into higher order taxa. On the determination of prey taxa, the systematics used were those of Eastman (1991) for fish, Barnard and Karaman (1991a, 1991b) and Brandt (1991) for peracarids, Hain (1990) for molluscs, Hartmann-Schöder (1986), Hartmann-Schöder and Rosenfeldt (1991) for polychaetes, and Sieg *et al.* (1990) for other groups. For each prey species the following information was collected: percentage contribution to the volume of stomach contents, number of items per stomach, state of digestion (Olaso 1990), and size in mm. To examine the relationship between prey length and predator length, all possible measurements of prey were taken. The relative importance of individual prey taxa was assessed with the percentage of volume index (Hyslop 1980).

Preliminary results

Sampling intensity. It is known that most of the fish change their trophic niche as they increase in size, and they may even change from being benthos and suprabenthos feeders to plankton feeders and pelagic fish feeders. In view of this, one needs to establish the position that they occupy within the fish group, since the pelagic and demersal system is related. To increase the knowledge of the trophic structure of the fish community, 920 stomach contents from 36 species of fish, 34 of which belong to the Notothenioidei were analyzed (Table 30). These species were regarded as the most important in terms of number and biomass (see Tables 34-36 and Fig. 47 in the chapter 2.4.1). The species of the genus *Trematomus* were used for other experiments and were not fully represented in the samples. Therefore the stomach contents of this genus, which were obtained during the EASIZ I cruise, two years ago in the Weddell Sea (Balguerías and Morales-Nin 1997), will be investigated. Due to the nature of cruise ANT XV/3, it is not possible to present a general spectrum of the trophic structure of the fish of the eastern Weddell Sea, in relation to the abundance of each species. The data gathered at present only produced superficial information on the species of fish that predate on pelagic food (i.e. all except true benthic and demersal feeders, such as Artedidraconidae, Macrouridae and some species of Nototheniidae).

Empty stomachs and state of sexual maturity. Use of the state of the gall bladder (mainly in channichthyids) prevented the overestimation of the incidence of empty stomachs. Few cases of regurgitation have been observed and the families Channichthyidae, Bathydraconidae and Nototheniidae present lower percentages of empty stomachs than recorded for the other species that migrate vertically in the water column (Table 31). Table 32 shows that gonad maturity is reached prior to spawning in some channichthyids and *Trematomus eulepidotus*, with a running stage in *Chionodraco myersi* and *T. eulepidotus* only. The state of maturity can result in an overestimation of the number of empty stomachs, as in the family Channichthyidae, since the gonadal volume may occupy up to 25% of the total volume of the body. Under these conditions they decrease their feeding intensity. The high number of *Pleuragramma antarcticum* individuals with spent gonads is similar to that found two years ago (Balguerías and Morales-Nin 1996), as this species spawns during August-September in the Weddell Sea.

Table 30: Species of fish and number of stomachs analyzed for the Eastern Weddell Sea during the cruise ANT XV/3 (summer 1998).

ARTEDIDRACONIDAE	
Artedidraco orianae	58
Artedidraco longedorsalis	43
Artedidraco skottsbergi	42
Artedidraco loennbergii	20
Pogonophryne marmorata	22
Pogonophryne barsukovi	12
Pogonophryne phyllopogon	8
Pogonophryne lanceobarbata	6
Artedidraco shackletoni	4
Pogonophryne scottii	3
Pogonophryne macropogon	1

BATHYDRACONIDAE	219
Prionodraco evansii	26
Cygnodraco mawsoni	20
Racovitzia glacialis	15
Bathydraco marri	28
Gerlachea australis	22
Bathydraco macrolepis	3

CHANNICHTHYIDAE	
Chionodraco myersi	118
Cryodraco antarcticus	50
Chaenodraco wilsoni	20
Chionobathyscus dewitti	15
Neopagetopsis ionah	7
Chionodraco hamatus	9
Pagetopsis maculatus	6
Pagetopsis macropterus	2
Dacodraco hunteri	34

NOTOTHENIIDAE	
Pleuragramma antarcticum	172
Trematomus lepidorhinus	42
Trematomus pennellii	40
Trematomus eulepidotus	17
Trematomus scotti	10
Trematonus loennbergii	8
Dissostichus mawsoni	7
Aethotaxis mitopteryx	17

OTHER FISH	
Anotopterus pharao	8
Macrourus whitsoni	5

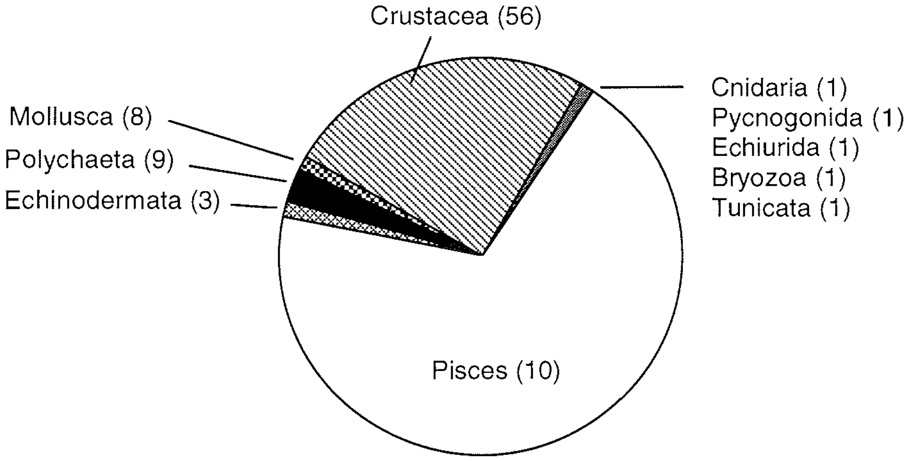
Table 31: The proportion (%) of empty stomachs for Notothenioidei (except Artedidraconidae) during the cruise ANT XV/3.

Family	% Empty	% Regurgitated	Total stomachs
Nototheniidae	31	2	311
Bathydraconidae	39	2	114
Channichthyidae	49	5	263

Table 32: Maturity stages found in the fish community in the Eastern Weddell Sea (summer 1998). Maturity scale from Kock and Kellermann (1991; 5 spent, 4 running, 3 developing, 2 maturing, 1 immature).

	Maturity Scale				
	5	4	3	2	1
Pleuragramma antarcticum	20			44	8
Chionodraco myersi	2	1	7	55	53
Trematomus pennellii	3			15	22
Chianobathyscus dewitti	1			3	7
Artedidraco skottsbergi			3	13	26
Artedidraco loennbergii			1	5	14
Cygnodraco mawsoni			1	5	15
Trematomus lepidorhinus			1	11	30
Chionobathyscus dewitti			1	3	11
Cryodraco antarcticus			3	12	35
Bathydraco marri			1	5	22

Total prey spectrum. A total of 2640 prey were found in the stomach contents (excluding *Dissostichus mawsoni, Anotopterus pharao* and *Macrourus whitsoni*). 92 taxa have been determined, spanning a wide spectrum of marine zoological groups, from small macroplankton of 2 mm long to large necton specimens of 440 mm. There were 56 taxa of crustaceans, 11 of polychaetes, 8 of molluscs, 3 of echinoderms, 10 of fish and different orders of invertebrates (bryozoan, echiurid, pycnogonid, cnidarian, tunicate) as shown in Fig. 38. Fish contributed 67.8% by volume, crustaceans and polychaetes 23.9% and 2.8% respectively, and the rest of the prey contributed 5.5%. The prey most abundant in number were copepods and krill, followed by the pelagic fish *Pleuragramma antarcticum*. The least important prey were groups of benthos and suprabenthos, such as the different groups of polychaetes, gammarid amphipods, and mysids (Fig. 39).



	Volume %	Number of taxa
Crustacea	25.0	
Caprelloidea	0.1	1
Gammaroidea	2.3	35
Hyperidea	0.5	1
Copepoda	1.7	2
Cumacea	0.2	2
Decapoda	2.7	3
Euphausiacea	15.7	2
Isopoda	0.8	7
Mysidacea	0.5	5
Pisces	68.0	
Nototheniidae	63.1	4
Channichthyidae	2.7	1
Artedidraconidae	0.7	2
Bathydraconidae	0.6	1
Myctophidae	0.5	1
Other Fish	1.1	1

	Volume %	Number of taxa
Mollusca	0.8	
Bivalvia	0.1	1
Gastropoda	0.5	5
Pteropoda	0.1	1
Scaphopoda	0.1	1
Polychaeta	3.0	
Ampharetidae	0.1	1
Aphroditidae	0.1	1
Maldanidae	0.1	1
Nephtyidae	0.1	1
Phyllodocidae	0.1	1
Polynoidae	2.0	1
Sabellidae	0.3	1
Spionidae	0.1	1
Terebellidae	0.1	1

Fig. 38: Partitioning of prey groups in the diet of fish assemblages. Data expressed as percentage by volume. Number of prey taxa in brackets.

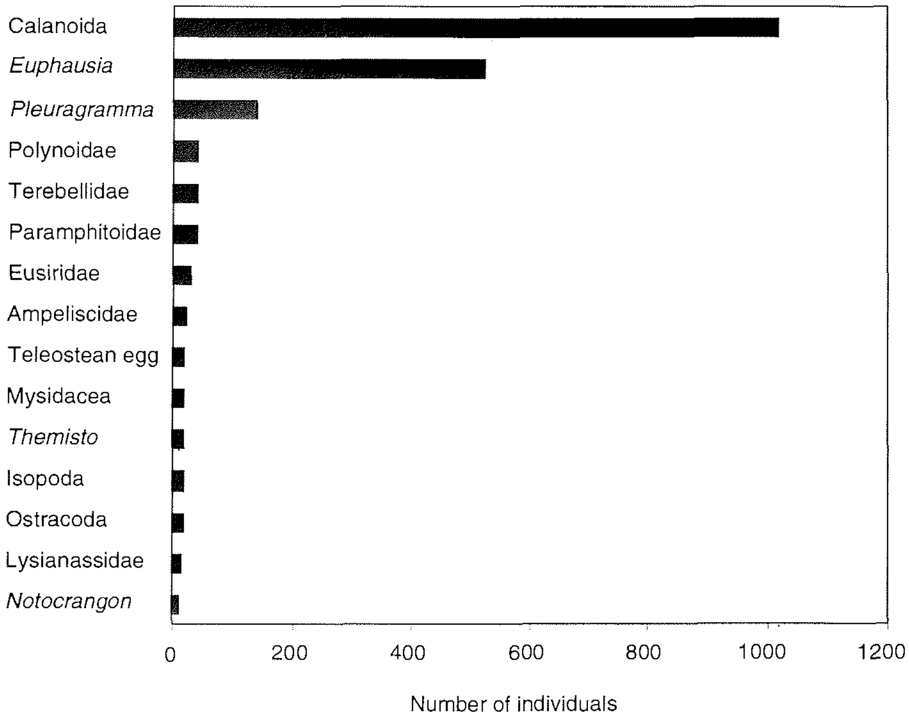


Fig. 39: Number of prey in the most important prey taxa.

Change of prey with size of predator. An overall impression of the trophic structure of the fish population in relationship to their size, was gained by determining the diet of fish predators within size ranges (Fig. 40). Fish smaller than 10 cm take prey associated with the benthos. Between 10 and 20 cm size they continue a relationship with the benthos, but they already take some food from higher up in the water column. From 30 cm length they clearly feed pelagically.

Diet composition of fish feeding pelagically:

Bathydraconidae (Fig. 41 a). *Prionodraco evansii* (8-26 cm). Food was present in 20 stomachs. When smaller than 15 cm, *P. evansii* consumes polychaetes, polynoids, gammarideans (*Atylopsis* sp., *Podoceros* sp.), and krill. When larger than 14 cm their consumption of polynoids and gammarideans decreases, and they start to include mysids (*Pseudomma belgicae*) and decapod crustaceans (*Notocrangon antarcticus*). *Bathydraco marri* (18-28 cm). Food was present in 17 stomachs. In total, 39% of stomachs were empty. Small ostracods, gammarideans (*Hyppomedon kerguelini* and Iphimediidae), mysids (Clysidae) and decapods (*Nematocarcinus lanceopes*) are taken. *Cygnodraco mawsoni* (16-45 cm). Food was present in 35 stomachs. When less than 35 cm in length, they maintain a similar diet as the large *Prionodraco evansii*, but from 35 cm, they also take small *Trematomus* and other nototheniids. At sizes smaller than 15 cm, the bathydraconids feed close to the bottom, and with increasing size they look for prey in the suprabenthos, and start to consume nototheniid fish of body lengths up to 35 cm.

Channichthyidae (Fig. 41 b). *Chaenodraco wilsoni* (11-27 cm), *Pagetopsis macropterus* and *Pagetopsis maculatus* (14-18 cm). Food was present in 25 stomachs. Channichthyids of small size fed on krill and were cannibalistic to a small degree. *Cryodraco antarcticus* (23-48 cm) and *Chionodraco myersi* (16-38 cm). Food was present in 101 stomachs. They are active predators of Antarctic silverfish, in the case of *C. myersi* starting from 16 cm in size. As a general rule one can say that the small channichthyids base their diet on krill, and change their habits with increasing size (fish predators of *Pleuragramma antarcticum*, channichthyids, and small *Trematomus spp*).

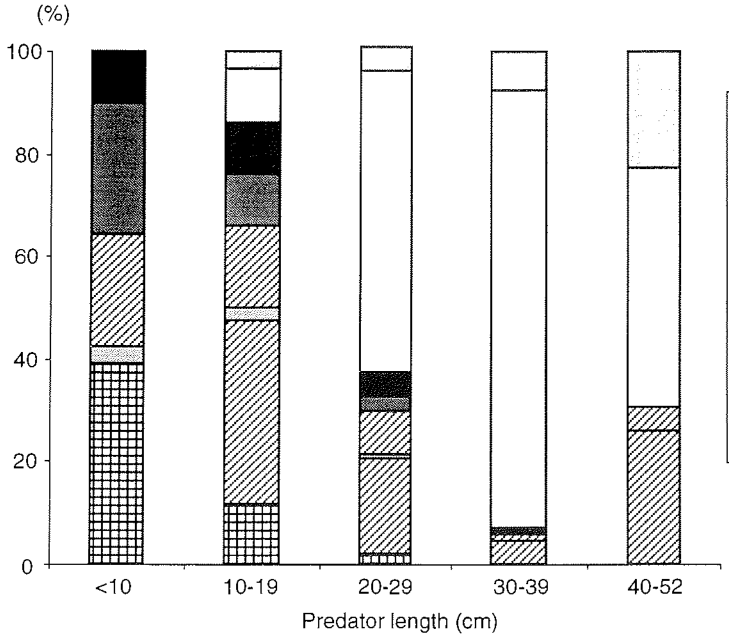
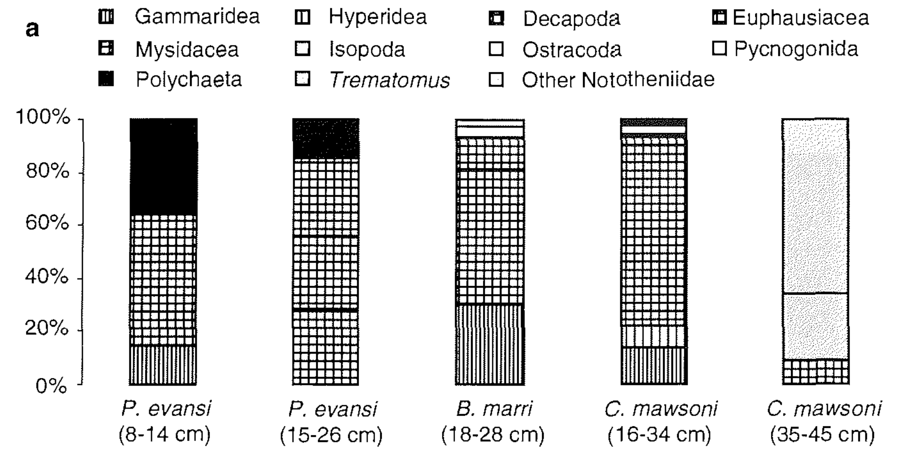


Fig. 40: Change in prey with size of predator (all fish redator species lumped).

<u>Nototheniidae (Fig. 42 a).</u> *Aethotaxis mitopteryx* (22-51 cm). Food was present in 4 stomachs, while 77% of stomachs were empty. It predates on krill and Antarctic silver fish and possesses special physiological adaptations to migrate vertically in the water column. *Dissostichus mawsoni* (18-122 cm). Food was present in 4 stomachs; 43% had empty stomachs. They feed on large big squid (*Psychroteuthys glacialis*) and fish, found in different habitats (*Muraenolepis* sp., *Chionodraco myersi*, other channichthyids). Despite so few stomachs investigated, they seem to feed throughout the whole column on large sized prey to satisfy their great energy demand.

<u>Other species in the water column (Fig. 42 a and b).</u> *Anotopterus pharao* (89-106 cm). Food was present in 4 stomachs and one regurgitated stomach. 37% of stomachs were empty. The importance of *Notolepis coatsi*, an exclusively pelagic species, and small quantities of krill, *Euphausia superba*, is stressed. *Notolepis coatsi*, myctophids, small *Trematomus* and channichthyids were not sampled in the present study for stomach content analysis. *Pleuragramma antarcticum* (10-24 cm). Food was present in 113 stomachs and in 6 regurgitated stomachs, while 34% of stomachs were empty. Individuals smaller than 15 cm feed mainly on copepods, euphausiids, and sometimes hyperiids (*Themisto gaudichaudii*). With increasing size (15-17 cm) they consume more euphausiids and less copepods, and myctophids start appearing. When larger than 17 cm the diet is more varied, decapod crustaceans (*Notocrangon antarcticus* and *Nematocarcinus lanceopes*) being taken, while the percentage intake of copepods gradually diminishes. The take of nototheniid fish increases with an increase in size (18-24 cm), while small *P. antarcticum* individuals (35-95 mm) feed on euphausiids.



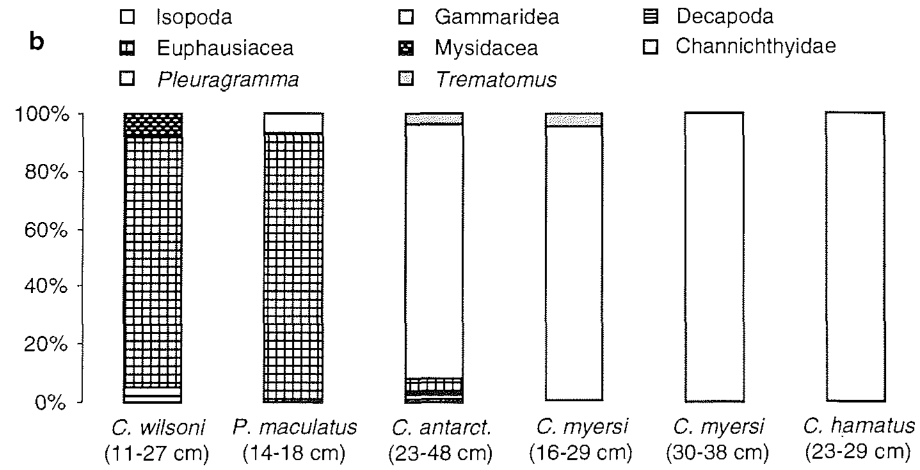
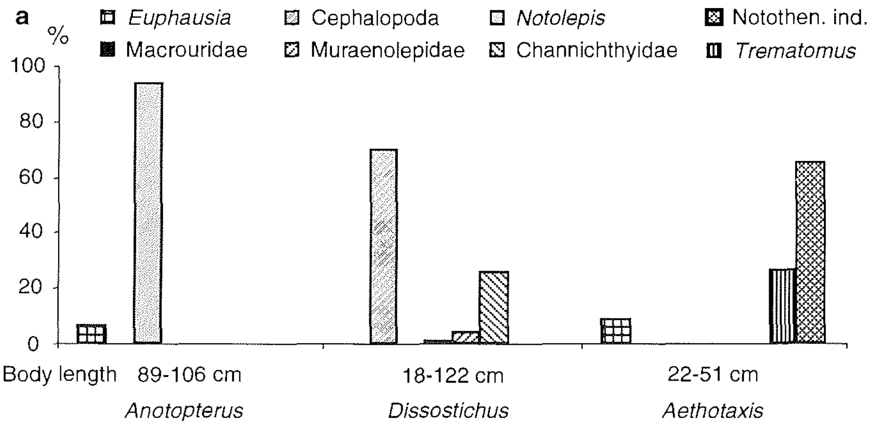


Fig. 41: Diets of (a) Bathydraconidae species, (b) Channichthyidae species.

Diel cycle of feeding in Antartic silverfish. Antarctic silverfish is the key fish prey in the food chains of the pelagic system. To estimate their potential as fundamental food of Weddell seals, we observed the state of their stomachs at different hours of the day. In Fig. 43 we present a model of the diel cycle, where the occurrence of empty stomachs starts to diminish around midday when the mean volume of the stomach contents begins to increase. At midnight the percentage of empty stomachs is zero, and the mean volume of contents is larger.

The feeding data will be analyzed by trophic niche, geographical area, depth and time schedule. The information obtained on the prey, their sizes and their state of digestion will be used to determine important aspects of the trophic ecology of those fish species that were adequately sampled.



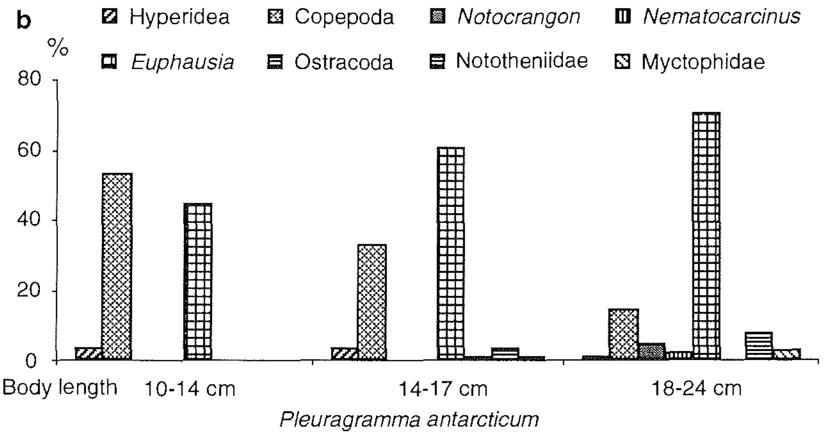


Fig. 42: Diets of (a) Nototheniidae and the midwater fish *Anotopterus*, (b) *Pleuragramma antarcticum*.

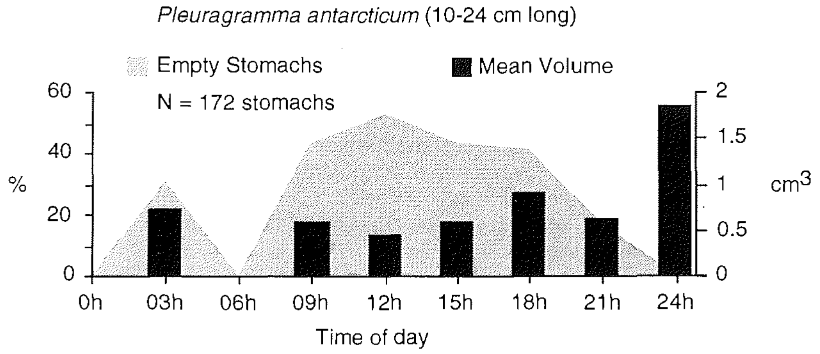


Fig. 43: Diel feeding cycle in *Pleuragramma antarcticum*.

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2.3.6 Organic Matter Production within, and Export from Antarctic Sea Ice Platelet Layer (G. S. Dieckmann, D. N. Thomas)

Background and general objectives

Ice platelets are discs of ice between 1 and 15 cm in diameter and 2 to 3 mm thick that are formed at depth in super cooled Antarctic ice-shelf water. The platelets are trapped - at times in vast quantities - below the sea ice cover where they consolidate into a layer with a semi-rigid honeycomb lattice structure between 0.5 and 5 m thick. Characteristically these “platelet layers” are found underneath land fast sea-ice, i.e. ice attached to the continent. It is less common to find them under free floating pack ice.

Platelet layers underlying land fast sea ice are unique habitats, and support among the highest standing stocks of ice algae in the Antarctic: Chlorophyll levels up to 1 mg Chla^{-1} having been reported, and in summer, values of over 200 µg Chla^{-1} are usual. This is true even though these habitats often occur at extremely high latitudes (e.g. McMurdo at approx. 77°S). The biological assemblages that develop within platelet layers have two components: algae and bacteria that grow attached to ice platelet surfaces, and an assemblage that grows unattached in the interstitial water trapped between the platelets. As in other sea ice assemblages, pennate diatoms dominate, although a wide range of other organisms are found, including bacteria, protozoa, and also metazoa such as copepods and amphipods.

These habitats are remarkable in that the factors constraining phytoplankton biomass accumulation in the open ocean are at least temporarily ineffective, resulting in the accumulation of standing stocks far in excess of those predicted from complete utilisation of nutrients in seawater environments. The obvious explanation is replenishment of nutrients from the surrounding water column while the algae grow on the crystals themselves or are retained within the physical boundaries of the lattice structure. However, rates of exchange with the surrounding seawater can be restricted by density stratification due to melt water input and the physical barrier imparted by the ice matrix, particularly during summer, the time of maximum algal growth. Algal nutrient demand may exceed rates at which these can be replenished, and algal growth must depend on *in situ* nutrient regeneration. Only in the recent years have investigations on the biogeochemistry of these highly productive habitats been done in any detail. Heterotrophic remineralisation by bacteria and phagotrophic flagellates is frequently invoked as the foremost explanation for supply of nutrients and the characteristic elevated phosphate and ammonia concentrations frequently measured. Recently platelet layers have been described where large numbers of metazoans (mainly copepods and amphipods) can accumulate, significantly influencing remineralisation dynamics.

An important aspect in the biogeochemical dynamics within the platelet ice system is production and lability of dissolved organic matter (DOM). DOM is produced through excretion, mortality and cell lysis, and amplified by inefficient ("sloppy") feeding by metazoan grazers. It is often stated that there are significant DOM pools in sea ice systems yet measurements of DOM in sea ice have only rarely been made, and the significance of DOM for ice based productivity and carbon turnover remains highly speculative. Certainly there are no reports of DOM from platelet layers. It is pertinent that these investigations are made if we are to make progress in our understanding the production and biogeochemical cycling in these important sources of organic matter in Antarctic ice-covered coastal regions.

Organic matter produced within the platelet layer is released into the underlying water continuously and particularly during sea ice break up, melting events or water turbulence disturbing and causing sloughing of the platelet layer. Often land fast ice and platelet layers lie over the shallowest depths of the continental shelves. These are also regions which have highly productive and diverse benthic communities. It is thought that transport of large amounts of organic matter produced in the fast ice/platelet ice system may be an additional food source for these communities. As there is only a short window for production in the water column it is unlikely that export of organic matter from this source alone can maintain such high benthic production. However, this relationship has not been tested, and it is essential that the quantity and quality of particulate and dissolved organic matter released from platelet layers is investigated.

2.3.6.1 Biogeochemistry in Platelet Ice Layers

Objectives

In order to improve our understanding of the limits to algal growth and the forcing of the community structure, comprehensive measurements of particulate and dissolved organic and inorganic constituents of a platelet layer underlying summer fast ice were made. Central to these were the first measurements of dissolved organic matter (DOC / DON / DOP) in platelet ice assemblages. At the same time standing stocks of bacteria, algae, protozoa and metazoa components of the biological assemblage were investigated.

Work at Drescher Inlet

The platelet layer (platelets and interstitial water) underlying fast ice at Drescher Inlet were sampled using standard techniques, and a specially designed device (ADONIS) that allows discrete interstitial water samples to be collected at different depths within the platelet layer. Interstitial waters, the platelets themselves and underlying waters up to a depth of 400m were collected from several locations in the Inlet during the 4 weeks of the Drescher campaign. The following parameters were measured, or samples taken in the platelet interstitial water and water underlying the platelet layer: oxygen, pH, alkalinity, nitrate, ammonia, nitrite, phosphate, silicate, dissolved organic carbon/ nitrogen/ phosphorous (DOC / DON / DOP), carbohydrates, salinity, temperature, and the carbon isotopic composition of dissolved inorganic carbon ($\delta^{13}C_{DIC}$). The species composition of the biological assemblages will be determined and quantified and this information complimented by measurements of chlorophyll, biogenic silicate, the concentration of particulate organic carbon and nitrogen (POC, PON), carbohydrates, and the isotopic composition of POC ($\delta^{13}C_{POC}$). In addition to measurements on the water samples, appropriate measurements were also made on melted ice platelets.

2.3.6.2 Export of Particulate Matter Under Fast Ice

Objectives

To measure the export and the nature of particulate and dissolved organic matter sedimenting from the platelet layer over time and assess the nature of the flux to the underlying sediments.

Work at Drescher Inlet

An array of 4 sediment traps and one current meter were deployed under the ice to collect sedimenting particulate material (Fig. 44). This array was left at the first site for only 3 days, after which it had to be retrieved because of ice break up and the danger of loosing the traps.

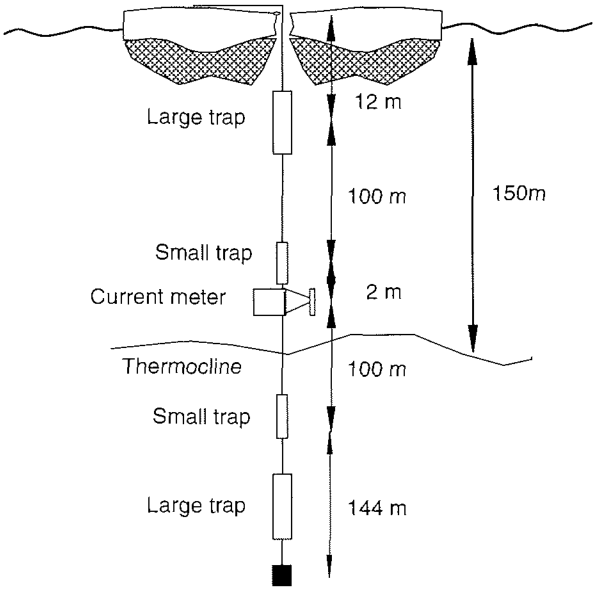

Fig. 44: Sediment trap array deployed under fast ice in the Drescher Inlet. Large traps were multitraps with 3 sample bottles each, set to switch every 6 days. Small traps had a single sample bottle. An Aanderaa current meter was placed above the pycnocline.

A second deployment was made through a tide crack further in the inlet, which lasted for 15 days. Samples were split: one for archive, organism and faecal pellet enumeration. The remaining splits will provide samples for POC/PON, chlorophyll and δ^{13}C-POC.

Preliminary results

Visual inspection of the sample bottles indicated that particle flux was high for the period collected. There was no discernible gradient from top to bottom, however, it did appear that the volume of sedimented material was higher in the traps situated below the 150 m thermocline. Further analyses are to be carried out in Bremerhaven and Bangor.

2.3.6.3 Exchange Processes in the Platelet Layer

Objectives

It is thought that confinement of sea ice algal communities often results in a paucity of inorganic nutrients and / or carbon dioxide. This has significant consequences for the growth and recycling of organic matter within sea ice. Recent laboratory investigations have shown that carbon dioxide may well be a limiting factor determining community structure.

Work at Drescher Inlet

A field experiment was conducted over 10 days to test the hypothesis that sea ice platelet layers can in fact be considered to be closed systems. Furthermore, using a series of closed bottle incubations we repeated the laboratory experiments referred to above to test whether the same biochemical changes took place in the algae as were measured in the laboratory.

2.3.6.4 Hydrography in Drescher Inlet

Objectives

Although the production of ice platelets in the water column in proximity of Antarctic ice shelves is largely understood we have no evidence for this process under the Riiser-Larsen ice shelf. Yet exceptionally large quantities of ice platelets are regularly observed under fast ice in the Drescher Inlet. These are assumed to arise in the water flowing from under the ice shelf. One objective was to determine whether the hydrographic features in the Drescher Inlet are conducive to supercooling and platelet ice formation at depth. Furthermore we intended to determine whether the behaviour of Weddell and crabeater seals in the Drescher Inlet may be related to the hydrographic and accompanying features in the inlet.

Work at Drescher Inlet

A SEABIRD CTD profiler was used to record standard hydrographic data in the water column under the fast ice in the Drescher Inlet. The CTD was lowered by electric winch down to 400 m through cracks in the ice or at the ice edge

Preliminary results

A total of 12 CTD profiles were obtained at more or less regular intervals between February 03 and 19. Figs 45 and 46 are representative CTD profiles showing the variation in the hydrography of Drescher Inlet. The temperature profile shown in Fig. 45 is characteristic for periods of calm and cold weather: The surface layer down to about 30 meters has cooled down while a remant of warmer water is still trapped above the distinct thermocline at 150 meters. During periods of warmer weather, the upper water column is mixed down to the stable thermocline as shown in Fig. 46. Very characteristic for the hydrography in the Drescher Inlet is the rather stable thermocline. While temperatures above this thermocline varied considerably during the period of investigation, probably depending mainly on weather conditions and

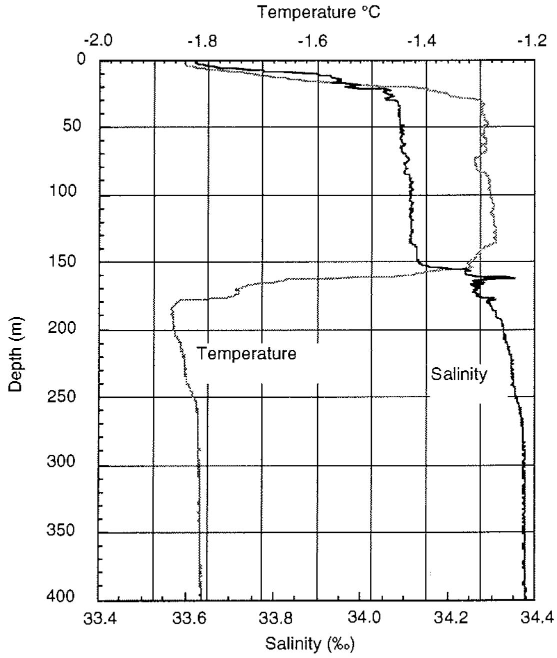

Fig. 45: CTD profile of the water column in Drescher Inlet on Feb 03, 1998.

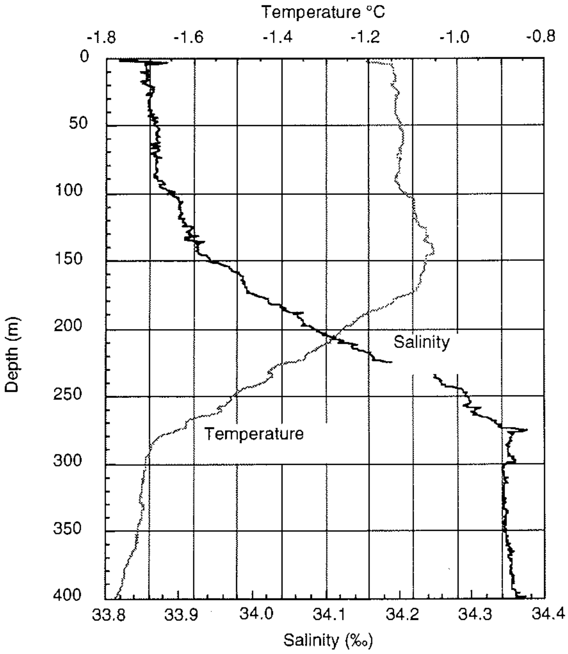

Fig. 46: CTD profile of water column in Drescher Inlet on Feb 19, 1998.

degree of ice cover prior to the measurements, those below the thermocline varied little. Here, temperatures do not appear to drop to levels which indicate super cooling. Further processing of the data is required to make a final evaluation. The stable thermocline may be attributable to the fact that the ice shelf bordering the Drescher Inlet is 150 m thick in this area and influences the hydrography. For the preliminary results concerning seal behaviour and hydrography see chapter 2.3.1.

2.3.6.5 Growth and Attachment of Diatoms on Ice Platelets

Objectives

Within the platelet layer the largest proportion of diatoms is attached to the platelets themselves, rather than floating in the interstitial water. How the diatoms attach themselves to the platelets is not known. Apart from determining the species which grow on the platelets, we intend to use scanning microscopic techniques (Cryostage) to identify the mechanisms of attachment.

Work at Drescher Inlet

Ice platelets were carefully sampled using a sieve and immediately stored as follows:

- Frozen individually in petri dishes
- Placed individually in scintillation vials containing 0.2 μ filtered sea water and frozen
- Placed in 0.2 μ filtered sea water and allowed to melt before preserving with 2% buffered formalin.

2.4 Biodiversity and Biogeography

Rationale and general objectives (A. Brandt, C. De Broyer)

The assessment of Antarctic biodiversity, the understanding of its role in ecosystem functioning and the requirements of its conservation are today of fundamental importance in the context of global environmental changes and the implementation of the Rio Convention.

Biodiversity can be defined as the variety and variability of genomes, species and populations, communities and ecosystems in space and time. Biogeography demonstrates the geographic distribution of species and taxa in our biosphere, tries to explain patterns of distribution and can help to identify the origin of species in certain areas on the basis of phylogenetic relationships of species and their evolution. Knowledge of biodiversity is extraordinarily important for example for conservational aims, as we might not be able to adequately protect the environment or its living organisms, if we do not know the species, assemblages and communities. Considering marine biodiversity, we always have to remember that roughly three quarters of the earth is ocean, less than 10% of which is coastal or shelf area and more than 90% is deep sea.

The remarkable species richness of many important benthos groups in the Antarctic Coastal and Shelf Ecosystem (ACSE), target of the EASIZ Programme, make them particularly appropriate for conceptual studies on biodiversity and the development of new synthetic tools for the description of biodiversity, such as biodiversity reference centers and computer-assisted identification methods.

Even though Antarctic research has been intensified during the last 20 years in many nations, the ACSE and moreover the Antarctic deep sea still harbours many unknown taxa and surprises for researchers. When deep-sea investigations intensified in the early 60ies, Howard Sanders and co-workers postulated a general increase of species richness with depth and a decrease of abundance (e.g. Sanders *et al.* 1965, Sanders and Hessler 1969). Benthic life depends on input of organic matter from the euphotic zone. As productivity is depending on solar energy, we must assume a much lower primary production at the poles compared to the tropics. However, in the tropics vast areas are oligotrophic, whereas certain polar areas can be almost eutrophic - due to frontal systems, upwelling, and other reasons - although mostly in short seasonal bursts. Whatever the true cause, there is no doubt that latitudinal gradients in species diversity exist at least in many deep-sea taxa from the tropics to the poles, especially in the geologically young Arctic Ocean, where these gradients are more pronounced. This hypothesis was first published by Poore and Wilson (1993) and supported by Rex *et al.* (1993) on the basis of epibenthic sledge samples between 500 and 4000 m depth. In a response to the publication by Rex *et al.* (1993), Brey *et al.* (1994) tested whether this general hypothesis would also prove true for the Southern Ocean, using data from the shelf and upper slope of the eastern and southern Weddell Sea. The latter authors could demonstrate that the expected number of Weddell Sea species of bivalves, gastropods, and isopods lies in the same range as that of tropical regions of about 20°S. However, these authors compared Agassiz trawl and box corer data with the epibenthic sledge data from Rex *et al.* (1993) and Poore and Wilson (1993). Now it will be possible for the first time to compare data on the biodiversity of peracarid taxa collected with the same gear, an epibenthic sledge (Brandt and Barthel 1995), from high Arctic (Brandt 1995, 1997, Brandt *et al.* 1996) and Antarctic ecosystems from shallow shelf stations of about 200 m depth down to about 2000 m depth. At the moment it appears that we find more distinct latitudinal gradients in species diversity in the northern hemisphere, and more heterogenous regional variations in the southern hemisphere, a fact which can most probably be attributed to the geological age of these polar ecosystems.

Biodiversity research in Antarctica appears particularly significant because the Antarctic ecosystem is of considerable age and cooling can be dated back at least to the Oligocene, about 35 my ago (Clarke and Crame 1992). Due to the antiquity of this ecosystem, Southern Ocean organisms have had a long timespan available for evolutionary processes, a likely reason for the observed adaptive radiation events in many benthic or benthopelagic taxa (e.g., Notothenioidei, Amphipoda, Isopoda, Gastropoda). This is the reason why the Antarctic was described as an evolutionary incubator for the amphipod family Iphimediidae (Watling and Thurston 1989). These evolutionary processes and the long evolutionary time are the most probable causes for the high degree of endemism, which approaches almost 90% in some taxa, like for example in sponges, peracarid crustaceans or some gastropod families.

This unique ecosystem has to be protected, and therefore the Madrid Protocol on Environmental Protection of the Antarctic signed in 1992 entered into force in 1997. The contributions to biodiversity research during this EASIZ II cruise deal in particular with Antarctic fish, molluscs, polychaetes, peracarid crustaceans, and nematodes and refer to different levels of biodiversity including chemoarchitecture and ultrastructure.

2.4.1 Demersal Fish Fauna (A. Schröder, A. Lombarte, I. Olaso, R. Knust)

Introduction and objectives

The intention of this study was to investigate the zoogeography and biodiversity of the demersal fish fauna in the eastern Weddell Sea. It developed as a by-product from the main tasks of studying the fish fauna in iceberg scours (chapter 2.1.2) and the investigation of the fishes at the Drescher Inlet as possible food for seals (chapter 2.3), and aims to complement work on the biodiversity of benthic invertebrates.

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

1992), that are in a pristine status, as they are free from anthropogenic influences and, especially, not subject to fisheries.

The demersal fish fauna is dependent on the structure of benthic invertebrate communities supplying shelter and food, but in turn they also contribute in structuring the benthic communities. Finally these fish communities represent the link between the benthic invertebrate communities and warm blooded animals such as seals and penguins, and thus are of major importance for the understanding of the whole Antarctic shelf ecosystem.

Work at sea

Demersal fish fauna: Species composition and relative abundances of the demersal fish fauna were studied on the basis of material from 16 otter trawl (GSN) and 17 Agassiz trawl (AGT) hauls (Table 33).

Table 33: Fish samples taken during ANT XV/3. Positions and exact depth data are given in the station list in the annex.

Area	Gear	Station number	Depth zone
Kapp Norvegia (KN)	GSN	71, 220*, 222*	250 m
	AGT	6, 39, 44, 49, 58, 62, 189, 194, 277	250 m
		77, 197	400 m
		206	600 m
Vestkapp (VK)	GSN	100	400 m
		97,123	650 m
		120, 150	850 m
	AGT	103	600 m
		88	1500 m
Drescher Inlet (DI)	GSN	78, 82, 84, 263	400 m
	AGT	264	400 m
Halley Bay (HB)	GSN	168	250 m
		167	400 m
		154	650 m
		95	850 m
	AGT	141	1500 m
		134	2000 m

* disturbed area in iceberg cemetery

Stations for the GSN were chosen to cover the depth range from about 230 m, representing the shallowest areas close to the shelf ice, to nearly 900 m on the continental slope. The depth range for the AGT stations was extended further down the slope to a maximum of 2000 m. Geographical differences within the eastern part of the Weddell Sea were investigated in three areas: Kapp Norvegia in the north, Vestkapp, including four stations inside the Drescher Inlet, and the southern area off Halley Bay.

After extruding the fish from the sometimes enormous amount of sponges and other bycatch, the fishes were whenever possible identified to species level. Reference material was taken from every species. All fish that could not be identified to species level on board were stored either frozen or in 10% formalin for later identification by taxonomic experts (mainly Zoarcidae, Muraenolepididae and Liparidae). Each individual fish was measured (TL) and weighed before subsamples of the most dominant species were taken for stomach analyses (chapter 2.3.5), morphological (chapter 2.4.2) and physiological studies (chapter 2.5.2.4). Representative samples of otoliths were taken from several species for later growth analyses.

Preliminary results

The following results are derived from the analysis of the abundance data from fish caught with the GSN only. Altogether at least 54 species have been found, but this number will increase after identification of those species that were so far identified only to family level. 80% of the species belong to four families within the suborder Notothenioidea (Perciformes), with 24% belonging to the Nototheniidae (15% of all species belong to the genus *Trematomus*), 22% to the Artedidraconidae, and 17% each to the Bathydraconidae and Channichthyidae. Nine other families, mostly from orders other than the Perciformes, were only represented by one or two species (Table 34).

Table 34: List of all fish species caught during ANT XV/3 in the eastern Weddell Sea with the GSN.

Taxon	n
Nototheniidae	
Aethotaxis mitopteryx	52
Dissostichus mawsoni	6
Pleuragramma antarcticum	3086
Pagothenia borchgrevinki	1
Trematomus eulepidotus	120
Trematomus hansoni	17
Trematomus lepidorhinus	301
Trematomus loennbergii	71
Trematomus nicolai	36
Trematomus pennellii	140
Trematomus scotti	286
Trematomus spp. juv.	2
Nototheniidae indet.	2
Artedidraconidae	
Artedidraco loennbergi	14
Artedidraco orianae	35
Artedidraco shackletoni	20
Artedidraco skottsbergi	5
Dolloidraco longedorsalis	213
Histiodraco velifer	4
Pogonophryne barsukovi	12
Pogonophryne lanceobarbata	4
Pogonophryne macropogon	1
Pogonophryne marmorata	23
Pogonophryne phyllopogon	6
Pogonophryne scotti	5
Bathydraconidae	
Akarotaxis nudiceps	4
Bathydraco macrolepis	5
Bathydraco marri	17
Cygnodraco mawsoni	16
Gerlachea australis	67
Gynmodraco acuticeps	10
Prionodraco evansii	43
Racovitzia glacialis	17
Vomeridens infuscipinnis	2
Channichthyidae	
Chaenodraco wilsoni	66
Chionobathyscus dewitti	21
Chionodraco hamatus	77
Chionodraco myersi	561
Cryodraco antarcticus	162
Dacodraco hunteri	61
Pagetopsis maculatus	16
Pagetopsis macropterus	4
Neopagetopsis ionah	6
Paralepididae	
Notolepis coatsi	3
Myctophidae	
Electrona antarctica c.f.	3
Gymnoscopelus sp.	9
Muraenolepididae	
Muraenolepis spp.	5
Bathylagidae	
Bathylagus antarcticus c.f.	5
Anotopteridae	
Anotopterus pharao	*
Macrouridae	
Macrourus whitsoni	337
Liparidae spp.	31
Zoarcidae spp.	7
Rajidae	
Bathyraja maccaini	12
Bathyraja sp.	5
Total	6025

* = only caught with BPN.

Regarding the numerical dominance of the Notothenioidea, a similar picture evolves. 93% of all fish belong to this suborder, largely due to *Pleuragramma antarcticum* accounting for 51%. Excluding *P. antarcticum*, which is a more pelagic species, still 86% of all fish belong to the Notothenioidea, including 35% Nototheniidae (mostly *Trematomus* spp. 33%), 33% Channichthyidae, 11% Artedidraconidae, and 6% Bathydraconidae. The only other family with a remarkable numerical dominance are the Macrouridae, being represented by only one species, *Macrourus whitsoni* (11% of all fish). This species inhabits deeper waters and was only caught in trawls below 500 m, where it was dominant with 29%. In former investigations *M. whitsoni* was probably named *M. holotrachys*, which was declared a synonym in the FAO species identification sheet, mentioning only this one species, but in recent literature (Gon and Heemstra 1990) three different species were identified. *M. whitsoni* is also the only species within this genus known for the eastern Weddell Sea.

The most widely distributed species were *Trematomus lepidorhinus*, which was present in every haul and *T. scotti*, which was absent only in the deepest hauls, *Pleuragramma antarcticum*, a more pelagic species and two Channichthyids, *Chionodraco myersi* and *Cryodraco antarcticum*, that were present in nearly 90% of all hauls. *P. antarcticum* and *C. myersi* were by far the most numerous species (Fig. 47). Most other species were restricted to certain depth strata or areas, where they can be quite frequent and numerous as will be shown below (Tables 35 - 36).

The analysis of the complete data set shows clear differences in the composition of the fish communities that are on the one hand correlated with depth and on the other hand with the geographical position of the area (Fig. 48).

Stations 220 and 222, encircled by a dashed line on the MDS plot in the upper left corner, were situated in the area of an iceberg cemetery at a place where previous observations with the ROV (chapter 2.1.1) had shown severe and relatively fresh iceberg scour marks. Details on the nature of these differences in the demersal fish fauna between the scour marks and supposedly undisturbed "normal" areas at the same depth are discussed in chapter 2.1.2. Several trends can be seen from Fig. 48 There is a clear gradient from the shallower stations in the upper part of the plot to the deepest stations in the lower part. The samples from the Kapp Norvegia and Vestkapp areas are situated on the left, while those from Halley Bay are placed on the right side. It also seems that the differences between the shallower stations of the two areas are more pronounced while the deeper catches show a more similar fish fauna.

The dominance structure of the samples shows clear differences in the fish fauna of the different depth strata (Fig. 49).

In the shallower catches the dominance is more evenly distributed amongst several species, while with increasing depth, the fish fauna is dominated by progressively fewer species. Furthermore, the catches from the disturbed area of the iceberg scouring take a prominent position in this figure, showing a dominance structure similar to the deepest stations, being dominated mainly by two species accounting for 70% and 65%, respectively, of the total numbers. In this area mainly *Trematomus pennellii* and *T. nicolai* were dominant, two species that did not occur in such high numbers in the other hauls at similar depth. More details are discussed in chapter 2.1.2. Characteristic species for the communities were chosen (Table 35) which fulfilled three of the following four prerequisites:

- Dominance > 5%
- Presence > 80%
- Percentage of individuals of one species occurring in this community (DAI) > 66%
- Percentage of stations where this species occurs that belong to this community (DAS) > 66%

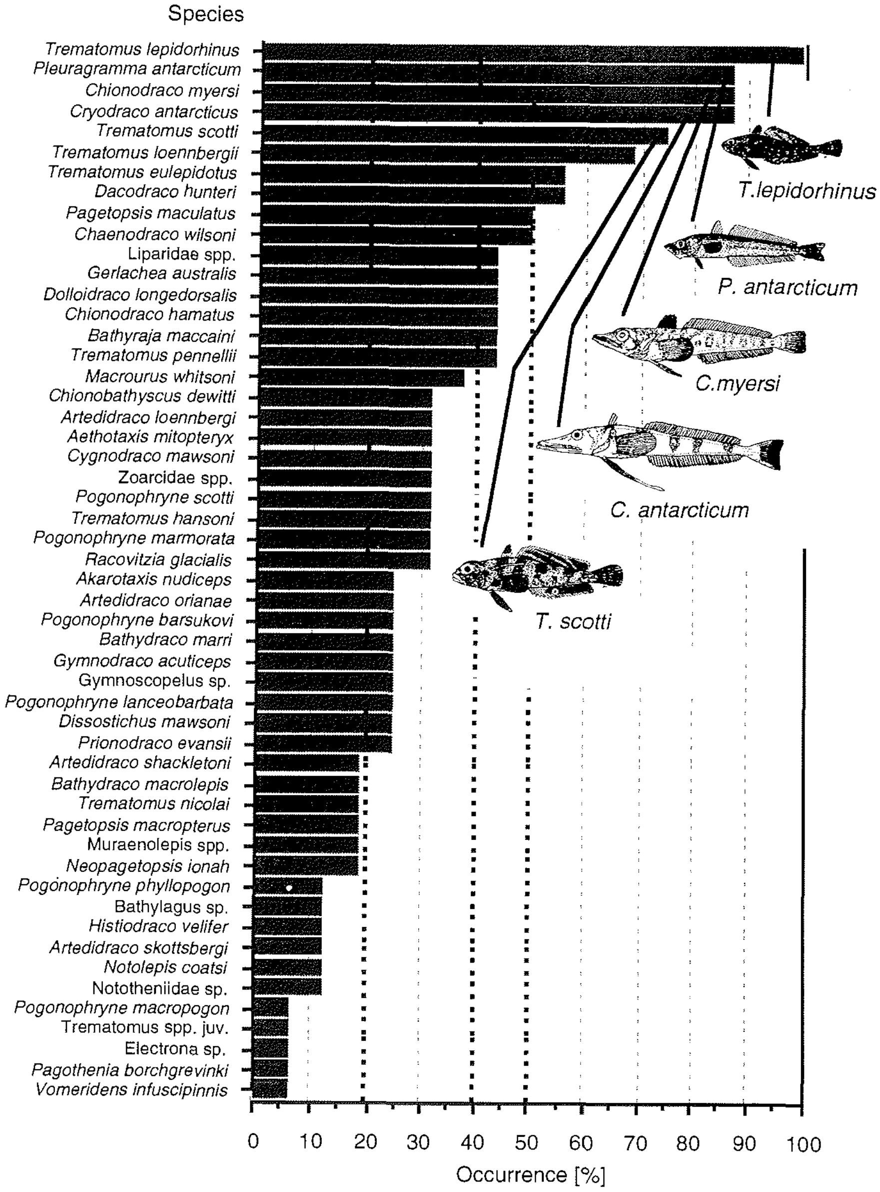

Fig. 47: Occurrence of the species over all GSN hauls (Fish drawings modified after Gon and Heemstra).

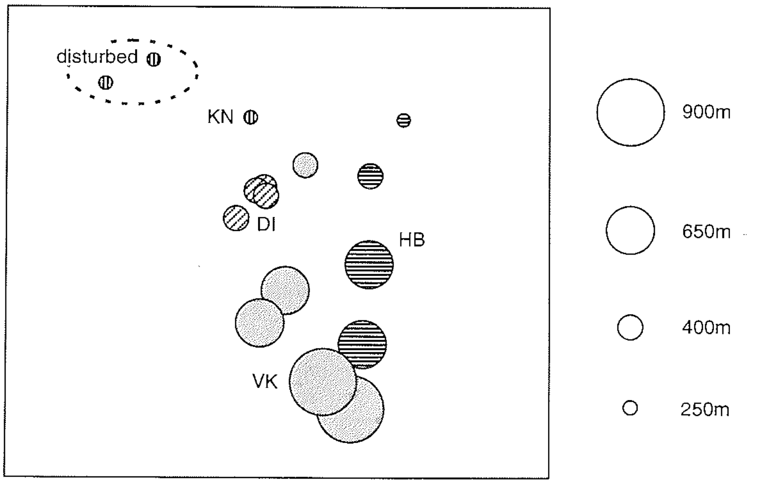

Fig. 48: MDS plot presenting similarities between the catches at all GSN stations as a function of depth (shown by the size of the dots) and of the area (shown by the colour). Bray-Curtis index, 4th root transformation, stress = 0.1, abbreviations as in Table 33.

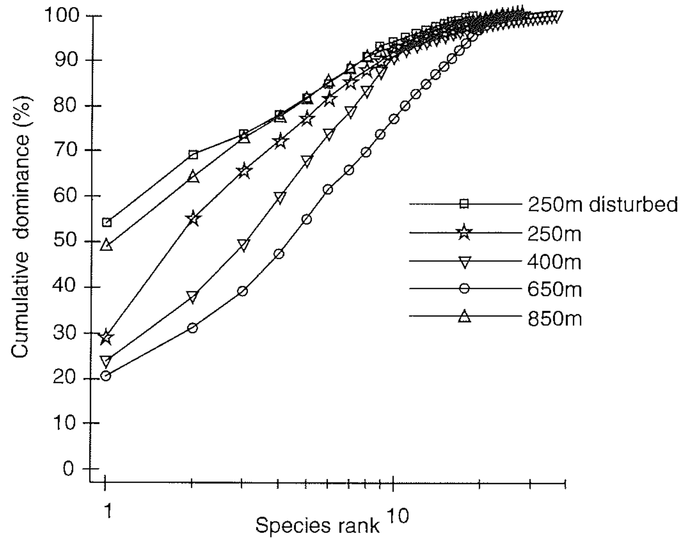

Fig. 49: Cumulative percentage of numerical dominance in the different depth strata.

Generally the shallower stations with less than 400 m were characterized by several *Trematomus* species (*T. eulepidotus, T. scotti, T. pennellii*), some Channichthyid species, notable *Cryodraco antarcticum* and several Artedidraconid species, most of which were restricted to these shallower areas but not very abundant, only *Dolloidraco longedorsalis* can be called a characteristic species (Table 35, Fig. 50). The numerically dominant species in the shallow areas was *Chionodraco myersi*, but as a very common species in all catches it can not be called characteristic. In the shallowest hauls from less than 250 m *Prionodraco evansi* and *Artedidraco orianae* were the characteristic species, and some other Artedidraconidae like *A.*

skottsbergi, *A. shackletoni* and *Histiodraco velifer* occurred only at these shallow depths.

Table 35: The ten most dominant species in catches from less than 400 m plus frequent species that were only found in these shallower areas.
(Characteristic species for this shallow community are printed in bold)

Rank	Species	Sum	Dom (%)	Pres. (%)	Min	Med	Max	DAI	DAS	Total Pres.
1	*Chionodraco myersi*	440	**18.6**	**80**	4	24	165	64	57	88
2	***Trematomus eulepidotus***	273	**11.5**	**90**	1	5	201	**100**	**100**	56
3	***Trematomus scotti***	248	**10.5**	**90**	2	27	55	**86**	**75**	75
4	***Trematomus pennellii***	210	**8.9**	70	2	4	147	**100**	**100**	44
5	***Dolloidraco longedorsalis***	190	**8.0**	60	2	8	156	**87**	**86**	44
6	***Cryodraco antarcticus***	165	**7.0**	**100**	2	10	47	**92**	**71**	88
7	*Trematomus lepidorhinus*	115	4.9	**100**	2	7	35	36	63	100
8	*Gerlachea australis*	109	4.6	70	1	3	69	**100**	**100**	44
9	*Chionodraco hamatus*	89	3.8	70	1	5	35	**100**	**100**	44
10	*Chaenodraco wilsoni*	87	3.7	50	1	1	81	**67**	63	50
12	*Trematomus nicolai*	56	2.4	30	2	17	38	**100**	**100**	19
13	*Prionodraco evansii*	44	1.9	40	6	8	22	**100**	**100**	25
14	*Artedidraco orianae*	32	1.4	40	2	7	16	**100**	**100**	25
15	*Trematomus hansoni*	24	1.0	50	1	2	11	**100**	**100**	31
19	*Cygnodraco mawsoni*	18	0.7	50	1	3	6	**100**	**100**	31
20	*Artedidraco skottsbergi*	15	0.6	20	2	8	14	**100**	**100**	13
22	*Artedidraco loennbergi*	14	0.6	50	1	1	7	**100**	**100**	31
24	*Pagetopsis macropterus*	11	0.5	30	1	3	8	**100**	**100**	19
25	*Histiodraco velifer*	10	0.4	30	1	2	8	**100**	**100**	19
29	*Pogonophryne phyllopogon*	7	0.3	20	3	3	4	**100**	**100**	13
31	*Artedidraco shackletoni*	5	0.2	30	2	2	2	**100**	**100**	19
35	*Akarotaxis nudiceps*	4	0.2	40	1	1	1	**100**	**100**	25

Table 36: The ten most dominant species in catches from more than 500 m depth plus frequent species that were only found in these deep areas. (Characteristic species for this deep community are printed in bold)

Rank	Species	Sum	Dom (%)	Pres. (%)	Min	Med	Max	DAI	DAS	Total Pres.
1	***Macrourus whitsoni***	339	**28.6**	**100**	3	54	118	**100**	**100**	38
2	*Chionodraco myersi*	251	**21.1**	**100**	2	41	83	36	43	88
3	*Trematomus lepidorhinus*	209	**17.6**	**100**	2	31	73	64	38	100
4	*Trematomus loennbergii*	57	4.8	**100**	1	10	20	**79**	55	69
5	*Aethotaxis mitopteryx*	49	4.1	67	1	8	33	**92**	**80**	31
6	*Chaenodraco wilsoni*	43	3.6	50	1	19	23	33	38	50
7	*Trematomus scotti*	41	3.5	50	2	11	29	14	25	75
8	*Dolloidraco longedorsalis*	29	2.4	17	29	29	29	13	14	44
9	*Dacodraco hunteri*	27	2.3	**100**	2	3	11	32	**67**	56
10	***Chionobathyscus dewitti***	23	1.9	**83**	2	4	8	**100**	**100**	31
11	*Bathydraco marri*	17	1.4	67	1	4	8	**100**	**100**	25
15	*Neopagetopsis ionah*	7	0.6	50	2	2	3	**100**	**100**	19
20	*Muraenolepis spp.*	5	0.4	50	1	2	2	**100**	**100**	19
24	*Bathydraco macrolepis*	4	0.3	33	1	2	3	**73**	**67**	19

Apart from the common species, several species appeared in the deep hauls that were not present in any shallower haul (Table 36). The most prominent one is *Macrourus whitsoni*, the dominant and characteristic species in this depth (Fig. 51). Two channichthyid species, *Chionobathyscus dewitti*, the second characteristic species for this depth, and *Neopagetopsis ionah* also were caught only at this depth. Additionally *Bathydraco marri* was never caught at lesser depths, *B. macrolepis* rarely, and *Muraenolepis* spp. did not appear elsewhere.

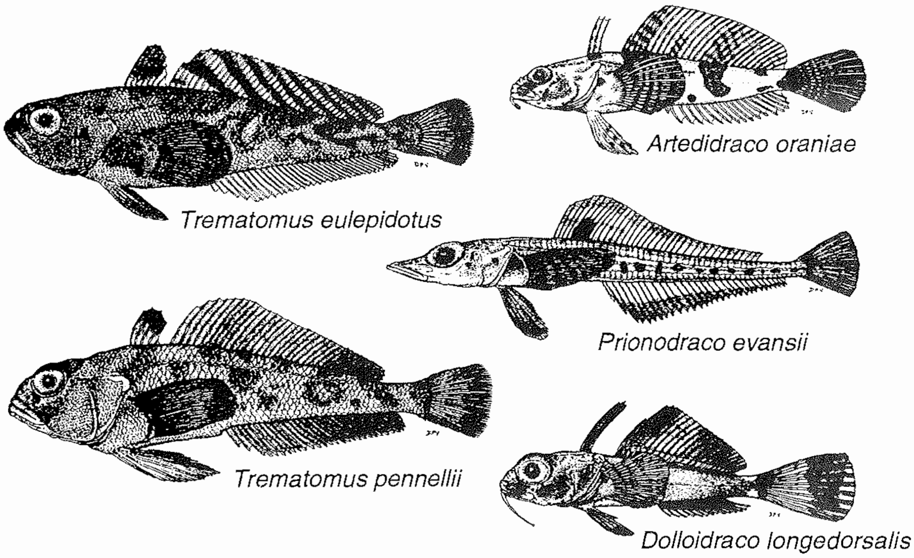

Fig. 50: Typical species for the demersal fish fauna in areas of less than 400 m depth (Fish drawings modified after Gon and Heemstra 1990).

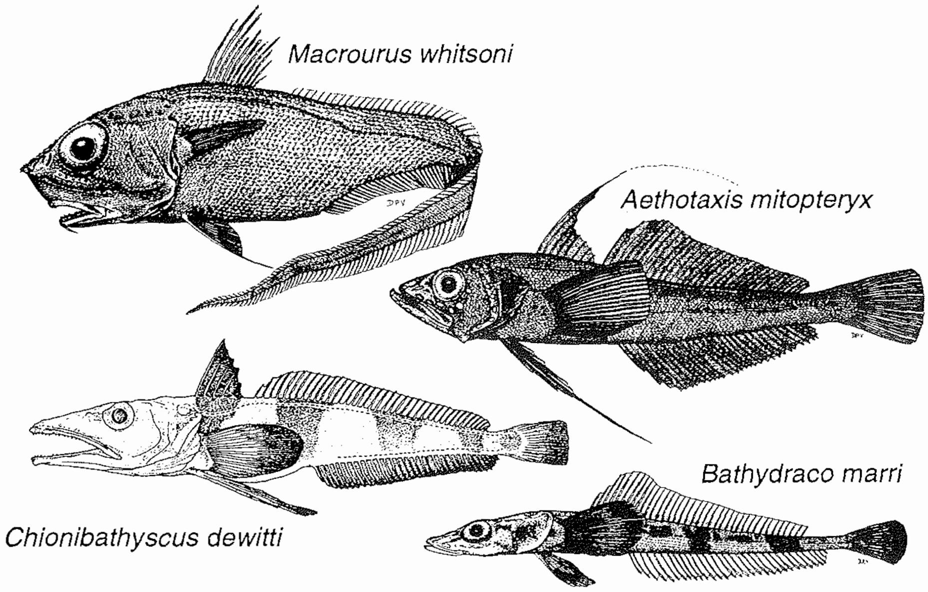

Fig. 51: Species typical of the demersal fish fauna in areas of more than 500 m depth (Fish drawings modified after Gon and Heemstra 1990).

2.4.2 External and Internal Morphology of the Sensory Organs in Artedidraconidae, Teleostei: Notothenoidei (A. Lombarte)

Introduction and objectives

The goal of ecomorphological studies is to determine the strength of the relationship between variation in shape and variation in actual resource use among individuals, populations, species, and higher taxa. In ecomorphological studies, the comparison of sensory structures between groups is a basic cue to understand the interaction between organism and environment (Norton *et al.* 1995).

The notothenioids are characterized by a high diversification. This monophyletic group of Perciformes is well adapted to Antarctic conditions and is able to occupy a large number of very different ecological niches and to assume ecological roles occupied by taxonomically diverse fishes in other communities (Eastman 1991, Ekau 1991). There are obvious gaps in our knowledge of the sensory biology of the Notothenoidei, especially in the study of mechanosensory and chemosensory receptors. Moreover, the amount of data is very different for the families of this Antarctic group. Most studies are focused on the families Nototheniidae and Channichthyidae, whereas very little is known about the family Artedidraconidae (plunderfishes). Most species of this family are Antarctic endemics and belong to four genera (*Artedidraco*, *Dolloidraco*, *Histiodraco* and *Pogonophryne*) with about 25 species.

The Artedidraconidae show a specialized structure, a mental barbel only present in this family, of variable length and structure, expandend distally and often bearing papillae and/or tapered or rounded end processes (Hureau 1985, Eastman 1991, Eakin 1990). The mental barbel of the Artedidraconidae may be related to a specialization in benthic habits (Ekau and Gutt 1991), especially the food supply. The food composition, based on the analysis of stomach contents, is characterized by a high percentage of benthic organisms such as polychaetes and isopods (Wyanski and Targett 1981, Daniels 1982, Schwarzbach 1987). Macdonald and Montgomery (1991) concluded from behavioural studies with *Histiodraco velifer* that the mental barbel functions as a lure and is also sensitive to tactile inputs important for the feeding responses of the fish. Janssen *et al.* (1993) indicated that mental barbels of *H. velifer* lack taste buds, but are studded with what appears to be Pacinian corpuscles. However, in most cases mental, mouth, or hyoid barbels have a chemosensory or mechanosensory function (Caprio 1988; Gomahr *et al.* 1992, Lombarte and Aguirre 1997).

For a better understanding of the adaptative function of these structures and the interactions between the morphology of organisms and their ecology, the evolutionary radiation and biodiversity generation of this group, it is necesary to analyze the morphological relationships between different sensory organs, such as eyes and mental barbels, and the correspondence with environmental factors. To improve the knowledge of the functional morphology of mental barbels and eyes of the Artedidraconidae, some material was fixed for histological studies.

Work at sea

The specimens were determined by means of keys provided by Eakin (1990). Seven morphological measurements (mental barbel total length, maximum and minimum diameter of the eye, eye depth, lens diameter, width and length of the mouth) were taken from the following members of the family Artedidraconidae: *Artedidraco loennbergi*, *A. orianae*, *A. shackletoni*, *A. skottsbergi*, *Dolloidraco longedorsalis*, *Histiodraco velifer*, *Pogonophryne barsukovi*, *P. lanceobarbata*, *P. marmorata* , *P. phyllopogon*, and *P. scotti* (Table 37).

To carry out principal component analyses (PCA) for species characterization, fish body size and allometry effects were avoided by normalizing all measurements to standard body size, taking into account the allometric relationship. For each of the seven morphologic measurements the allometric relationship with body length of the fish was calculated. The equation used was the standard $Y=aX^b$, fitted using logarithmic transformation to homogenize residuals. For the analyses of the whole family, 150 mm was used as standard body length (X_0), for *Artedidraco* analyses the length reference was 80 mm and for *Pogonophryne* 180 mm.

Table 37: Species, size and depth range and number of specimens used in the morphometric analyses.

Species	Size range (mm)	Depth range (m)	No. of individuals
A. loennbergi	47 - 111	281 - 417	24
A. orianae	56 - 161	227 - 360	42
A. shackletoni	65 - 119	184 - 301	9
A. skottsbergi	35 - 114	184 - 301	30
H. velifer	158 - 183	227 - 416	6
D. longedorsalis	56 - 132	390 - 583	29
P. barsukovi	168 - 216	440 - 758	14
P. lanceobarbata	93 - 150	341 - 659	4
P. marmorata	52 - 242	211 - 670	29
P. phyllopogon	73 - 222	281 - 407	10
P. scottii	191- 297	234 - 670	5

For examination with SEM, the barbels were immersed in an ice-cold solution of 2.5% glutaraldehyde in phosphate buffer (pH 7.2). The eyes were removed, the external layers were perforated, and the eyes were then immersed in an ice-cold solution consisting of 1.5% glutaraldehyde and 1.5% paraformaldehyde in phosphate buffer (pH 7.2). After 24 hours the solution was changed and the eyes were stored in phosphate buffer.

Preliminary results

Gross morphology of the mental barbel. All examined species of *Artedidraco* have a relatively short barbel that is called "light" by Eakin (1990). *A. orianae* differs from other species of the same genus in the distal portion of the mental barbel which is thicker than the proximal part and equipped with some protrusions. The length of the expanded distal portion is around 20% of the total barbel length. *A. skottsbergi* is characterized by the shortest mental barbel in the family Artedidraconidae. *A. loennbergi* and *A. shackletoni* have longer barbels than *A. skottsbergi*, but in both species the mental barbel is tapered to a point. *Dolloidraco longedorsalis* has a long mental barbel that is either tapered or extended. The length of the extended distal portion, when present, is between 6 and 7% of the total barbel length. *Histiodraco velifer* has a long barbel like *Dolloidraco*, but in this case the barbel is expanded distally with fringelike processes. The expanded part reaches 8-10% of the barbel length. In *Pogonophryne*, the mental barbel is tapered to a point or to varying degrees expanded distally, often with tapered or rounded, branched or unbranched processes. *P. barsukovi* has the shortest barbel in the genus, tapered to a point or rounded distally and covered with some papillae. There is no expanded distal process on the mental barbel. *P. lanceobarbata* has a very long mental barbel with a lance-shaped distal expansion of 25-35% barbel length with branched superficial processes. The barbel of *P. marmorata* has an intermediate length in relation the two above mentioned species. Its terminal process reaches 40-70% barbel length, and is formed by convoluted ridges. *P. scotti* has a slender and relatively short mental barbel covered with papillae and without distal processes. The mental barbel of *P. phyllopogon* is similar to that of *P. scotti*, but it is thinner and papillae are absent from the whole surface of the barbel.

Morphometric analyses. CPA of the family Artedidraconidae. In the quadrants, outlined by factors 1 and 2 (Fig. 52), the following attributes can be assigned to the four genera of the family Artedidraconidae: *Histiodraco* species are characterized by big eyes, a large mouth, and long barbels. *Dolloidraco* has similar characters except for a relatively smaller mouth. *Pogonophryne* and *Artedidraco* show medium-sized to small eyes and a great variation in barbel size. The two genera are separated basically by the size of the mouth, which is relatively larger in the genus *Pogonophryne*.

CPA of the genus *Artedidraco*. The axes 1 and 2 (Fig. 53) ordered the specimens based on the following attributes: axis 1 ordered the specimens in relation to the mental barbel length.

Artedidraco orianae and *A. shackletoni* are characterized by the longest barbels in the genus while the shallowest living species, *A. skottsbergi*, carries the shortest mental barbel. *Artedidraco loennbergi* shows intermediate barbel length. In relation to axis 2, *A. shackletoni* is separated from the rest of the species by a larger mouth and a smaller lens diameter (related to small focal length).

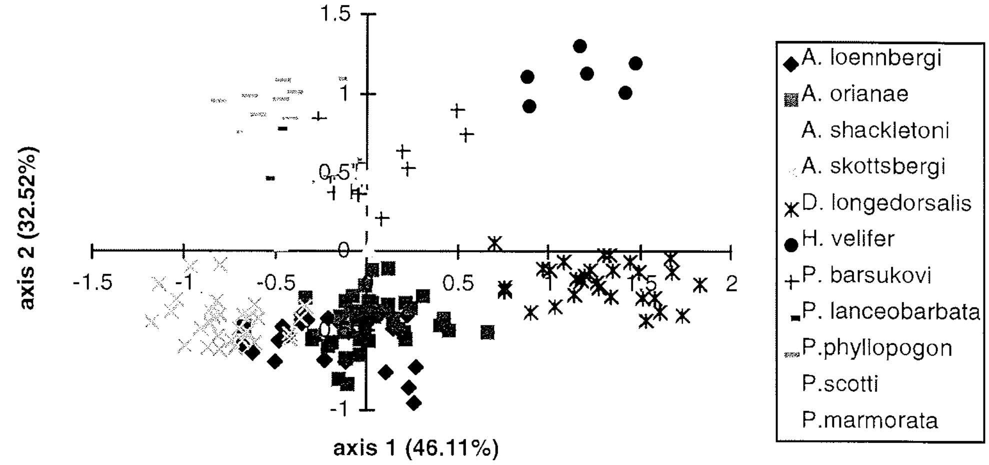

Fig. 52: Ordination of the specimens of eleven species of Artedidraconidae according to their scores on axes 1 and 2 of the CPA.

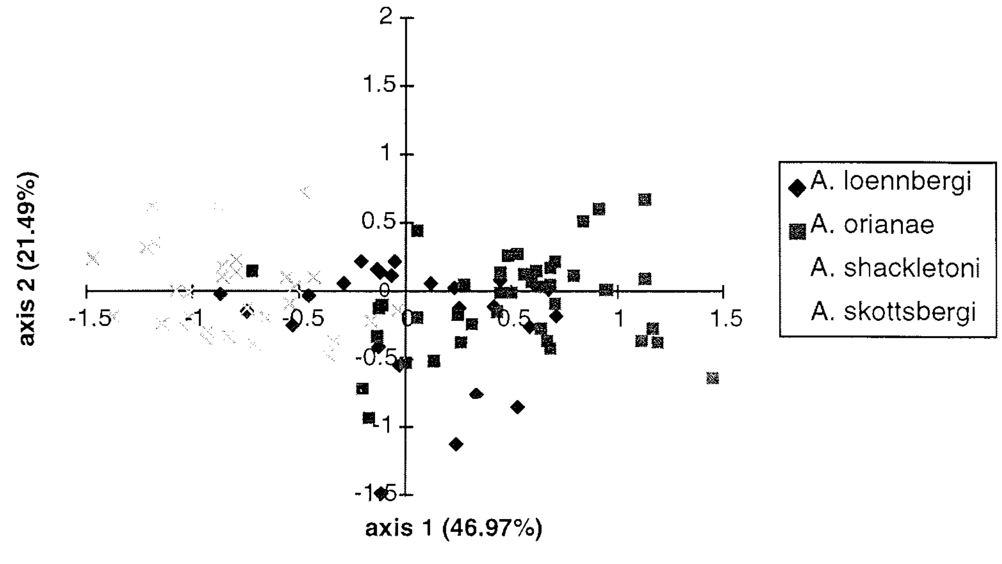

Fig. 53: Ordination of four species of the genus *Artedidraco* according to their scores on axes 1 and 2 of the CPA.

CPA of the genus *Pogonophryne*. In the first axis the species are ordered in function of the mental barbel length (Fig. 54). Thus, *P. lanceobarbata* carries the longest barbel of the analyzed species, *P. marmorata* , *P. phyllopogon*, and *P. scotti* have intermediate size, and *P. barsukovi* has the shortest barbel. The second axis separates the genera by the size of mouth and eyes. *P. scotti* and *P. phyllopogon* are characterized by a larger mouth and smaller eyes (especially lens length) than the other species of this genus.

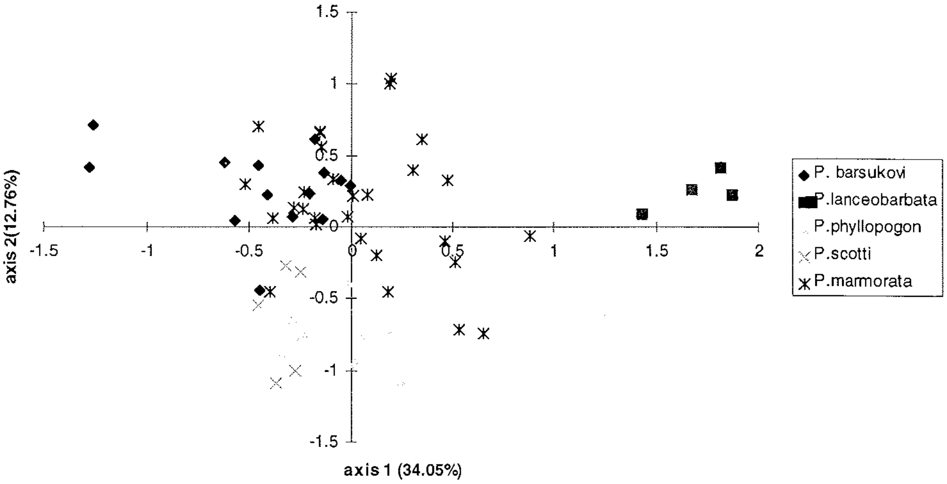

Fig. 54: Ordination of five species of the genus *Pogonophryne* according to their scores on axes 1 and 2 of the CPA.

The results of the CPA indicate that species and genera of Artedidraconidae can be characterized using few morphological characters related to sensory organs and mouth size. These results suggest a differential development of sensory organs, such as eyes and mental barbels, related with the fast radiation and speciation processes into the Artedidraconidae. These processes may be related to the avoidance of competition, especially in terms of feeding habits, as shown by clear specific differences in diet composition and feeding strategies (see chapter 2.3.5).

2.4.3 Biodiversity and Zoogeography of Mollusca, Polychaeta, and Crustacea Peracarida (A. Brandt, B. Hilbig, K. Linse, G. Wegener)

Introduction

During this study, the zoogeography, phylogeny, and biodiversity of molluscs, peracarid crustaceans, and polychaetes is investigated. The results shall be compared with existing data on the mollusc and peracarid fauna of the Magellan area, European northern seas, and the polychaete fauna of deep-sea regions in the northern Atlantic and Pacific oceans. Quantitative and qualitative samples were taken along two transects in the southern Weddell Sea (S of Vestkapp and off Halley Bay), a single deep station off Kapp Norvegia, and a third transect off King George Island. Stations were established in depths between 200 and 2500 m to assess shelf and slope environments with different topographical and sedimentary conditions.

Objectives

Crustacea Peracarida: Besides Euphausiacea and Copepoda the Peracarida (Amphipoda, Cumacea, Isopoda, Mysidacea, Tanaidacea) are the most successful taxon of Crustacea in the Southern Ocean, occurring with a high percentage of endemic species (≈ 90%). A comparison of the results from this expedition, i.e., the above mentioned transects with data from the Magellan area and the background of published phylogenetic analyses might help to elucidate further the origin of these taxa in Antarctica and the relation of the Antarctic and Magellanic fauna in general. Moreover, a comparison of the biodiversity data from these transects with our knowledge from the high Arctic (European northern seas) shall be done on the background of the discussions concerning latitudinal biodiversity gradients. In this respect the more ancient Antarctic ecosystem can be compared with the Quaternary, Neogene Arctic one on the basis of material sampled with the same gear, an epibenthic sledge (construction and deployment described in Brandt and Barthel 1995), which was used in a standardized manner at all areas of investigation.

Polychaeta: The biodiversity of the Polychaeta is investigated with emphasis on the infaunal communities of the deep sea, focussing on quantitative samples taken with the multibox corer (MG). The species composition of the polychaete communities at different depths shall be described and viewed in relation to sedimentary conditions and topography. The occupation of certain ecological niches by different polychaete families will be assessed as far as possible, for example, in terms of feeding types, sessile or motile life forms, etc. Comparisons will be made with data from other deep-sea regions, such as the northwestern Atlantic and the northeastern Pacific off the U.S. American coasts. The issue of latitudinal gradients in species diversity between equatorial and polar waters can be adressed as far as boreal and Antarctic seas are concerned. In addition, the samples taken with a coring device (MG) will be compared with those obtained with the epibenthic sledge (EBS), Agassiz trawl (AGT), and a large TV grab (TVG). Even though the latter do not sample in a quantitative way as it is traditionally understood - with a constant and precisely known surface area as a reference -, the results are of interest as far as the community composition is concerned. The generally very coarse-grained and stony or very hard, clayey bottoms that appear to predominate even at considerable depths do not lend themselves to burrowing infaunal organisms as they are known from soft deep-sea mud. It may therefore be necessary to develop a different concept for "quantitative", that is, reasonably representative, sampling of such communities.

Mollusca: The horizontal and vertical distribution of the Mollusca of the southeastern Weddell Sea and the region of the Antarctic Peninsula (King George Island) shall be investigated and compared with data from the Magellan area in order to improve the knowledge of both areas. The molluscan data from the EBS will be compared with abundance and diversity data from the Beagle Channel that were also based on samples taken by the same epibenthic sledge model (Linse 1997).

This malacological comparison shall also serve for the investigation of the history of the colonization of Antarctica by the Mollusca. To follow this aim, a phylogenetic analysis of selected, abundant taxa, e.g., of the trochid genera occuring in the Southern Ocean, like *Falsimargarita* or *Antimargarita* is necessary and - besides the morphological comparison - is planned for the future on a molecular basis. In this context the molecular genetic approach should serve to provide reliable data on genetic distances of closely related species from South America and Antarctica. This technique will be applied later in order to test the results of the phylogenetic analyses of the investigated species.

Work at sea

The biodiversity of macrobenthic invertebrates in the South Atlantic was investigated on the basis of two vertical transects in the Weddell Sea, southwest of Vestkapp and off Halley Bay from about 200 m down to 2000 m depth (≈ 200, 400, 750, 1000, 1500 and 2000 m, respectively), and one horizontal deep-sea transect with stations at about 2000 m depth off Kapp Norvegia and the deep stations SW of Vestkapp and off Halley Bay. Another transect was sampled off King George Island towards the Drake Passage (see 2.4.10). On all of these transects the following gears were employed: CTD, epibenthic sledge, Agassiz trawl or bottom trawl, Rauschert dredge, the multicorer (MUC) (selected stations only), and multibox corer or, alternatively, TV grab if the sediment at the shallow stations was expected to contain too many big stones. Gammaridean and Caprellidean amphipods (and in addition Leptostraca and

Pycnogonida) were collected from additional stations in Drescher Inlet, off Kapp Norvegia, and off Atka Bay. Systematic sampling of the scavenger component of these communities by baited traps, performed for the first time in the Weddell Sea during EASIZ I, has been continued and extended to 200, 400, 600, 800, 1200 and 1500 m (13 operations).

The epibenthic sledge, which is equipped with an epibenthic (500 µm mesh size) and a suprabenthic net (300 µm mesh size, both bearing a cod end of 300 µm mesh size) of 1 m width, was trawled at every station with 1.5 times wire length to depth for 10 minutes over the ground with a mean velocity of one knot. The haul distances were calculated on the basis of the GPS derived positions of the ship at start and end of the haul (distance in meters = 1852 • $\sqrt{}$ (Δ lat' $)^2$ + (cos lat' • Δ long'$)^2$, after Brattegard pers. comm., compare Brandt 1993. The sample volume was then calculated by multiplying the haul distance with the area of the box opening. As the sample distances varied from 317 to 482 m (see 3.2), the numbers of individuals will later be calculated for a standardized 1000 m haul for reasons of comparison of both abundance and diversity values of Peracarida, Polychaeta and also Mollusca.

The multibox corer with the attached UW-video system was successfully deployed at 26 stations along the southeastern Weddell Sea shelf, covering a depth range from 180 to 2415 m (see Table 38).

Table 38: MG stations.

Date	Station	Position (S; W)	Depth (m)	No. of cores	Macro/Meiofauna	Remarks
30-01	047	72° 52.15'; 10° 29.26'	243	9	7/2	scour; 2 photos
30-01	048	72° 52.15'; 10° 29.26'	245	7	5/2	scour
31-01	063	70° 52.10'; 10° 32.40'	234	6	5/1	scour
31-01	064	70° 52.10'; 10° 31.80'	241	0		scour
31-01	065	70° 51.90'; 10° 32.20'	227	4	2/2	scour
01-02	067	70° 49.90'; 10° 36.70'	305	9	7/2	undisturbed
01-02	068	70° 50.30'; 10° 38.10'	269	3	3/0	undisturbed
01-02	069	70° 51.70'; 10° 33.70'	227	2	2/0	undisturbed
04-02	091	73° 28.70'; 22° 48.20'	1506	8	6/2	biodiversity
04-02	092	73° 34.06'; 22° 26.50'	993	7	5/2	biodiversity
04-02	093	73° 28.30'; 22° 53.70'	1985	9	7/2	biodiversity
06-02	112	73° 38.70'; 22° 13.10'	378	1	1/0	stones
06-02	113	73° 36.20'; 22° 22.22'	746	2	1/0	stones
08-02	131	73° 23.70'; 22° 09.10'	1944	7	5/2	biodiversity
08-02	132	73° 19.80'; 22° 22.50'	2415	8	6/2	biodiversity
09-02	136	74° 33.00'; 27° 13.10'	2011	9	7/2	biodiversity
09-02	137	74° 36.20'; 27° 12.70'	1500	9	7/2	biodiversity
10-02	146	74° 37.80'; 27° 08.00'	1000	6	4/2	biodiversity
15-02	187	71° 32.30'; 13° 31.70'	255	9	7/2	directly scour
15-02	188	71° 31.50'; 13° 30.60'	225	5	5/0	undisturbed
18-02	216	71° 06.46'; 11° 32.67'	180	2	2/0	4-Season Inl.
19-02	223	70° 50.19'; 10° 35.39'	273	6	4/2	Auståsen, scour
19-02	224	70° 49.79'; 10° 34.40'	279	9	7/2	undisturbed
19-02	225	70° 50.15'; 10° 35.03'	276	8	6/2	scour
20-02	227	70° 49.32'; 10° 38.84'	360	9	7/2	undisturbed
20-02	228	70° 49.83'; 10° 37.53'	293	9	7/2	undisturbed
20-02	230	70° 50.94'; 10° 32.18'	229	9	7/2	semidisturbed
14-03	299	62° 15.88'; 58° 42.61'	212	9	7/2	off P. Cove
14-03	300	62° 16.80'; 58° 41.85'	423	9	7/2	off P. Cove
17-03	325	62° 22.04'; 58° 42.73'	829	9	7/2	off P. Cove
17-03	326	62° 20.18'; 58° 38.50'	625	9	7/2	off P. Cove
18-03	330	61° 20.65'; 58° 14.78'	2000	6	4/2	Drake Passage
19-03	334	61° 26.55'; 58° 06.49'	1043	9	7/2	Drake Passage
19-03	341	61° 34.55'; 58° 06.73'	428	9	7/2	Drake Passage
20-03	345	61° 53.40'; 59° 07.04'	218	9	7/2	Drake Passage
20-03	356	62° 00.20'; 59° 15.00'	120	9	7/2	Drake Passage

Table 39: Inventory of the malacofauna of the Weddell Sea.

Gear	Stn No.	Depth (m)	Solenogastres		Polyplacophora		Gastropoda		Scaphopoda		Bivalvia		Mollusca	
			Ind	spp.**	Ind	spp.**	Ind	spp.**	Ind	spp.**	Ind	spp.**	Ind	spp.**
TVG	004	291	1	1	4	1	6	4	1	1	14	6	26	13
AGT	006	178					4	2			2	1	2	3
TVG	027	191					2	1			5	1	7	2
TVG	030	65					20	2					20	2
TVG	031	64					3	2					3	2
TVG	032	62					2	2					2	2
TVG	033	65					9	3					9	3
D	037	146					2	2					2	2
AGT	039	230			1	1	3	1	1	1			5	3
AGT	044	238	3	1	20	1	38	18			16	2	77	22
AGT	049	246			6	1	21	6			11	1	38	8
D	050	267			2	1	1	1					3	2
AGT	058	223	1	1	10	1	13	5			8	7	32	14
AGT	062	248			5	1	56	9			17	5	78	15
GSN	071	231			24	1	32	9			15	6	71	16
AGT	077	433	3	1	14	1	59	10			32	8	108	20
GSN	078	413	2	1	10	1	22	9			109	7	143	18
GSN	082	390	1	1	7	1	12	6	1	1	71	4	92	13
AGT	088	1681					77	6	8	1	14	4	99	11
GSN	094	813					23	5			2	2	25	7
GSN	097	605			3	1	24	4			1	1	28	6
GSN	100	437			2	1	10	4					12	5
AGT	103	600	1	1							1	1	2	2
AGT	129	209					3	3			2	2	5	5
AGT	134	2080					10	5					10	5
AGT *	134	2080			1	1	76	15	564	2	1613	5	2254	23
D	141	1488					6	2			2	1	8	3
AGT	141	1488			3	1	7	5			2	1	12	7
D	144	972					2	2			5	1	7	3
GSN	150	746			2	1	4	3			3	1	9	5
GSN	154	666			3	1	5	2			4	2	12	5
D	166	396					1	1					1	1
GSN	167	392					17	2					17	2
GSN	168	247					4	2			3	2	7	4
TVG	170	233							1	1			1	1
AGT	194	263	3	1	1	1							4	2
AGT	206	518					12	1					12	1
TVG	209	67					17	5			3	2	20	7
TVG	210	65					6	2					6	2
TVG	212	75			1	1	14	7			9	9	24	17
D	213	110					20	6			21	5	41	11
GSN	263	380					4	2			1	1	5	3
AGT	264	450			1	1	2	2			3	1	6	4

* = 500 µm ** = no. of species

The effects of grounding icebergs on meio- and macrofauna were studied on the shelf in the Kapp Norvegia area, including areas north of the Kapp in front of Auståsen. Transects sampled SW of Vestkapp and off Halley Bay provided quantitative samples and videos for studies of biodiversity, especially of peracarid crustaceans, molluscs, and polychaetes. These stations cover a great depth range and extend our faunistic inventory of the deeper areas in this part of the Weddell Sea, where up to now only 7 stations were sampled with quantitative gear. Table 3 (2.1.3) summarizes the station work done; shown are number of deployments and number of cores obtained for the different fields of work.

In the Drake Passage and also on the eastern side of King George Island in the Bransfield Strait a transect was sampled with the above mentioned gear in order to compare the fauna of the Magellan region and the area of the Antarctic Peninsula.

All quantitative samples obtained were sieved over 500 µm mesh size, at 8 stations partly over 300 µm mesh, and preserved in 4% hexamethylene buffered formalin prior to sorting in the labs in Bremerhaven and Hamburg. Generally, the top 10 cm were taken out of the cores and the deeper sediment discarded. In cases where the sediment was extremely stiff blue clay, the core was gently broken apart, rinsed over the sieve, and discarded when no infaunal life could be detected.

Whenever feasible, small sediment samples were collected for grain size analysis. At several stations that were anticipated to be very stony, the multibox corer (MG) was replaced with the TV grab because the hydraulic opening and closing mechanism of the grab allowed for a more controlled sampling in this difficult terrain. Once on deck, the grab was left standing upright with the jaws closed, and the sample was inspected through the four doors on top for the condition of the sample surface. In cases where a reasonably undisturbed surface was seen, a subcore was gently pushed into the sample through the doors. The surface area of the core was 25 by 25 cm, and the depth was about 10 cm. Once the core was placed in the sample, the sediment within the core was carefully transferred with a small shovel into a bucket and then sieved on a 0.3 mm sieve. If there was enough undisturbed sediment, the procedure was repeated once so that a total of two quantitative samples was obtained from one grab.

For the inventory of the malacofauna of the Weddell Sea, especially of Gastropoda and Bivalvia, Mollusca caught in the different gears (AGT, GSN, TVG, D, EBS) were sorted and identified, if possible to species level (Table 39). While in the AGT and GSN the bigger sized molluscs were found, the EBS also collected smaller taxa and individuals, which will be sorted and identified later. Some selected species, e.g., *Falsimargarita gemma*, *Antimargarita dulcis*, *Margarella* sp. 1 and *Marginella* cf. *ealesae*, were kept alive in aquaria for behavioural observations. The animals for later genetic studies were either fixed in precooled 80% ethanol or were deep frozen.

Preliminary results

Crustacea Peracarida: At present, one of the best sampling devices for the small Crustacea Peracarida is the epibenthic sledge because it yields a high number of individuals, usually in good condition. Due to the large numbers of specimens sampled and the tremendous biodiversity of Antarctic Peracarida (almost 1500 known species) the samples are not processed (sorted and identified) on board; this will be done later in Hamburg. However, larger species of Isopoda and Amphipoda (see 2.4.7) were also qualitatively collected from the TV grabs and the Agassiz and bottom trawls. The most diverse taxon were the Amphipoda (compare 2.4.7; DeBroyer and Jazdzewski 1996), which were found in high abundances in almost all shelf samples. Of the Isopoda 22 larger species could be identified on the shallower shelf stations. These were the following species: The giant Antarctic isopod *Glyptonotus antarcticus* (Chaetiliidae, predator), *Antarcturus furcatus, A. americanus, Litarcturus bovinus, Dolichiscus meridionalis* (Arcturidae, passive filter feeders), *Ceratoserolis trilobitoides, C. meridionalis, C. pagenstecheri, Frontoserolis bouvieri, Cuspidoserolis luethjei, C.* cf. *gerlachei* (Serolidae, predators, omnivorous), *Natatolana albinota, N. obtusata, N. oculata,* and *N. intermedia* (Cirolanidae, scavengers), *Accalathura gigantissima* (Anthuridea, Paranthuridae, predator), *Aega antarctica* (Aegidae, fish ectoparasite), *Cryptoniscus* sp. (Epicaridea, Epicaridae, parasite), *Gnathia calva* and *Heterognathia gigas* (Gnathiidae, the larval Pranizae are parasites), and the asellote isopod species *Acanthaspidia drygalskii* (Acanthaspidiidae), *Stenetrium weddellensis* (Stenetriidae), and *Munnopsurus cf. australis* (Munnopsidae). At stations which were characterized by huge amounts of large Demospongiae, numbers of *Glyptonotus* and also of Serolidae - if present - were quite low, whereas the Arcturidae were slightly more frequent at those localities. Interestingly, the serolid isopods *Ceratoserolis trilobitoides* and *C. meridionalis* were never sampled together in one haul. *C. trilobitoides* always occurred much shallower (down to 450 m depth), whereas *C. meridionalis* was apparently distributed much further down the slope and was found on stations deeper than 850 m depth, indicating that these two species might have an allopatric depth distribution.

The sediment of the shallower shelf stations was mainly characterized by drop stones, coarse sand, clay and silt and possessed a high amount of sponge spicules (at some stations the ocean bottom was covered by a thick mat of sponge spicules). Only at the deeper stations at 1500 (besides the big boulders collected with the Agassiz trawl at one station) and 2000 m the sediment was consisting of fine mud. The one and only Agassiz trawl taken deeper than 2000 m (2080 m) was characterized by very fine mud which contained some quite interesting isopods that were not sampled frequently with other gears or in other depths. These were more typical deep-sea specimens that belonged to the families Ilyarachnidae, Eurycopidae, and especially the families Ischnomesidae, Desmosomatidae, Haploniscidae, and Macrostylidae.

Polychaeta: The quantitative MG samples could not be analyzed on board ship, and the only preliminary information that can be derived from visual inspection of the cores is a general paucity of the infauna compared with soft deep-sea mud communities in other areas. Some of the semiquantitative and qualitative samples (bycatch) have been sorted and identified to family level (Table 40), including one Agassiz trawl haul from about 2000 m that consisted of mud and was sieved entirely through a 0.5 mm mesh screen. The polychaete fauna consists of mainly small infaunal species, including such typical deep-sea organisms as *Fauveliopsis* sp. (family Fauveliopsidae) and *Paramphinome* sp. (family Amphinomidae). By far the most abundant species, making up nearly 50% of all individuals, belongs to the family Ampharetidae, which are tube dwellers and deposit feeders. Also abundant are several species of Cirratulidae, deposit feeders which typically live near the sediment-water interface, and a species of *Myriochele* (tube dwelling Oweniidae). Large, deep-burrowing organisms are relatively scarce and represented only by a large *Notomastus* sp. (family Capitellidae) and very few individuals of a species of Maldanidae. One of the more exotic finds was an archiannelid, most likely belonging to the genus *Polygordius*. Interestingly, the Spionidae, one of the dominant families in boreal deep-sea muds, are rare, and Paraonidae, also very typical for the deep sea in other areas, are virtually absent. The composition of the semiquantitative sample may be an indication that the Antarctic deep-sea fauna is in some respects similar to other deep-sea areas, but much less species-rich, which may be a characteristic of the high Antarctic and would favour the hypothesis of Poore and Wilson (1993) and Rex *et al.* (1993).

Mollusca: The inventory of the benthic seashells (Gastropoda and Bivalvia) is based on 40 trawl and grab samples. Live animals of 64 gastropod and 27 bivalve species were found (Tables 41a, b), also shells of another 18 gastropod and 5 bivalve species. Hain (1990) reported 93 gastropod and 39 bivalve species from the Weddell Sea. As Hain (1990) mentioned, the diversity of the eastern Weddel Sea molluscs is remarkably high but populations are patchily distributed. During this cruise those species occurred in higher numbers, already reported as common for the Weddell Sea (Hain 1990): *Parmaphorella mawsoni*, *Margarella* sp. 1 (small groups of up to 13 animals in nearly ervery bigger hexactinellid sponge), *Torellia mirabilis*, *Aforia magnifica*, *Ponthiotauma ergata*, *Harpovoluta charcoti* (Gastropoda) and *Limopsis marionensis*, *Philobrya sublaevis*, *Lissarca notorcadensis* (on spines of sea urchins), *Limatula hodgsoni*, and *Cyclocardia astartoides*. For the first time four live *Adamussium colbecki* were found in the Weddell Sea. Before, only dead shells had been sampled. The live specimens were collected with the GSN from Drescher Inlet (station 078, 413 m) and southwest of Vestkapp (station 097, 605 m). This otherwise common Antarctic scallop is reported from littoral regions of the Antarctic Penninsula and the Ross Sea. Another new record, *Laternula elliptica* from the shallow station (about 60 m) off Four Seasons Inlet, was known to have a circumantarctic distribution, but had never been sampled in the Weddell Sea before.

Most interesting for biodiversity research in the Weddell Sea are the deep-sea stations. While the malacofauna of the shelf seems to be well known, good data for the slope are generally lacking. Preliminary investigations on the deep AGT samples revealed species of Nuculidae (Bivalvia) and Cyclostrematidae (Gastropoda) not commonly known for the high Antarctic. In one 2080 m AGT two small species of Scaphopoda that belong to the Siphonodentaliidae occurred in relatively high abundance. The sediment of this AGT sample was sieved through 500 µm and

Table 40: Polychaetes collected with several types of gear and analyzed qualitatively.

	AGT, TVG	TVG	TVG	AGT 039	AGT 044	AGT 049	AGT 058
				230 m	238 m	246 m	223 m
Family	25-01	25-01	28-01	29-01	30-01	30-01	31-01
Ampharetidae	20		1				2
Amphinomidae							
Aphroditidae							
Capitellidae							
Cirratulidae		4					
Euphrosinidae							1
Fauveliopsidae							
Flabelligeridae							
Glyceridae	3			3	7	5	10
Hesionidae	3	1			2	1	
Lumbrineridae	4						
Maldanidae	6	7				2	1
Nephtyidae	5		1	6	1	1	5
Nereididae	3				6	2	2
Opheliidae			1				
Orbiniidae	2			1	3		3
Oweniidae	3	27					
Paraonidae							
Pholoidae							
Phyllodocidae	1		1	2	4	2	
Pilargiidae							
Polygordiidae							
Polynoidae	7			4	22	1	
Sabellidae	4	2			2		
Scalibregmatidae							
Serpulidae			1				
Sphaerodoridae							
Spionidae	4	6			1		
Spirorbidae		1					
Syllidae	2	9	2	4	16	18	16
Terebellidae	12		6	1	27	16	10
Trichobranchidae							
Oligochaeta							
TOTAL	79	57	13	21	91	48	50

Table 40 continued.

	AGT 062	AGT 077	AGT 206	AGT 103, rocks	AGT 088	AGT 088	AGT 141
	248 m	433 m	518 m	600 m	1370 m	0.25 mm sub	1488 m
Family	31-01	02-02	18-02	05-02	04-02	04-02	10-02
Ampharetidae	2	1				2	
Amphinomidae						2	
Aphroditidae							
Capitellidae							
Cirratulidae							
Euphrosinidae							
Fauveliopsidae					1		
Flabelligeridae					16		
Glyceridae	12	12	2				
Hesionidae		2					
Lumbrineridae							
Maldanidae	2	10		13			
Nephtyidae	1	8	4				17
Nereididae	2	3	5	1			
Opheliidae						1	2
Orbiniidae							1
Oweniidae							
Paraonidae							
Pholoidae							
Phyllodocidae	3	3			1		
Pilargiidae							
Polygordiidae							
Polynoidae	10	3			8		
Sabellidae							
Scalibregmatidae							
Serpulidae				5			
Sphaerodoridae							
Spionidae							
Spirorbidae				4			
Syllidae	12	43	16	2			
Terebellidae	6	16	2	3	1	1	
Trichobranchidae							
Oligochaeta							
TOTAL	50	101	29	28	27	6	20

Table 40 continued.

Family	AGT 141 0.5 mm 10-02	AGT 134 2070 m 09-02	AGT 134 0.5 mm sub 09-02	GSN 071 280 m 01-02	GSN 082 390 m 03-02	GSN 154 600 m 11-02	MG 063 ql 234 m 31-01
Ampharetidae		3	1171	3	7		
Amphinomidae	15		216				
Aphroditidae	1						
Capitellidae	1	2	56				
Cirratulidae	6		309				5
Euphrosinidae							
Fauveliopsidae			23				
Flabelligeridae			2				
Glyceridae	2		25	2	4	1	
Hesionidae				5			
Lumbrineridae	1	8	18		1		2
Maldanidae		7	11	5			1
Nephtyidae		2	91	4	1	3	
Nereididae			1	18	3	18	
Opheliidae	5	30	189				
Orbiniidae	5			1	1		
Oweniidae			119				1
Paraonidae							
Pholoidae							
Phyllodocidae	1		78	1		2	
Pilargiidae							
Polygordiidae			19				
Polynoidae	2		4				
Sabellidae	1						2
Scalibregmatidae	1	1					
Serpulidae							
Sphaerodoridae	1		6				
Spionidae	1		84				8
Spirorbidae							
Syllidae	1			6		2	
Terebellidae			4	19			
Trichobranchidae			1				
Oligochaeta							
TOTAL	44	53	2427	64	17	26	14

Table 40 continued.

Family	MG 112 ql 400 m 06-02	MG 113 ql 750 m 06-02	D 214 60 m (rock site) 18-02	D 050 280 m 30-01	D 206 600 m 18-02	D 141 1500 m 10-02	D 134 2070 m 09-02
Ampharetidae	1	3		1		1	8
Amphinomidae						75	9
Aphroditidae							
Capitellidae	1	3					2
Cirratulidae	4	4					7
Euphrosinidae		1	1		8	13	5
Fauveliopsidae						2	6
Flabelligeridae		1				1	
Glyceridae		5		2	2	2	1
Hesionidae			4	1	1		
Lumbrineridae	7	2	1		2		5
Maldanidae	32	17					
Nephtyidae		1	1	3		1	7
Nereididae							
Opheliidae		1		1		2	3
Orbiniidae	5	9		2		14	
Oweniidae	25	11					2
Paraonidae	2	3				4	
Pholoidae							7
Phyllodocidae	5	1					
Pilargiidae							1
Polygordiidae							
Polynoidae	1		9		15	3	2
Sabellidae	30	3				3	
Scalibregmatidae	2				1	4	
Serpulidae							
Sphaerodoridae	3	1			1	8	
Spionidae	86	10			3	6	
Spirorbidae							
Syllidae		6	2	1	7	3	
Terebellidae	2	4			4	1	
Trichobranchidae							
Oligochaeta	36	37					
TOTAL	242	124	18	11	44	143	39

Table 41a: Gastropoda.

	Gear	TVG	AGT	TVG	TVG	TVG	TVG	TVG	D	AGT	AGT	AGT	D	AGT
Species	Station	004	006	027	030	031	032	033	037	039	044	049	050	058
Iothia coppingeri					6									
Lepetidae sp. 1					4	2		2	1					
Parmaphorella mawsoni											2	15		8
Anatoma euglypta														
Antimargarita dulcis												2		
Margarites refulgens				2							1			
Falsimargarita gemma					13	1	1	5			1	1		
Margarella sp. 1											3			
Trochidae sp. 1										2				
Trochidae sp. 2 Opi dick											1	1	1	
Trochidae sp. 3														
Trochidae sp. 4														
Cyclostrematidae sp. 1														
Cerithiella cf. erecta			1											
Turritellopsis gratissima														
Ceritopsidae sp. 1									1					
Ceritopsidae sp. 2														
Balcis antarctica														
Balcis tumidula														
Torellia mirabilis											3		1	1
Torellia planispira														1
Torellia smithi														
Torellia insignis														
Rissoidae			3											
Marseniopsis conica									1					
Naticidae sp. 1 (rot)														
Naticidae sp. 2														
Naticidae sp. 4														
Aforia magnifica											1	1		
Pontiothauma ergata											4			
Turridae sp. 1 "metheuthria"											2			
Turridae sp. 2														
Turridae sp. 3														
Turridae sp. 4														
Turridae sp. 5														
Pareuthria innocens							1							
Antarctodomus thielei											2			
Chlanidota lamyi														
Neobuccinum eatoni														
Probuccinum costatum														
Probuccinum cf. tenuistriatum											9			1
Prosipho sp. 1														
Prosipho sp. 2					1									
Prosipho sp. 3											1			
Buccinidae sp. 2											1			
Harpovoluta charcoti														
Volutomitra cf. curta											2			
Volutomitra sp. 1											1			
Volutomitra sp. 2												1		
Admete sp. 1								2						
Marginella ealesae											2			
Marginella sp. 1													1	
Trophon drygalski														
Trophon shackletoni														1
Trophon sp. 1											1			
Trophon sp. 2 (sp1 Hain)														
Newnesia antarctica														
Toledonia sp. 1											1			
Diaphana extrema														
Philine alata														
Scaphandridae sp. 1														
Cylichna sp. 1		1												
Opistho. sp. 2														
Limacina helicina														

Table 41a continued.

	Gear	AGT	GSN	AGT	GSN	GSN	AGT	GSN	GSN	GSN	AGT	AGT	D	AGT
Species	Station	062	071	077	078	082	088	094	097	100	129	134	141	141
Iothia coppingeri														
Lepetidae sp. 1														
Parmaphorella mawsoni		25	17	20	4	3								
Anatoma euglypta													2	2
Antimargarita dulcis					1									
Margarites refulgens														
Falsimargarita gemma			1	2	1									
Margarella sp. 1			3	22										
Trochidae sp. 1														
Trochidae sp. 2 Opi dick														
Trochidae sp. 3					1									
Trochidae sp. 4							6							
Cyclostrematidae sp. 1							16							
Cerithiella cf. erecta														
Turritellopsis gratissima														
Ceritopsidae sp. 1														
Ceritopsidae sp. 2				3										
Balcis antarctica													4	1
Balcis tumidula											1			
Torellia mirabilis		17	1		1				3					
Torellia planispira		1												
Torellia smithi		5	1	2										
Torellia insignis						1								
Rissoidae											1			
Marseniopsis conica														
Naticidae sp. 1(rot)		1		2	3				3					
Naticidae sp. 2					1	2								
Naticidae sp. 4							2	1				1		
Aforia magnifica			5	4	2	1		2	2					
Pontiothauma ergata		1	2	1		1		3		3				
Turridae sp. 1 "metheuthria"														
Turridae sp. 2							2							
Turridae sp. 3												5		
Turridae sp. 4												1		
Turridae sp. 5														1
Pareuthria innocens														
Antarctodomus thielei														
Chlanidota lamyi														
Neobuccinum eatoni								2		1				
Probuccinum costatum		3												
Probuccinum cf. tenuistriatum		1												
Prosipho sp. 1														
Prosipho sp. 2														
Prosipho sp. 3				2										
Buccinidae sp. 2														1
Harpovoluta charcoti			1		7	1	3	15	16	5				
Volutomitra cf. curta				1							1			
Volutomitra sp. 1														
Volutomitra sp. 2														
Admete sp. 1														
Marginella ealesae			1											
Marginella sp. 1							1							
Trophon drygalski														
Trophon shackletoni														
Trophon sp. 1														
Trophon sp. 2 (sp1 Hain)										1				
Newnesia antarctica														
Toledonia sp. 1														
Diaphana extrema							1							
Philine alata												1		1
Scaphandridae sp. 1												1		
Cylichna sp. 1														
Opistho. sp. 2		1												
Limacina helicina														

Table 41a continued.

Species	Gear Station	D 144	GSN 150	GSN 154	D 166	GSN 167	GSN 168	AGT 206	TVG 209	TVG 210	TVG 212	D 213	GSN 263	AGT 264	Σ
Iothia coppingeri															6
Lepetidae sp. 1									4	4	1				18
Parmaphorella mawsoni													3		97
Anatoma euglypta															4
Antimargarita dulcis				3											6
Margarites refulgens															3
Falsimargarita gemma							1			2	1				30
Margarella sp. 1						13		12							53
Trochidae sp. 1															2
Trochidae sp. 2 Opi dick															3
Trochidae sp. 3															1
Trochidae sp. 4															6
Cyclostrematidae sp. 1															16
Cerithiella cf. erecta												15			16
Turritellopsis gratissima												1			1
Ceritopsidae sp. 1															1
Ceritopsidae sp. 2															3
Balcis antarctica		1													6
Balcis tumidula									1						2
Torellia mirabilis															27
Torellia planispira															2
Torellia smithi															8
Torellia insignis															1
Rissoidae											1				5
Marseniopsis conica															1
Naticidae sp. 1(rot)									1			1		1	12
Naticidae sp. 2									1		1				5
Naticidae sp. 4															4
Aforia magnifica															18
Pontiothauma ergata															15
Turridae sp. 1 "metheuthria"															2
Turridae sp. 2															2
Turridae sp. 3															5
Turridae sp. 4															1
Turridae sp. 5									3						4
Pareuthria innocens					1						1	3			6
Antarctodomus thielei			1												3
Chlanidota lamyi											1				1
Neobuccinum eatoni															3
Probuccinum costatum															3
Probuccinum cf. tenuistriatum															11
Prosipho sp. 1												1			1
Prosipho sp. 2											2				3
Prosipho sp. 3															3
Buccinidae sp. 2				2											4
Harpovoluta charcoti						4	3						1		56
Volutomitra cf. curta															4
Volutomitra sp. 1															1
Volutomitra sp. 2															1
Admete sp. 1															2
Marginella ealesae														1	4
Marginella sp. 1															2
Trophon drygalski			2												2
Trophon shackletoni			1												2
Trophon sp. 1															1
Trophon sp. 2 (sp1 Hain)															1
Newnesia antarctica												1			1
Toledonia sp. 1															1
Diaphana extrema															1
Philine alata															2
Scaphandridae sp. 1															1
Cylichna sp. 1															1
Opistho. sp. 2															1
Limacina helicina		1													1

Table 41b: Bivalvia

species	gear / stn	TVG / 004	AGT / 006	TVG / 027	TVG / 030	AGT / 039	AGT / 044	AGT / 049	AGT / 058	AGT / 062	GSN / 071	AGT / 077	GSN / 078	GSN / 082	AGT / 088	GSN / 094	GSN / 097	AGT / 103	AGT / 129	D / 141	AGT / 141	D / 144	GSN / 150	GSN / 154	GSN / 168	TVG / 209	TVG / 212	D / 213	GSN / 263	AGT / 264	Σ
Nuculidae sp.1															1																1
Yoldiella valettei															8																8
Limopsis enderbyensis							1				1	9																			11
Limopsis lillei												2																			2
Limopsis marionensis		1									2	2	2	5		1		1						3	1		1				19
Philobrya cf. quadrata		1			3				8	3																					15
Philobrya sublaevis							5	7			5	3	1						1						2		1	1			26
Adacnarca nitens							3					8																			11
Adacnarca limopsoides						1																						1			2
Lissarca notorcadensis												4	100	64					1											3	172
Dacrydium albidum															4						2										6
Adamussium colbecki													2				1												1		4
Limatula hodgsoni							1	2		4	3	1		1		1							3	1							17
Limatula ovalis																											1	15			16
Genaxius bongraini		2																		2											4
Kellia nimrodiana																											1				1
Kellia simulans		1																													1
Kellia sp.1							3																								3
Mysella charcoti																											1	1			2
Mysella sp.1																						5									5
Cyamiomactra robusta							1			2		1																			4
Cyclocardia astartoides		2	2					1		7	3	4																			19
Lyonsia cf. arcaeformis													1	1																	2
Thracia meridionalis		2		2																						1	1				6
Poromya sp.1								1					1		2																4
Cuspidaria tenella							2			1	1		2																		6
Laternula elliptica					2																						1				3
	Σ	9	2	2	3	1	16	11	8	17	15	34	109	71	14	2	1	1	2	2	2	5	3	4	3	1	6	18	1	3	366

sorted. The abundance and species richness of molluscs was quite high, one specimen of a solenogaster, 76 of gastropods (15 species), more than 560 of scaphopods (apparently 2 species) and more than 1600 bivalves (5 species) were found. Until now some samples of the supranet from the epibenthic sledge have been sorted on high taxon level. These preliminary results are presented in Table 42.

Table 42: Abundances (n/1000m^2) from the supranet of the epibenthic sledge on a high taxonomic level.

Station No.	89	107	111	114	133	142	145	156	165	171
EBS No.	1	2	3	4	6	7	8	9	10	11
Area	S/VK	S/VK	S/VK	S/VK	HB	HB	HB	HB	HB	HB
Haul length (m)	452	420	382	397	335	442	317	328	482	392
Depth (m)	1645	938	397	755	2119	1574	1074	782	397	231
Medusae	55	2				9				
Siphonophora	7	12								
Nematoda	31	24			9	27		46	37	10
Mollusca				40			32			
Caudofoveata							3			
Monoplacophora								3		
Gastropoda	53	50						3	6	3
Bivalvia	4	83			9	9		24	29	
Scaphopoda	7									
Polychaeta	1015	440	16	96	24	66	76	204	753	33
Halacarida								3		
Pantopoda		2		3		2		9		
Ostracoda	774	1338	31	96	9	11	25	73	151	3
Copepoda	16737	12357	702	48	90	1310	1457	665	548	232
Amphipoda	108	162		128	9	70	57	85	89	18
Isopoda	55	124		63	6	18	19	24	23	43
Mysidacea	489	424		10	90	50	54	168	50	
Tanaidacea	15	12		15				3	4	
Cumacea	22	124		60		11	13	3	6	5
Decapoda	15	138		8	6	5				10
Chaetognatha	631	698	50				19	6	29	
Echinodermata	27	21		8	6	23	6	3	10	
Appendicularia	44	74	10			18			10	
Fish larvae	22	10			3					
Total (n/1000 m^2)	20113	16095	736	574	260	1629	1760	1323	1747	357
Total (n)	9091	6760	309	228	87	720	558	434	842	140

2.4.4 Macrobenthos Distribution Patterns in Relation to Environmental and Biotic Parameters (D. Gerdes, H. Bohlmann)

Introduction and objectives

Benthos

Only little is known about the benthos living in waters around the Antarctic Peninsula. Gaps exist in the taxonomic inventory of many groups as well as in their distribution patterns, i.e., their abundances and their biomass. Such data are of special interest because we need to compare these with corresponding data from the Magellan region, which has been sampled recently. We intend to determine links between these adjacent areas, which are clearly separated by the Drake Passage. Station work in and in front of the Potter Cove will extend the shore based shallow water benthos activities of Jubany Station into the deeper parts of the Bransfield Strait. Further quantitative and qualitative work has been performed on the southeastern shelf of the Weddell Sea between Kapp Norvegia and Halley Bay in cooperation with A. Brandt, B.

Hilbig and K. Linse for the investigation of the zoogeography, phylogeny, and biodiversity of different macrobenthic groups (cf. chapter 2.4.3 above). The samples from water depths between 200 and 2500 m will enlarge the data base required to determine latitudinal diversity gradients from the high Antarctic to the Arctic Sea.

Bottom current regime on the shelf off Kapp Norvegia

Moorings. During ANT XIII/3 several moorings with current meters were deployed on the shelf off Kapp Norvegia in order to obtain first insights into the current regime on the shelf. Along the continental slope the main current flows towards the south west (the southern branch of the Weddell Sea Gyre) and current velocities near the seafloor are in the range of 5 to 60 cm s^{-1}. Several moorings deployed during ANT XIII/3 directly on the shelf showed the near bottom currents to be less strong; maxima of 20 cm s^{-1} were measured and the directions of the currents at different sites on the shelf were highly variable with mainly eastern, southern and western components. Current velocities and their directions influence the particle flux towards the benthic realm considerably (cf. Bathmann *et al.* 1991), i.e. they are one of the environmental factors affecting and structuring benthic communities. In order to clarify the ´confusing´ current regime on the shelf, 3 additional moorings were deployed for measuring the near bottom currents (velocity, direction, S‰, t°C); one of the moorings was equipped with a sediment trap to profile the vertical flux pattern over the 4-week study period.

CTD profiles. A Seabird CTD combined with a rosette water sample will provide temperature and salinity profiles of the water column for various purposes and water from specific depth. The latter will be used for experimental work in the aquarium containers on board and for the measurement of Ra in seawater as a tracer for iron, which has been shown to play a controlling role for primary production in the Southern Ocean (cf. chapter 2.5.6)

Work at sea

MG stations. For a short description of the sampling see chapter 2.1.3. A comprehensive station list is given in Table 38, chapter 2.4.3.

Moorings and CTD. Three moorings (Table 43) were deployed for 4 weeks on the shelf off Kapp Norvegia. All were equipped with Aanderaa current meters 8 m above the seafloor. In addition M7 was equipped with a sediment trap 18 m above the seafloor. The current meters continuously monitored salinity, water temperature, current velocity and current direction. The sediment trap provided only 10 samples instead of 20 (Table 44), because 10 sampling bottles of the trap were broken due to unknown reasons. The remaining bottles did not show any signs of an algal bloom during the deployment period. The detailed analysis of the bottle content, however, has to be done in Bremerhaven.

Table 43: Moorings deployed during ANT XV/3 off Kapp Norvegia.

Mooring No.	Position (S;W)	Deployed	Recovered	Depth (m)
M 6	71°10.28'; 13°01.45'	25.01.98	27-02-98	462
M 7	71°30.66'; 13°31.06'	25.01.98	03-03-98	235
M 8	71°44.97'; 14°45.19'	25.01.98	failure	288

Mooring 8 could not be retrieved and the subsequent effort to dredge the mooring also failed. The analysis of the retrieved data will be carried out in Bremerhaven.

Table 44: Sampling scheme for the sediment trap.

Sample No.	Sampling time	Sample No.	Sampling time
1	27-01 - 29-01-98	6	08-02 - 10-02-98
2	29-01 - 31-01-98	7	10-02 - 12-02-98
3	31-01 - 02-02-98	8	12-02 - 14-02-98
4	02-02 - 04-02-98	9	22-02 - 24-02-98
5	06-02 - 08-02-98	10	24-02 - 26-02-98

CTD measurements were performed with a seabird 911 plus at 39 stations along the SE shelf between Atka Bay in the NE and Halley Bay in the south and at 5 stations in the Drake Passage and the Bransfield Strait (see Table 45). Six stations were performed on a transect off Halley Bay, covering a depth range from 224 to 1498 m. 10 stations were done south of Vestkapp (22 to 1449 m). 13 CTD stations in and in front of the Drescher Inlet (378 to 2000 m water depth) provided data for the fishery activities in this area. Around Kapp Norvegia the Seabird was deployed at additional 10 stations in water depths between 170 to 2000 m.

Table 45: CTD stations.

Date	Station No.	Position (S; W)	Depth (m)	Area
26-01	012	72° 50.70'; 19° 18.40'	390	DI
27-01	018	72° 49.70'; 19° 23.30'	455	DI
27-01	022	72° 51.30'; 19° 19.10'	378	DI
28-01	027	71° 19.20'; 12° 24.30'	170	KN
30-01	051	70° 52.00'; 10° 23.50'	267	N/KN
01-02	074	70° 49.30'; 10° 28.80'	284	N/KN
03-02	079	72° 50.50'; 19° 25.10'	445	DI
03-02	083	72° 52.30'; 19° 05.40'	428	DI
03-02	084	72° 51.30'; 19° 32.20'	464	DI
04-02	087	73° 28.80'; 22° 29.50'	1449	S/VK
05-02	096	73° 33.30'; 22° 02.60'	713	S/VK
05-02	098	73° 36.40'; 22° 24.00'	771	S/VK
05-02	101	73° 35.40'; 22° 02.40'	442	S/VK
06-02	106	73° 34.50'; 22° 40.90'	1007	S/VK
06-02	109	73° 37.30'; 22° 08.10'	409	S/VK
06-02	116	73° 35.90'; 22° 21.10'	767	S/VK
06-02	118	73° 59.90'; 22° 50.70'	186	S/VK
07-02	121	73° 34.30'; 22° 11.00'	814	S/VK
07-02	124	73° 36.50'; 22° 24.10'	751	S/VK
08-02	127	73° 39.10'; 20° 59.90'	224	S/VK
10-02	140	74° 36.60'; 27° 16.30'	14	HB
10-02	147	74° 39.40'; 27° 07.90'	738	HB
10-02	148	74° 38.20'; 27° 09.80'	1007	HB
11-02	151	74° 36.70'; 26° 53.80'	606	HB
12-02	163	75° 00.00'; 27° 13.10'	387	HB
12-02	169	75° 26.40'; 26° 40.00'	233	HB
14-02	183	72° 10.00'; 16° 31.70'	360	KN
16-02	196	71° 15.30'; 12° 20.40'	171	KN
18-02	208	71° 06.90'; 11° 28.30'	95	KN
20-02	231	70° 50.90'; 10° 30.40'	234	KN
22-02	243	72° 52.50'; 19° 04.60'	416	DI
22-02	252	72° 48.00'; 19° 32.00'	907	DI
22-02	254	72° 50.70'; 19° 23.20'	406	DI
23-02	257	72° 47.30'; 19° 39.60'	2000	DI
24-02	259	72° 51.00'; 19° 14.20'	386	DI
25-02	260	72° 52.50'; 19° 04.40'	426	DI
25-02	265	72° 48.80'; 19° 25.20'	466	DI
26-02	273	71° 30.20'; 15° 13.70'	2073	KN
27-02	275	71° 45.10'; 14° 45.30'	293	KN
14-03	305	62° 16.70'; 58° 42.80'	403	PC
18-03	332	61° 26.20'; 58° 08.80'	1012	Drake P.
19-03	334	61° 26.20'; 58° 08.80'	1016	Drake P.
20-03	344	61° 53.20'; 59° 06.40'	208	Drake P.
21-03	358	62° 24.60'; 58° 36.50'	1365	PC

Preliminary results

Latitudinal gradients of macrobenthos distribution: The 7 multibox corer stations performed on a transect south of Vestkapp covered a depth range from 378 to 2415 m and yielded a total of 41 cores, 31 of which will be used for the analysis of macrofauna. These multibox corer samples are the first from this part of the southeastern Weddell Sea shelf, thus filling a gap between the well studied Kapp Norvegia area and 14 multibox corer stations worked up on the shelf off and south of Halley Bay.

Although this study area belongs to the 'Eastern Shelf Community' sensu Voß (1998) and Gerdes *et al.* (1992), the benthos appears less rich as compared to the shelf fauna in front of Kapp Norvegia. Especially sponges, which are the dominant and community structuring faunistic element in the Kapp Norvegia region, seem to be less dominant. Following our transect towards the deeper slope we found hexactinellids (*Rossella* sp.) down to 1000 m water depth, but in very low numbers. At even greater water depths, the epibenthos was dominated especially by several species of ophiuroids and caridean decapods (stns 131, 132). Holothurians (1 species dark red, about 30 cm in length and 10 cm in diameter, 1 greyish, smaller species), regular echinoids and asteroids were less abundant but occurred regularly. Many holes in the sediment surface indicate that infaunal polychaetes may contribute considerably to benthic abundance and biomass at these stations. Surprisingly at least ophiuroids, caridean decapods and probably also polychaetes attained densities on the deep stations, which seem to be almost comparable to those on the shelf stations in the Vestkapp area. The same holds true for the Halley Bay transect. Due to many drop stones on the shelf, the multibox corer was deployed here only at 3 deeper stations (1000 to 2011 m water depth) and the TV grab provided samples from the shelf instead. The Halley Bay shelf also belongs to the 'Eastern Shelf Community', however, biomass and organism density are generally lower as compared to Kapp Norvegia (Gerdes *et al.* 1992). The deepest station (stn 136, 2011 m) was characterized by a thick layer of fluff on the sediment surface with dense aggregations of ophiuroids and holothurians. Asteroids and echinoids were also quite abundant. The fluff layer was structured by numerous meandering tracks caused by the feeding activities of the organisms. Did this concentration of fluff attract motile organisms from the vicinity? We assume the densitiy at these station to be rather untypical for this water depth. At the nearby 1500 m station (6.2 nm distance) no fluff at all was visible on the seafloor and the epifauna was dominated by ophiuroids, echinoids, asteroids and crinoids, the latter of which did not occur at the deeper station. Like in the Vestkapp area hexactinellids also occurred off Halley Bay down to 1000 m water depth (stn 146). The infaunal benthos in the Bransfield Strait and Drake Passage appeared much richer, especially sedentary polychaetes were very abundant. Concerning the epifauna, echinoderms appeared very diverse, wheras sponges, hydrozoans and bryozoans were clearly less abundant as compared to the eastern Weddell Sea shelf.

Latitudinal CTD stations. The profiles of the water column looked very similar at all stations and we summarize the characteristic features examplarily using 2 station profiles (Fig. 55). The first is from a deep-water station and the other from a shallower shelf station, both situated in front of Drescher Inlet. Along the southeastern shelf, a warmer and less saline surface water layer reached down to 50 to 150 m water depth. The water temperatures in the surface layer varied from about -0.5 to -1.6°C, and the salinity was usually less than 34‰ S.

The surface water at stations in the vicinity of the shelf ice edge often showed lower temperatures than further offshore; wind induced mixing is another factor being responsible for the observed variability of surface temperatures. Below this surface water layer exists a mixed water layer, characterized by water temperatures permanently decreasing to about -1.8°C and salinity increasing to about 34.5‰ S.

The warm deep water occurs from about 800 m water depth down to the seafloor and is characterized by water temperatures higher than + 0.5°C and a salinity around 34.7‰ S.

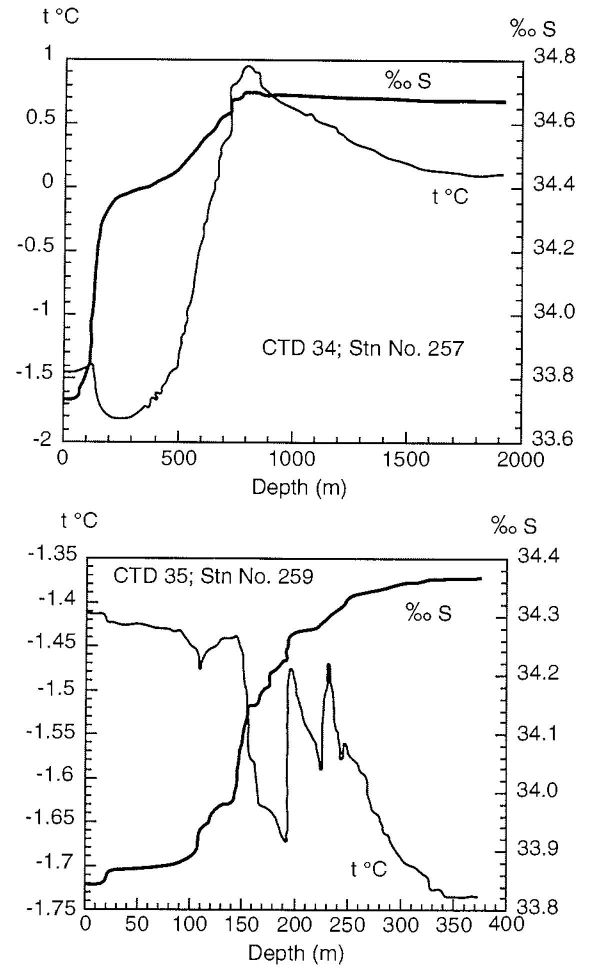

Fig. 55: CTD profiles of stn 257 in front of, and stn 259 inside the Drescher Inlet; 23 and 24 February, 1998.

2.4.5 Macrobenthos: Visual Check of Trawl and Dredge Catches on Deck
(W. E. Arntz)

Objectives

The comparison of macrobenthic communities based on rough visual estimates of the significance of major taxa in the catches of trawled gear (AGT, GSN, D) was to be continued during the EASIZ II cruise. The idea is to find out which groups dominate on the Weddell Sea shelf and slope, on either side of the Drake Passage, and in the Magellan Region, which are nowadays distinct areas of a formerly connected ecosystem. These data, which are an easily accessible byproduct of trawling which in the first instance serves the needs of specialists working on individual taxa or those that require large amounts of material, have been taken from the eastern Weddell Sea since the EPOS I/3 cruise in 1989 (Arntz *et al.* 1990) and from the

Magellan Region since the Joint "Victor Hensen" campaign in 1994 (Arntz and Gorny 1996). The northern slope of the Drake Passage was sampled in 1996 (Fahrbach and Gerdes 1997). The southern slope of the Drake Passage, which could not be sampled in 1996 due to bad weather, was included in the EASIZ II cruise plan.

The data resulting from this comparison also serve as background information for studies on biodiversity and as a further approach within our attempt to explore Antarctic and Subantarctic benthic communities with a variety of gears, ranging from imaging methods via quantitative corers to trawls and dredges.

Work at sea

To determine relative abundance of major taxonomic groups, the catches from trawled gears (AGT, GSN, and D) were subjected to a visual check by several experienced marine biologists who then agreed on a classification within a simple four-point scheme: 0=absent, -=scarce, +=regular appearance to fairly common; ++=very common, dominant. The EBS was not included in this procedure because most of the fauna caught by this sledge is small and brittle. The otter trawl used was a 130 ft Engel bottom trawl with a herring codend (15 mm mesh). In the Weddell Sea we used an Agassiz trawl of 3 m width and 10 mm meshes in the codend, identical to the one used there during former cruises, whereas at the Antarctic Peninsula we used a smaller AGT (1.5 m width), however with the same mesh, which had been deployed in this area before. All nets keep back much smaller organisms than would correspond to their meshes when large amounts of sponges, bryozoans or spicule mats are caught. The small Rauschert dredge (D) has meshes of 1mm. The results from this dredge are more representative of very small taxa such as cumaceans, harpacticoids etc. the majority of which escape through the wider meshes of the trawls.

The material from the eastern Weddell Sea comprised 17 more or less successful AGT, of which 14 (175- 2068 m depth) were checked on deck and appear in the list (Table 46). AGT 9 contained large boulders which smashed the catch, AGT 5 and 16 were not considered. From the same area, 13 GSN (231-893 m depth) were subjected to a visual check (Table 47); GSN 2 (same as 3) and 4 were not considered. 28 successful dredge hauls were checked (Table 48) from the Weddell Sea.

The bottom trawl was not deployed around King George Island. From the Bransfield Strait 5 successful AGT hauls (256-1502 m depth) and 5 dredges were taken, from the open Drake Passage another 5 AGT (129-2061 m depth) and 4 dredges (Tables 46 and 48).

Preliminary results

The AGT and GSN catches from the high Antarctic Weddell Sea did not yield great surprises as the faunal composition in this area is fairly well known (surprises came from the very shallow fauna, which was, however, obtained using different gear). The three very deep AGT catches (>1300 m) can be well distinguished from the shallower catches, however these themselves are not easily distinguishable, possibly due to the eurybathic properties of many faunal elements. Former results were confirmed that the shelf fauna off Vestkapp and Halley Bay differs to some extent from the Kapp Norvegia fauna, which may be due to the diversifying effect of iceberg scour on large scales (Gutt et al. in press) and the dominance of the three-dimensional suspension feeding community in the latter area. Dominant fauna at the relatively shallow stations off Kapp Norvegia and in the Austasen iceberg cemetery includes bryozoans, sponges, gorgonians and asteroids; other echinoderms (crinoids, ophiuroids and holothurians) can be very common, and at some stations polychaetes and ascidians play an important role. Off SW Vestkapp caridean shrimps *(Notocrangon, Chorismus)* are dominant together with crinoids, holothurians, asteroids and (sometimes) octopod cephalopods at the shallower stations, whereas at depth ophiuroids, other caridean shrimps *(Nematocarcinus)* and holothurians take over. This composition is valid also for the deep stations off Halley Bay. In this latter area, sponges were surprisingly common from shallow waters to over 700 m depth. Echinoderms (mainly asteroids, occasionally also holothurians and ophiuroids) also play a dominant part here on the deeper shelf and upper slope.

Table 46: AGT check aboard.

Station no.			6	39	44	49	62	77	88	134	141	189	194	197	206	277	295	303	308	322	324	336	338	348	352
AGT no.			1	2	3	4	6	7	8	10	11	12	13	14	15	17	18	20	23	24	25	27	28	29	30
Depth (m) **			175	241	228	258	238	351	1353	2068	1536	246	245	416	598	184	256	440	831	640	1502	1137	416	216	129
Porifera			++	-	++	++	++	++	-	0	-	+	-	-	+	+	-	-	0	-	0	-	-	-	-
Cnidaria	Hydroidea		-	-	-	+	-	-	0	0	0	-	-	-	+	+	-	-	-	-	-	0	-	-	-
	Actiniaria		0	0	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	+	0	++	-	-	0
	Gorgonaria		+	-	-	++	++	++	0	0	-	+	+	++	-	+	-	0	0	-	0	-	-	-	-
	Pennatularia		0	0	0	0	0	-	+	0	-	-	0	-	-	0	0	-	0	0	0	0	-	0	0
	Alcyonaria		0	0	0	-	-	-	0	0	0	0	0	0	-	0	-	++	0	0	0	-	0	0	0
	Scleractinia		0	0	0	0	0	-	-	-	0	-	0	0	0	0	-	0	0	0	0	+	+	++	-
Nemertini			-	0	0	0	-	-	0	-	0	-	-	0	0	-	+	0	-	-	0	-	-	0	-
Mollusca	Bivalvia		-	0	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	+	-	-	+	-
	Aplacophora		0	0	-	0	0	-	0	-	0	-	-	0	0	-	-	0	0	-	0	0	0	0	0
	Gastropoda	Prosobranchia	-	0	+	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	0	+	++	-	0
		Ophistobranchia	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	0	+	-	0	0
	Polyplacophora		-	-	-	-	-	-	0	0	0	-	-	0	0	-	-	0	0	0	0	0	0	0	0
	Octopoda *		0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	+	-	-
	Scaphopoda		0	0	0	0	0	0	-	0	0	-	0	0	0	0	-	0	-	-	0	0	-	-	0
Polychaeta	Sedentaria		+	-	+	-	-	-	-	-	-	++	-	-	-	+	++	-	+	++	++	-	-	-	-
	Errantia		-	-	+	+	+	+	-	-	-	-	-	-	-	-	+	-	++	+	-	++	+	+	-
Priapulida			0	0	0	0	0	0	0	0	0	0	0	-	0	0	-	0	-	0	0	0	0	0	0
Sipunculida			-	0	0	0	0	-	-	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0
Echiurida			0	0	0	0	0	0	0	0	0	-	0	-	0	-	-	0	0	0	0	++	-	0	-
Crustacea	Cirripedia		0	0	0	0	0	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	+	0
	Amphipoda		+	-	+	+	+	+	0	-	-	-	+	+	++	+	-	-	+	+	0	+	++	+	-
	Isopoda		-	-	-	-	-	-	+	-	-	-	-	-	-	0	0	-	+	-	-	+	-	-	-
	Cumacea		-	-	-	-	+	-	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0
	Mysidacea		0	0	-	0	-	-	-	0	0	0	-	-	-	-	-	-	-	-	0	-	-	0	0
	Decapoda	Natantia	-	0	-	-	-	+	++	+	+	-	+	++	-	+	-	-	0	-	0	-	-	0	0
Pantopoda			-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	++	-	-	+	+	-	-
Bryozoa			+	++	++	++	++	++	0	0	-	-	-	+	+	++	++	+	+	-	-	-	-	-	++
Brachiopoda			0	-	-	-	-	-	+	0	-	-	-	-	0	-	-	0	0	-	0	0	0	0	0
Pterobranchia			-	0	-	+	-	-	0	0	0	-	-	-	0	-	0	0	-	-	-	0	0	0	0
Echinodermata	Ophiuroidea		+	-	+	+	+	+	++	++	++	+	++	-	-	-	++	++	-	++	-	++	++	++	++
	Asteroidea		-	-	-	+	-	-	-	-	-	+	++	-	+	-	+-	-	0	-	-	++	++	+	-
	Echinoidea	Regularia	-	-	-	-	-	+	0	++	-	-	-	-	-	-	-	-	-	-	0	-	+	-	-
		Irregularia	0	0	0	0	-	-	++	-	0	+	0	0	0	0	-	-	-	-	0	-	+	-	0
	Crinoidea		-	-	-	+	+	+	-	0	+	++	++	+	-	-	-	-	0	++	0	-	+	0	-
	Holothuroidea		-	-	-	+	+	+	-	++	++	+	-	-	-	++	-	++	+	-	0	-	+	0	0
Ascidiacea			+	+	+	-	+	-	-	0	0	++	-	-	0	++	+	++	-	-	0	-	-	-	++
Pisces			0	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	0	0	0	-	-	-	-

0 = absent, - = scarce, + = regular to fairly common, ++ = very common (dominant)

* Pelagic Cephalopoda (squids) not considered.

** Depth refers to mean between position 2 and 3 (cf. Annex 3.2).

Table 47: GSN check aboard.

Station no.			71	82	95	97	100	120	123	150	154	167	168	220	222
GSN no.			1	3	5	6	7	9	10	11	12	13	14	15	16
Depth (m)			291	406	893	644	442	875	654	734	576	407	231	254	251
Porifera			++	++	-	++	++	-	+	++	++	++	++	-	++
Cnidaria	Hydroidea		-	-	-	-	0	0	0	-	-	-	-	+	-
	Actiniaria		-	-	-	-	-	-	-	-	-	-	-	+	+
	Gorgonaria		+	-	-	-	-	0	-	+	-	-	+	-	-
	Pennatularia		0	-	-	0	-	-	0	-	-	+	-	-	0
	Alcyonaria		-	-	0	0	0	0	0	-	-	-	0	0	0
	Scleractinia		0	-	-	-	-	-	-	0	0	-	0	0	0
Nemertini			-	-	-	0	-	-	-	-	-	-	0	-	-
Mollusca	Bivalvia		-	-	-	0	0	-	-	-	-	-	-	0	-
	Aplacophora		0	-	0	0	0	0	0	-	-	-	0	-	-
	Gastropoda	Prosobranchia	-	-	-	-	-	-	-	-	-	-	-	-	+
		Ophistobranchia	-	-	-	-	-	-	-	-	-	-	-	-	-
	Polyplacophora		-	-	-	-	-	0	0	-	+	0	0	-	-
	Octopoda		+	+	-	++	+	+	0	+	-	-	0	-	+
	Scaphopoda		0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta	Sedentaria		-	-	+	-	-	-	-	-	-	+	-	-	-
	Errantia		+	+	+	-	-	-	+	+	-	-	-	-	-
Priapulida			0	-	0	0	0	0	0	0	0	0	0	0	0
Sipunculida			0	-	0	0	-	0	0	-	-	0	0	0	-
Echiurida			0	0	-	-	-	-	-	0	0	0	0	0	-
Crustacea	Cirripedia		0	0	0	-	0	0	0	-	+	0	0	0	0
	Amphipoda		+	+	-	-	-	-	-	+	+	0	-	-	-
	Isopoda		-	+	-	-	-	+	-	-	-	0	0	-	-
	Cumacea		-	0	0	0	0	0	0	0	-	0	0	0	0
	Mysidacea		-	+	-	-	-	-	-	0	-	0	0	0	-
	Decapoda	Natantia	+	+	++	++	++	++	+	-	-	-	-	-	-
Pantopoda			-	-	-	-	-	-	-	-	+	-	-	-	-
Bryozoa			++	+	-	-	-	-	-	-	-	-	+	-	-
Brachiopoda			-	-	-	-	-	0	-	-	-	0	0	-	-
Pterobranchia			-	-	-	-	-	0	-	0	0	0	-	+	+
Echinodermata	Ophiuroidea		+	+	-	+	-	++	-	++	+	-	+	-	-
	Asteroidea		++	+	+	++	+	+	+	++	++	+	-	+	++
	Echinoidea	Regularia	-	+	-	-	0	-	-	+	+	-	-	-	+
		Irregularia	-	-	++	-	-	+	-	-	-	-	0	0	0
	Crinoidea		++	-	-	++	++	+	+	-	-	-	-	+	-
	Holothuroidea		+	-	+	++	+	+	++	-	-	++	++	-	+
Ascidiacea			+	-	-	+	-	-	+	-	-	-	++	-	+
Pisces			+	+	+	++	+	+	+	+	+	++	-	+	+

(For symbols and further explanations cf. Annex 3.3)

Table 48: Dredge check aboard.

Station no.			6	37	44	50	88	100	115	128	134	141	144	157	166	172
Dredge no.			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Depth (m)			174	70	238	283	1365		756	216	2066	1541	1000	724	400	233
Porifera			++	-	++	++	0	-	++	++	-	-	-	++	-	
Cnidaria	Hydroidea		+	+	-	+	0	0	0	-	0	0	-	-	0	-
	Actiniaria		0	0	0	-	0	-	-	-	0	0	0	-	0	-
	Scleractinia		0	0	0	0	0	0	-	0	0	0	0	-	0	0
	Stolonifera		0	0	0	0	0	0	0	0	0	0	-	0	0	0
	Alcyonaria		0	+	0	0	0	0	0	0	0	0	0	-	0	0
	Pennatularia		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gorgonaria		0	+	0	-	0	0	-	-	-	-	-	-	-	-
Brachiopoda			-	-	0	-	0	-	-	-	-	-	-	-	-	-
Bryozoa			+	+	+	+	-	-	-	+	-	-	-	-	-	-
Plathelmintes			0	0	0	0	0	0	-	-	-	0	-	-	0	-
Nemertini			0	-	0	-	0	-	-	-	-	0	-	-	-	-
Nematoda			0	0	-	-	-	-	-	-	-	-	-	-	-	-
Kamptozoa			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Priapulida			0	0	0	0	0	0	0	0	0	0	0	0	0	-
Mollusca	Polyplacophora		0	0	0	0	0	-	0	0	0	0	-	-	0	-
	Aplacophora		0	0	0	0	0	0	-	0	0	0	-	-	0	-
	Gastropoda	Prosobranchia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Ophistobranchia	0	0	0	0	0	0	0	0	0	0	0	0	-	-
		Nudibranchia	0	-	0	-	0	0	0	-	-	-	0	-	0	0
	Bivalvia		-	-	-	-	0	0	-	-	-	-	-	-	-	-
	Scaphopoda		0	0	0	0	0	0	0	0	-	0	0	-	-	-
	Octopoda		0	0	0	0	0	-	0	0	0	0	0	0	0	0
Sipunculida			-	-	0	0	0	0	-	0	-	0	-	-	0	-
Echiurida			-	0	0	0	0	0	0	0	0	0	0	0	0	0

0 = absend, - = scare, + = regular to fairly common, ++ = very common (dominant)

Table 48 continued.

Station no.			189	198	206	214	277	296	303	308	322	329	336	337	346	355
Dredge no.			15	16	17	18	19	20	21	22	23	24	25	26	27	28
Depth (m)			250	400	600	64	180	230	450	800	600	2000	1000	400	200	100
Porifera			+	+	++	++	+	-	-	0	0	0	0	-	-	0
Cnidaria	Hydroidea		0	0	+	+	+	-	0	0	0	0	0	-	-	-
	Actiniaria		0	0	-	-	-	0	0	0	0	0	0	-	0	0
	Scleractinia		0	0	0	0	0	0	0	0	0	0	0	-	-	-
	Stolonifera		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Alcyonaria		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pennatularia		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gorgonaria		-	-	+	-	+	-	0	0	0	0	0	-	-	0
Brachiopoda			-	-	-	-	-	0	0	0	0	0	0	0	0	0
Bryozoa			-	++	+	-	-	++	-	-	-	0	-	-	-	-
Plathelmintes			0	0	-	-	0	0	0	-	-	0	-	-	0	0
Nemertini			-	-	-	-	0	-	0	-	-	0	-	-	-	-
Nematoda			-	-	-	-	-	0	-	-	-	0	-	-	-	-
Kamptozoa			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Priapulida			0	-	0	0	0	0	0	0	0	-	0	0	-	0
Mollusca	Polyplacophora		-	-	0	0	-	0	0	0	0	0	0	0	0	0
	Aplacophora		0	0	-	-	-	0	0	0	0	0	0	0	-	-
	Gastropoda	Prosobranchia	-	-	-	-	-	-	-	-	-	0	-	-	-	-
		Ophistobranchia	0	0	0	0	-	0	0	0	0	0	0	0	0	0
		Nudibranchia	0	-	-	-	-	0	0	0	0	0	0	0	0	0
	Bivalvia		-	-	-	-	-	0	-	0	0	0	-	-	-	-
	Scaphopoda		-	0	0	0	-	0	-	0	0	0	-	-	-	-
	Octopoda		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sipunculida			-	0	0	-	-	0	0	-	0	0	-	-	-	+
Echiurida			0	0	0	0	0	0	0	0	0	0	-	0	0	0

Table 48 continued.

Station no.			6	37	44	50	88	100	115	128	134	141	144	157	166	172
Dredge no.			1	2	3	4	5	6	7	8	9	10	11	12	13	14
Depth (m)			174	70	238	283	1365		756	216	2066	1541	1000	724	400	233
Polychaeta	Errantia		-	+	-	-	-	+	+	+	-	+	-	+	-	++
	Sedentaria		-	+	-	-	0	0	-	-	0	0	0	0	0	-
Pantopoda			-	+	-	-	-	-	-	-		-		-	-	-
Acari			0	0	0	0	0	0	0	0		0		0	0	-
Crustacea	Ostracoda		-	-	-	-	-	-	-	-	-	-	-	-	-	+
	Cirripedia		0	0	0	0	0	0	0	0	0	0	0	-	0	0
	Leptostraca		0	0	0	0	0	-	-	-	-	-	-	-		-
	Decapoda	Natantia	0	+	0	-	-	-	-	-	-	0	0	-	-	-
		Reptantia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mysidacea		0	0	0	-	-	-	-	-	-	-	-	-	-	+
	Amphipoda		++	++	++	++	++	++	++	+	+	+	+	++	+	++
	Cumacea		-	+	+	-	-	-	-	-	-	-	-	-	-	-
	Tanaidacea		0	-	-	-	-	-	-	-	0	-	-	-	-	-
	Isopoda		-	+	+	-	-	-	-	-	-	-	-	-	-	-
	Stomatopoda		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pogonophora			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterobranchia			-	0	-	+	0	-	-	-	0	0	-	-	-	-
Echinodermata	Crinoidea		0	0	0	0	0	++	+	+	+	-	-	+	+	-
	Holothuroidea		-	++	-	+	-	-	-	-	-	-	-	-	-	-
	Echinoidea	Regularia	0	++	0	-	+	-	-	-	-	-	-	-	0	-
		Irregularia	0	0	0	0	+	0	-	0	-	-	0	0	0	0
	Asteroidea		0	+	-	-	-	-	-	-	-	-	-	-	-	-
	Ophiuroidea		+	+	-	+	+	-	+	-	+	+	-	-	-	-
Ascidiacea			+	+	0	+	-	-	-	-	-	-	0	-	-	-
Pisces			0	0	0	0	0	-	0	-	0	0	0	0	0	-

Table 48 continued.

Station no.			189	198	206	214	277	296	303	308	322	329	336	337	346	355
Dredge no.			15	16	17	18	19	20	21	22	23	24	25	26	27	28
Depth (m)			250	400	600	64	180	230	450	800	600	2000	1000	400	200	100
Polychaeta	Errantia		-	-	+	-	+	+	++	++	+	+	++	++	+	++
	Sedentaria		0	-	-	0	-	+	-	0	-	-	+	-	-	+
Pantopoda			-	-	-	-	-	+	-	-	-	0	-	-	-	-
Acari			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Ostracoda		-	-	-	-	-	+	-	-	-	0	-	-	-	-
	Cirripedia		0	0	0	0	0	0	0	0	0	0	0	-	-	0
	Leptostraca		-	0	-	-	-	0	0	0	0	0	0	0	0	0
	Decapoda	Natantia	-	-	-	+	-	0	0	0	0	0	0	0	0	0
		Reptantia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mysidacea		-	-	-	-	-	-	0	-	-	0	-	-	-	-
	Amphipoda		+	++	++	++	+	+	-	+	+	-	++	++	++	++
	Cumacea		-	-	-	-	-	-	-	-	-	0	+	-	-	-
	Tanaidacea		-	-	-	-	-	-	-	-	-	0	-	-	-	-
	Isopoda		-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Stomatopoda		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pogonophora			0	0	0	0	0	0	0	-	0	-	0	0	0	0
Pterobranchia			-	-	-	-	-	-	0	-	0	0	0	0	0	0
Echinodermata	Crinoidea		-	-	0	0	0	0	0	0	0	0	-	-	-	-
	Holothuroidea		-	-	-	-	-	-	0	-	-	0	-	-	-	-
	Echinoidea	Regularia	-	-	-	+	+	-	0	-	0	0	-	-	0	-
		Irregularia	0	0	0	0	0	0	0	0	0	0	-	-	-	0
	Asteroidea		0	-	-	-	-	0	0	0	0	0	-	-	-	-
	Ophiuroidea		-	-	+	-	-	-	-	-	-	-	+	+	+	+
Ascidiacea			-	-	-	0	-	+	0	-	-	0	0	-	-	-
Pisces			0	0	0	0	0	0	0	0	0	0	0	0	0	-

Sampling on the southern slope of the Drake Passage indicated full Antarctic conditions, with a particularly rich benthos between 400 and 1000 m depth. Both in the Bransfield Strait and in the open Drake Passage, the endofauna - especially polychaetes - appeared to be much better developed than in the southeastern Weddell Sea whereas the typical high Antarctic epifauna (in particular, sponges, hard-shelled bryozoans and gorgonians) was largely missing. Errant polychaetes, particularly deep-living Onuphidae, were common on both sides of King George Island whereas sedentary forms (Sabellidae, Terebellidae, Cirratulidae) only abounded in the Bransfield Strait. Algal remains and soft cheilostomatic bryozoans were very common at the shallowest stations (ca. 100 m) both in the Bransfield Strait and the Drake Passage. Large scleractinian single corals occurred frequently in the Drake Passage but were almost missing in the Bransfield Strait. Large gastropods, with the conspicuous species *Aforia magnifica* dominating, were common in the Drake Passage. Contrary to the northern slope of the Drake Passage sampled during ANT XIII/4, not a single reptant decapod was encountered on the southern slope, and stomatopods do not seem to exist here either. Among the echinoderms, ophiuroids were found to be strongly dominant on both sides of King George Island whereas relatively few asteroids occurred in the Bransfield Strait in comparison with the Drake Passage (and the high Antarctic). Crinoids, a very dominant element in the southeastern Weddell Sea, were abundant only off Admiralty Bay but showed a trend of increasing importance in relation to the northern slope of the Drake Passage and, in particular, the Magellan Region.

2.4.6 Preliminary Observations on Species Composition and Distribution of Aphroditidae and Polynoidae (Polychaeta) in the Eastern Weddell Sea

(M. C. Gambi)

Introduction and objectives

The study of distribution, biodiversity and reproductive biology of the two related families Aphroditidae and Polynoidae started during the EASIZ I campaign in 1996 (ANT XIII/3) (Gambi 1997). A total of 1 species of Aphroditidae and about 30 species of Polynoidae have been sorted out during the campaign, while previous studies on both families in the eastern Weddell Sea (see Stiller 1996 and references cited), reported up to 2 species of Aphroditidae and 25 species of Polynoidae.

The aim of this research was therefore to complete the study with the collection of additional specimens belonging to Aphroditidae and Polynoidae for further investigations of some aspects of their bioecology and distribution. In particular it was focused on:

- species composition and distribution at the investigated spatio-temporal scale of the cruise and along the geographic gradient from the eastern Weddel Sea to the Antarctic Peninsula
- biogeographic comparisons with other Antarctic areas (e.g., Ross Sea) and with the Magellan Province
- some reproductive features, such as state of the gonads, incubation habit, size and number of eggs
- allometric analysis and possible relationships with animal age (by counting the jaw's rings); population structure of the most abundant species
- gut content analysis of the most abundant species in order to evaluate their role in food web
- possible associations (symbioses, commensalism, etc.) of these polychaetes with other organisms, mainly sponges, cnidarians, and echinoderms

Work at sea

The specimens belonging to Aphroditidae and Polynoidae were sorted into possible similar species (e.g., *Harmothoe* spp). Only the taxa more easily recognizable during a superficial examination were identified to species level and when possible counted. All the specimens were checked before fixation for the occurrence of incubating eggs under the elytra, as this habit had been observed in a few specimens during the previous EASIZ I cruise (Gambi 1997). The specimens bearing the eggs under the elytra were fixed separately. Most of the specimens were fixed with 4% formaldehyde, after a few hours of relaxation. Some specimens of *H. spinosa,* belonging to two different forms ("light" and "dark" forms, for explanations see Stiller 1996 and Gambi 1997) were fixed in absolute alcohol for further molecular analysis of some DNA markers in order to clarify their taxonomic relationships. Most of the specimens of the polynoid species *Polyeunoa laevis* were immediately frozen for the analysis of secondary metabolites (in collaboration with K. Iken and C. Avila), in relation to the typical associaton of this species with different species of "brush-like" gorgonians (mainly *Thouarella* spp., and *Dasystenella* spp., Gambi 1997). Other specimens of the same species were kept in the laboratory for behavioural observation of host gorgonian colonization and choice. Most specimens of some common species, such as the aphroditid *Laetmonice producta*, or the polynoid *Eulagisca gigantea* and *Eunoe* sp. a, were not collected quantitatively, due to the large numbers already obtained during the previous EASIZ I cruise (Gambi 1997).

Preliminary results

Scaleworms (both Aphroditidae and Polynoidae) were collected in almost all samples and at all depths, including the shallowest stations sampled at the Four Seasons Inlet (65 m depth), and the deepest sample at 2000 m depth. A preliminary list of the taxa identified, their depth distribution and their occurrence in the different areas of sampling (Kapp Norvegia, Vestkapp and Halley Bay) is given in Table 49. Among the Aphroditidae only *Laetmonice producta* was found, while among the polynoids the taxa up to date identified to species level (8) are all well known for the region (Stiller 1996) and were among the most common taxa sampled also during the EASIZ I campaign (Gambi 1997). The two most frequent and abundant species were *L. producta* and *P. laevis*, while *Barrukia cristata* was relatively frequent but not very abundant. *Polyeunoa laevis* was particularly abundant in those samples where also its host gorgonians occurred in large numbers, and most of the worms have in fact been sampled in association with such gorgonians. Analyzing the species depth distribution (Table 49), most of the taxa and of the specimens were collected on the shelf (100-600 m depth), whereas at 800 m and at deeper stations only a few species occurred, and in these depths only *L. producta* was really abundant.

Table 49: Preliminary species list of Aphroditidae and Polynoidae found.

	F	depth range (m)	Area		
			KN	VK	HB
APHRODITIDAE					
Laetmonice producta Grube	13	300-1600	+	+	+
POLYNOIDAE					
Polyeunoa laevis McIntosh	15	75-800	+	+	+
Barrukia cristata (Willey)	15	65-800	+	+	+
Eulagisca gigantea Monro	10	200-800	+	+	+
Eulagisca cf corrientis Monro	8	200-800	+	+	+
Eucranta mollis (McIntosh)	2	400-500	-	+	-
Harmothoe spinosa Kinberg (light form)	6	100-400	+	-	+
Harmothoe spinosa (dark form)	10	200-800	+	+	+
Hermadion cf ferox Baird	4	200-400	+	+	-
Hermadion cf magalhaensis Kinberg	8	200-800	+	+	+
Hermadion-type	3	200-400	+	+	-
Eunoe sp. a	8	200-500	+	+	-
Polynoe sp. (?)	4	300-800	+	+	+
other Polynoidae (unidentified)	18	65-2000	+	+	+

F = frequency (total no. of samples: 39). KN= Kapp Norvegia, VK= Vestkapp, HB= Halley Bay

On the whole, both the potential number of species and that of the individuals collected seems to be lower compared to the previous campaign. This can likely be explained by the fact that many samples have been collected in disturbed areas (iceberg scour marks) and yielded a reduced number of taxa. Furthermore, in many of the samples a large amount of big stones and boulders caused damage to the benthos, especially of fragile taxa such as polychaetes.

Regarding the reproductive features, it is interesting to note that several specimens belonging to different species (*Harmothoe spinosa*, light form), and a few other *Harmothoe*-like species), have been observed bearing mature eggs on their backs, under the elytra. The eggs in *H. spinosa* were included in a thin membrane and grouped in single oval masses (approx. two masses for each parapodium). The eggs of the other polynoids were also enveloped in a thin membrane but had the shape of flat cylindrical, rope-like lines located on both sides of the worm. Mean egg diameter for the specimens observed (both *H. spinosa* and the other polynoids) was 150 µm. This fact is quite interesting because until now no polynoids have been reported to brood eggs in Antarctica. However, egg dimension and the fact that the elytra are very delicate organs suggest that the external brooding of the eggs is short and that larvae hatching from these eggs are most probably pelagic and planktotrophic.

2.4.7 Structural and Ecofunctional Biodiversity of the Benthic Amphipod Taxocoenoses (C. De Broyer, M. Rauschert, Y. Scailteur)

Introduction

In the Antarctic benthic communities, the peracarid crustaceans (Amphipoda, Isopoda, Tanaidacea, Cumacea, Mysidacea) are by far the most speciose group and probably the most "ecologically" diversified, at least in terms of life styles, trophic types, habitats and size spectra (De Broyer and Jazdzewski 1996). The peracarid crustaceans, and in particular the most numerous group, the amphipods, despite their low biomass, constitute a dominant group in terms of energy fluxes in the High Antarctic shelf ecosystem (Weddell Sea: Jarre-Teichmann *et al.* 1997) and they can show high densities e.g. in the maritime Antarctic sublittoral communities. Peracarids provide, on the other hand, an important food resource to many Antarctic demersal and benthic fishes.

The assessment of the biodiversity of the very rich fauna of Antarctic amphipods living in the Antarctic Coastal and Shelf Ecosystem has to be pursued and, in the future, extended to the nearly totally unknown Antarctic deep sea. On the other hand, the various ecological roles played by the diverse amphipod species remain to be more thoroughly investigated. Indeed, one promising approach of the role of biodiversity in ecosystem functioning – which is of some significance in the evaluation of the potential stability and resilience of ecosystems facing environmental changes - is the study of the functional role(s) of species or species groups in key ecological processes. The ecofunctional role, and in particular the trophodynamic role, of most of the Antarctic peracarids (in particular amphipods) is still poorly known, despite notable contributions this last decade. The preferential or exclusive trophic types have been studied in less than 10% of amphipod species, with extremely few quantitative approaches so far. On the other hand, among the most important families of Antarctic amphipods, the feeding type cannot be deduced with certainty from the morphology of feeding appendages. A qualitative and quantitative characterisation of the trophic roles of amphipods and peracarids in general, at the level of the key-species and of the whole taxocoenoses, could significantly contribute to a more accurate image of the trophic structure and fluxes in Antarctic benthic communities.

Objectives

- Structural biodiversity
  - To document the faunistical, zoogeographical and ecological traits of the amphipod taxocoenoses on a latitudinal scale (southeastern Weddell Sea, West Antarctic, in comparison with the Magellanic region) and to pursue

taxonomical and phylogenetical studies of particular families (e.g., Lysianassidae s.l., Stenothoidae).

- To contribute by taxonomical material and distributional and ecological data to the preparation of the "Synopses of Antarctic Amphipods" (De Broyer, Andres, Bellan-Santini, Coleman, Jazdzewski, Rauschert, Takeuchi, Vader, Wakabara, in prep.) and the development of the first "Antarctic Biodiversity Reference Centre" (focussing on amphipod Crustacea) in the framework of the EASIZ, Diversitas, and Systematics Agenda 2000 programmes.

- Ecofunctional biodiversity
  - To continue the trophodynamic approach undertaken in the southeastern Weddell Sea region during the EASIZ I campaign *i.e.*, to characterize and to quantify the trophodynamic role of the amphipod taxocoenoses and to compare it on a latitudinal scale with the West Antarctic region. Particular topics to investigate are: diet composition, food consumption and assimilation efficiency, characterisation and functional role of the amphipod trophic guilds, significance of amphipods as preys for other macrobenthos and demersal fish.

Work at sea

Samples for stomach content analysis, life history, growth and fecundity studies, and for SEM studies as well as data on amphipod predators were systematically collected. Selected species have been collected for DNA analysis. Living specimens of more than 40 species were kept in aquaria in cool container for ethological observations and feeding experiments on board and for further feeding, ethological and growth studies in the cool laboratory at IRScNB, Brussels. The amphipod material was sorted on board to the species level (except the EBS and MG material and part of the dredge material), and when possible identified. Peracarid crustaceans from the stomach contents of demersal and benthic fish have been identified in the framework of the fish biology investigations.

Preliminary results

Faunistics. On the different sites investigated (Kapp Norvegia, Vestkapp, Drescher Inlet, Halley Bay, about 60.000 specimens of at least 179 species of gammaridean amphipods, 2 species of Caprellidea, and 4 species of pelagic Hyperidea (3 Hyperiidae, 1 Phrosinidae) have been collected. Three genera and 38 species are presumably new to science (1 family indet., 1 Ampeliscidae, 1 Amphilochidae, 1 Clarenciidae, 1 Dexaminidae, 2 Epimeriidae, 1 Gammaridae s.l., 2 Liljeborgiidae, 4 Lysianassidae s.l., 1 Melitidae, 1 Melphidippidae, 3 Podoceridae, 15 Stenothoidae, 1 Synopiidae, 3 Urothoidae). Eighteen dredge samples (D) provided a good number of small-sized amphipods and other peracarids usually in good condition, and together with the EBS samples (see 2.4.3) very usefully complemented the larger mesh-sized Agassiz trawl catches. The following families of Gammaridea were found in the different trawl, dredge, trap and corer samples: Ampeliscidae, Amphilochidae, Clarenciidae, Colomastigiidae, Corophiidae *s.l.*, Dexaminidae, Epimeriidae, Eusiridae *s.l.*, Gammaridae *s.l.*, Iphimediidae, Ischyroceridae, Leucothoidae, Liljeborgiidae, Lysianassidae *s.l.*, Melitidae, Melphidippidae, Odiidae, Oedicerotidae, Pardaliscidae, Phoxocephalidae, Podoceridae, Sebidae, Stenothoidae, Synopiidae, Urothoidae, as well as Caprellidae for the Caprellidea and Hyperiidae and Phrosinidae for the Hyperidea. A preliminary list of amphipod species collected by AGT, BPN, GSN, D, Traps and TVG is given in the Annex (Table 50). In addition to Amphipoda, two species of Leptostraca (*Nebalia* sp. and *Nebaliella* sp.) were found in the dredge samples and one (*Nebaliella* sp.) was also caught in a baited trap.

Zoogeography. Among the 130 identified species recorded, 46 species were known from the West Antarctic and only 12 from the Magellan area. The family Clarenciidae was detected in the East Antarctic for the first time. The leptostracan *Nebaliella* sp. had been previously collected in Maxwell Bay, King George Island (Rauschert unpubl.). In addition to trawl samples, systematic trap sampling at approx. 200, 400, 600, 800, 1200 and 1500 m allowed to document

Table 50: Preliminary list of amphipod species collected by AGT, BPN, D, GSN, Traps and TVG.

No	Family	Genus	Species	E-Ant	W-Ant	Mag
1	Ampeliscidae	*Ampelisca*	*richardsoni*	X	X	
2	Ampeliscidae	*Ampelisca*	sp.n.	X		
3	Amphilochidae	gen.	sp. 1 (nov.?)	X		
4	Amphilochidae	gen.	sp. 2	X		
5	Amphilochidae	gen.	sp. 3	X		
6	Amphilochidae	gen.	sp. 4	X		
7	Clarenciidae	*Clarencia*	*chelata*	X	X	
8	Clarenciidae	*Clarencia*	sp.n.	X		
9	Colomastigidae	*Colomastix*	*fissilingua*	X	X	X
10	Colomastigidae	*Colomastix*	sp.	X		
11	Corophiidae	*Gammaropsis*	sp.	X		
12	Corophiidae *s.l.*	*Haplocheira*	sp. (*plumosa*?)	X		
13	Corophiidae *s.l.*	gen.	sp.	X		
14	Corophiidae *s.l.*	*Kuphocheira*	*setimanus*	X	X	
15	Corophiidae *s.l.*	*Pseudericthonius*	sp.	X		
16	Dexaminidae	*Lepechinella*	sp.	X		
17	Dexaminidae	*Polycheria*	*antarctica*	X	X	
18	Dexaminidae	*Polycheria*	sp.n.	X		
19	Epimeriidae	*Epimeria*	*georgiana*	X	X	
20	Epimeriidae	*Epimeria*	*grandirostris*	X	X	
21	Epimeriidae	*Epimeria*	*macrodonta*	X	X	
22	Epimeriidae	*Epimeria*	*robusta*	X		
23	Epimeriidae	*Epimeria*	*rubrieques*	X		
24	Epimeriidae	*Epimeria*	*similis*	X	X	
25	Epimeriidae	*Epimeria*	sp.n.	X		
26	Epimeriidae	*Epimeria*	sp.n.?	X		
27	Epimeriidae	*Epimeriella*	sp. A	X		
28	Epimeriidae	*Epimeriella*	sp. B	X		
29	Epimeriidae	*Epimeriella*	sp. C	X		
30	Eusiridae *s.l.*	*Atyloella*	*quadridens*	X	X	
31	Eusiridae *s.l.*	*Atylopsis*	*megalops*	X	X	X
32	Eusiridae *s.l.*	*Atylopsis*	sp.	X		
33	Eusiridae *s.l.*	*Eusirus*	*perdentatus*	X	X	
34	Eusiridae *s.l.*	*Eusirus*	sp. A	X		
35	Eusiridae *s.l.*	*Eusirus*	sp. B	X		
36	Eusiridae *s.l.*	*Eusirus*	sp. C	X		
37	Eusiridae *s.l.*	*Liouvillea*	*oculata*	X	X	
38	Eusiridae *s.l.*	*Oradarea*	*edentata*	X	X	
39	Eusiridae *s.l.*	*Oradarea*	sp.	X		
40	Eusiridae *s.l.*	*Paramoera*	*fissicauda*	X	X	X
41	Eusiridae *s.l.*	*Paramoera*	*hurleyi*	X	X	
42	Eusiridae *s.l.*	*Prostebbingia*	*gracilis*	X	X	X
43	Eusiridae *s.l.*	*Rhachotropis*	*antarctica*	X	X	X
44	Eusiridae *s.l.*	*Schraderia*	*gracilis*	X	X	
45	Gammaridae *s.l.*	*Paraceradocus*	*gibber*	X	X	

Table 50 continued.

No	Family	Genus	Species	E-Ant	W-Ant	Mag
46	Gammaridae *s.l.*	*Paraceradocus*	*miersii*	X	X	
47	Gammaridae *s.l.* (fam.	gen.	sp.n.?	X		
48	Iphimediidae	*Echiniphimedia*	*hodgsoni*	X		
49	Iphimediidae	*Echiniphimedia*	sp. A	X		
50	Iphimediidae	*Echiniphimedia*	sp. B	X		
51	Iphimediidae	*Gnathiphimedia*	*mandibularis*	X	X	
52	Iphimediidae	*Gnathiphimedia*	*sexdentata*	X	X	
53	Iphimediidae	*Gnathiphimedia*	sp. A	X		
54	Iphimediidae	*Gnathiphimedia*	sp. B	X		
55	Iphimediidae	gen.	sp. 1	X		
56	Iphimediidae	gen.	sp. 2	X		
57	Iphimediidae	gen.	sp. 3	X		
58	Iphimediidae	*Iphimediella*	sp. A	X		
59	Iphimediidae	*Iphimediella*	sp. B	X		
60	Iphimediidae	gen.	spp.	X		
61	Ischyroceridae	*Jassa*	sp. A	X		
62	Ischyroceridae	*Jassa*	sp. B	X		
63	Ischyroceridae	*Jassa*	sp. C	X		
64	Ischyroceridae	gen.	sp. 1	X		
65	Ischyroceridae	gen.	sp. 2	X		
66	Leucothoidae	*Leucothoe*	sp.	X		
67	Leucothoidae	*Leucothoe*	*spinicarpa*	X	X	X
68	Liljeborgiidae	gen.	sp.n. ?	X		
69	Liljeborgiidae	gen.	sp.n.	X		
70	Lysianassidae *s.l.*	*Abyssorchomene*	*nodimanus*	X	X	
71	Lysianassidae *s.l.*	*Abyssorchomene*	*plebs*	X	X	
72	Lysianassidae *s.l.*	*Abyssorchomene*	*rossi*	X	X	
73	Lysianassidae *s.l.*	*Abyssorchomene*	*scotianensis*	X	X	
74	Lysianassidae *s.l.*	*Aristias*	*antarcticus*	X	X	X
75	Lysianassidae *s.l.*	*Eurythenes*	*gryllus*	X	X	X
76	Lysianassidae *s.l.*	*Hippomedon*	cf. *kergueleni*	X	X	
77	Lysianassidae *s.l.*	*Hippomedon*	sp.	X		
78	Lysianassidae *s.l.*	*Hirondellea*	*antarctica*	X		
79	Lysianassidae *s.l.*	*Lepidepecreella* (cf.)	sp. A	X		
80	Lysianassidae *s.l.*	*Lepidepecreum* (cf.)	sp. A	X		
81	Lysianassidae *s.l.*	*Lepidepecreum* (cf.)	sp.n.	X		
82	Lysianassidae *s.l.*	*Opisa* (cf.)	sp.n.	X		
83	Lysianassidae *s.l.*	*Orchomenopsis*	sp. A	X		
84	Lysianassidae *s.l.*	*Orchomenopsis*	sp. B	X		
85	Lysianassidae *s.l.*	*Orchomenopsis*	sp. D	X		
86	Lysianassidae *s.l.*	*Orchomenopsis*	sp. E	X		
87	Lysianassidae *s.l.*	*Orchomenopsis*	sp. F (sp.n.?)	X		
88	Lysianassidae *s.l.*	*Orchomenopsis*	spp.	X		
89	Lysianassidae *s.l.*	*Parschisturella*	*carinata*	X	X	
90	Lysianassidae *s.l.*	*Parschisturella*	sp.	X		
91	Lysianassidae *s.l.*	*Pseudorchomene*	*coatsi*	X	X	
92	Lysianassidae *s.l.*	*Pseudorchomene*	sp.n.	X		

Table 50 continued.

No	Family	Genus	Species	E-Ant	W-Ant	Mag
93	Lysianassidae *s.l.*	*Socarnoides* (cf.)	sp. A	X		
94	Lysianassidae *s.l.*	*Socarnoides* (cf.)	sp. B	X		
95	Lysianassidae *s.l.*	*Shackletonia*	sp.	X		
96	Lysianassidae *s.l.*	*Tryphosella*	*murrayi*	X	X	
97	Lysianassidae *s.l.*	*Tryphosella*	sp. A	X		
98	Lysianassidae *s.l.*	*Tryphosella*	sp. B	X		
99	Lysianassidae *s.l.*	*Tryphosella*	sp. C	X		
100	Lysianassidae *s.l.*	*Tryphosella*	sp. D	X		
101	Lysianassidae *s.l.*	*Tryphosella*	sp. E	X		
102	Lysianassidae *s.l.*	*Tryphosella*	sp. F	X		
103	Lysianassidae *s.l.*	*Tryphosella*	sp. G	X		
104	Lysianassidae *s.l.*	*Tryphosella*	sp. H	X		
105	Lysianassidae *s.l.*	*Tryphosella*	sp. I	X		
106	Lysianassidae *s.l.*	*Uristes*	*gigas*	X	X	X
107	Lysianassidae *s.l.*	*Uristes*	sp. A	X		
108	Lysianassidae *s.l.*	*Uristes*	sp. B	X		
109	Lysianassidae *s.l.*	*Uristes*	sp. C	X		
110	Lysianassidae *s.l.*	*Uristes*	sp. D	X		
111	Lysianassidae *s.l.*	*Uristes*	sp. E	X		
112	Lysianassidae *s.l.*	*Uristes*	sp. F	X		
113	Lysianassidae *s.l.*	*Waldeckia*	*obesa*	X	X	
114	Lysianassidae *s.l.*	gen.	sp.n. A	X		
115	Lysianassidae *s.l.*	gen.	sp.n. B	X		
116	Lysianassidae *s.l.*	gen.	spp.	X		
117	Melphidippidae	*Melphidippa*	*antarctica*	X	X	
118	Melphidippidae	*Melphidippa*	sp.	X		
119	Melphidippidae	*Melphidippa*	sp.n.	X		
120	Melitidae	gen. nov.	sp.n.	X		
121	Odiidae	*Odius*	sp.	X		
122	Oedicerotidae	*Oediceroides*	*calmani*	X	X	
123	Oedicerotidae	*Oediceroides*	*emarginatus*	X		
124	Oedicerotidae	gen.	spp.	X		
125	Pardaliscidae	*Halicella*	cf. *parasitica*	X		
126	Pardaliscidae	*Pardalisca*	sp.4(cf. *cuspidata*)	X		
127	Pardaliscidae	*Pardalisca*	sp. 1	X		
128	Pardaliscidae	*Pardalisca*	sp. 2	X		
129	Pardaliscidae	*Pardalisca*	sp. 3	X		
130	Phoxocephalidae	*Heterophoxus*	*videns*	X	X	X
131	Phoxocephalidae	gen.	spp.	X		
132	Podoceridae	*Podocerus*	sp.n.	X		
133	Podoceridae	*Pseudodulichia*	sp.n. 1	X		
134	Podoceridae	*Pseudodulichia*	sp.n. 2	X		
135	Sebidae	*Seba*	*antarctica*	X	X	
136	Sebidae	*Seba*	sp.	X		
137	Stegocephalidae	gen.	sp. A	X		
138	Stegocephalidae	gen.	sp. B	X		
139	Stegocephalidae	gen.	sp. C	X		

Table 50 continued.

No	Family	Genus	Species	E-Ant	W-Ant	Mag
140	Stenothoidae	*Antatelson*	*walkeri*	X	X	
141	Stenothoidae	*Metopoides*	sp.n. 1	X		
142	Stenothoidae	*Metopoides*	sp.n. 2	X		
143	Stenothoidae	*Metopoides*	sp.n. 3	X		
144	Stenothoidae	*Metopoides*	sp.n. 4	X		
145	Stenothoidae	*Probolisca*	*ovata*	X	X	X
146	Stenothoidae	*Scaphodactylus*	sp.	X		
147	Stenothoidae	*Scaphodactylus*	sp.n. 1	X		
148	Stenothoidae	*Scaphodactylus*	sp.n. 2	X		
149	Stenothoidae	*Thaumatelson*	*herdmani*	X	X	
150	Stenothoidae	*Thaumatelson*	sp.n.	X		
151	Stenothoidae	*Torometopa*	*antarctica*	X	X	
152	Stenothoidae	*Torometopa*	sp.n. 1	X		
153	Stenothoidae	*Torometopa*	sp.n. 2	X		
154	Stenothoidae	*Torometopa*	sp.n. 3	X		
155	Stenothoidae	*Torometopa*	sp.n. 4	X		
156	Stenothoidae	*Torometopa*	sp.n. 5	X		
157	Stenothoidae	*Torometopa*	sp.n. 6	X		
158	Stenothoidae	gen. nov. 1	sp.n.	X		
159	Stenothoidae	gen. nov. 2	sp.n.	X		
160	Stenothoidae	gen. 1	sp.	X		
161	Stenothoidae	gen. 2	sp.	X		
162	Stenothoidae	gen. 3	sp.	X		
163	Stenothoidae	gen. 4	sp.	X		
164	Stenothoidae	gen. 5	sp.	X		
165	Stenothoidae	gen. 6	sp.	X		
166	Stilipedidae	gen.	sp. A	X		
167	Stilipedidae	gen.	sp. B	X		
168	Stilipedidae	gen.	sp. C	X		
169	Stilipedidae	gen.	sp. D	X		
170	Synopiidae	gen.	sp. 1	X		
171	Synopiidae	gen.	sp. 2	X		
172	Synopiidae	gen.	sp. 3	X		
173	Synopiidae	gen.	sp.n.	X		
174	Urothoidae	gen. 1	sp.n.	X		
175	Urothoidae	gen. 2	sp.n.	X		
176	Urothoidae	gen. 3	sp.	X		
177	Urothoidae	gen. 4	sp.n.	X		
178	indet.	gen.	sp.n.	X		
179	Caprellidae	*Aeginoides*	*gaussi*	X	X	X
180	Caprellidae	gen.	sp.	X		
181	Hyperiidae	*Hyperiella*	*dilatata*	X	X	X
182	Hyperiidae	*Themisto*	*gaudichaudi*	X	X	X
183	Hyperiidae	gen.	sp.	X		
184	Phrosinidae	*Primno*	*macropa*	X	X	X

the bathymetric distribution of the shelf and slope scavenger species (Table 51). Four specimens (up to 13 cm long) of the cosmopolitan abyssal species *Eurythenes gryllus* have been collected in traps at 1200 and 1500 m.

Table 51: Trap samples. Bathymetric distribution of the shelf and slope species.

Station	area	Depth (m)	Duration (h)	Amphipoda spp (ind)	Isopoda spp (ind)	Mysidacea spp (ind)	Leptostraca spp (ind)	Ostracoda spp (ind)	Fish spp (ind)
T1 (011/025)	DI	377	38	7 (24 883)	2 (482)				
T2 (028/076)	N/KN	171	103	5 (10 527)	1 (1)				
T3 (038/075)	N/KN	389	82	8 (727)	2 (38)				
T4 (094/119)	S/VK	813	50	7 (760)	3 (28)				
T5 (102/122)	S/VK	396	46	8 (507)	1 (9)				
T6 (138/155)	HB	798	39	12 (3434)					1 (2)
T7 (160/179)	HB	403	38	16 (3907)	2 (281)			1 (4)	
T8 (202/233)	KN	808	58	14 (374)	2 (26)		1 (1)	1 (4002)	
T9 (203/234)	KN	442	58	14 (697)	2 (90)	1 (6)			
T10 (251/267)	DI	895	66	10 (1820)				1 (6)	
T11 (255/268)	DI	1453	58	12 (1566)	2 (76)			1 (4)	
T12 (279/283)	AB	1136	48	7 (58)	2 (16)				1 (1)
T13 (280/284)	AB	550	48	10 (1534)	2 (547)			1 (6)	2 (4)
Total				33 (50 794)	3 (1594)	1 (6)	1 (1)	1 (4022)	3 (7)

Habitats and microhabitats. The natural habitats have been documented for a few species e.g. by means of observations of undisturbed box corer samples and of behaviour in aquaria (Table 52a). Commensal amphipods (lysianassids, stegocephalids or stenothoids) were found in some living ascidians (mostly *Ascidia challengeri*). One single specimen of ascidian usually hosts only one amphipod species but in a few cases, lysianassids and stenothoids were found together. Few species of particular genera of Stenothoidae were found associated with Hydrozoa or Gorgoniacea (as *Primnoella* sp.), mostly from assemblages colonizing large stones. These stone assemblages from stn 035 and 210 provided 353 adults and juveniles of Stenothoidae, 2 Ischyroceridae and 1 Eusiridae (*Atylopsis* sp.).

Quantitative distribution. Density and biomass data will be obtained from the MG corer samples from this cruise and other recent Weddell sea cruises (EASIZ I, EPOS) and compared with the expected EBS quantitative data (see 2.4.3).

Selection and maintenance of live specimens for long-term studies. About 10,000 specimens of more than 40 species have been kept alive onboard in aquaria, to allow feeding experiments and general behaviour observations on board. Samples of 25 species have been selected for long-term studies of life history and growth, and to continue feeding biology studies in the cool laboratory of IRScNB, Brussels, after transportation by air.

Ecofunctional biodiversity: trophodynamics. To identify the trophic type of the most common species, stomach contents were analyzed on board. In addition, observations of the feeding behaviour in aquaria were made, allowing a.o. to compare the different modes of detection and prehension of the food items (Table 52b). Baited trap results indicated 33 species of amphipods to be regular scavengers (Table 53). Traps provided 30 species of lysianassoids, 2 eusirids, and 1 epimeriid, represented by more than 50,000 specimens. In order to characterize amphipod trophic guilds, systematic observations in aquarium were also made of the different modes of life and general behavioural traits e.g., attitude, position on or above the bottom, on sessile benthos, swimming capacity, burrowing and other locomotory activity, etc. (Tables 52a, b). To evaluate the importance of the amphipods as preys for demersal and benthic fishes, stomach contents of selected fish species were analyzed in co-operation with the fish biology team (see 2.4.1) and amphipods identified (Table 53).

Table 52a: Natural habitats and food preferences of amphipods.
Position on the bottom: epibenthic = directly on the sediment, 1st level = on substrate or lower strata of epibenthos, 2nd level = on the upper strata of epibenthos (cnidarians, sponge...); Feeding experiments: L. + item means living prey.

Family	Species	Usual position	Food ingested (aquarium)
AMPE	*Ampelisca richardsoni*	endobenthic in a "cell"	amphipod "juice"
EPIM	*Epimeria georgiana*	epibenthic (1st level)	Cnidaria, Hydrozoa, Polychaeta, squid
EPIM	*Epimeria grandirostris*		
EPIM	*Epimeria macrodonta*	epibenthic (1st and 2nd level)	squid, L.gorgonacea, L.bryozoa, Amphipoda, pieces of Polychaeta
EPIM	*Epimeria robusta*	epibenthic (1st and 2nd level)	pieces of Amphipoda, pieces of Polychaeta
EPIM	*Epimeria rubrieques*	epibenthic (1st level)	pieces of Amphipoda, pieces of Polychaeta
EPIM	*Epimeria similis*	epibenthic (1st and 2nd level)	pieces of Amphipoda, pieces of Polychaeta,fish
EPIM	*Epimeriella* cf *walkeri*	epibenthic (2nd level)	none
EUSO	*Eusirus antarcticus*	epibenthic up to several meters	L.Amphipoda (by forceps)
EUSO	*Eusirus perdentatus*	epibenthic on the bottom	L.Amphipoda (by forceps)
EUSO	*Rhachotropis antarctica*		
GAM	*Paraceradocus gibber*	epibenthic or in cracks	L. Amphipoda (by forceps)
IPHI	*Echiniphimedia hodgsoni*	epibenthic on sponge	Porifera ?
IPHI	*Echiniphimedia* sp. 2	epibenthic on sponge	Porifera ?
IPHI	*Iphimediella* sp. A	epibenthic (1st and 2nd level)	none
IPHI	*Gnathiphimedia mandibularis*	epibenthic on bryozoa	Bryozoa
IPHI	*Iphimediella* sp. B	epibenthic (1st and 2nd level)	
ISCH	*Jassa* sp. A	hung on the bottom or on 1st level	L.plankton , fragments of Amphipoda
LILJ	*Liljeborgia georgiana*	epibenthic on the bottom	pieces of Polychaeta
LYSO	*Abyssorchomene nodimanus*	burrowed in the sediment	L.fish, squid, L.octopod, L.mysid, Amphipoda
LYSO	*Abyssorchomene plebs*	epibenthic or in the water-column	L.fish, squid, L.octopod, L.mysid, Amphipoda
LYSO	*Abyssorchomene rossi*	epibenthic	
LYSO	*Aristias antarcticus*		
LYSO	*Hirondellea antarctica*	epibenthic	none
LYSO	*Lepidepecreella* sp.	epibenthic on the bottom	
LYSO	*Orchomenopsis* sp. E	epibenthic	squid, Amphipoda, fish
LYSO	*Pseudorchomene coatsi*	epibenthic or burrowed in the sediment	squid, fish, Amphipoda, L.Polychaeta
LYSO	*Tryphosella murrayi*	epibenthic	fish, Amphipoda, squid
LYSO	*Tryphosella* sp. 2		
LYSO	*Uristes* cf *adarei*	epibenthic on the bottom	
LYSO	*Uristes gigas*	epibenthic on the bottom	fish, Amphipoda, squid
LYSO	*Waldeckia obesa*	epibenthic on the bottom	fish, Amphipoda, squid, L.Holothuridea (part of it)
MELI	*Antamelita* sp.	epibenthic on the sediment	none
MELP	*Melphidippa antarctica*	epibenthic on the bottom	L.plankton , fragments of Amphipoda
OEDI	*Oediceroides calmani*	endobenthic, half buried in sediment	L.Amphipoda (one observation)
OEDI	*Oediceroides emarginatus*	endobenthic, half buried in sediment	none
PHOX	*Heterophoxus* cf *videns*	endobenthic , in the sediment	?
STIL	*Stilipedidae* gen sp. A	epibenthic (1st and 2nd level)	

Table 52a continued.

Family	Species	Usual position	Food refused (aquarium)
AMPE	*Ampelisca richardsoni*	endobenthic in a "cell"	Amphipoda macroscopic fragments
EPIM	*Epimeria georgiana*	epibenthic (1st level)	Living animals (?)
EPIM	*Epimeria grandirostris*		
EPIM	*Epimeria macrodonta*	epibenthic (1st and 2nd level)	L.Asteroidea, L.Amphipoda
EPIM	*Epimeria robusta*	epibenthic (1st and 2nd level)	L.Holothuridea, L.Polychaeta, L. mysis
EPIM	*Epimeria rubrieques*	epibenthic (1st level)	L.Holothuridea, L.Polychaeta, L. mysid, squid
EPIM	*Epimeria similis*	epibenthic (1st and 2nd level)	L.echinoderms,L.Polychaeta,L.Amphipoda
EPIM	*Epimeriella* cf *walkeri*	epibenthic (2nd level)	L.echinoderms,L.Polychaeta,L.Amphipoda
EUSO	*Eusirus antarcticus*	epibenthic up to several meters	L.Polychaeta, Amphipoda, squid
EUSO	*Eusirus perdentatus*	epibenthic on the bottom	L.Polychaeta, Amphipoda, squid
EUSO	*Rhachotropis antarctica*		
GAM	*Paraceradocus gibber*	epibenthic or in cracks	L.Amphipoda, L.Polychaeta, pieces of Polychaeta, squid, pieces of Amphipoda
IPHI	*Echiniphimedia hodgsoni*	epibenthic on sponge	4 different species of L. sponge
IPHI	*Echiniphimedia* sp. 2	epibenthic on sponge	4 different species of L. sponge
IPHI	*Iphimediella* sp. A	epibenthic (1st and 2nd level)	pieces of Amphipoda, L.Holothuroidea, L.Polychaeta
IPHI	*Gnathiphimedia mandibularis*	epibenthic on bryozoa	squid, pieces of Amphipoda
IPHI	*Iphimediella* sp. B	epibenthic (1st and 2nd level)	
ISCH	*Jassa* sp. A	hung on the bottom or on 1st level	
LILJ	*Liljeborgia georgiana*	epibenthic on the bottom	L.Polychaeta, L.Holothuridea, L.and dead Amphipoda, squid
LYSO	*Abyssorchomene nodimanus*	burrowed in the sediment	L.echinoderms
LYSO	*Abyssorchomene plebs*	epibenthic or in the water-column	L.Amphipoda, L.Polychaeta
LYSO	*Abyssorchomene rossi*	epibenthic	
LYSO	*Aristias antarcticus*		
LYSO	*Hirondellea antarctica*	epibenthic	L.gorgonaria, L.Hydrozoa, L.Polychaeta, L.Holothuroidea, squid
LYSO	*Lepidepecreella* sp.	epibenthic on the bottom	
LYSO	*Orchomenopsis* sp. E	epibenthic	L.Amphipoda, L.Polychaeta, L.Holothuroidea
LYSO	*Pseudorchomene coatsi*	epibenthic or burrowed in the sediment	
LYSO	*Tryphosella murrayi*	epibenthic	L.Polychaeta, L.Amphipoda
LYSO	*Tryphosella* sp. 2		
LYSO	*Uristes* cf *adarei*	epibenthic on the bottom	
LYSO	*Uristes gigas*	epibenthic on the bottom	L.Polychaeta, L.Amphipoda
LYSO	*Waldeckia obesa*	epibenthic on the bottom	
MELI	*Antamelita* sp.	epibenthic on the sediment	Polychaeta, Amphipoda, squid, echinoderms, o.m from sediment
MELP	*Melphidippa antarctica*	epibenthic on the bottom	
OEDI	*Oediceroides calmani*	endobenthic, half buried in sediment	L.Amphipoda, L.Polychaeta, pieces of Polychaeta, squid, pieces of Amphipoda
OEDI	*Oediceroides emarginatus*	endobenthic, half buried in sediment	L.Amphipoda, L.Polychaeta, pieces of Polychaeta, squid, pieces of Amphipoda
PHOX	*Heterophoxus* cf *videns*	endobenthic , in the sediment	every items dead or alive present in aquarium
STIL	*Stilipedidae* gen sp. A	epibenthic (1st and 2nd level)	L.Bryozoa, L.Polychaeta, Amphipoda, pieces of Polychaeta

Table 52b: Feeding types, gut content and feeding behaviour of amphipods.

Family	Species	Feeding type	Main items in gut	Motility related to feeding	Locomotion type
AMPE	*Ampelisca richardsoni*	suspension feeder	organic matter, plankton	weak	swimmer
EPIM	*Epimeria georgiana*	opportunist, deposit feeder	Holothuridea,Cnidaria, Crustacea.	weak	walker
EPIM	*Epimeria macrodonta*	micropredatory grazer	Hydroidea, Porifera,Gorgonacea	weak	walker/swimmer
EPIM	*Epimeria robusta*	predatory grazer/scavenger	Crustacea,Cnidaria,Polychaeta	weak	walker/swimmer
EPIM	*Epimeria rubrieques*	predatory grazer/scavenger	Crustacea,Holothuroidea,Cnidaria	weak	walker
EPIM	*Epimeria similis*	micropredatory grazer	Cnidaria,Polychaeta,Porifera	weak	walker/swimmer
EPIM	*Epimeriella* cf *walkeri*	predator(?)	Ophiuoridea	high	swimmer
EUSO	*Eusirus* sp. B	macropredator	Crustacea (mainly amphipoda)	moderate	walker/swimmer
EUSO	*Eusirus perdentatus*	macropredator	Crustacea	weak	walker/swimmer
EUSO	*Rhachotropis antarctica*	selective predator, scavenger	Crustacea, Polychaeta	high	swimmer
GAM	*Paraceradocus gibber*	suspension feeder macrophag. (?)	organic matter, plankton,Amphipoda	weak	crawler
IPHI	*Echiniphimedia hodgsoni*	micropredatory grazer	Porifera	weak	walker
IPHI	*Echiniphimedia* sp. B	micropredatory grazer	Porifera	weak	walker
IPHI	*Iphimediella* sp. A *"white"*	deposit feeder/scavenger	org. matter, plankton, Crustacea, Ophiuoridea	weak	walker
IPHI	*Gnathiphimedia mandibularis*	micropredatory grazer	Bryozoa, Porifera	weak	walker
IPHI	*Iphimediella* sp. B	micropredatory grazer	Cnidaria	weak	walker
ISCH	*Jassa* sp. A	suspension feeder	organic matter, plankton	weak	swimmer
LILJ	*Liljeborgia georgiana*	predator/scavenger	Amphipoda, Polychaeta, Cnidaria	weak	crawler
LYSO	*Abyssorchomene nodimanus*	scavenger	fish, Crustacea	high	swimmer
LYSO	*Abyssorchomene plebs*	scavenger	fish, Crustacea, Polychaeta	high	swimmer
LYSO	*Abyssorchomene rossi*	scavenger	fish, Crustacea, Polychaeta	high	swimmer
LYSO	*Hirondellea antarctica*	micropredatory grazer	Cnidaria	high	swimmer
LYSO	*Lepidepecreella* sp.	scavenger		high	swimmer
LYSO	*Orchomenopsis* sp. E	scavenger/deposit feeder	Crustacea, organic matter	high	swimmer
LYSO	*Pseudorchomene coatsi*	scavenger	fish, Crustacea, Polychaeta	high	swimmer
LYSO	*Tryphosella murrayi*	scavenger and predator	fish, Polychaeta, Crustacea	high	swimmer
LYSO	*Tryphosella* sp. 2	scavenger	Amphipoda, fish, Porifera	high	swimmer
LYSO	*Uristes adarei*	predator, deposit feeder	Amphipoda, organic matter	high	swimmer
LYSO	*Uristes gigas*	predator/scavenger	Crustacea	high	swimmer
LYSO	*Waldeckia obesa*	scavenger	fish, Crustacea,...	moderate	swimmer
MELI	*"Antamelita"* sp.	deposit feeder	Crustacea, Polychaeta	weak	walker
MELP	*Melphidippa antarctica*	suspension feeder	plankton, Crustacea	weak	
OEDI	*Oediceroides calmani*	opportunist, deposit feeder	Amphipoda,organic matter	weak	swimmer
OEDI	*Oediceroides emarginatus*	predator	Crustacea, Polychaeta	weak	swimmer
PHOX	*Heterophoxus* cf *videns*	predator(?), scavenger	Polychaeta, Nematoda, Crustacea	moderate	swimmer
STEG	*Bathypanoploea schellenbergi*	micropredatory grazer	Gorgonacea, Holothuroidea, Bryozoa?	weak	
STILI	*Stilipedidae* gen sp. A	predator (?)	Ophiuroidea	weak	swimmer

Table 53: Amphipods found in fish stomach contents (in cooperation with I. Olaso)

Family	Species	Fish	Station
Ampeliscidae	*Ampelisca richardsoni*	*Trematomus lepidorhinus*	154
		Artedidraco skottsbergi	34, 49, 189, 277
	Ampeliscidae *indet.*	*Artedidraco skottsbergi*	277
Corophiidae s.l.	Corophiidae *indet.*	*Artedidraco skottsbergi*	194
Epimeriidae	*Epimeria georgiana*	*Trematomus pennellii*	123
		Trematomus lepidorhinus	194
		Artedidraco orianae	58,77,150, 222
		Pogonophryne marmorata	97
	Epimeria grandirostris	*Artedidraco skottsbergi*	277
	Epimeria macrodonta	*Artedidraco orianae*	77
	Epimeria sp.	*Trematomus scotti*	165
		Artedidraco orianae	78
		Pogonophryne marmorata	
		Pogonophryne phyllopogon	77
	Epimeriidae indet.	*Artedidraco orianae*	77
Eusiridae s.l.	*Atyloella magellanica*	*Trematomus lepidorhinus*	154
		Dolloidraco longedorsalis	
	Atylopsis sp.	*Prionodraco evansii*	194
	Eusirus perdentatus	*Chaenodraco wilsoni*	123
	Liouvillea oculata	*Cygnodraco mawsoni*	62, 277
	Paramoera sp.	*Trematomus pennellii*	277
		Pogonophryne marmorta	263
	Prostebingia gracilis	*Dolloidraco longedorsalis*	154
	Rachotropis sp.	*Artedidraco skottsbergi*	189
		Artedidraco orianae	222
	Eusiridae indet.	*Trematomus pennellii*	222
		Pleurogramma antarcticum	206, 277
Gammaridae s.l.	Gammaridae indet.	*Dolloidraco longedorsalis*	154
		Pogonophryne barsukovi	
Iphimediidae	Iphimediidae indet.	*Trematomus lepidorhinus*	168
		Bathydraco marri	206
		Artedidraco orianae	222
Ischyroceridae	Ischyroceridae indet.	*Trematomus pennellii*	222
	Pseudericthonius sp.	*Artedidraco orianae*	194
Leucothoidae	*Leucothoe spinicarpa*	*Chaenodraco wilsoni*	123
		Artedidraco orianae	78
Liljeborgiidae	Liljeborgiidae indet.	*Artedidraco orianae*	220
		Pogonophryne marmorata	263
Lysianassidae s.l.	*Hippomedon kergueleni*	*Bathydraco marri*	206
	Lysianassidae indet.	*Trematomus lepidorhinus*	206
		Artedidraco loennbergi	197
		Prionodraco evansii	220
		Dolloidraco longedorsalis	197
	Uristes gigas	*Trematomus lepidorhinus*	154
		Dolloidraco longedorsalis	263

Table 53 continued.

Family	Species	Fish	Station
	Waldeckia obesa	*Pogonophryne marmorata*	82
	Tryphosella murrayi	*Dolloidraco longedorsalis*	100
	Tryphosella sp.	*Artedidraco orianae*	222
		Dolloidraco longedorsalis	263
		Pogonophryne marmorata	222
		Artedidraco skottsbergi	189
Oedicerotidae	Oedicerotidae indet.	*Artedidraco skottsbergi*	189
Phoxocephalidae	Phoxocephalidae indet.	*Artedidraco skottsbergi*	44
		Artedidraco orianae	222
		Dolloidraco longedorsalis	78
Podoceridae	Podoceridae indet.	*Artedidraco orianae*	222
	Podocerus sp.	*Prionodraco evansii*	194
Stenothoidae	Stenothoidae indet.	*Artedidraco orianae*	206
	Torometopa sp.	*Artedidraco skottsbergi*	194
		Artedidraco orianae	220
Synopiidae	Synopiidae indet.	*Bathydraco macrolepis*	134
		Artedidraco skottsbergi	189
Caprellidae	Caprellidae indet.	*Pleuragramma antarcticum*	245
Phtisicidae	*Aeginoides gaussi*	*Artedidraco orianae*	220, 222
Hyperiidae	Hyperiidae indet.	*Trematomus pennellii*	71
	Themisto gaudichaudii	*Pleuragramma antarcticum*	13, 84
		Trematomus lepidorhinus	154
		Cygnodraco mawsoni	194
		Artedidraco skottsbergi	194
		Artedidraco orianae	194
		Trematomus eulepidotus	167
Phrosinidae	*Primno macropa*	*Pleuragramma antarcticum*	245
Amphipoda	Amphipoda indet.	*Pleuragramma antarcticum*	78, 97
		Trematomus pennellii	71, 123, 194, 222
		Cygnodraco mawsoni	194
		Trematomus scotti	128
		Bathydraco marri	167
		Bathydraco marri	120, 206
		Bathydraco macrolepis	88
		Artedidraco loennbergi	82, 84, 100, 197, 263
		Artedidraco skottsbergi	44, 71, 194
		Racovitzia glacialis	71
		Artedidraco orianae	58, 71, 77, 78, 194, 220
		Dolloidraco longedorsalis	167, 220
		Pogonophryne lanceobarbata	71, 77
		Pogonophryne marmorata	77, 78, 82, 84

2.4.8 Biodiversity of Antarctic Nematodes (H. J. Lee, J. Van de Velde)

Objectives

Free-living nematodes are mostly of small, microscopic size. The shape of infaunal nematodes (marine or terrestrial) is not very different from that of animal or plant parasite nematodes. Despite their uniformity of body morphology, their ability of adaptation to various environments is surprising. Being a primitive metazoan taxon, the evolutionary history of nematodes dates back long into geological time, and this fact might have caused their many different life styles. Although some nematodes are known to be able to swim to some extent, they are bottom dwellers during their whole life. Nematodes are one of the most interesting taxa for biodiversity study related to zoogeography. The distribution pattern of nematodes might reflect their evolutionary radiation. However, due to the lack of fossil records we know very little about the evolutionary history of these animals.

Many Antarctic nematode species have been already described. An ecological study was accomplished during the EPOS programme. However, our knowledge on Antarctic nematodes is still too scarce to generalize the biodiversity of nematodes of this area. During the first EASIZ cruise in 1996 we took some quantitative sediment samples along the east coast of the Weddell Sea for a biodiversity study. During that cruise it turned out that the sea floor of this area is very heterogenous, which was also reflected in the nematode distribution pattern. Although the Antarctic continent is considered a most isolated area, the Antarctic nematodes are not so different from those of other areas, especially from South America, at the generic level. However, we are expecting that species identification will help to reveal differences of evolutionary processes in those two areas and possibly enable us to understand evolutionary processes of Magellan and Antarctic species.

Work at sea

Sediment sample process. The biodiversity samples were taken along the depth transects off South Vestkapp, Halley Bay, in the Bransfield Strait and the Drake Passage (see meiofauna part of iceberg scouring report for the station list). The multibox corer (MG) was used at most of these stations. In order to estimate the sampling efficiency of the MG, the multicorer (MUC) was deployed at some parallel stations. The MG cores were subsampled using two kinds of hand corers with a diameter of 3.5 and 6.0 cm. The 3.5 cm cores will be used for meiofauna and the study of environmental parameters (e.g. grain size, nutrients, pigments, bacteria and diatoms). Each meiofauna core was sliced into 0-1 cm, 1-3 cm, 3-5 cm, 5-10 cm and rest. Preservation was obtained by using 4% formalin. All cores for environmental parameters were sliced into centimetres up to 3 cm depth. These cores will be used for pigments, diatom, bacteria and carbon/nitrogen analysis or isotopic study. The pigments, carbon/nitrogen and isotope samples were deep frozen. The diatom and bacteria samples were preserved with 2% formalin. The 6 cm core will be used for nutrient and sediment analysis and the samples were deep frozen. Leftovers from the boxes were used to fill the aquarium to take some live material back home. Sediment cores from MUC were sliced and treated in the same way.

Sponge associated nematodes. Sponges are one of the most important taxa in the coastal area of eastern Weddell Sea in terms of biomass and abundance. Some nematodes are living in close association with sponges during their lives. In order to understand the importance of sponges as a potential habitat of nematodes, some sponges were collected from various gears at various stations. Sponges were gently rinsed and fixed in formalin or deep frozen for the close observation at home.

Preliminary results

A comparison was made of meiofaunal abundance in mud versus abundance in a sponge spicule mat. The quantitative samples taken by MG and MUC will be worked up in Gent in order to obtain data comparable with former studies. However, we tried to quantify the sediments taken by other gears and analyzed the abundance and composition of meiofauna communities.

The Agassiz trawl brought a large amount of fine mud at stn 134 while the Rauschert dredge sampled sponge spicules at stn 214 (Fig. 56). In order to compare the composition of meiofaunal communities in different habitats we counted meiofauna (500 ml sample each) from both sediments. Sediments were decantated and sieved 10 times. Sediments were then divided 5 times into the 1/32 fractions. After dying the animals by using Bengal Rose, meiofauna was counted by means of a stereomicroscope.

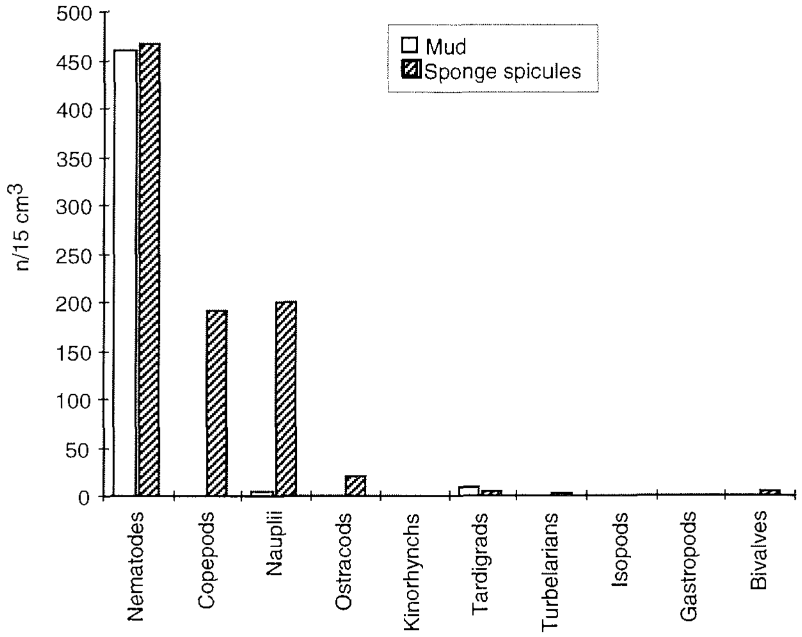

Fig. 56: Comparison of meiofaunal composition and abundance in mud (Agassiz trawl; stn 134) and in a sponge spicule mat (Rauschert dredge; stn 214).

Six different meiofaunal groups were observed in the mud. The most dominant taxon was Nematoda which comprised 96.4% (406/15 cm^3) of the total meiofauna. Tardigrades, the second dominant taxon in terms of abundance, accounted for 2.1%. Copepods including nauplii were only 1.1% of total meiofauna. In the sponge spicules nine different meiofaunal groups were observed. Although the abundance of nematodes, the most dominant group, between the sponge spicules was higher (460/cm^3), the dominance was less pronounced (52.5%) than in the mud. The next important group was crustaceans (i.e. copepods, ostracods and nauplii) comprising 46.1% of the total meiofauna with 410 individuals sampled (Fig. 56).

It is likely that sponge spicule mats play an important role in providing and structuring a habitat for meiofauna. Sponge spicules may provide interstitial space which is probably rather inconvenient for the macrofauna. The structure of sponge spicules seems to have a capacity to trap small suspending particles which can be an important food source for the infauna.

Giant nematodes were in the sponge spicule mat. Since nematodes have no circulatory and respiratory organ the oxygen transportation is dependent on the diffusion. This means that free-living nematodes have a certain limit of body size. Ignoring all intrinsic factors, the best strategy for nematodes to have a maximum size is an environment with sufficient oxygen and low temperatures so that they have a maximum soluble oxygen rate and also a minimum metabolic rate. This condition is met in both polar seas.

In February 1998 the Rauschert dredge collected sponge spicules. Between these sponge spicules a giant free-living marine nematode species was found which is about 5 cm together with some other smaller species who seem to belong to the same genus. During the preliminary examinations using a binocular dissection microscope we could recognize some important characters such as: body slender; cuticle thick and smooth; head narrowed at the lip region; head capsule present; labial and cephalic sensillas papillaeform; ocelli present; tail brunt, round; females with two out-stretched ovaries; males with pre-cloacal supplement. At first view, this nematode most likely belongs to the family Leptosomatidae. However, further analyses are required.

2.4.9 Ultrastructure and Histochemistry

2.4.9.1 Inventory of Chemo- and Mechanosensitive Sensillae and Lipid Storage in Antarctic and Boreal Isopoda (Crustacea, Malacostraca)

(A. Brandt, G. Wegener)

Introduction and objectives

Chemo- and mechanosensitive sensillae of Antarctic Isopoda will be compared with those of phylogenetically related boreal species. Boreal and Antarctic Isopoda are facing different environmental conditions. Besides the temperature differences Antarctic Isopoda are strongly affected by the changing light regime in wintertime (compared to the boreal relatives) and have to cope with a strongly pulsed seasonal food supply, whereas for boreal species changes in food availability are less pronounced between summer and winter. The question is whether reactions of closely related boreal and Antarctic species are also different, i.e. whether the chaetotaxy of these species varies. In order to scrutinize whether there are differences between Antarctic and boreal isopods' perception of chemical and mechanical stimuli in general, different lifetypes are compared: predators, which are not likely to be affected strongly by seasonality, and herbivores or detritivores, which are supposed to be more dependent on seasonal food supply. We also want to investigate, whether a relation between feeding type and sensory equipment exists.

At first, position and structure of the sensillae of these species shall be compared using both scanning and transmission electron microscopy. Hypotheses on the possible function of potential chemo- and mechanoreceptive sensillae will later be tested on the boreal relatives electrophysiologically. This analysis on the background of two different lifetypes shall be done in order to investigate whether a relation between feeding mode, seasonality and sensory equipment might exist. In cooperation with V. Storch histologic analyses of the alimentary canal of the scavenging isopod *Natatolana obtusata* (especially the midgut gland, stomach and hindgut; see 2.4.9.2) will be performed. Later we would like to investigate whether quality and amount of storage lipids can be distinguished between boreal and Antarctic isopod species in general and whether there might also be a relation between lipid storage, feeding mode, and seasonality.

Work at sea

A variety of appendages (antennae, antennulae, pereiopods and uropods) of 17 species of peracarid crustaceans from different localities were dissected for electron microscopy. Detritivorous or omnivorous species were, *Ampelisca richardsoni* (Amphipoda, Ampeliscidae), *Paraceradocus gibber* (Amphipoda, Gammaridae), *Acanthaspidia drygalskii* (Isopoda, Acanthaspidiidae) and the passive filter feeding arcturid isopods *Dolichiscus meridionalis*, *Antarcturus furcatus*, and *Antarcturus bovinus* (Arcturidae). Scavenging species used and frequently sampled were *Natatolana albinota* (only 1 specimen; Cirolanidae), *N. obtusata*, and *N. oculata*, as well as the giant Antarctic isopod *Glyptonotus antarcticus* (Chaetiliidae), which might also scavenge. Other predators fixed belonged to the isopod family Serolidae (Sphaeromatidea), namely *Ceratoserolis trilobitoides*, and *C. meridionalis*, *Frontoserolis* *bouvieri*, and *Cuspidoserolis* cf. *luethjei*, as well as *Accalathura gigantissima* (Anthuridae), and *Aristias antarcticus* (Amphipoda, Lysianassidae). One parasitic isopod *Aega antarctica* (Aegidae) was also dissected and fixed.

The dissected appendages were fixed in 6% buffered glutaraldehyde, washed in phosphate or cacodylate buffer, postfixed in 2% OsO_4 and after another washing procedure samples were dehydrated in ethanol (40-100%) before they were transferred into propylene oxide and finally after 24 hours into Epon resin. The samples were then polymerized at 60°C for three days. Later at home, selected blocks will be cut with an ultramicrotome, the ultrathin sections (≈ 30 nm) will be picked up with fine-meshed grids and finally stained with leadcitrate and uranylacetate. Finally, the cellular structure of the sensory organs will be investigated in the transmission electron microscope. Concurrently, specimens of the above mentioned species were also fixed in formalin, washed and later transferred into ethanol. Some of these will serve to investigate the morphology and distribution of the sensory organs on the appendages of different species in the scanning electron microscope.

Shrimps (*Chorismus antarcticus* and *Notocrangon antarcticus*) and amphipods (*Waldeckia obesa* and *Abyssorchomene plebs*) were collected from Agassiz trawl as well as bottom trawl catches and amphipod-traps, respectively. Live specimens were transferred to aquaria and will be maintained alive for the ageing analysis with the confocal microscope at the AWI. Several specimens were preserved in 4% formalin-seawatersolution, 70% methanol or frozen at -30°C to investigate the effects of such treatments on the autofluorescence of lipofuscin. Moults are measured so as to determine growth rates under maintenance conditions. Several specimens of preserved *C. antarcticus* were dissected and brains fixed for microscopic analysis.

Preliminary results

First results on the ultrastructure of the sensory sensillae can only be achieved at home after preparation of the ultrathin sections. However, at first view, we have the impression that the sensillae of the omnivorous and herbivorous species are more slender and fragile, maybe serving primarily as pure chemoreceptors, whereas the scavengers and predators are characterized by a higher number of strong, heavily cuticularized sensory organs of almost spine-like appearance. It might be that these species bear - besides pure chemoreceptors - also quite a number of contact chemoreceptors (combined chemo- and mechanoreceptive sensillae) and sensillae, which only respond to mechanic stimulation.

2.4.9.2 Anatomy, Histochemistry, and Ultrastructure of Selected Taxa

(V. Storch, B. Bluhm, A. Brandt, A. Lombarte)

Objectives

The study of the trophic role of certain benthic animals in Antarctic waters has been quite intense for some taxa, whereas other groups have been completely neglected (Arntz *et al.* 1994). In recent years, electron microscopy proved to be a valuable tool for various aspects of nutrition. It was used in the interpretation of the nutritional status of animals taken from their natural environment and from animals under experimental conditions, since absorptive and storage cells in many cases reflect the quality and quantity of food metabolized. This approach supplements the conventional analysis of stomach and gut contents. Most of the following text refers to food detection, food uptake, digestion, and ultrastructure of the alimentary canal. In Antarctic waters, suspension feeders are dominant members of benthic communities. Among these, the Pterobranchia are a neglected group, even though they may contribute considerably to the benthic community. Scavengers are another important group: in Antarctic waters, a widespread predilection for necrophagy has been observed. Finally, endobenthic animals occur in various taxa, the food requirements of which are poorly known.

Preliminary results

Pterobranchia: Pterobranchia is a small phylum of colony-forming sessile organisms comprising about 20 species. They occur mainly in Antarctic waters. Conventionally, they are grouped together with the Enteropneusta in the taxon Hemichordata, the systematic position of which is still controversial. Some authors stress their close affinities to the Chordata, others regard them as close relatives of lophophorates or as the ancestors of all deuterostomes. This demonstrates that Pterobranchia are a taxon of particular evolutionary interest. On this cruise several species of *Cephalodiscus* in various stages of development (sexual and asexual reproduction) were collected and fixed for histochemical purposes, and light and electron microscopy. Notochord, peristomochordal connective tissue, coelomic linings, tentacular apparatus, and alimentary canal will be analyzed to verify or falsify one of the above-mentioned hypothesis. For the first time, the distribution of collagen and glycosaminoglycans can be analyzed in Pterobranchia.

Monograph of Priapulida: Priapulida are a marine benthic group comprising 18 species (Saldarriaga and Storch 1997, Storch 1991). They are the oldest living fossils of the metazoans, and the early fossil records date back to the mid-Cambrian (Burgess Shale, Canada, and Chengjiang, Yunan, China). The extant macrobenthic genera *Priapulus* and *Priapulopsis* have a bipolar distribution. Among these, *Priapulus tuberculatospinosus* is the only described Antarctic species. It was found on this cruise in the eastern Weddell Sea, however, only a few mature specimens. In continuation of work on these genera, *P. tuberculatospinosus* was fixed for electron microscopy. Notably the alimentary canal and the nervous system need to be analyzed.

Digestion of Echiura: The Echiura are a benthic marine group of unsegmented, coelomate protostomes. Approximately 150 species have been described. It is clear from a review (Pilger 1993) and corroborated later (Pilger in litt.) that there is virtually nothing known about the structure and function of the echiuran digestive tract. The Antarctic species, *Alomasoma belyaevi*, which was found at several places in the Eastern Weddell Sea, has a very long alimentary canal (about 2 m in a specimen of 9 cm length). It is coiled and large portions are filled with mud moulded into pellets. All selected specimens are mature females. Males of this species are dwarfed living in the androecium of females. Tissue samples were taken for light microscopy, electron microscopy and histochemistry. Gut contents were deep frozen for analysis of carbohydrates, lipids, and proteins (J. M. Gili, Barcelona).

Ultrastructure of the alimentary canal of selected Eucarida (Euphausiacea, Decapoda) and Peracarida (Isopoda, Amphipoda): Malacostraca play an important role in Antarctic waters. It is mainly Euphausiacea that dominate in the Antarctic pelagial, while Decapoda Natantia are represented by several species, both in the pelagic and the benthic subsystem, and can be dominant in benthic communities. Amphipoda and Isopoda are the species-richest groups of Malacostraca in Antarctic benthic communities. The three most common decapod species are *Chorismus antarcticus*, *Notocrangon antarcticus*, and *Nematocarcinus lanceopes*. They are distributed in a depth gradient, with *C. antarcticus* being the most common in shallower waters (200-500 m), *N. antarcticus* at intermediate depths (300 - 700 m), and *N. lanceopes* occurring in 600 to over 2000 m. Substantial information has been collected on abundance, distribution, reproductive ecology, and growth of these species. However, knowledge is still lacking on feeding habits as well as mechanical and biochemical degradation of the scarce and seasonally highly variable food in the course of its passage through the alimentary canal.

On board, mandibles, stomach, primary and secondary filters, and midgut glands of these species were photographically documented and fixed for light, as well as scanning and transmission electron microscopy. All these structures differ considerably among the three species. The secondary filters in the pyloric stomach region are much finer in *Chorismus antarcticus* and *Notocrangon antarcticus* than in *Nematocarcinus lanceopes*. Their mesh size lies under 1 µm. Analysis of stomach contents showed a variety of food items. However, interpretation of the preferred food is difficult for the following reasons: (1) Our knowledge of the diurnal rhythm of the three investigated species is still poor. We found the stomachs of *Chorismus* caught at 4 a.m. filled with food items, *Notocrangon* caught at the same time, had either completely empty stomachs or contained only small amounts of food. (2) There is probably an ultradianic rhythm in the digestion process of Malacostraca: Feeding and trituration are followed by enzymatic breakdown, which may result in stomach contents of shredded pieces of various kinds of Crustacea, Polychaeta or other food items. A large variety of food organisms was found in the three species: Diatomea, Radioloaria, Foraminifera, Tintinnida, Mollusca (*Yoldiella sabrina*, Rissoidae), setae of Polychaeta (Polynoidae, Spionidae, Sabellidae, Maldanidae), various Crustacea (Copepoda Harpacticoida, Mysidacea, Isopoda, Decapoda). The largest food items had a length of over 5 mm.

Among the Isopoda (Brandt 1991) we selected *Natatolana obtusata*, which was found in large numbers in amphipod traps. The specimens were conspicuous by their peculiar inflated body shape. In fact, the animals had taken so much of the offered bait (meat of mammals) that they could only lie in a dorsal position. The alimentary canal turned out to be very unusual in arthropod standards (cf. Storch and Strus 1989). The unusually small stomach was filled with the bait, and the following midgut shaped the whole animal. Dissection after four weeks showed that only small amounts of the meat had been digested.

Among the Amphipoda, *Waldeckia obesa* was chosen (De Broyer and Jazdzewski 1996). This species was caught by the thousands in the amphipod traps. Its stomach is extraordinarily long, the midgut glands extend into the posterior part of the body. Digestion was completed after several weeks. Midgut glands will be analyzed by TEM following Storch and Burkhard (1984).

Midgut glands of *Euphausia superba*: Earlier work within the main focus of Antarctic research was done on the stomach and filter systems of adult krill and on their development (Ullrich *et al.* 1991). The tissue samples taken from the midgut glands did not meet the requirements. On board RV "Polarstern" freshly caught *Euphausia superba* were dissected and fixed for TEM analysis of the midgut glands.

Digestive tract of Holothurioidea: Holothurians are among the dominating benthic invertebrates in Antarctic waters (Gutt 1991). The alimentary canal of sea cucumbers is less known than the alimentary canal of other Echinodermata, as can be seen from recent summarizing papers. Questions to be answered are: Occurrence of secretory cells in the alimentary canal, mucins, carbohydrate histochemistry, distribution of secretory cells, links to the blood vascular system, innervation, proliferation centers, zones of apoptosis. Various techniques will be applied: lectin histochemistry, immunohistochemistry, electron microscopy.

Connective tissue in various invertebrate groups: Among the major tissues composing the metazoan body the connective tissues of invertebrates have been neglected. It is especially the Echinodermata that have evolved a large variety of connective tissue types with many peculiarities (Erlinger *et al.* 1993, Trotter and Koob 1989). In this group, mutable connective tissue occurs. An analysis of glycosaminoglycans and fibrillar collagen, typical components of vertebrate connective tissue and which may also be associated with extracellular structures of epithelia, will be done in laboratories in Germany (mainly Department of Anatomy, University of München). Antarctic waters house a large number of holothurians, and for these investigations we selected *Ekmocucumis steineni* and *Psolus dubiosus* (Dendrochirota), *Bathyplotes* (Aspidochirota), *Laetmogone wyvillethompsoni* (Elasipoda), and *Molpadia musculus* (Molpadiida), because the body walls of these species differ fundamentally. The extremes are *Psolus dubiosus* with a very thin, calcified integument, and *Laetmogone wyvillethompsoni* with a jellyfish-like consistency. Questions to be answered are: Mechanical properties of the different connective tissue types, occurrence of elastic fibres, questioned existence of microfilaments that are interpreted as precursors of elastic fibrils in vertebrates (oxytalan fibres), location (near muscle cells, basemant membranes, etc). The technique comprises Alcian blue and Cupromeronic blue in various modifications (see Scott 1988, for details).

Ultrastructure of barbels of Plunderfishes (Artedidraconidae): The Artedidraconidae are a family of epibenthic notothenioid fishes, most of which are endemic to the Southern Ocean. Morphologically, they are characterized by a mental barbel of differing length and structure that can possibly be related to a specialization in feeding habits. Food composition, based on analysis of stomach contents, is characterized by a high percentage of benthic organisms like polychaetes and isopods (for further details see chapter 2.4.2). Barbels of *Artedidraco orianae, A. skottsbergi, Dolloidraco longedorsalis, Histiodraco velifer, Pogonophryne barsukovi, P. lanceobarbata, P. marmorata and P. scotti* were fixed for scanning and transmission electron microscopy.

2.4.9.3 Age Determination of Selected Species of Benthic Crustacea (B. Bluhm)

Introduction and objectives

As yet, a reliable, precise and practicable technique of age determination is still lacking for a wide range of Crustacea, though strongly needed for investigations on population dynamics. The fluorescent age pigment lipofuscin has been analyzed as a residue of reactions between oxidized lipids and proteins. It accumulates age-dependently in post-mitotic tissue of most invertebrates and vertebrates and has been widely recognized as a marker of physiological age. The substance can be quantified either by chemical extraction or by histological image analysis of lipofuscin granules in thin sections. Both methods involve chemical treatment of the tissue. Several investigations, however, have revealed fixation to influence the autofluorescence of lipofuscin. As a more promising approach the optical sectioning of fresh unsectioned material by means of confocal microscopy has recently been proposed. The objective of this study is to collect specimens of common Antarctic decapod and amphipod species and eventually determine the age structure of the populations. Combined with size frequencies, size-weight functions, and data on abundance, population dynamical parameters are to be calculated. This study is carried out in the framework of a PhD thesis financed by the DFG (Age determination of polar benthic Crustacea).

Preliminary results

Overall, approximately 950 specimens of *Chorismus antarcticus* and 1500 specimens of *Notocrangon antarcticus* were caught by means of 16 bottom trawl and 17 Agassiz trawl hauls in the Weddell Sea. Some 200 *C. antarcticus* are maintained in aquaria at present. *C. antarcticus* occurred between 180 m and 600 m depth but was most common down to 400 m, whereas *N. antarcticus* occurred between 230 m and 600 m but was most abundant between 300 m and 500 m. The smallest specimens caught measured 2.9 mm and 5.6 mm in carapax length for *C. antarcticus* and *N. antarcticus*, respectively, while the largest ones had a carapax length of 20.5 mm and 22.5 mm, respectively. Approximately 7800 specimens of *Waldeckia obesa* and 700 specimens of *Abyssorchomene plebs* were caught in 13 traps (see De Broyer and Scailteur, chapter 4.8), and some 300 *A. plebs* and 400 *W. obesa* are kept in aquaria at present.

2.4.10 Peninsula Transects (A. Brandt, H. Bohlmann, C. De Broyer, M. C. Gambi, D. Gerdes, H. J. Lee, B. Hilbig, K. Linse, M. Rauschert, Y. Scailteur, V. Storch, J. Van de Velde, G. Wegener)

Introduction and objectives

The majority of benthos investigations carried out so far by AWI biologists have been done along the southeastern Weddell Sea shelf. During a recent workshop on benthos investigations in waters around the tip of South America it turned out that presently only little information is available on the benthic fauna around the Antarctic Pensinsula and the areas directly south of the Drake Passage. Therefore a station transect was needed in order to fill these gaps from Potter Cove (Bransfield Strait) across the Drake Passage. To follow this aim several stations were established in the Admiralty Bay, and furthermore two transects were sampled, one in the Bransfield Strait from 200 - 1500 m, and the other one in the Drake Passage from 130 - 2000 m depth. At these stations an extensive array of gears was deployed (see station list, 3.2) to cover as many aspects as possible on the ecology and evolution of benthic communities.

Work at sea / preliminary results (amphipods)

Baited amphipod traps were deployed at 400 and 800 m (Bransfield Strait/Admiralty Bay). Approximately 500 specimens of the large cosmopolitan abyssal species *Eurythenes gryllus* were caught at 800 m. It was frequently collected from the regurgitated material of juvenile giant petrels and juvenile skuas. During previous studies in the same area, (Maxwell Bay/King George Island, 1980-1991) these indications of a high abundance are in contrast to the rare occurrence of only 4 specimens in the Weddell Sea, caught between 1200 and 1500 m by traps during this expedition. The dredge (D) was used five times in the Bransfield Strait and four times in the Drake Passage at water depths between 130 and 2007 m. The amphipod fauna in the Bransfield Strait is appearently related to muddy bottom and algal remains. It is relatively poor in comparison to the Weddell Sea, however, the Ampeliscidae, Dexaminidae, Ischyroceridae, Phoxocephalidae and Urothoidae were more abundant. At a depth of 2007 m in the Drake Passage only 3 amphipods species were caught: one phoxocephalid and two urothoids. In contrast, a rich amphipod fauna was found at 1000 m. The families Ampeliscidae, Corophiidae, Dexaminidae, Pardalescidae, Phoxocephalidae, Stilipedidae and Synopiidae were notably rich in specimens. Until now 43 species have been identified from the material collected in the Bransfield Strait and the Drake Passage. 24 of these species are restricted to the east Antarctic while only 6 species live in the Magellan area.

2.4.11 Photographic Inventory of the Weddell Sea Benthos Species
(M. Rauschert)

Elaboration of a comprehensive Atlas of the Weddell Sea benthos species, as an aid to identification. More than 2000 colour photographs of live specimens of zoobenthos (about 300 species of 35 taxonomic groups) have been taken to document species diversity and to record natural colours and attitudes.

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2.5 Chemical Ecology and Ecophysiology (K. Iken)

General introduction

The marine Antarctic ecosystem is, among others, characterized by low temperatures, a pronounced seasonality in ice cover as well as in food and light conditions, and limited food resources. This causes animals to adapt to those factors in their morphology, behaviour, life cycle, ecology as well as physiology. To date, however, our kowledge on special adaptations of benthic organisms to the Antarctic environment is still very poor. This includes specialisations in inter- and intraspecific interactions such as chemical defense against predators as well as physiological adaptations especially to the limited food resources and the constant cold. During EASIZ II, two major topics of special adaptations were investigated:

- The chemical ecology of Antarctic opisthobranchs
- Respiration rates of benthic organisms

The latter comprises the study of respiration of various benthic animals, which allows to assess carbon mineralization and standard metabolismas well as the respiration of isolated tissues, which gives insight to enzymatic and biochemistry processes of cold adaptation.

2.5.1 Chemical Ecology of Opisthobranchs and Related Species

(C. Avila, K. Iken, K. Beyer)

Introduction

Secondary metabolites play important roles in intra- and interspecific relationships among organisms, regulating many biological interactions. Opisthobranch molluscs are known from temperate and tropical regions to exhibit a great variety of secondary metabolites, some of them with defensive function (see Avila 1995 for review). Chemical defense against predators has been described recently in Antarctic organisms (Baker *et al.* 1995, Slattery and McClintock 1997), and recent studies showed also that some Antarctic nudibranch species contain defensive chemicals (McClintock *et al.* 1992, McClintock *et al.* 1994). Studies are scarce though, and little is known on the chemistry, biochemistry, as well as on the ecological function of the secondary metabolites in Antarctic opisthobranchs and other invertebrates.

Objectives

- To collect opisthobranch molluscs and related species from benthic samples
- To identify taxonomically all the species, if necessary by anatomical studies and SEM analysis of fixed material later in the home lab
- To study the feeding ecology of opisthobranchs, by doing experiments such as feeding preference tests and Y-maze tests (chemoreception)
- To establish the function of some secondary metabolites of opisthobranchs, by carrying out experiments such as feeding deterrence tests with potential predators
- To preserve the samples of opisthobranch molluscs and other interesting invertebrates (freezing at -30 °C) for further chemical analysis and localization of the secondary metabolites.

Work at sea

During the EASIZ II cruise, opisthobranchs and related species were collected from benthic samples from the Eastern Weddell Sea, mainly taken by AGT (n=17), GSN (n=16), dredge (n=6), and TV-grab (n=6). At the Antarctic Peninsula additional samples were taken from six AGTs. When possible animals were immediately classified to species level. Alive and undamaged specimens were kept in aquaria for experimental work. Dead and seriously damaged individuals were directly stored at -30 °C for later use in feeding deterrence experiments and for further chemical analysis of secondary metabolites. These chemical analyses consist of extraction with organic solvents, isolation and purification of the more interesting compounds and identification of their chemical structure.

Several putative preys of the opisthobranchs (e.g. sponges, tunicates) were collected and frozen for a comparative chemical study (analysis of chemical markers in prey-predator relationships). Some of them were maintained alive and used in feeding preference experiments, in which opisthobranchs were allowed to choose between two food items. In order to determine the existence of chemotaxis towards the prey in opisthobranchs, experiments in a Y-maze aquarium were conducted. Depending on the size of the tested mollusc, we used a Y-maze of 1 m or 0.7 m length.

At the same time, potential predators of opisthobranchs were collected and maintained in aquaria to perform feeding deterrence tests. The asteroid *Odontaster validus* and a still unidentified actinia were maintained successfully in aquaria and fed regularly with frozen krill (*Euphausia superba*). In feeding deterrence tests they were randomly offered opistobranchs or krill as food and their reaction was observed. In these tests, live opisthobranchs as well as tissue parts of frozen animals were tested as food. Also mantle extracts of several opistobranch species were incorporated into artificial food cubes and krill pieces and then tested for their effects on the above mentioned predators.

Apart from opisthobranchs and related molluscs, about 135 samples of different invertebrates have been frozen for further chemical analysis, including mainly sponges, tunicates and holothurians. Some of the specimens collected are supposed to be the prey of some of the opisthobranchs.

At the Antarctic Peninsula the seastar *Odontaster validus* and the unidentified Actinia were collected to maintain them alive until Bremerhaven to continue with the experimental work.

Preliminary results

Taxonomy: A total of 310 specimens were collected at 48 sampling stations in the Eastern Weddell Sea and 65 specimens from 6 stations at the Antarctic Peninsula. The number of specimens from each species found per station is reported in Table 54 for the Weddell Sea and in Table 55 for the Antarctic Peninsula. Mean abundance (number of individuals) and mean number of species for the four main investigated areas in the Weddell Sea: Kapp Norvegia (26 stations), Drescher Inlet (5 stations), Vestkapp (9 stations), Halley Bay (8 stations), are plotted in Fig. 57. The distribution of the species among these different localities and at different depths are reported in Tables 56 and 57, respectively. All animals have been classified to species level when possible. *Doto* spp *Marseniopsis* spp and *Notaeolidia* spp, as well as the Notaspidea spp collected need further taxonomical study in the home lab (SEM of radula and jaws; study of the internal anatomy, especially the reproductive system) before assigning them to known taxa, and may perhaps include some new species.

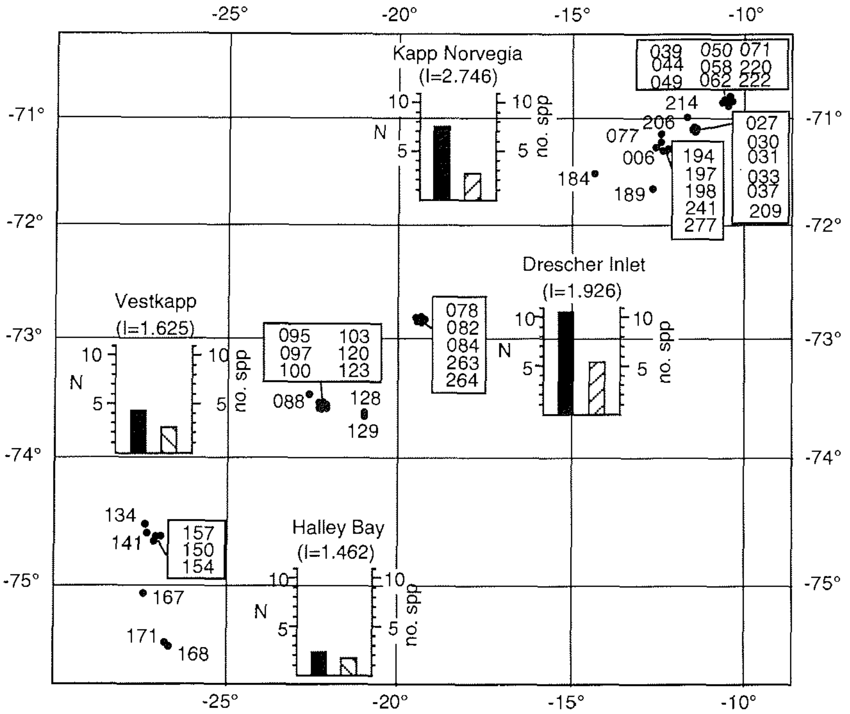

Fig. 57: Mean abundance (black bars) and mean number of species (striped bars) of opisthobranchs and related molluscs in the four main sampling areas (numbers beside spots refer to station numbers).

Experimental work: Feeding preferences seem to exist in the common nudibranch *Austrodoris kerguelenensis* only for some species of *Rossella* sponges. *A. kerguelenensis* also seems to be able to detect *Rossella* sponges by chemotaxis in a Y-maze. Feeding deterrence tests with the seastar *Odontaster validus* and with the actinia using *A. kerguelenensis* showed that this species was not eaten by the predators, neither alive nor when offered as mantle pieces. Mantle pieces of *Bathydoris hodgsoni* were not eaten by these predators either, however repellent activity seems to be different in the mantle tissue respect to the dorsal papillae. Live *Philine* cf. *alata* and *Marseniopsis* sp. were not eaten either, but both predators seem to be able to eat the mantle pieces of these two molluscs. Deterrence tests with mantle extracts of opisthobranchs incorporated into artificial food cubes and krill pieces also supported the defensive role of their secondary metabolites.

Table 54: Number of specimens per species collected from the different stations in the eastern Weddell Sea.

Station	Ak	Bh	Bc	M spp	Pa	Mc	Tb	N spp	D spp	N	Aa	Pq	Total
006	1			2	2								5
027				1	1								2
030							1	1					2
031				1									1
033									13				13
037							4	1	1				6
039								1					1
044	1				5			1					7
049	6			2				1					10
050	1							1				2	4
058	4							1					5
062	4			7	3								14
071	10			2			1		1				14
077	4			2		4		2	1				13
078	4	2		2	1		1	1		1			12
082	4	1		1	3	3	3						15
084	5	1		1		1					3		11
088										1			1
095		3					1			1			5
097	3	2			1	2							8
100	1	6	1	2									10
103		2											2
120		1						1					2
123	1	3		1									5
128				1	2						1		4
129	1										1		2
134					1								1
141	1												1
150	1	4	1			1							7
154	8		1										9
157			1										1
167	2												2
168	1			1									2
171	1												1
184	1												1
189	7	1				1				2			11
194	1			1			1			1			4
197	5	1		1									7
198									1				1
206	3		1								2		6
209				1	1								2
214	2						1	1	1			1	6
220	10				1								11
222	14				1		1						16
241				1									1
263	1		1				1						3
264	3	2	2	1		2	1						11
277	6			2	3		14			3	4		32
Total	117	29	8	33	25	14	30	12	18	10	11	3	310

Ak: *Austrodoris kerguelenensis*, Bh: *Bathydoris hodgsoni*, Bc: *Bathydoris clavigera*, M spp: *Marseniopsis spp*, Pa: *Philine* cf. *alata*, Mc: *Marionia cucullata*, Tb: *Tritoniella belli*, N spp: *Notaeolidia* spp, D: *Doto* spp, N: Notaspidea, A: *Aegires* cf. *albus*, Pq: *Pseudotritonia quadrangularis*.

Table 55: Number of specimens of opisthobranchs and related molluscs found at the different stations sampled at the Antarctic Peninsula.

Station	Depth	Mm	Mspp	Tb	Ak	N	C	Pq	Total
Rothera	20	5							5
297	232		3	1					4
322	643				1				1
329	2059					1			1
336	1047			1			45		46
338	416		1	4					5
353	132		2					1	3
Total		5	6	6	1	1	45	1	65

Mm: *Marseniopsis mollis*, M spp: *Marseniopsis* spp, Tb: *Tritoniella belli*, Ak: *Austrodoris kerguelenensis*, N: Notaspidea, C: Cephalaspidea sp., Pq: *Pseudotritonia quadrangularis*..

Table 56: Number of specimens of opisthobranchs and related molluscs found at the different localities sampled in the Eastern Weddell Sea.

Species	Kapp Norvegia	Drescher Inlet	Vestkapp	Halley Bay	Total
Ak	80	17	6	14	117
Bh	2	6	17	4	29
Bc	1	3	1	3	8
M spp	23	5	4	1	33
Pa	17	4	3	1	25
Mc	5	6	2	1	14
Tb	23	6	1	-	30
N spp	11	1	-	-	12
D sp.	18	-	-	-	18
N	3	1	3	3	10
Aa	6	3	2	-	11
Pq	3	-	-	-	3
Total N	192	52	39	27	310
No. of species	12	10	9	7	>16
No. of stations	26	5	9	8	48

Ak: *Austrodoris kerguelenensis*, Bh: *Bathydoris hodgsoni*, Bc: *Bathydoris clavigera*, M spp: *Marseniopsis spp*, Pa: *Philine* cf. *alata*, Mc: *Marionia cucullata*, Tb: *Tritoniella belli*, N spp: *Notaeolidia* spp, D sp: *Doto* sp., N: *Notaspidea* spp, Aa: *Aegires albus*, Pq: *Pseudotritonia quadrangularis*. Total N: number of specimens.

Table 57: Number of species of opisthobranchs and related molluscs found at different depths in the Eastern Weddell Sea.

Depth	Ak	Bh	Bc	M spp	Pa	Mc	Tb	N spp	D sp	N	Aa	Pq	Total	No. of species	No. of stns
0-100	2			2	1		2	2	14			1	24	7	5
101-200	8			6	6		18	1	1	3	4		47	8	6
201-300	51	1		12	12	1	2	6		3	2	2	92	12	14
301-400	24	3	1	7	1	8	3	3	2	1	3		53	11	5
401-500	15	10	3	5	3	2	4		1				46	8	6
501-600	8		1										9	2	1
601-700	7	7	1	1	1	2					2		21	7	4
701-800	1	4	2			1							8	4	2
900-1000		4					1			2			7	3	2
1300-1400										1			1	1	1
1500-1600	1												1	1	1
2000-2100					1								1	1	1
Total	117	29	8	33	25	14	30	12	18	10	11	3	310	>16	48

Ak: *Austrodoris kerguelenensis*, Bh: *Bathydoris hodgsoni*, Bc: *Bathydoris clavigera*, M spp: *Marseniopsis* spp, Pa: *Philine* cf. *alata*, Mc: *Marionia cucullata*, Tb: *Tritoniella belli*, N spp: *Notaeolidia* spp, D sp: *Doto* sp., N: Notaspidea species, Aa: *Aegires albus*, Pq: *Pseudotritonia quadrangularis*. Total: number of specimens.

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2.5.2 Ecophysiology: Respiration of Benthic Organisms and Isolated Tissues

(M. Schmid, O. Krüger)

Introduction

Oxygen consumption, i.e. the metabolic rate of an organism is often used as the sum of all active processes (basic metabolism, gonadic and somatic growth) during the measurement. Not all of these processes need oxygen, but oxygen consumption enables us to arrive at an estimate for the energy budget of an organism. Determining the oxygen consumption is the easiest and often the only way to measure the metabolic rate. The following formula describes ecological energy transformations:

$C = P + R + F + U$

C = Consumption, P = Production, R = Respiration, F = Faeces, U = Urea whereas also the term production as Ps (somatic production) and Pg (gonadic production) requires oxygen. Therefore we can write the term C as

R + R (Ps +Pg) + F+ U

Identifying the oxygen consumption of an organism as a bulk parameter can therefore describe well internal and external processes.

The literature identifies several definitions of the term "metabolism" and the distinction is often not very clear. Basal metabolism is defined as the cost of living for an organism. This parameter cannot be measured, hence there will always be additional energy transformations such as growth, production and accumulation of storage lipids, etc. Standard metabolism describes the oxygen consumption of an unstressed and calm animal, with no spontaneous or feeding activity. The measurement of the standard metabolism as an approach for the basal metabolism is applicable if activity is monitored parallelly (Clarke 1987). Activity metabolism is often measured in fishes. It describes the maximum oxygen consumption of the organism including internal and external work.

While cold adaptation of whole organisms is difficult to investigate using respiration techniques, at the tissue level oxygen consumption rates can be used to study the basic mechanisms that allow stenothermal animals to maintain the capacity for growth and reproduction in the cold. The investigations deal with the effect of temperature and pH on the oxygen consumption and especially the protein synthesis rate as an important factor determining growth and reproduction potential. Data from stenothermal species can be compared to eurythermal species to see if indeed living in extreme conditions such as the Antarctic has led to physiological adaptations.

The benthic respiration group addresses a variety of topics which will be described briefly in the following sections.

2.5.2.1 Respiration of Macro- and Megabenthic Organisms (M. Schmid)

Objectives

- What are the standard respiration rates of selected species?
- Does the metabolic performance indicate an adaptation to seasonally pulsed nutrient supply?

These investigations will be combined with issues concerning absolute densities of epibenthic species (see ice scouring part of the report) and provide estimates of the population carbon mineralization potential (and hence, population carbon demand) of the species selected (Piepenburg and Schmid 1997).

Within the frame of the co-operation with the working groups covering other community fractions (e.g. sponges), it will be possible to assess the relative contribution of the species selected to the total benthic carbon flow. Moreover, productivity values estimated from metabolic measurements by assuming a certain growth efficiency can be compared to those derived from other methods.

The measurements of respiration rates in gorgonians were mainly part of the general study on the role of benthic suspension feeders and are, therefore, described in chapter 2.2.5.

Work at sea

To address the question mentioned above two means of respiration measurements have been set up during the cruise:

Couloxymetry. This method is used for the detection of low respiration rates of small organisms such as amphipods, nudibranchs, small isopods or brachiopods. Small seawater samples (10 µl) from the respiration chambers are injected into a desorber, where the oxygen is bubbled out by a carrier gas and transported to a fuel cell. There a chemical reaction reduces the oxygen thus releasing ions which are detected with an integrator. The integrated value is directly proportional to the oxygen concentration in the seawater sample (Peck and Uglow 1990).

Automated Intermittent-Flow Respirometry. With this system animals can be measured for longer time spans, since it is designed to maintain the oxygen saturation in the respiration chamber between 95% and 85% or any other user defined level (Schmid 1996). The sensor is a Clarke type electrode, built for measuring at low temperatures (i.e. 0°C or below).

Life animals were taken from the trawl catches and traps and maintained in a cooled aquarium container at ambient temperatures prior to the measurements. All animals were kept at least for 72 hours in the aquaria to avoid accidentally measuring damaged animals from the catches. Each experiment was carried out for 24 hours, measuring continuously the oxygen tension. Additionally the activity was monitored with an infrared sensitive video camera and taped to a time lapse recorder (Schmid 1996). Organisms measured so far:

Intermittent Flow	Couloxymetry
Natatolana obtusata (5 specimens)	*Austrodoris kerguelenensis* (2 specimens)
Abyssochormene plebs (4 specimens)	*Tritoniella belli* (1 specimen)
Chorismus antarcticus (10 specimens)	*Marseniopsis mollis* (2 specimens)
Polychaeta (2 specimens)	*Marseniopsis* sp. (3 specimens)
Euphausia superba (3 specimens)	*Epimeria macrodonta* (4 specimens)
	Waldeckia obesa (5 specimens)
	Abyssochormene plebs (5 specimens)
	Natatolana obtusata (5 specimens)

Natatolana obtusata has been choosen as an experimental organism in cooperation with A. Brandt and V. Storch to monitor changes in the respiration rates over the period where they are digesting food (for details see chapter 2.4). Organisms have been taken out of amphipod traps and transferred to the aquaria. All *Natotulana* were stuffed with the bait. Three measurement cycles have been carried out during the cruise. If the animals can be kept until arriving in Kiel they will be measured again.

Preliminary results

All measurements have to be evaluated at home.

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2.5.2.2 Respiration of Antarctic Sponges (S. Gatti)

Objectives

For objectives see chapter 2.5.5.

Work at sea

Respiration experiments were carried out with unfiltered seawater in a closed but intermittently opened (whenever oxygen saturation was below 80-85%) system. Oxygen saturation in the water was determined by micro optodes (Holst *et al.* 1997). Constant mixing in the respiration chambers was assured using peristaltic pumps which pumped the water from the chambers to the measuring optodes and back to the chambers. An additional empty chamber (i. e. containing water but no animal) was used in every run to compensate for bacterial respiration. So far three individuals of *Stylocordyla borealis* and four individuals of *Cinachyra antarctica* have been measured.

To support findings from the respiration experiments the analysis of ETS (activity of the electron transport system) was planned. That would give an estimate of maximum capacities of oxygen consumption. Unfortunately these measurements had to be postponed because the photometer failed (see also chapter 2.5.5).

Preliminary results

All specimens so far tested tolerated being transferred from the aquarium to respiration chambers apparently without problems. After an initial phase of slight contraction of the oscula all sponges opened their oscula, thus showing active water transport through their systems. So far data for the four specimens of *Cinachyra antarctica* have been worked up (Table 58). For these sponges only dripping wet weight has been determined on board. Specimens were frozen for later determination of dry weight (dw) and ash-free dry weight (afdw). To enable this preliminary calculation dry weight and ash-free dry weight have been estimated using conversion factors given by Barthel (1995).

Table 58: Oxygen consumption [mg O_2 g^{-1} ww h^{-1}] of four specimens of *Cinachyra antarctica* measured during two consecutive cycles (whenever oxygen saturation dropped below 80-85% the respiration chambers were opened to allow the saturation to rise to 100%. Respiration between two openings are regarded as one cycle.). These data are raw data and have not yet been corrected for bacterial respiration.

Specimen no. ww [g]	Cina ant 1 64	Cina ant 2 46	Cina ant 3 7	Cina ant 4 1.5
1st cycle				
mg O2 g^{-1} ww h^{-1}	0.0021	0.0020	0.0104	0.0162
mg O2 g^{-1} dw h^{-1}	0.0322	0.0311	0.0680	0.1058
mg O2 g^{-1} afdw h^{-1}	0.0030	0.0029	0.0149	0.0231
2nd cycle				
mg O2 g^{-1} ww h^{-1}	0.0037	0.0039	0.0258	0.0175
mg O2 g^{-1} dw h^{-1}	0.0280	0.0293	0.0506	0.0344
mg O2 g^{-1} afdw h^{-1}	0.0053	0.0056	0.0369	0.0250

As for now no respiration rates for Arctic or Antarctic sponges are available. Compared to oxygen consumption rates of other Antarctic animals those measured here are very low. Chapelle and Peck (1995) found respiration rates for *Waldeckia obesa* - an Antarctic amphipod - to be up to threefold higher than those presented here for sponges.

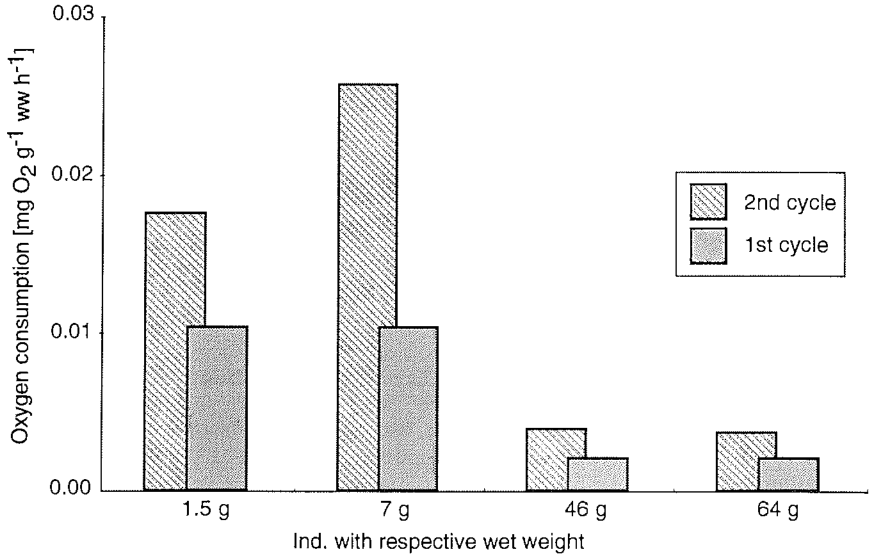

Fig. 58: Oxygen consumption rates of four individuals of *Cinachyra antarctica*. Values have not yet been corrected for bacterial respiration.

Both cycles, though different in their absolute oxygen consumption, show the same basic difference for the four individuals (Fig. 58). There is a marked difference in mass specific respiration rate i. e. smaller individuals have a larger oxygen consumption per unit of weight and time than bigger ones. This difference has not been documented for sponges hitherto.

References

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2.5.2.3 Respiration of Antarctic Asteroids and Holothurians (S. Terpstra)

Objectives

Asteroids and holothurians are abundant members of Antarctic benthos, however their importance in the energy flow of the benthic community is yet unknown. The main reason is that no methods of age determination for these groups have been found up to now, since the hard structures of their skeleton do not show clear growth marks. To get nevertheless an idea of the contribution of asteroids and holothurians to the energy transfer in the system, respiration rates can be used to estimate production and consumption. Mass specific respiration rates should be obtained and connected with data of size frequency distribution and biomass of the investigated populations to estimate energy consumption. Moreover, information on the energy transfer will be derived from stomach content analyses.

Work at sea

Quantitative samples of asteroids and holothurians from 13 Agassiz trawls and 14 bottom trawls from the eastern Weddell Sea shelf and slope were taken and preserved in formalin, ethanol or deep frozen at -30°C for biomass, size frequency distribution and stomach content analyses. Live specimens were kept in aquaria in a cooling container at 0°C. Those species were chosen that (i) were abundant, (ii) had survived the catch without being seriously damaged and (iii) stayed alive and in good condition in the aquaria. Of the holothurians, oxygen consumption of *Ekmocucumis steineni* was measured, and further measurements are planned with *Abyssocucumis liouvillei*. Respiration measurements on asteroids were carried out up to now on three individuals of 2 species that have not yet been determined. More specimens and other species are kept in aquaria to measure them later in the AWI.

Preliminary results

First measurements of the holothurian *Ekmocucumis steineni* showed mean respiration rates between 3.2 and 3.7 µl O_2/h/g wet weight (see Table 59). There seems to be no remarkable difference in the mass specific respiration rate between different sizes of the animals. These results, however, base on measurements of 2 individuals only and should be considered as a first indication.

First measurements of two species of asteroids showed mean respiration rates between 2.1 and 6.0 µl O_2/h/g wet weight. Mass specific respiration rates do not decrease with increasing animal size, as usually observed. Further measurements will have to check these first trends.

Table 59: Mean respiration rates of holothurians and asteroids.

Species	Animal no.	Wet weight (g)	Mean respiration rate (µl O_2/h/g wet weight)
Ekmocucumis steineni	1	7.5	3.7
	2	49.75	3.2
Asteroidea sp. 1	1	20.75	2.1
	2	120.75	3.9
Asteroidea sp. 2	1	14.75	6.0

2.5.2.4 Physiological Adaptations to Cold in Antarctic Ectotherms

(O. Krüger, H. Großpietsch, T. Hirse, R. Knust)

Objectives

The work on board dealt with the basic mechanisms that allow Antarctic organisms to maintain a high aerobic capacity and the capacity for growth and reproduction. The ability for growth and reproduction is determined by the capacity for protein synthesis and this rate was estimated by determining oxygen consumption. Using cycloheximide as a protein synthesis inhibitor, the fraction of oxygen consumption related to protein synthesis was calculated for different tissues of octopods (Cephalopoda). Antarctic eelpouts (Zoarcidae sp.) will be investigated in the same way at the AWI. In addition, tissue samples of eelpouts will be studied to see if an increase of aerobic capacity is related to increasing numbers of mitochondria and their morphological characteristics. Eelpouts are one of the few fish taxa that are not endemic to the Antarctic and are thus a potential model to study cold adaptation. Data from cold stenothermal eelpouts will be compared to those collected in seasonally cold adapted (eurythermal) eelpouts from the North Sea to identify possible coherencies between physiological adaptation and the growth and reproduction potential of species from different climatic regions.

Besides the experiments, an important goal of this cruise was to collect Antarctic animals and to take tissue and blood samples from different phyla for further investigation at the AWI. Mg^{2+}-

ion concentration has been reported to be correlated inversely with temperature and the blood samples will be studied to see if this holds true for the Antarctic, and if there are correlations with the life style of the organism as well.

Work at sea

Octopods were caught using AGT and GSN (see station list, 3.2, for details). Since the overwhelming majority of individuals belonged to the species *Pareledone charcoti*, experiments were conducted using this species only. Eelpouts (Zoarcidae sp.) were caught with fish traps at depths below 400 m, and in addition some specimens and other animals were obtained from AGT, BPN and GSN to take blood and tissue samples for ion and pH determination at the AWI (Table 60).

Table 60: Animal material obtained during the cruise (AGT = Agassiz trawl, BPN = bentho-pelagic trawl, GSN = bottom trawl, AP = Antarctic Peninsula, DI = Drescher Inlet, KN = Kapp Norvegia, VK = Vestkapp).

Species	Live specimens	Tissue sample (muscle)	Blood sample	Gear	Location
Pisces					
Aethotaxis mitopteryx		10	10	GSN	VK
Pleuragramma antarcticum		10	10	BPN	DI
Trematomus lepidorhinus		10	10	GSN	VK
Trematomus loennbergii		10	10	GSN	KN/VK
Gymnodraco acuticeps		6	6	GSN	KN
Chionodraco hamatus		7	7	GSN	KN
Chionodraco myersi		10	10	GSN	VK
Cryodraco antarcticus		10	10	GSN	VK
Dacodraco hunteri		9	9	GSN	VK
Anotopterus pharao		10	10	BPN	DI
Macrourus whitsoni				GSN	VK
Notothenia coriceps	20			Gill net	AP
Zoarcidae sp.	>500			Trap/GSN	AP/DI/VK
Crustacea					
Chorismus antarcticus			21	GSN	AP/VK
Notocrangon antarcticus			33	GSN	AP/VK
Aega glacialis	>100			Trap	DI
Mollusca					
Limopsis marionensis	25			AGT	DI/KN/VK
Pareledone charcoti	15	x	x	AGT	DI/KN/VK
Pareledone sublitoralis	15			AGT	AP

Animals were kept in 80 l aquaria with running water at 0 ± 1°C. Some octopods were tempered in small steps to 3.5 and 4.5°C and the latter ones were kept one week before the experiment. Octopods were anaesthetized using 2.5% ethanol in seawater for twenty minutes, body length and weight determined and tissue samples of arm and mantle were taken. Two samples of each tissue were freeze-clamped in liquid nitrogen and stored at -120°C for metabolite determination at the AWI. Living tissue samples were stored in airated Leibovitz L 15 media at approximately 4°C. Tissue were cut into 1x1 mm pieces and put in a thermostatted (0, 3.5 or 4.5°C) respiration chamber (2 ml volume). Respiration measurements were obtained at two pH values (7.4 and 8.0) of both arm and mantle tissue using Eschweiler (Germany) oxygen electrodes. To inhibit the protein synthesis, cycloheximide was used which blocks the peptidyl transferase reaction.

Preliminary results

A total of approximately 100 octopods were caught alive during the cruise, mainly *Pareledone charcoti* and a few *Pareledone polymorpha* and *Pareledone sublitoralis* (species determined by hectocotylus characteristics). However, mortality was high during the first three weeks in captivity so that only 20% survived. Reasons for this high mortality are injuries from sponge spicules and the fact that AGT and GSN are not the most gentle ways of obtaining live specimens. This is also true for the 30 Antarctic eelpouts which were caught alive using AGT and GSN. Of these, less than ten individuals survived while mortality was much less among the approximately 500 individuals caught with traps in Admiralty Bay at King George Island.

The oxygen consumption of octopod tissues could only be estimated roughly because dry weights could not be obtained. As a surrogate, we obtained the fresh weight of bigger tissue pieces and calibrated this weight to the 1x1 mm tissue units. Oxygen consumption of both arm and mantle tissue fluctuated between 0.5 (arm pH 7.4 at 0°C) and 2 (mantle pH 8.0 at 4.5°C) µmol O_2 per g tissue and hour (Fig. 59). For all experimental treatments, the mantle consumed significantly more oxygen than the arm tissue while the difference in oxygen consumption between the two pH values was significant for the mantle at 4.5°C only (t_{25} = 3.042, p = 0.005). The effect of higher temperatures on the oxygen consumption rate was in most cases not significant: only for the arm at both pH values comparing 0°C control values with the 3.5°C incubation and for both tissues at pH 8.0 comparing 0°C control values with the 4.5°C incubation. However, comparing the incubation treatments with the 4.5°C control showed that only the mantle at pH 8.0 and 4.5°C consumed significantly more oxygen than the 4.5°C control (t_{26} = 2.339, p = 0.027).

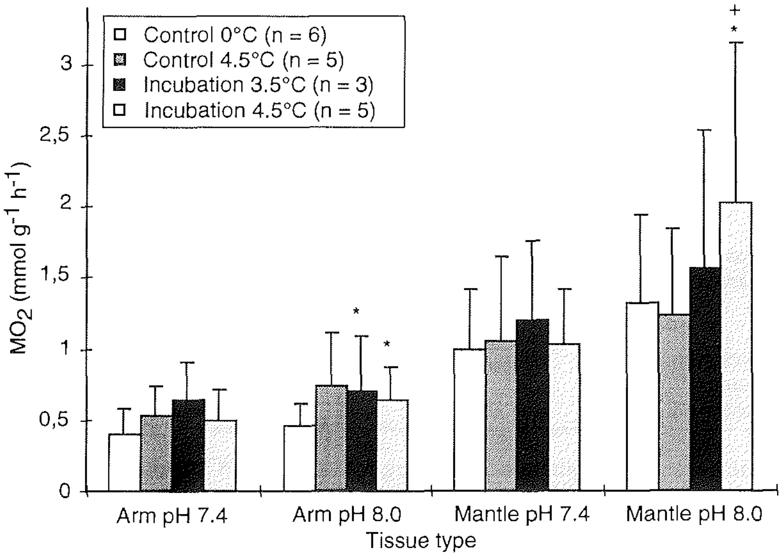

Fig. 59: Oxygen consumption of arm and mantle tissue of *Pareledone charcoti* (mean ± one s.d.). Treatments are: tempered and measured at 0°C (white bars), tempered at 0°C but measured at 4.5°C (dark grey bars), tempered and measured at 3.5°C (black bars) and tempered and measured at 4.5°C (light grey bars). Stars indicate a significant difference in comparison to the 0°C control values and plusses indicate a significant difference in comparison to the 4.5°C control values.

The amount of oxygen consumption related to protein synthesis could be determined accurately and fluctuated between 53% (arm pH 7.4 at 0°C) and 93% (mantle pH 8.0 at 4.5°C). There was a significant effect of pH for both arm and mantle at 0°C with regard to the % change in oxygen consumption elicited by cycloheximide (Fig. 60, $t_{33} = 3.123$, $p = 0.004$ and $t_{29} = 2.613$, $p = 0.014$ respectively). However, there were no significant differences in the fractional contribution of protein synthesis to oxygen consumption between tissues at both pH values. Octopods kept at 0°C but tissues measured at 4.5°C (control 4.5°C) revealed a significant pH effect for the arm only ($t_{28} = 3.884$, $p = 0.001$), whereas differences in the fractional contribution of protein synthesis to oxygen consumption for mantle and between the two tissues were not significant. With regard to the comparison between 0°C control and 4.5°C control, significantly higher fractions of protein synthesis were found for the arm tissue at both pH values (pH 7.4, $t_{31} = 2.999$, $p = 0.005$ and pH 8.0, $t_{30} = 2.440$, $p = 0.021$) and for the mantle tissue at pH 7.4 ($t_{27} = 2.064$, $p = 0.048$).

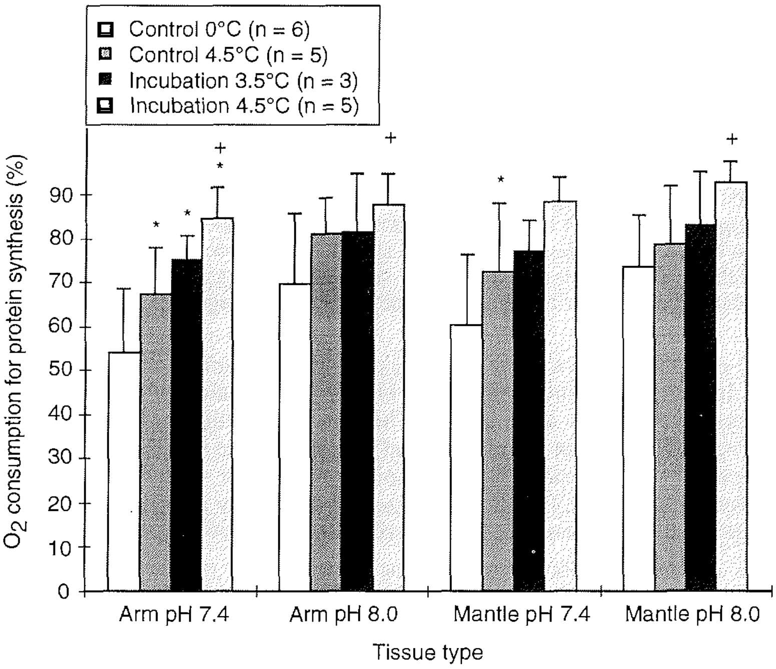

Fig. 60: Percentage of oxygen consumption related to protein synthesis in arm and mantle tissue of *Pareledone charcoti* (mean ± one s.d.). For treatment and symbol explanation, refer to Fig. 59 legend.

For both arm and mantle there was no pH effect at 3.5°C or between tissues. In comparison to the 0°C measurements, arm and mantle at pH 7.4 had a significantly higher oxygen consumption related protein synthesis ($p < 0.01$) while there was only a trend for both tissues at pH 8.0 ($p < 0.1$) However, in comparison to the 4.5°C control, there was only a trend of increasing fractions of oxygen consumption devoted to protein synthesis for the arm at pH 7.4 ($t_{22} = 2.021$, $p = 0.056$) although for all tissues, more oxygen was consumed for protein synthesis compared to the crosscontrol. The 4.5°C incubation treatment had significantly higher fractions of oxygen consumption related to protein synthesis for both tissues and pH values compared to both the 0°C control as well as the 4.5°C control. A pH effect was found for the mantle and at pH 8.0, the mantle tissue had a significantly higher fraction of oxygen consumption devoted to protein synthesis compared to the arm.

In conclusion, our findings seem to indicate that the total amount of oxygen consumption is different between arm and mantle but that incubation to higher temperatures is not paralleled by significant increases in the oxygen consumption. It is more likely that a shift towards a higher fraction of oxygen consumption related to protein synthesis occurs as a consequence of both temperature and pH stress.

2.5.3 Lipid Investigation (M. Graeve)

2.5.3.1 $^{13}C/^{12}C$ Ratio in the Lipids of Polar Copepods

Objectives

Polar copepods of the genus *Calanus* and its relatives dominate the zooplankton biomass. These filter-feeding herbivorous animals are able to produce high amounts of lipids to buffer the pronounced seasonality of food availability: They produce their energy reserves during the short but productive summer to compensate for the dark winter when phytoplankton is short. With the aid of these compact energy stores, they preserve energy over a long period of time. In the food web they are the link between the primary producers (phytoplankton) and fish. Hence, copepods transfer energy to higher trophic levels. *Calanus propinquus*, *Calanoides acutus* and *Rhincalanus gigas* are the most important Antarctic large Copepoda (Grindley and David 1985). All species are able to biosynthesize large lipid stores, but have developed different strategies of lipid accumulation. *C. acutus* and *R. gigas* store their energy as wax esters, whereas *C. propinquus* accumulates large amounts of triacylglycerols (Hagen *et al.* 1993, Graeve *et al.* 1994).

The chemistry of carbon in the oceans is largely controlled by biological processes due to kinetic fractionation. In the marine environment the biggest fractionation of carbon isotopes occurs during photosynthetic carbon assimilation. This process results in ^{13}C depletion in marine biomass relative to DIC. Within the marine food web an increase of ^{13}C with every trophic level take place because ^{12}C disappear during respiration. Further fractionation happens during additional biosynthetical steps. Lipids synthesized *de novo* show an increase of ^{13}C compared to fatty acids from the diet, because they are derived from metabolic substances.

Measurements of stable carbon isotope ratios were carried out in order to quantify and characterize the carbon flux between different trophic levels and to get information about the origin of fatty acids.

Work at sea

For feeding experiments copepods were caught with a bongo net (310 µm) hauled vertically in the upper 300-100 m depth. Closed 2 l jars served as "codends" to avoid damage to the specimens. Immediately after the haul, the living animals were carried to a cool container (3°C) and sorted into species and stages. For the short time experiments adult females and subadult copepods were placed in 9 1 l bottles containing filtered seawater and a suspension of ^{13}C enriched unialgal culture of *Thallassiosira weissflogii* or *T. antarctica* were added. The concentration of copepods was 35/l. The experiments were run at 0°C and dim light and lasted for 48 hours or 14 days. Subsamples of copepods, phytoplankton lipids and cell numbers were taken in regular time periods and stored in dichloromethan:methanol (2:1, by volume). To fix the samples for cell counting a few drops of 5% formol solution were added. More then 2600 copepods were sorted out of 66 bongo hauls. The measurement of the stable carbon isotopes will be carried out at the home institute.

2.5.3.2 Reproduction of Decapod Shrimps from Different Climatic Zones

Objectives

Although protein is the main component of eggs in marine invertebrates (Holland 1978), lipids play an important role in the embryonic metabolism since they represent the most important energy source, and form at least 60% of the total energy expenditure of the developing crustacean embryo (Herring 1974, Holland 1978). The fatty acid composition of decopod eggs has rarely been studied. An additional aspect of the lipid investigations during this cruise was to support an ongoing project, which deals with the reproduction of decapod shrimps from different climatic zones. Lipid class and fatty acid composition will be analyzed to find out the consumption of lipids during embryonic development. The results obtained should contribute to the understanding of the relationship between latitude, expenditure of energy for egg production and kind of larval development.

Work at sea

Egg-bearing females of *Chorismus antarcticus*, *Notocrangon antarcticus* and *Nematocarcinus lanceopes* were collected from Agassiz trawl, epibenthos sledge or bottom trawl. The embryonic state of the eggs was divided into three stages according to the following criteria by Wehrtmann (1990): Stage I: recently produced eggs, uniform yolk. Stage II: eye pigments barely visible. Stage III: eyes clearly visible and fully developed; abdomen free. All eggs were removed from the animal, counted and stored in glass vials with dichloromethane:methanol, 2:1 by volume. 3 to 5 eggs from each female were used to measure the length and width to calculate the egg volume (Turner and Lawrence 1979).

Further processing will be carried out in the institute at home.

2.5.3.3 Investigations into the Changes in Lipid Composition in an Antarctic Diatom in Relation to Inorganic Nutrient Depletion

Objectives

It has often been observed that nutrient and/or light limited Antarctic diatoms accumulate lipid droplets within their cells. This is thought to be a stategy for laying down energy reserves until nutrient/light repleat conditions prevail once more. It is probable that not only the total amount of lipids, but also the lipid composition may change in response to limiting conditions. This may have important consequences for the nutritional value of the diatoms for copepods.

Work at sea

An experiment was conducted using ^{13}C as a tracer to investigate such changes in an Antarctic diatom, *Thalassiosira antarctica.*

Four 5 l cultures of *Thalassiosira antarctica* were established, enriched with ^{13}C:
Bottle 1: Nutrient enriched seawater (Drebes added in full), High light.
Bottle 1: Nutrient enriched seawater (Drebes added in full), Low light.
Bottle 1: Seawater only, High light.
Bottle 1: Seawater only, Low light.

Samples for the following parameters were taken from each bottle at t = 0, 2, 4, 8, 12, 16, 20 days: Chlorophyll a, cell numbers, inorganic nutrients, Particulate Organic Carbon (POC and $PO^{13}C$), and the stable isotope composition of the lipids.

These will all be analyzed in the institute at home.

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2.5.4 Trophic Relations within the Weddell Sea Benthic Shelf Community

(K. Iken, K. Beyer)

Introduction

The determination of trophic pathways is a critical point in the understanding of the structure, interactions and energy transfer in marine ecosystems. Hitherto, studies of food web structures have been based mainly on stomach content analyses. As a result, resolution of both temporal and spatial patterns is low.

Naturally occurring stable isotopes of carbon (^{13}C) and nitrogen (^{15}N) can provide useful information about trophic pathways. These isotopes undergo a stepwise enrichment in the body-tissues of species of subsequent trophic levels (prey-consumer). This method bases on the actually assimilated material and allows the evaluation of trophic long term relationships.

Autecological studies on abundant and conspicuous species of the Weddell Sea benthic community have yielded considerable information on prey items, feeding ecology, and trophic relations. The overall structure of the food web and the trophic position of species within this web, however, still remains rather unclear.

Objectives

The main purpose was to complete the sampling of abundant benthic macro- and megafauna for stable isotope analysis which had been started during EASIZ I (ANT XIII/3) in 1996. Emphasis was put on sampling individuals separately rather than pooling samples for species, as had been done previously. Some samples of pelagic organisms were to be taken for reference of isotopic composition to evaluate the flux and trophic links between the pelagic and benthic subsystems.

Work at sea

A total of 252 samples referring to 76 species have been taken for stable isotope analysis (Table 61) mainly from AGT, GSN, and TV grabs. Animals were dissected freshly after sampling to remove muscle tissue, if possible (e.g. Crustacea, Mollusca, Polychaeta, Pisces). From other species, parts of the body (e.g. Cnidaria, Ascidiacea) or complete specimens (e.g. Bryozoa, Porifera) were used. All samples were freeze dried for subsequent isotope analysis in the AWI.

Table 61: Number of species per taxonomic group collected for stable isotope analysis.

Taxonomic group	No. of species	Taxonomic group	No. of species
Porifera	5	Polychaeta	5
Cnidaria		Echiurida	1
Hydrozoa	4	Crustacea	
Anthozoa		Copepoda	2
Alcyonaria	2	Decapoda	1
Actinaria	4	Isopoda	5
Gorgonaria	7	Hemichordata	2
Bryozoa	3	Echinodermata	
Plathelminthes	1	Crinoidea	1
Nemertini	1	Asteroidea	1
Priapulida	1	Ophiuroidea	1
Mollucsa		Echinoidea	4
Gastropoda	4	Holothuroidea	6
Bivalvia	1	Ascidiacea	5
Cephalopoda	2	Pisces	7
		Total	76

2.5.5 Storage and Flow of C and Si (S. Gatti)

Objectives

Flow of carbon: Antarctic sponges are supposed to grow very slowly due to low ambient water temperatures on one hand and to scarce, seasonally strongly varying food supply on the other. As sponges do not build any permanent hard skeleton parts, it is impossible to assess their age by analyzing such structures. Turnover rates for spicules in Antarctic sponges are not known and as for now no method exists that utilizes the silicious sponge spicules for age analysis. It is therefore impossible to assess growth or age via direct methods as, for example, in some molluscs, echinoderms, or fishes.

To provide a rough first estimate of growth rates and the age of sponges, mass specific respiration rates have to be established. After conversion these will provide estimates of consumption and production rates. (For further details of respiration experiments see 2.5.2.2).

Flow of silicon: For the Antarctic the silicon cycle in the water column has been studied extensively. Thus the role of diatoms, radiolarians, and silicoflagellates is quite well understood. However, no effort has been made to study the role of sponges in the silicon cycle. Not seldom up to 90% of the wet weight of silicious sponges (Demospongia and Hexactinellida) consist of opal (biologically synthesized silica) (Barthel 1995). As methods for age determination in sponges are lacking, it is impossible to assess how long it takes for a sponge to accumulate these enormous amounts of opal.

In order to understand the role of sponges in the Antarctic silicon cycle the following experiments were planned:

- silicate uptake experiments with living sponges (species see below)
- monitoring silicate release (if there is any) of living sponges
- monitoring silicate release of dead spicule mats at ambient temperature/salinity
- analysis of opal contents of whole sponges and spicule mats

Sponges once they are out of the water are very susceptive to invading air. They apparently have no way of refilling the choanocyte chambers with water, once air is caught in there. Thus a great percentage of sponges from trawl catches will die. All experiments with live animals must therefore focus on species that contract heavily once they are taken out of the water. These species do not catch air in their choanocyte chambers and have a better chance to survive.

Work at sea

All AGTs, GSNs and some of the TV grabs were sorted and specimens of the following four species of sponges were routinely collected: *Monosyringa longispina*, *Cinachyra antarctica*, *Cinachyra barbata*, and *Stylocordyla borealis*. Healthy and intact specimens were taken into live maintenance, the rest was frozen. Frozen samples will be worked up at the AWI to get size-frequency distributions, and size mass functions.

Live maintenance of the collected sponges was successful. Individuals that were in good condition have in part been used for respiration experiments already (for preliminary results see 2.5.2.2). Additional respiration experiments and silicate uptake experiments were performed during ANT XV/4. Silicate concentration was monitored in the experimental medium (750 ml filtered seawater with 5 drops of liquid invertebrate food) for up to three days. A control was run to compensate for changes in Si-concentrations e. g. due to evaporation of water.

Preliminary results

At first inspection I got the impression that i. e. specimens of *Monosyringa longispina* and *Cinachyra antarctica* were in average smaller in those areas that are regarded 'disturbed' areas e. g. by iceberg scouring. A careful comparison of sponges collected from the different areas will show, whether there are any differences regarding size frequency distributions or percentags of individuals carrying eggs or larvae.

Comparing control run and experimental run, silicate uptake was clearly detectable (Fig. 61).

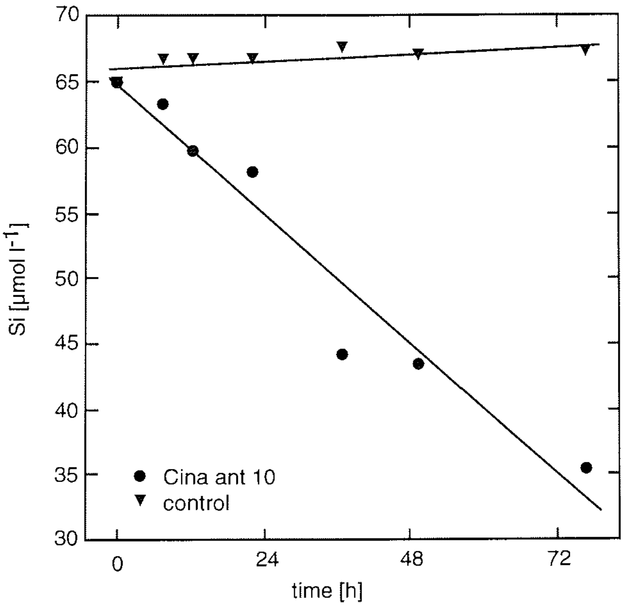

Fig. 61: Uptake of silicate by one *Cinachyra antarctica* (7.3 g ww) measured as silicate concentration in experimental medium (750 ml filtered seawater with liquid food added). Decrease of concentration in the experimental run (dots) is linear: y=64.8-0.42x with $r^2 = 0.972$ (please note that the values have not yet been corrected for the replacement of sample water; triangles: control without sponge).

More than 20 µmol Si were taken up by the sponge (*Cinachyra antarctica* , 7.3g ww) during the 77 hour experiment. Compared to boreal or tropical sponges silicate uptake in this experiment was slow. But as silicate uptake in sponges is considered to be an energy consuming process (Frøhlich and Barthel 1997) and respiration rates are very low, a slow silicate uptake is to be expected.

Due to failure of a previously successfully tested photometer no silicate uptake or release experiments could be performed so far. Another photometer was taken on board in Rothera and all experiments concerning the silica cycle will be performed during ANT XV/4.

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2.5.6 Identification of Possible Iron Sources by Trace Element Analysis in the Southern Ocean (C. Hanfland)

Objectives

Studies and experiments in recent years have led to the hypothesis that iron is playing an important role in controlling primary productivity and hence the uptake of carbon dioxide from the atmosphere into the world's oceans (e.g. Martin *et al.* 1990, De Baar *et al.* 1995). The Antarctic Circumpolar Current (ACC) is characterized by sufficient nutrients (N, P, Si) so that algal growth is thought to be limited by the available iron concentrations.It is not clear by which pathways the iron reaches the surface waters of the Southern Ocean. Possible major sources are: upwelling of deep water masses, input from continental shelf areas and eolian input. Identification of main transport routes would allow better predictions on how the productive polar regions will react to possible climatic variations such as changes in ocean circulation or in atmospheric dust transport linked to glacial-interglacial transitions.

Input from continental shelf areas. ^{228}Ra can be used as a tracer for prolonged contact of water masses with continental shelf areas. It is a daughter product of ^{232}Th, which is common in most sediment types but nearly absent in seawater due to its particle reactive behaviour. In contrast, radium is soluble in water and can accumulate to high activities over fine-grained sediment (Rutgers van der Loeff 1994). According to its half-life of 5.8 years, the activity of ^{228}Ra will decrease with distance from the source and is extremely low in the open ocean. However, the half-life of ^{228}Ra should be long enough to show any signal from the Patagonian or Antarctic Shelf in the waters of the ACC.

Eolian input. Atmospheric input can be identified with ^{232}Th, Al and Nd. ^{232}Th and Al are derived from continental source regions and have a short residence time in surface waters, therefore representing suitable tracers for eolian input. Their geographical distribution should primarily be linked to their input from the atmosphere which implies that a strong signal would reflect a high input of dust particles (Helmers and Rutgers van der Loeff 1993). The Patagonian plains, oceanic islands and the Antarctic Peninsula could serve as sources of iron by transport of dust into the Southern Ocean. As the ^{143}Nd/^{144}Nd isotopic ratio is characteristic of different kind of rocks, possible source regions of dust can be distinguished by means of this isotopic fingerprint (Jeandel *et al.* 1995).

Work at sea

So far, only a limited amount of data exists about the large scale distribution of ^{228}Ra in oceanic surface waters. To identify possible sources of iron for the Atlantic Sector of the Southern Ocean, a large number of samples has been taken on two transects across the ACC (Capetown -

Neumayer and Antarctic Peninsula - South America) as well as in the Weddell Sea itself. Dependant on the behaviour of the investigated tracers, both dissolved and particulate fractions have been sampled. Analysis of radium will be done by isolation of its isotopes and counting of the disintegrations. To obtain acceptable counting statistics in a reasonable period of counting time, large volumes in the order of at least 1000 litres have been sampled. Table 62 gives a short overview of the sampling procedures and the planned measuring techniques to process the samples for other trace elements. Fig. 62 shows the positions of the locations sampled in the Southern Ocean. This data set not only increases the resolution of the samples taken during ANT XV/2 by Walter and Geibert, but also includes data on as yet unsampled areas such as the transect through the ACC towards South America.

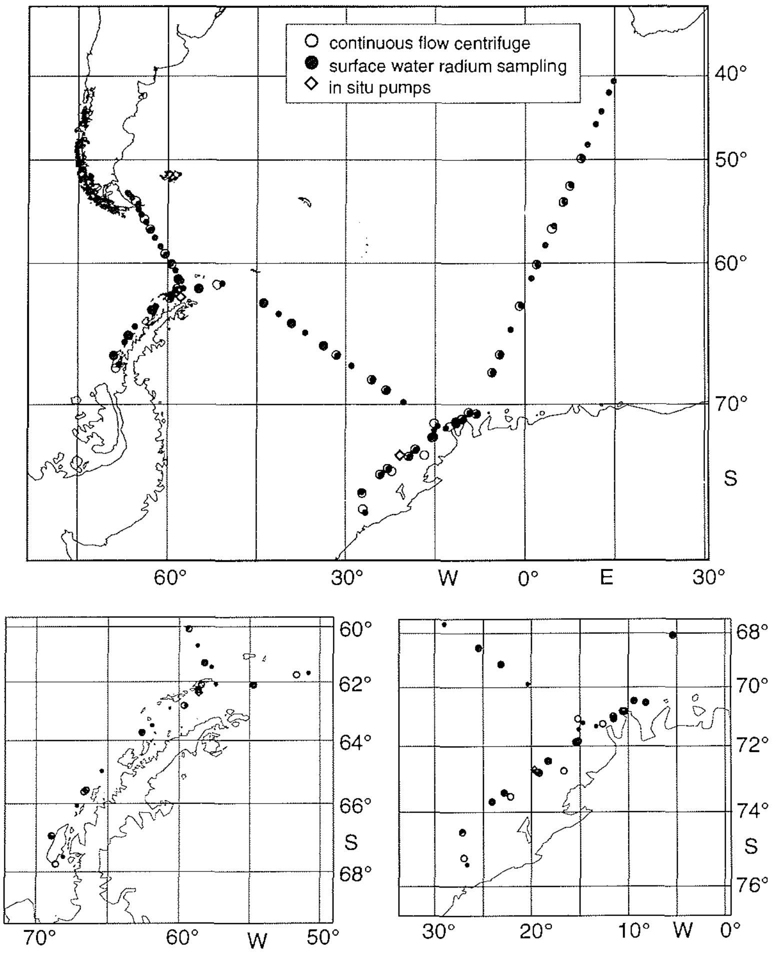

Fig. 62: Map of the Atlantic Sector of the Southern Ocean showing the sample locations for trace element analysis during ANT XV/3. Samples taken during the steaming of the ship (especially crossings Cape Town - Neumayer, Neumayer - Peninsula, Peninsula - Punta Arenas) represent integrated values over as much as 40 nautical miles. In this case, the starting position of the sample is given. Sampling of the water column with in-situ pumps was done in front of the Drescher Inlet at the 2000 m line (72°7.6'S, 19°39.7'W) and in the Bransfield Strait at 1500 m (62°24'S, 58°37'W).

Table 62: Overview of sampling and planned measuring techniques for radium and several trace elements, representing tracers for possible sources of iron input into the Atlantic Sector of the Southern Ocean (diss. = dissolved; part. = particulate).

Element	Fraction	Sampling method	Measuring technique
$^{228}Ra/^{226}Ra$	diss.	adsorption on MnO_2-coated cartridges	γ-spectrometry on $BaSO_4$-precipitate
^{226}Ra	diss.	20 l subsample	γ-spectrometry on $BaSO_4$-precipitate
^{232}Th	part.	continuous flow centrifuge	α-spectrometry on electroplated silver disks
Al	diss.	0.5 l	fluorimetric determination on Lumogallio-Al-complex
Al	part.	continuous flow centrifuge	AAS/ICPMS
Fe	part.	continuous flow centrifuge	AAS/ICPMS
Mn	part.	continuous flow centrifuge	AAS/ICPMS
$^{144}Nd/^{143}Nd$	part.	continuous flow centrifuge	TIMS; Toulouse

Radium sampling in surface waters. Measurement of radium in surface waters was done by continuous underway sampling. Large volumes of water (between 1000 and 3500 litres) from the ship's seawater supply were passed through two MnO_2-coated polypropylene cartridges put in series. An uncoated cartridge served as a trap for the particulate fraction and was exchanged after several hundred litres of pumping in places with high particulate content to maximize the flow rate. If taken during ship movement, the samples represent a mixed value over a sampling area of up to 40 nautical miles. The cartridges with the particulate fraction were sealed in plastic bags and frozen for further analyses, e.g. ^{232}Th. The coated filters were dried at 50°C and stored in plastic bags. At home, these cartridges will be leached to separate radium from thorium and protactinium. After the precipitation of radium, they will be measured by γ-spectrometry for their $^{228}Ra/^{226}Ra$ isotopic ratio. For determination of ^{226}Ra, discrete samples of 20 l of seawater were taken parallel to the large volume sampling. Under continuous stirring, a solution of $BaCO_3$ was added drop by drop to precipitate radium as $BaSO_4$. The precipitate was then concentrated by centrifugation and stored in plastic tubes to be measured at home. The ^{228}Ra-content of each of the samples can then be calculated from the $^{228}Ra/^{226}Ra$ values and the absolute ^{226}Ra-concentration.

Radium sampling in the water column. Large volume samples from different water depths can be obtained by time-programmed in-situ pumps. Water is pumped for about 2 hours through a 293mm filter (1 μm nucleopore) for the particulate fraction and two consecutive MnO_2-coated cartridges to adsorb the dissolved radium. Subsamples of 20 litres for the determination of ^{226}Ra have been taken with a water-rosette at the respective depths. Further treatment of the filters is as described for sea-surface samples. The deep water station were located in front of the Drescher Inlet at 2000 m depth (72°7.6'S/19°39.7'W) and in the Bransfield Strait at 1500 m (62°24'S, 58°37'W).

Sampling of particulate fraction. A continuous flow centrifuge (type Padberg Z61) was deployed for collecting suspended matter in the surface water to measure particle reactive elements like Al, Nd, Fe and ^{232}Th. Whereas ^{232}Th could also be processed from the particulate cartridge of the Ra-sampling, great care must be taken when sampling trace elements with risk of contamination. The suspended material was concentrated on a teflon foil inside the cylinder of the centrifuge, transferred under clean room conditions into plastic tubes and frozen. Sampled volumes were between 1500 and 5000 l of water, taken from the ship's seawater supply.

Dissolved Aluminium. It was also planned to measure concentrations of dissolved aluminium in the surface water. To get uncontaminated samples, a snorkel system with teflon tubing at the bottom of the ship should be used for sampling. Due to damages on the cage of the moon pool during ANT XV/2, the snorkel system could not be mounted. Therefore, Al-samples (0.5 l) had to be taken from the normal seawater supply. Nevertheless, we hope that trends in the Al-distribution will be detectable in order to support future planned sampling.

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3. Annexes

3.1 Abreviations of Gears and Investigation Areas

AGT	Agassiz trawl
ARGOS Buoy	ARGOS Buoy deployed
A trap	Amphipod trap deployed
A trap recov.	Amphipod trap recovered
BO	Bongo net
BPN	Bentho-pelagic trawl
CTD	Conductivity-Temperature-Depth data logger
D	Dredge (small Rauschert type)
EBS	Epibenthic sledge
F trap	Fish trap deployed
F trap recov.	Fish trap recovered
FTS	Photo sled
GKG	Giant box corer
GSN	Bottom trawl
GSN pelagic	GSN used for pelagic fishing
ISP	In situ pumps
MG	Multigrab (Multibox corer)
M	Mooring deployed
M recov.	Mooring recovered
SF	Sediment trap
MUC	Multicorer
ROV	Remotely operated vehicle
Tile bags	Tile bags deployed
TVG	TV grab

AB	Atka Bay
KN	Kapp Norvegia
N/KN	North of KN
S/KN	South of KN
DI	Drescher Inlet
VK	Vestkapp
S/VK	South of VK
HB	Halley Bay
KG	King George Island
DP	Drake Passage

3.2 Station List

For AGT, EBS, BPN, D, and GSN 1st position refers to deployment, 2nd on ground, 3th start of heaving, 4th on deck.
(Note: Cruise ANT XV/3 was cruise no. 48 of RV "Polarstern", so the station nos. should be read 48-001 etc.)

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
19-01		1	09:00	ARGOS	56° 46.0'	04° 46.9'	4468
25-01	KN	2	05:47	BO	71° 14.3'	12° 21.5'	227
	"	3	06:55	BO	71° 09.6'	12° 18.5'	338
	"	4	08:18	TVG	71° 14.2'	12° 21.7'	241
	"		08:56	TVG	71° 14.0'	12° 22.1'	244
	"	5	10:05	TVG	71° 18.1'	12° 16.0'	177
	"	6	11:26	AGT	71° 18.0'	12° 16.9'	178
	"		11:39		71° 18.4'	12° 17.7'	177
	"		11:49		71° 18.5'	12° 18.0'	172
	"		12:03		71° 18.6'	12° 18.1'	173
	"	7	14:14	M	71° 10.3'	13° 01.0'	463
	"	8	17:10	M, SF	71° 30.6'	13° 31.1'	235
	"	9	19:01	2 Tile bags	71° 35.35'	13° 54.25'	341
	"		19:30	2 Tile bags	71° 35.35'	13° 54.25'	341
	"		20:01	2 Tile bags	71° 35.36'	13° 54.26'	341
	"	10	22:24	M	71° 45.0'	14° 45.1'	288
26-01	DI	11	13:11	A trap	72° 50.8'	19° 15.5'	377
	"		14:38	ROV	72° 51.0'	19° 14.8'	383
	"		18:09	4 BO	72° 51.0'	19° 14.8'	385
	"	12	21:41	CTD	72° 50.7'	19° 18.4'	390
	"	13	22:41	BPN	72° 51.1'	19° 14.8'	387
	"		23:21		72° 50.2'	19° 25.5'	449
	"		00:00		72° 50.2'	19° 35.8'	582
27-01	DI		00:36		72° 50.2'	19° 41.0'	1314
	"	14	01:45	BPN	72° 51.3'	19° 14.0'	388
	"		02:27		72° 51.1'	19° 21.8'	414
	"		03:05		72° 50.6'	19° 31.9'	485
	"		03:37		72° 51.0'	19° 37.2'	583
	"	15	04:35	BPN	72° 51.3'	19° 15.2'	398
	"		02:18		72° 50.7'	19° 26.1'	441
	"		06:04		72° 50.2'	19° 37.1'	736
	"		06:34		72° 50.3'	19° 42.7'	1525
	"	16	09:25	FTS	72° 51.0'	19° 18.0'	390
	"		10:29		72° 51.1'	19° 18.3'	392
	"	17	11:02	FTS	72° 49.8'	19° 24.0'	457
	"		11:27		72° 49.7'	19° 23.6'	457
	"	18	11:57	CTD	72° 49.7'	19° 23.3'	456
	"		12:35	2 BO	72° 49.6'	19° 22.0'	451
	"	19	14:22	ROV	72° 51.2'	19° 16.7'	384
	"	20	16:29	FTS	72° 50.8'	19° 17.5'	389
	"	21	18:21	FTS	72° 03.2'	19° 18.9'	395
	"	22	18:58	CTD	72° 51.3'	19° 19.1'	396

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
27-01	DI	23	19:51	BPN	72° 51.4'	19° 17.2'	394
	"		20:36		72° 50.5'	19° 29.3'	468
	"		21:19		72° 49.6'	19° 40.5'	1441
	"		21:56		72° 49.1'	19° 44.7'	2066
	"	24	22:54	BPN	72° 51.3'	19° 18.3'	393
	"		23:58		72° 47.6'	19° 26.9'	695
28-01	DI		00:43		72° 45.1'	19° 34.0'	2166
	"		01:14		72° 43.9'	19° 36.1'	2451
	"	25	02:47	A trap recov.	72° 50.8'	19° 15.7'	388
	"	26	03:13	BPN	72° 51.3'	19° 16.3'	392
	"		03:46		72° 50.4'	19° 23.3'	435
	"		04:29		72° 48.3'	19° 30.9'	709
	"		05:02		72° 47.1'	19° 32.2'	1270
	KN	27	21:08	TVG	71° 19.4'	12° 25.2'	191
	"		21:44	TVG	71° 19.3'	12° 24.7'	182
	"		22:40	CTD	71° 19.2'	12° 24.5'	179
	"		23:02	A trap	71° 19.0'	12° 24.2'	171
29-01	N/KN	28	00:58	4 BO	71° 09.1'	12° 03.1'	403
	"	29	06:14	FTS	71° 07.4'	11° 28.0'	65
	"		07:03		71° 07.1'	11° 27.4'	169
	"	30	08:10	TVG	71° 07.3'	11° 28.2'	65
	"	31	08:53	TVG	71° 07.3'	11° 28.3'	64
	"	32	09:21	TVG	71° 07.3'	11° 28.1'	62
	"	33	09:48	TVG	71° 07.3'	11° 28.3'	65
	"	34	10:12	FTS	71° 07.2'	11° 28.3'	68
	"		11:35		71° 07.3'	11° 29.5'	116
	"	35	12:02	TVG	71° 07.2'	11° 28.2'	64
	"	36	12:24	TVG	71° 07.2'	11° 28.2'	68
	"	37	13:24	D	71° 06.7'	11° 28.0'	146
	"		13:50		71° 07.2'	11° 28.6'	105
	"		13:54		71° 07.2'	11° 28.8'	105
	"		14:06		71° 07.2'	11° 29.3'	114
	"	38	15:23	A trap	70° 59.0'	11° 09.1'	389
	"	39	17:22	AGT	70° 53.5'	10° 29.9'	230
	"		17:45		70° 52.8'	10° 31.4'	237
	"		17:55		70° 52.6'	10° 31.9'	244
	"		18:19		70° 52.5'	10° 32.7'	241
	"	40	19:02	ROV	70° 52.1'	10° 31.2'	243
	"		20:58		70° 51.5'	10° 34.2'	226
	"	41	21:49	ROV	70° 53.8'	10° 33.8'	247
	"		23:35		70° 54.0'	10° 33.1'	246
30-01	N/KN	42	00:04	FTS	70° 54.0'	10° 33.7'	259
	"		00:41		70° 54.1'	10° 33.0'	243
	"	43	01:37	2 BO	70° 49.9'	10° 49.6'	420
	"	44	08:30	AGT	70° 51.5'	10° 36.5'	238
	"		09:05		70° 51.8'	10° 34.0'	227
	"		09:08		70° 51.9'	10° 33.8'	229
	"		09:44		70° 52.7'	10° 34.8'	230

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
30-01	N/KN	45	10:32	ROV	70° 52.2'	10° 28.3'	247
	"		12:04		70° 52.1'	10° 28.8'	246
	"	46	13:54	GKG	70° 52.1'	10° 29.3'	244
	"	47	15:15	MG	70° 52.1'	10° 29.4'	244
	"	48	17:03	MG	70° 52.1'	10° 29.3'	245
	"	49	17:57	AGT	70° 52.2'	10° 29.0'	246
	"		18:18		70° 52.0'	10° 27.3'	255
	"		18:28		70° 51.9'	10° 26.8'	261
	"		18:55		70° 51.8'	10° 26.5'	266
	"	50	19:05	D	70° 51.7'	10° 26.1'	267
	"		19:42		70° 51.6'	10° 24.3'	282
	"		19:52		70° 51.7'	10° 24.1'	283
	"		20:28		70° 51.9'	10° 23.8'	278
	"	51	20:47	CTD	70° 52.0'	10° 23.6'	279
	"	52	21:53	ROV	70° 52.4'	10° 28.9'	247
	"		22:47		70° 52.4'	10° 29.9'	246
	"	53	23:03	FTS	70° 52.4'	10° 30.2'	245
	"		23:57		70° 52.6'	10° 30.6'	241
31-01	N/KN	54	06:10	BO	70° 55.7'	10° 24.5'	192
	"	55	06:31	BO	70° 55.9'	10° 24.9'	200
	"	56	07:25	FTS	70° 53.2'	10° 29.4'	234
	"		08:06		70° 53.5'	10° 29.4'	232
	"	57	08:37	2 GKG	70° 52.3'	10° 29.4'	247
	"	58	10:10	AGT	70° 52.1'	10° 32.5'	223
	"		10:32		70° 52.1'	10° 29.8'	243
	"		10:42		70° 52.2'	10° 29.0'	247
	"		11:05		70° 52.3'	10° 29.0'	246
	"	59	11:44	ROV	70° 53.3'	10° 27.8'	242
	"		13:25		70° 53.8'	10° 27.4'	233
	"	60	14:03	2 TVG	70° 52.1'	10° 29.5'	244
	"	61	15:31	FTS	70° 53.4'	10° 27.7'	242
	"		16:14		70° 53.5'	10° 27.6'	241
	"	62	16:42	AGT	70° 52.6'	10° 28.6'	248
	"		17:38		70° 53.6'	10° 28.1'	241
	"		17:46		70° 53.7'	10° 28.2'	235
	"		18:10		70° 54.0'	10° 28.2'	232
	"	63	19:28	MG	70° 52.1'	10° 32.4'	234
	"	64	20:32	MG	70° 52.1'	10° 31.8'	241
	"		21:01	MG	70° 52.1'	10° 32.9'	231
	"	65	21:44	ROV	70° 51.9'	10° 32.2'	231
	"		23:27		70° 51.9'	10° 34.2'	227
01-02	N/KN	66	08:12	ROV	70° 50.8'	10° 30.4'	238
	"		09:54		70° 51.0'	10° 32.2'	230
	"	67	10:30	MG	70° 49.9'	10° 36.5'	311
	"	68	11:22	MG	70° 50.2'	10° 37.2'	268
	"	69	12:15	MG	70° 51.7'	10° 33.7'	277
	"	70	13:31	ROV	70° 49.4'	10° 28.9'	288
	"		14:44		70° 49.6'	10° 29.8'	275

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
01-02	N/KN	71	15:23	GSN	70° 50.5'	10° 32.8'	231
	"		15:49		70° 49.3'	10° 28.6'	281
	"		16:10		70° 48.3'	10° 26.0'	301
	"		16:51		70° 46.8'	10° 21.5'	309
	"	72	18:00	FTS	70° 50.8'	10° 31.4'	230
	"		18:19		70° 50.8'	10° 31.3'	232
	"	73	18:14	FTS	70° 49.5'	10° 30.4'	286
	"		19:38		70° 50.0'	10° 30.0'	290
	"	74	20:00	CTD	70° 49.4'	10° 28.6'	284
	"		20:26	ROV	70° 49.3'	10° 28.8'	284
	"		23:00		70° 49.3'	10° 33.6'	278
02-02	N/KN	75	01:10	A trap recov.	70° 59.1'	11° 09.6'	392
	"	76	06:00	A trap recov.	70° 19.0'	10° 24.1'	169
	"	77	07:41	AGT	71° 08.6'	12° 26.6'	433
	"		08:10		71° 09.7'	12° 28.7'	360
	"		08:20		71° 09.9'	12° 29.2'	341
	"		08:56		71° 10.2'	12° 30.7'	330
03-02	DI	78	06:24	GSN	72° 51.7'	19° 07.6'	413
	"		06:54		72° 51.1'	19° 15.1'	391
	"		07:11		72° 50.9'	19° 18.7'	390
	"		07:51		72° 50.5'	19° 24.2'	439
	"	79	08:42	CTD	72° 50.5'	19° 24.9'	444
	"	80	10:08	F trap	72° 51.2'	19° 34.4'	493
	"	81	10:34	F trap	72° 51.5'	19° 35.2'	488
	"	82	11:23	GSN	72° 51.1'	19° 11.5'	390
	"		11:50		72° 50.8'	19° 18.8'	395
	"		12:05		72° 50.8'	19° 21.9'	417
	"		12:40		72° 50.5'	19° 28.0'	463
	"	83	13:58	CTD	72° 52.3'	19° 05.4'	428
	"		14:28	2 BO	72° 52.3'	19° 05.4'	428
	"	84	15:51	GSN	72° 51.4'	19° 08.6'	403
	"		16:18		72° 51.0'	19° 15.8'	391
	"		16:32		72° 50.8'	19° 19.1'	395
	"		17:02		72° 50.5'	19° 23.0'	433
	"		17:27	CTD	72° 51.3'	19° 32.2'	464
	"	85	18:20	F trap recov.	72° 51.2'	19° 34.3'	493
	"	86	19:12	F trap recov.	72° 51.6'	19° 35.5'	488
04-02	S/VK	87	05:02	CTD	73° 28.8'	22° 29.5'	1465
	"	88	06:19	AGT (527)	73° 28.5'	22° 30.0'	1681
	"		07:22		73° 29.0'	22° 35.2'	1353
	"		07:32		73° 20.8'	22° 36.3'	1352
	"		08:48		73° 28.4'	22° 40.5'	1286
	"	89	09:26	EBS 1 (452)	73° 27.5'	22° 43.1'	1583
	"		10:42		73° 27.3'	22° 45.7'	1639
	"		10:51		73° 27.3'	22° 46.6'	1633
	"		12:05		73° 27.6'	22° 47.8'	1573
	"	90	12:51	MUC	73° 27.9'	22° 48.0'	1557
	"	91	14:45	MG	73° 28.4'	22° 48.8'	1510

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
04-02	S/VK	92	17:16	MG	73° 34.2'	22° 38.0'	994
	"	93	19:13	MG	73° 28.3'	22° 54.5'	1988
05-02	S/VK	94	06:04	A trap	73° 35.7'	22° 23.4'	813
	"	95	06:17	GSN	73° 35.7'	22° 23.4'	813
	"		07:00		73° 33.5'	22° 15.3'	920
	"		07:15		73° 34.0'	22° 12.3'	866
	"		08:11		73° 33.4'	22° 03.5'	726
	"	96	08:25	CTD	73° 33.3'	22° 02.7'	720
	"	97	09:22	GSN	73° 34.2'	22° 03.8'	605
	"		10:04		73° 35.8'	22° 12.9'	629
	"		10:18		73° 35.9'	22° 16.0'	659
	"		11:14		73° 36.6'	22° 24.7'	736
	"	98	11:36	CTD	73° 36.4'	22° 24.0'	772
	"	99	12:25	FTS	73° 36.3'	22° 22.6'	725
	"		12:51		73° 36.3'	22° 22.0'	688
	"	100	13:28	GSN	73° 38.0'	22° 14.6'	437
	"		14:05		73° 36.4'	22° 07.0'	440
	"		14:21		73° 35.7'	22° 04.4'	444
	"		14:57		73° 34.3'	22° 00.9'	519
	"	101	15:17	CTD	73° 35.5'	22° 03.0'	445
	"	102	15:56	A trap	73° 36.0'	22° 00.5'	396
	"	103	16:28	AGT	73° 34.4'	22° 04.5'	600
	"		16:48		73° 34.9'	22° 06.6'	616
	"		16:57		73° 35.0'	22° 07.0'	611
	"		17:38		73° 34.9'	22° 07.0'	615
	"	104	20:13	FTS	73° 34.0'	22° 02.0'	591
	"		20:54		73° 33.0'	22° 01.4'	594
	"	105	21:05	5 BO	73° 33.8'	22° 01.4'	602
06-02	S/VK	106	06:23	CTD	73° 34.0'	22° 36.1'	996
	"	107	07:34	EBS 2 (420)	73° 34.4'	22° 36.7'	1000
	"		08:25		73° 34.8'	22° 38.4'	934
	"		08:34		73° 34.9'	22° 38.9'	924
	"		09:20		73° 53.0'	22° 39.8'	914
	"	108	09:39	MUC	73° 34.6'	22° 40.7'	1054
	"	109	11:37	CTD	73° 37.3'	22° 08.1'	406
	"	110	12:20	D	73° 37.5'	22° 07.7'	393
	"		12:49		73° 38.0'	22° 08.5'	379
	"		13:20		73° 38.3'	22° 08.9'	369
	"	111	13:52	EBS 3 (382)	73° 38.2'	22° 11.0'	400
	"		14:13		73° 38.3'	22° 11.6'	397
	"		14:22		73° 38.4'	22° 12.2'	397
	"		14:14		73° 38.6'	22° 12.8'	396
	"	112	15:12	MG	73° 38.7'	22° 13.1'	394
	"	113	16:41	MG	73° 36.2'	22° 22.2'	743
	"	114	18:06	EBS 4 (397)	73° 36.3'	22° 23.5'	769
	"		18:43		73° 36.7'	22° 24.5'	755
	"		18:54		73° 36.8'	22° 24.9'	746
	"		19:38		73° 36.8'	22° 25.0'	721

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
06-02	S/VK	115	19:52	D	73° 37.0'	22° 24.9'	731
	"		20:35		73° 36.3'	22° 23.1'	757
	"		21:30		73° 35.8'	22° 21.2'	780
	"	116	21:53	CTD	73° 35.9'	22° 21.1'	763
	"		22:24		73° 35.7'	22° 21.0'	776
07-02	S/VK	117	06:16	GSN	74° 03.7'	22° 46.2'	200
	"		06:40		74° 01.7'	22° 47.9'	200
	"		06:47		74° 01.5'	22° 48.1'	197
	"		07:13		74° 00.1'	22° 50.2'	187
	"	118	07:25	CTD	73° 59.9'	22° 50.4'	186
	"	119	10:38	A trap recov.	73° 36.0'	22° 23.6'	793
	"	120	11:20	GSN	73° 35.7'	22° 23.3'	812
	"		12:02		73° 33.5'	22° 14.8'	928
	"		12:17		73° 34.0'	22° 12.2'	826
	"		13:08		73° 35.5'	22° 05.5'	489
	"	121	13:41	CTD	73° 34.3'	22° 11.0'	814
	"	122	14:44	A trap recov.	73° 35.9'	22° 00.2'	399
	"	123	15:38	GSN	73° 34.1'	22° 02.7'	588
	"		16:22		73° 35.8'	22° 14.6'	638
	"		16:37		73° 36.1'	22° 17.2'	670
	"		17:21		73° 36.5'	22° 23.8'	748
	"	124	17:33	CTD	73° 36.5'	22° 24.1'	751
	"	125	18:25	FTS	73° 38.2'	22° 11.5'	400
	"		19:25		73° 38.2'	22° 11.7'	404
	"	126	19:47	5 BO	73° 38.2'	22° 11.9'	406
08-02	S/VK	127	05:57	CTD	73° 39.1'	20° 59.9'	215
	"	128	08:32	D	73° 38.4'	20° 59.8'	215
	"		09:09		73° 39.1'	20° 59.6'	211
	"	129	09:31	TVG	73° 39.2'	20° 59.6'	209
	"	130	13:04	EBS 5 (367)	73° 23.6'	22° 09.3'	2034
	"		14:40		73° 24.0'	22° 08.3'	1982
	"		14:50		73° 23.8'	22° 08.7'	1973
	"		16:36		73° 23.9'	22° 08.7'	1992
	"	131	17:02	MG	73° 23.7'	22° 09.1'	1985
	"	132	19:05	MG	73° 20.7'	22° 18.4'	2387
09-02	HB	133	08:50	EBS 6 (335)	74° 31.3'	27° 11.6'	2091
	"		10:20		74° 31.7'	27° 12.8'	2043
	"		10:30		74° 31.9'	27° 13.2'	2029
	"		12:04		74° 31.8'	27° 13.2'	2114
	"	134	12:17	AGT (633)	74° 31.9'	27° 13.4'	2103
	"		13:13		74° 32.2'	27° 13.8'	2081
	"		13:23		74° 32.5'	27° 14.5'	2054
	"		14:59		74° 33.0'	27° 14.3'	2004
	"	135	15:25	MUC	74° 32.9'	27° 13.7'	2021
	"	136	17:36	MG	74° 33.0'	27° 13.1'	2012
	"	137	20:08	MG	74° 36.2'	27° 12.7'	1521
	"	138	21:55	A trap	74° 39.8'	27° 13.1'	798
	"	139	23:45	3 BO	74° 36.2'	27° 15.6'	1546

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
10-02	HB	140	05:05	CTD	74° 36.6'	27° 16.3'	1498
	"	141	06:18	AGT (581)	74° 36.5'	27° 15.9'	1488
	"		06:58		74° 36.1'	27° 13.0'	1549
	"		07:08		74° 36.1'	27° 11.9'	1523
	"		08:24		74° 35.6'	27° 02.9'	1560
	"	142	09:09	EBS 7 (442)	74° 35.8'	27° 17.4'	1650
	"		10:28		74° 36.1'	27° 16.1'	1573
	"		10:38		74° 36.3'	27° 15.5'	1535
	"		12:01		74° 36.8'	27° 13.8'	1383
	"	143	12:54	MUC	74° 36.1'	27° 12.9'	1528
	"	144	14:23	D	74° 38.8'	27° 14.2'	972
	"		15:06		74° 38.6'	27° 12.5'	988
	"		15:16		74° 38.5'	27° 12.3'	997
	"		16:06		74° 38.8'	27° 13.0'	961
	"	145	16:28	EBS 8 (317)	74° 38.2'	27° 12.4'	1051
	"		17:16		74° 38.0'	27° 11.0'	1056
	"		17:26		74° 37.9'	27° 10.4'	1061
	"		18:12		74° 37.8'	27° 08.9'	1045
	"	146	18:45	MG	74° 39.4'	27° 08.0'	1021
	"	147	19:54	CTD	74° 39.4'	27° 07.9'	744
	"	148	21:03	CTD	74° 38.2'	27° 09.6'	1007
	"	149	22:12	5 BO	74° 39.8'	27° 09.5'	722
11-02	HB	150	06:19	GSN	74° 40.0'	27° 12.4'	746
	"		07:08		74° 38.0'	27° 00.2'	710
	"		07:23		74° 37.2'	26° 58.6'	758
	"		08:20		74° 35.8'	26° 55.0'	789
	"	151	09:00	CTD	74° 36.7'	26° 53.9'	606
	"	152	09:37	F trap	74° 36.8'	26° 53.9'	597
	"	153	10:09	F trap	74° 36.3'	26° 52.2'	585
	"	154	10:39	GSN	74° 36.3'	26° 53.0'	666
	"		11:15		74° 38.7'	26° 59.3'	569
	"		11:25		74° 39.2'	27° 01.2'	583
	"		12:04		74° 40.3'	27° 06.0'	567
	"	155	12:30	A trap recov.	74° 39.7'	27° 13.5'	813
	"	156	13:52	EBS 9 (328)	74° 36.8'	26° 58.0'	780
	"		14:29		74° 37.0'	26° 58.6'	781
	"		14:39		74° 37.2'	26° 58.2'	746
	"		15:16		74° 37.4'	26° 58.7'	720
	"	157	15:52	D	74° 36.5'	26° 57.4'	811
	"		16:34		74° 37.5'	26° 58.8'	725
	"		16:49		74° 37.8'	26° 59.2'	698
	"		17:24		74° 38.5'	27° 00.3'	652
	"	158	17:52	TVG	74° 38.6'	27° 03.7'	755
	"	159	19:13	FTS	74° 38.6'	27° 03.1'	744
	"		20:00		74° 38.7'	27° 03.0'	723
	"	160	20:32	A trap	74° 40.0'	26° 57.9'	403
	"	161	20:58	3 BO	74° 40.5'	26° 59.3'	403
	"	162	22:05	FTS	74° 40.6'	26° 59.9'	402

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
12-02	HB	163	06:06	CTD	74° 59.8'	27° 12.8'	404
	"	164	06:53	TVG	75° 00.0'	27° 13.1'	401
	"	165	08:09	EBS 10 (482)	75° 00.4'	27° 13.1'	398
	"		08:28		75° 00.5'	27° 13.2'	397
	"		08:38		75° 00.8'	27° 13.5'	398
	"		09:01		75° 01.0'	27° 13.6'	396
	"	166	09:13	D	75° 01.1'	27° 13.6'	396
	"		09:42		75° 01.6'	27° 14.1'	395
	"		09:52		75° 01.7'	27° 14.3'	394
	"		10:20		75° 01.9'	27° 14.6'	392
	"	167	10:49	GSN	75° 02.0'	27° 14.8'	392
	"		11:18		75° 03.7'	27° 20.7'	406
	"		11:23		75° 03.9'	27° 21.3'	407
	"		11:52		75° 04.9'	27° 25.1'	411
	"	168	14:40	GSN	75° 26.1'	26° 34.6'	247
	"		15:03		75° 26.3'	26° 41.7'	233
	"		15:07		75° 26.4'	26° 42.9'	228
	"		15:33		75° 26.9'	26° 48.3'	225
	"	169	16:22	CTD	75° 26.4'	26° 40.0'	233
	"	170	16:51	TVG	75° 26.6'	26° 39.4'	233
	"	171	17:45	EBS 11 (392)	75° 26.6'	26° 40.0'	232
	"		17:56		75° 26.7'	26° 39.9'	231
	"		18:06		75° 26.9'	26° 39.3'	231
	"		18:19		75° 27.0'	26° 39.2'	232
	"	172	18:34	D	75° 27.1'	26° 39.7'	232
	"		18:49		75° 26.9'	26° 38.8'	233
	"		18:59		75° 26.9'	26° 38.6'	234
	"		19:13		75° 26.8'	26° 37.8'	237
	"	173	19:31	FTS	75° 26.8'	26° 37.6'	238
	"		19:50		75° 26.7'	26° 37.5'	238
	"	174	19:57	FTS	75° 26.6'	26° 37.3'	239
	"		20:28		75° 26.5'	26° 37.6'	229
	"	175	20:37	3 BO	75° 26.5'	26° 38.0'	230
	"	176	22:14	ROV	75° 27.0'	26° 34.6'	234
	"		23:53		75° 26.7'	26° 33.9'	242
13-02	HB	177	01:11	ROV	75° 28.5'	27° 05.4'	254
	"		02:44		75° 27.8'	27° 07.8'	262
	"	178	03:49	ROV	75° 26.8'	26° 45.4'	223
	"		04:25		75° 27.0'	26° 46.0'	222
	"	179	10:39	A trap recov.	75° 40.0'	26° 58.2'	240
	"	180	11:38	F trap recov.	74° 36.4'	26° 52.5'	321
	"	181	12:29	F trap recov.	74° 36.9'	26° 54.5'	611
	"	182	12:47	3 BO	74° 36.9'	26° 54.6'	607
14-02	KN	183	21:19	CTD	72° 10.0'	16° 31.7'	358
15-02	KN	184	06:41	3 BO	71° 30.9'	14° 22.0'	166
	"	185	07:52	FTS	71° 31.7'	14° 22.8'	170
	"		08:51		71° 31.7'	14° 23.7'	167
	"	186	09:11	ROV	71° 31.8'	14° 24.0'	168

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
15-02	KN		10:51		71° 31.8'	14° 25.8'	169
	"	187	14:05	MG	71° 32.3'	13° 31.7'	255
	"	188	15:25	MG	71° 31.5'	13° 30.6'	226
	"	189	18:08	AGT	71° 40.5'	12° 45.0'	236
	"		18:20		71° 40.2'	12° 43.6'	244
	"		18:28		71° 40.1'	12° 43.2'	248
	"		18:44		71° 40.3'	12° 43.5'	244
	"	190	19:37	ROV	71° 41.6'	12° 44.7'	238
	"		20:54		71° 41.4'	12° 45.8'	237
	"	191	21:25	FTS	71° 41.8'	12° 43.9'	242
	"		23:09		71° 41.9'	12° 44.7'	243
16-02	KN	192	06:10	FTS	71° 13.6'	12° 25.4'	253
	"		07:02		71° 13.5'	12° 25.3'	257
	"	193	07:15	ROV	71° 13.6'	12° 25.5'	256
	"		08:56		71° 13.9'	12° 27.5'	249
	"	194	09:23	AGT	71° 14.2'	12° 28.8'	263
	"		09:31		71° 14.1'	12° 27.7'	244
	"		09:41		71° 14.0'	12° 27.6'	246
	"		10:03		71° 14.0'	12° 27.9'	247
	"	195	10:36	FTS	71° 15.3'	12° 20.4'	183
	"		11:08		71° 15.3'	12° 20.6'	174
	"	196	11:19	CTD	71° 15.3'	12° 20.4'	171
	"	197	12:31	AGT	71° 16.4'	12° 36.5'	406
	"		12:52		71° 17.0'	12° 36.3'	415
	"		12:57		71° 17.1'	12° 36.0'	416
	"		13:25		71° 17.0'	12° 36.2'	414
	"	198	13:41	D	71° 17.0'	12° 36.6'	416
	"		14:06		71° 16.9'	12° 36.1'	412
	"		14:11		71° 16.9'	12° 35.10	412
	"		14:36		71° 16.9'	12° 36.7'	413
	"	199	14:47	3 BO	71° 16.9'	12° 36.4'	409
	"	200	17:35	FTS	71° 15.3'	13° 08.8'	162
	"		18:30		71° 15.9'	13° 10.2'	162
	"	201	18:45	ROV	71° 16.0'	13° 10.5'	160
	"		19:10		71° 16.2'	13° 11.6'	166
18-02	KN	202	06:09	A trap	70° 57.0'	11° 40.6'	808
	"	203	06:37	A trap	70° 58.8'	11° 39.4'	442
	"	204	06:53	F trap	70° 58.8'	11° 41.3'	588
	"	205	07:41	F trap	70° 59.1'	11° 41.3'	548
	"	206	08:27	AGT	71° 00.2'	11° 41.6'	518
	"		08:58		71° 00.4'	11° 42.6'	602
	"		09:13		71° 00.7'	11° 42.5'	594
	"		09:50		71° 00.8'	11° 44.4'	728
	"	207	09:59	3 BO	71° 00.9'	11° 44.8'	759
	"	208	12:41	CTD	71° 06.9'	11° 28.3'	78
	"	209	13:34	TVG	71° 07.3'	11° 28.4'	65
	"	210	14:05	TVG	71° 07.2'	11° 28.4'	67
	"	211	14:30	FTS	71° 07.3'	11° 27.8'	87

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
18-02	KN		15:38		71° 07.6'	11° 29.6'	119
	"	212	15:48	TVG	71° 07.3'	11° 28.5'	75
	"	213	16:38	ROV	71° 07.7'	11° 28.2'	114
	"		18:01		71° 08.3'	11° 28.8'	113
	"	214	18:21	D	71° 07.2'	11° 28.8'	110
	"		18:31		71° 07.3'	11° 28.2'	64
	"		18:41		71° 07.4'	11° 28.0'	66
	"		18:48		71° 07.5'	11° 27.9'	65
	"	215	19:33	FTS	71° 06.4'	11° 31.9'	176
	"		20:27		71° 06.9'	11° 31.9'	150
	"	216	20:47	MG	71° 06.3'	11° 32.3'	211
19-02	KN	217	05:01	3 BO	70° 50.6'	10° 35.4'	258
	"	218	06:19	FTS	70° 50.8'	10° 31.1'	232
	"		07:19		70° 50.8'	10° 30.3'	239
	"	219	07:51	ROV	70° 50.6'	10° 33.2'	257
	"		09:27		70° 50.1'	10° 35.4'	277
	"	220	09:58	GSN	70° 48.2'	10° 41.5'	509
	"		10:57		70° 50.4'	10° 35.4'	272
	"		11:06		70° 50.9'	10° 35.5'	236
	"		11:44		70° 52.4'	10° 33.6'	231
	"	221	12:24	FTS	70° 50.1'	10° 35.6'	270
	"		13:31		70° 49.6'	10° 34.9'	285
	"	222	13:52	GSN	70° 49.1'	10° 39.2'	385
	"		14:27		70° 50.6'	10° 35.5'	267
	"		14:37		70° 51.0'	10° 35.6'	234
	"		16:04		70° 50.5'	10° 41.8'	307
	"	223	18:01	MG	70° 50.2'	10° 35.5'	276
	"	224	18:51	MG	70° 49.8'	10° 35.0'	273
	"	225	19:47	MG	70° 50.1'	10° 35.2'	278
	"	226	20:20	FTS	70° 50.4'	10° 34.9'	270
	"		21:23		70° 50.3'	10° 34.2'	268
20-02	KN	227	06:12	MG	70° 49.4'	10° 38.7'	332
	"	228	07:08	MG	70° 49.8'	10° 38.0'	298
	"	229	08:09	FTS	70° 50.7'	10° 30.9'	234
	"		09:09		70° 50.9'	10° 30.2'	238
	"	230	10:22	MG	70° 50.8'	10° 32.2'	220
	"	231	11:22	CTD	70° 50.9'	10° 30.4'	226
	"	232	12:08	FTS	70° 49.3'	10° 28.9'	283
	"		12:54		70° 49.2'	10° 29.5'	284
	"	233	15:40	A trap recov.	70° 57.0'	11° 41.0'	830
	"	234	16:40	A trap recov.	70° 58.9'	11° 39.8'	442
	"	236	18:06	BO	70° 38.7'	11° 42.0'	646
	"	237	18:34	BO	70° 59.2'	11° 42.4'	637
	"	238	20:05	ROV	71° 06.1'	11° 31.8'	195
	"		21:13		71° 05.9'	11° 31.8'	215
	"	239	21:32	FTS	71° 06.3'	11° 31.9'	183
	"		22:35		71° 05.8'	11° 31.9'	232
21-02	KN	240	08:06	FTS	71° 18.0'	12° 15.5'	178

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
21-02	KN		09:08		71° 18.0'	12° 16.0'	176
	"	241	10:10	GKG	71° 18.0'	12° 16.5'	178
	"	242	10:59	FTS	71° 16.3'	12° 19.7'	166
	"		11:52		71° 16.2'	12° 19.8'	165
22-02	DI	243	08:06	CTD	72° 52.5'	19° 04.6'	430
	"	244	08:40	CTD	72° 52.6'	19° 04.5'	428
	"	245	09:05	BPN	72° 52.5'	19° 04.7'	420
	"		09:35		72° 51.2'	19° 11.8'	392
	"		10:15		72° 50.7'	19° 22.7'	418
	"		10:38		72° 50.5'	19° 26.3'	445
	"	246	11:38	BPN	72° 52.3'	19° 04.6'	427
	"		12:15		72° 50.9'	19° 14.5'	387
	"		13:00		72° 51.0'	19° 21.4'	403
	"	247	13:48	BPN	72° 52.2'	19° 04.8'	419
	"		14:31		72° 50.9'	19° 14.8'	390
	"		15:21		72° 50.8'	19° 25.1'	437
	"		15:46		72° 50.7'	19° 28.0'	454
	"	248	16:53	BPN	72° 52.4'	19° 04.0'	424
	"		17:42		72° 51.0'	19° 17.1'	391
	"		17:55		72° 51.2'	19° 19.1'	389
	"		18:29		72° 50.8'	19° 24.1'	422
	"	249	19:08	F trap	72° 51.1'	19° 23.8'	405
	"	250	19:33	F trap	72° 50.4'	19° 21.3'	407
	"	251	20:17	A trap	72° 47.8'	19° 31.4'	895
	"	252	20:32	CTD	72° 48.0'	19° 32.0'	906
	"	253	21:25	BO	72° 47.9'	19° 32.8'	1005
	"	254	22:52	CTD	72° 50.7'	19° 23.2'	406
23-02	DI	255	05:01	A trap	72° 48.4'	19° 39.6'	1453
	"	256	06:03	2 BO	72° 49.0'	19° 27.0'	520
	"	257	07:52	CTD	72° 47.3'	19° 39.6'	2016
24-02	DI	258	08:16	ISP	72° 47.6'	19° 39.7'	1977
	"	259	18:39	CTD	72° 51.0'	19° 14.2'	386
	"	260	19:53	CTD	72° 52.5'	19° 04.4'	426
	"	261	20:29	GSN pelagic	72° 52.5'	19° 04.8'	427
	"		20:54		72° 51.4'	19° 09.6'	408
	"		21:28		72° 51.1'	19° 17.5'	392
	"		21:38		72° 51.0'	19° 19.4'	540
	"	262	23:00	GSN pelagic	72° 52.5'	19° 04.8'	425
	"		23:23		72° 51.5'	19° 09.3'	543
25-02	DI		00:03		72° 51.1'	19° 18.8'	396
	"		00:28		72° 51.2'	19° 23.3'	419
	"	263	01:09	GSN	72° 51.7'	19° 07.7'	411
	"		01:34		72° 51.0'	19° 13.1'	388
	"		01:44		72° 51.0'	19° 15.2'	383
	"		02:32		72° 51.1'	19° 22.3'	409
	"	264	03:46	AGT	72° 50.7'	19° 26.6'	444
	"		04:12		72° 49.9'	19° 26.5'	470
	"		04:18		72° 49.8'	19° 26.4'	473

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
25-02	DI		04:56		72° 49.8'	19° 26.2'	471
	"	265	07:38	CTD	72° 49.8'	19° 25.2'	466
	"	266	13:27	F trap recov.	72° 50.5'	19° 21.8'	419
	"	267	14:12	A trap recov.	72° 48.3'	19° 33.0'	857
	"	268	15:03	A trap recov.	72° 49.3'	19° 40.3'	1751
26-02	S/KN	269	06:28	EBS 12 (548)	71° 18.5'	15° 51.1'	2504
	"		08:23		71° 18.4'	15° 48.4'	2554
	"		08:33		71° 18.2'	15° 47.5'	2442
	"		10:33		71° 18.4'	15° 45.5'	2442
	"	270	10:58	MG	71° 18.5'	15° 47.4'	2456
	"	271	13:57	MG	71° 27.5'	15° 05.6'	2005
	"	272	14:34	EBS 13 (466)	71° 27.5'	15° 06.5'	2007
	"		16:10		71° 28.8'	15° 10.4'	2076
	"		16:20		71° 29.0'	15° 10.3'	2003
	"		17:50		71° 30.4'	15° 13.3'	2061
	"	273	18:03	CTD	71° 30.2'	15° 13.7'	2073
	"	274	19:32	3 BO	71° 31.1'	15° 14.0'	2060
27-02	S/KN	275	06:04	M recov.	71° 45.1'	14° 45.3'	293
	"		07:03	CTD	71° 44.9'	14° 44.4'	296
	"	276	12:12	M search	71° 10.2'	13° 01.7'	417
	KN	277	15:30	AGT	71° 18.2'	12° 16.4'	177
	"		15:42		71° 18.0'	12° 15.3'	184
	"		15:52		71° 18.0'	12° 15.0'	184
	"		16:10		71° 18.0'	12° 15.0'	184
	N/KN	278	20:45	FTS	70° 53.4'	10° 41.9'	296
	"		21:48		70° 53.4'	10° 41.2'	289
28-02	AB	279	06:11	A trap	70° 24.1'	07° 52.2'	1136
	"	280	06:46	A trap	70° 27.4'	07° 55.9'	550
	"	281	18:50	ROV	70° 40.2'	08° 01.5'	66
	"		20:17		70° 40.0'	08° 02.3'	69
29-02	AB	282	05:01	3 BO	70° 23.7'	07° 53.5'	1119
	"	283	06:20	A trap recov.	70° 24.1'	07° 53.0'	1108
	"	284	08:00	A trap recov.	70° 27.3'	07° 56.5'	552
	"	285	16:17	ROV	70° 47.4'	10° 24.6'	296
	"		17:57		70° 47.8'	10° 26.3'	296
	"	286	19:08	ROV	70° 51.7'	10° 45.2'	317
	"		20:47		70° 51.6'	10° 47.2'	318
03-03	KN	287	00:30	ROV	71° 13.8'	12° 15.0'	269
	"		01:45		71° 13.4'	12° 13.8'	284
	"	288	06:17	M recov. (failure)	71° 10.5'	13° 01.7'	405
	"	289	12:57	M recov.	71° 30.6'	13° 30.9'	235
14-03	KG	290	07:57	2 BO	62° 16.0'	58° 17.5'	727
	"	291	09:32	A trap	62° 16.6'	58° 15.8'	798
	"	292	10:25	A trap	62° 11.3'	58° 20.2'	414
	"	293	10:34	F trap	62° 11.0'	58° 20.7'	405
	"	294	10:53	F trap	62° 11.2'	58° 20.8'	437
	"	295	13:39	AGT	62° 15.8'	58° 42.6'	237
	"		13:54		62° 16.0'	58° 43.0'	267

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
14-03	KG		14:04		62° 15.8'	58° 43.3'	245
	"		14:19		62° 15.9'	58° 43.3'	252
	"	296	14:43	D	62° 15.8'	58° 42.7'	199
	"		14:55		62° 15.8'	58° 42.9'	222
	"		15:00		62° 15.8'	58° 42.9'	245
	"		15:18		62° 16.1'	58° 42.9'	269
	"	297	15:35	AGT	62° 15.9'	58° 42.7'	223
	"		15:49		62° 15.8'	58° 42.7'	211
	"		15:55		62° 15.7'	58° 42.9'	232
	"		16:10		62° 15.7'	58° 42.9'	234
	"	298	16:35	MUC	62° 15.8'	58° 42.6'	239
	"	299	17:30	MG	62° 15.8'	58° 42.7'	207
	"	300	18:50	MG	62° 16.8'	58° 42.1'	423
	"	301	20:01	MUC	62° 16.6'	58° 42.0'	398
	"	302	20:39	MUC	62° 16.6'	58° 42.3'	374
	"	303	21:12	AGT	62° 16.9'	58° 41.3'	375
	"		21:45		62° 16.5'	58° 43.1'	430
	"		21:53		62° 16.5'	58° 43.3'	450
	"		22:00		62° 16.5'	58° 43.2'	449
	"	304	22:36	AGT	62° 16.7'	58° 43.2'	460
	"		22:54		62° 16.4'	58° 43.5'	447
	"		23:04		62° 16.3'	58° 43.9'	451
	"		23:26		62° 16.3'	58° 43.6'	417
	"	305	23:43	CTD	62° 16.7'	58° 42.8'	403
15-03	KG	306	15:45	MUC	62° 21.9'	58° 43.0'	801
	"	307	16:26	AGT	62° 22.0'	58° 43.4'	829
	"		16:56		62° 22.4'	58° 44.6'	817
	"		17:06		62° 22.5'	58° 44.8'	864
	"		17:41		62° 22.2'	58° 44.0'	823
	"	308	20:26	AGT	62° 22.0'	58° 40.9'	843
	"		20:56		62° 22.0'	58° 42.4'	840
	"		21:06		62° 21.9'	58° 42.5'	821
	"		21:53		62° 21.4'	58° 41.8'	710
	"	309	22:33	BO	62° 22.0'	58° 42.1'	822
16-03	KG	310	16:24	EBS 14 (336)	62° 15.7'	58° 23.1'	180
	"		16:33		62° 15.7'	58° 23.0'	189
	"		16:43		62° 15.8'	58° 23.3'	205
	"		16:53		62° 15.8'	58° 23.3'	204
	"	311	17:14	EBS 15 (295)	62° 16.4'	58° 23.8'	418
	"		17:33		62° 16.4'	58° 23.8'	412
	"		17:43		62° 16.4'	58° 24.1'	378
	"		18:02		62° 16.3'	58° 24.0'	359
	"	312	18:34	A trap recov.	62° 16.6'	58° 15.2'	792
	"	313	19:48	F trap recov.	62° 11.2'	58° 20.7'	455
	"	314	20:20	F trap recov.	62° 10.9'	58° 20.8'	397
	"	315	20:33	A trap recov.	62° 11.3'	58° 20.2'	407
	"	316	21:49	EBS 16 (207)	62° 16.5'	58° 16.3'	743
	"		22:22		62° 16.4'	58° 16.6'	742

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
16-03	KG		22:32		62° 16.4'	58° 16.8'	742
	"		23:13		62° 16.3'	58° 16.2'	738
17-03	KG	317	00:52	FTS	62° 21.9'	58° 41.9'	801
	"		01:57		62° 21.8'	58° 40.3'	787
	"	318	07:01	FTS	62° 16.5'	58° 42.1'	344
	"		07:40		62° 16.5'	58° 42.3'	373
	"	319	07:59	FTS	62° 15.8'	58° 43.0'	236
	"		08:28		62° 15.6'	58° 43.0'	199
	"	320	09:25	EBS 17 (243)	62° 22.5'	58° 42.0'	1025
	"		10:09		62° 22.7'	58° 41.8'	1054
	"		10:18		62° 22.6'	58° 42.1'	1056
	"		11:10		62° 22.2'	58° 41.2'	910
	"	321	11:31	D	62° 20.3'	58° 40.3'	544
	"		12:04		62° 20.0'	58° 39.2'	595
	"		12:12		62° 19.8'	58° 38.2'	439
	"		12:46		62° 19.8'	58° 36.0'	558
	"	322	13:11	AGT + D	62° 20.6'	58° 35.7'	637
	"		13:32		62° 20.3'	58° 35.9'	636
	"		13:42		62° 20.6'	58° 36.3'	643
	"		14:12		62° 20.3'	58° 35.6'	601
	"	323	15:10	EBS 18 (215)	62° 25.3'	58° 42.4'	1486
	"		16:17		62° 25.3'	58° 42.2'	1499
	"		16:26		62° 25.4'	58° 42.5'	1490
	"		17:34		62° 25.5'	58° 41.4'	1494
	"	324	17:43	AGT	62° 25.6'	58° 41.2'	1496
	"		18:33		62° 25.6'	58° 43.0'	1502
	"		18:42		62° 25.6'	58° 43.2'	1502
	"		19:33		62° 25.4'	58° 42.1'	1490
	"	325	20:27	MG	62° 21.9'	58° 42.6'	805
	"	326	22:02	MG	62° 20.1'	58° 38.8'	606
	"	327	23:22	ISP	62° 24.7'	58° 37.4'	1443
18-03	KG	328	13:45	EBS 19 (428)	61° 20.2'	58° 13.4'	2086
	"		15:14		61° 20.2'	58° 11.8'	2072
	"		15:24		61° 20.0'	58° 11.7'	2076
	"		17:00		61° 19.0'	58° 10.0'	2131
	"	329	17:21	AGT	61° 20.3'	58° 12.5'	2063
	"		18:26		61° 20.5'	58° 14.7'	2059
	"		18:55		61° 20.4'	58° 15.5'	2047
	"		-		61° 20.2'	58° 15.1'	2113
	"	330	20:31	MG	61° 20.6'	58° 15.1'	2009
	"	331	22:45	BO	61° 21.1'	58° 13.6'	1853
19-03	DP	332	00:37	CTD	61° 26.2'	58° 08.8'	1016
	"	333	01:45	FTS	61° 26.8'	58° 08.1'	994
	"	334	09:08	MG	61° 26.7'	58° 06.6'	1028
	"	335	10:49	EBS 20 (468)	61° 26.7'	58° 07.0'	1016
	"		11:37		61° 27.0'	58° 07.2'	988
	"		11:47		61° 27.2'	58° 07.5'	939
	"		12:36		61° 27.3'	58° 08.4'	901

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
19-03	DP	336	12:57	AGT	61° 26.5'	58° 07.4'	1031
	"		13:46		61° 26.8'	58° 06.2'	1047
	"		14:02		61° 27.1'	58° 05.2'	1227
	"		15:00		61° 27.6'	58° 04.1'	967
	"	337	16:14	D	61° 34.2'	58° 14.6'	405
	"		16:41		61° 34.1'	58° 13.2'	403
	"		16:51		61° 34.0'	58° 12.8'	407
	"		17:15		61° 33.9'	58° 12.2'	417
	"	338	17:18	AGT	61° 33.9'	58° 12.2'	417
	"		17:38		61° 33.9'	58° 11.0'	416
	"		17:48		61° 34.0'	58° 10.6'	416
	"		18:14		61° 34.0'	58° 09.8'	417
	"	339	18:28	EBS 21 (335)	61° 34.0'	58° 09.2'	419
	"		18:48		61° 34.2'	58° 08.5'	409
	"		18:58		61° 34.2'	58° 08.1'	403
	"		19:17		61° 34.3'	58° 08.0'	401
	"	340	19:28	MUC	61° 34.3'	58° 07.6'	411
	"	341	20:17	MG	61° 34.5'	58° 07.0'	429
	"	342	20:57	FTS	61° 34.6'	58° 06.6'	428
	"		21:44		61° 34.7'	58° 06.8'	426
	"	343	21:46	CTD	61° 34.7'	58° 06.9'	425
20-03	DP	344	01:53	CTD	61° 53.2'	59° 06.4'	208
	"	345	09:09	MG	61° 53.3'	59° 06.9'	218
	"	346	09:48	D	61° 53.4'	59° 07.1'	214
	"		10:04		61° 53.6'	59° 07.5'	191
	"		10:09		61° 53.7'	59° 07.6'	187
	"		10:23		61° 53.8'	59° 07.7'	184
	"	347	10:41	EBS 22 (334)	61° 53.5'	59° 07.3'	215
	"		10:50		61° 53.5'	59° 07.0'	211
	"		11:01		61° 53.5'	59° 06.6'	210
	"		11:14		61° 53.5'	59° 06.4'	209
	"	348	11:27	AGT	61° 53.4'	59° 06.5'	216
	"		11:40		61° 53.4'	59° 07.2'	215
	"		11:55		61° 53.4'	59° 08.0'	217
	"		12:11		64° 53.4'	59° 08.2'	218
	"	349	12:23	MUC	61° 53.2'	59° 07.9'	226
	"	350	12:49	FTS	61° 53.2'	59° 07.8'	225
	"		14:09		61° 53.2'	59° 07.1'	222
	"	351	15:53	MUC	62° 01.0'	59° 15.5'	122
	"	352	16:11	AGT	62° 00.7'	59° 15.6'	126
	"		16:20		62° 00.4'	59° 15.3'	129
	"		16:29		62° 00.3'	59° 15.2'	129
	"		16:44		62° 00.0'	59° 15.1'	128
	"	353	16:58	AGT	61° 59.7'	59° 14.8'	128
	"		17:08		61° 59.4'	59° 14.4'	129
	"		17:18		61° 59.2'	59° 14.3'	132
	"		17:29		61° 58.9'	59° 14.4'	142
	"	354	17:44	EBS 23 (531)	61° 59.2'	59° 14.1'	130

Date	Area	Station No.	Time (UTC)	Operation (Haul length, m)	Latitude (S)	Longitude (W)	Depth (m)
20-03	DP		17:53		61° 59.4'	59° 14.4'	127
	"		18:03		61° 59.6'	59° 14.7'	127
	"		18:12		61° 59.7'	59° 14.8'	126
	"	355	18:17	D	61° 59.8'	59° 14.8'	128
	"		18:27		61° 59.9'	59° 14.8'	130
	"		18:33		62° 00.0'	59° 14.8'	128
	"		18:44		62° 00.1'	59° 14.8'	130
	"	356	19:04	MG	62° 00.3'	59° 14.9'	130
	"	357	19:56	FTS	62° 00.2'	59° 15.3'	129
	"		20:21		62° 00.3'	59° 15.6'	132
21-03	KG	358	09:36	CTD	62° 24.6'	58° 36.5'	1440

3.3 Seabird Observations along the Cruise (A. Lombarte, O. Krüger)

This short section deals with the observations on pelagic and coastal seabirds during the cruise. A total of 31 species was observed (Table 1). We present only the species that could be identified positively following Narosky and Yzurieta (1988) and Harrison (1991). The table shows the percentage of occurrence by day (number of days observed divided by number of days in the area). Most species identified are of the order Procellariiformes, the most characteristic pelagic group of birds, especially in the areas far away from the coast or ice shelf. This order is characteristic of the regions: South Atlantic (SA) area and Antarctic Ocean (AO) (between Cape Town and Neumayer), eastern Weddell Sea (EWS) and Drake Passage area (DP). The Drake Passage is also characterized by oceanic species such as *Diomedea exulans* and *Pelecanoides urinatrix.*

In the southern regions like Atka Bay and Kapp Norvegia (KN), Vestkapp and Drescher Inlet (VK), and Halley Bay (HB) there are less species than in the oceanic areas, but these species form a group well defined by the Sphenisciformes, *Pygoscelis adeliae* and *Aptenodytes forsteri,* the Procellariiformes *Thalassoica antarctica* and *Pagodroma nivea* associated to the pack-ice, and a continental species of the family Stercorariidae, *Catharacta maccormicki..*

The area of the western Weddell Sea (WWS) exhibits an intermediate avifaunistic composition between southern areas and oceanic areas because the pack-ice was more abundant than on the eastern side of the Weddell Sea.

The composition of the species associated with the Bransfield Strait and Adelaide Island (BR) are characterized by a high percentage of coastal birds such as Pelecaniformes, *Phalocrocorax atriceps* and the Charadriiformes *Chionis alba*, *Catharacta antarctica* and *Larus dominicanus.*

References

Harrison, P. (1996): Seabirds - an identification guide. Christopher Helm, London, U.K. pp. 448.

Narosky, T. and D. Yzurieta (1988). Guía para la identificación de las aves de Argentina y Uruguay. Vázquez Mazzini Editores, Buenos Aires, Argentina. pp 345.

Table 63: Bird species observed along the cruise ANT XV/3 (EASIZ II) and percentage of occurrence by day. The observations refer to the following areas: SA = South Atlantic (between Cape Town and Antarctic Convergence), AO = Antarctic Ocean (between Antarctic Convergence and Neumayer), KN = Kapp Norvegia and Atka Bay, VK = Vestkapp and Drescher Inlet, HB = Halley Bay, EWS = eastern Weddell Sea, WWS = western Weddell Sea, BR = Bransfield Strait and Adelaide Island, DP = Drake Passage (south of Antarctic Convergence), * = coastal habitats.

Area	SA	AO	KN	VK	HB	EWS	WWS	BR	DP
Days of observation	5	4	19	14	6	4	2	10	4
SPHENISCIFORMES									
Spheniscidae									
Aptenodytes forsteri			0.21	0.29	0.33				
Pygoscelis adeliae			0.37	0.43	0.33		1.00	0.10	0.25
Pygoscelis antarctica									0.50
PROCELLARIIFORMES									
Diomedeidae									
Diomedea chrysostoma								0.10	0.75
Diomedea epomorpha									0.25
Diomedea exulans	0.40								0.25
Diomedea melanophrys	0.60							0.60	1.00
Phoebetria fusca		0.25							
Phoebetria palpebrata		0.50							
Procellariidae									
Daption capense	0.20					0.50	0.50	0.30	1.00
Fulmarus glacialoides	0.20	0.25	0.05			0.50	0.50	0.40	0.75
Halobaena caerulea		0.25							
Macronectes giganteus	0.20	0.50	0.37	0.29	0.33	0.25	1.00	1.00	1.00
Macronectes halli									0.50
Pachyptila desolata	0.20	0.25				0.25			0.50
Pagodroma nivea		0.25	1.00	0.93	0.83	0.50	0.50		
Procellaria aequicnotialis									0.50
Pterodroma incerta	0.20								
Pterodroma lessoni	0.20								
Pterodroma mollis	0.20								
Puffinus griseus	0.20								
Thalassoica antarctica		0.75	0.89	0.93	1.00	0.75	0.50	0.10	0.25
Oceanitidae									
Fregetta tropica	0.20	0.25							0.75
Oceanites oceanicus		0.25	0.21	0.14	0.00	0.25	1.00	0.70	0.75
Pelecanoididae									
Pelecanoides urinatrix									0.25
PELECANIFORMES									
Phalacrocoridae									
*Phalocrocorax atriceps**								0.20	
CHARADRIIFORMES									
Chionididae									
*Chionis alba**								0.10	
Stercorariidae									
*Catharacta antarctica**								0.70	
*Catharacta maccormicki**			0.21	0.21				0.10	
Laridae									
*Larus dominicanus**								0.10	0.25
Sternidae									
Sterna paradisea				0.07		0.25	0.50	0.10	0.75
Number of species	11	10	8	8	5	8	8	14	16

3.4 Participants

EASIZ participants

Arntz, Wolf E.	AWI	D
Avila, Conxita	CEAB	E
Bester, Marthan	UPR	SA
Beyer, Kerstin	AWI	D
Bluhm, Bodil	AWI	D
Bohlmann, Harald	ISITEC	D
Bornemann, Horst	AWI	D
Brandt, Angelika	ZIZM	D
Buschmann, Alexander	AWI	D
De Broyer, Claude	IRSNB	B
Dieckmann, Gerhard	AWI	D
Dijkstra, Jennifer	AWI	D
Dimmler, Werner	RM	D
Filipe, Patricia	ICM/UL	P
Gambi, Maria Cristina	SZI	I
Gatti, Susanne	AWI	D
Gerdes, Dieter	AWI	D
Gili, Josep María	ICM	E
Graeve, Martin	AWI	D
Großpietsch, Heike	AWI	D
Gutt, Julian	AWI	D
Hanfland, Claudia	AWI	D
Hilbig, Brigitte	ZIZM	D
Hirse, Timo	AWI	D
Iken, Katrin	AWI	D
Knust, Rainer	AWI	D
Krüger, Oliver	AWI	D
Lee, Hee Jong	UGZ	KOR
Linse, Katrin	ZIZM	D
Lombarte, Antoni	ICM	E
López, Pablo	USE	E
Odendaal, Paul Nielen	UPR	SA
Olaso, Ignacio	IEO	E
Orejas, Covadonga	AWI/ICM	E
Piepenburg, Dieter	IPÖ	D
Plötz, Joachim	AWI	D
Rauschert, Martin	AWI-FP	D
Ros, Joandomènec	UB	E
Scailteur, Yves	IRSNB	B
Schmid, Michael	IPÖ	D
Schröder, Alexander	AWI	D
Storch, Volker	UHZ	D
Teixidó, Nuria	UB	E
Terpstra, Sita	AWI	NL
Thomas, David	UWB	UK
Van de Velde, Johan	UGZ	B
Wegener, Gisela	ZIZM	D

Helicopter Crew, Meteorologists

Böhm, Joachim	HSW	D
Brauner, Ralf	DWD	D
Dinkeldein, Wolfgang	HSW	D
Köhler, Herbert	DWD	D
Lahrmann, Uwe	HSW	D
Zeppick, Burkhard	HSW	D

To and from Neumayer

Ams, Joachim	AWI/RM	D
Brehme, Andreas	AWI	D
Bretfeld, Holger	AWI/RM	D
Büßelberg, Thorsten	AWI	D
Ebberler, Alexandra	AWI	D
Förster, Winfrid	AWI/RM	D
Gierlichs, Anette	AWI	D
Hofmann, Jörg	AWI	D
Janneck, Jürgen	AWI	D
Kaiser, Wolfgang	AWI/RM	D
Kästner, Rudolf	AWI/RM	D
König-Langlo, Gert	AWI	D
Köhnlein, Andreas	AWI	D
Lippmann, Erich	AWI	D
Miller, Georg	AWI	D
Müller, Beate	AWI	D
Przybilla, Thomas	AWI	D
Quaas, Christian	AWI/RM	D
Riedel, Katja	AWI	D
Sacker, Carsten	AWI	D
Tibcken, Michael	AWI	D
Weynand, Markus	AWI	D
Wlochowitz, Dirk	AWI	D

From Jubany

Dietrich, Désirée	IFÖ	D
Kim, De Hong	AWI	KOR
Kowalke, Jens	AWI	D
Matz, Thomas	AWI	D
Meyer, Michaela	IPÖ	D
NN (Argentina)	AA	ARG
Reimann, Niels	IFM	D
Schmoll, Tim	UJÖ	D
Steinmetz, Richard	AWI	D

3.5 Participating Institutions

AA
Armada Argentina (observer)

AWI
Alfred-Wegener-Institut
für Polar- und Meeresforschung
Columbusstr.
27568 Bremerhaven, Germany

CEAB
Centre d'Estudis Avançats de Blanes
Camí de Sta. Bàrbara s/n
17300 Blanes
Girona, Spain

DWD
Deutscher Wetterdienst
Geschäftsfeld Seeschiffahrt, Bordwetterdienst
Bernhard-Nocht-Str. 76
20359 Hamburg, Germany

HSW
Helicopter Service Wasserthal GmbH
Kättnerweg 43
22393 Hamburg, Germany

ICM
Institut de Ciències del Mar
Plaça del Mar s/n
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IEO
Instituto Español de Oceanografía
Centro Oceanográfico de Santander
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IPÖ
Institut für Polarökologie
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IRSNB
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ISITEC
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SZI
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80077 Ischia (Napoli), Italy

UB	Universitat de Barcelona Fac. Biología, Dept. Ecología Avinguda Diagonal, 645 08028 Barcelona, Spain
UGZ	University of Gent Institute of Zoology, Marine Biology Section K. L. Ledeganckstraat 35 B-9000 Gent, Belgium
UHZ	Universität Heidelberg Zoologisches Institut Im Neuenheimer Feld 230 69120 Heidelberg, Germany
UPR	University of Pretoria Dept. of Zoology & Entomology Pretoria 0002, South Africa
USE	Universidad de Sevilla Laboratorio de Biología Marina Apdo. 1095 41080 Sevilla, Spain
UWB	University of Wales -Bangor School of Ocean Sciences, Menai Bridge Anglesey LL 59 5EY, United Kingdom
ZIZM	Zoologisches Institut und Zoologisches Museum Martin-Luther-King-Platz 3 20146 Hamburg, Germany

3.6 Ship's Crew

Greve, Ernst-Peter	Master	D
Grundmann, Uwe	1. Offc.	D
Knoop, Detlef	Ch. Eng.	D
Fallei, Holger	2. Offc.	D
Peine, Lutz G.	2. Offc.	D
Spielke, Steffen	2. Offc.	D
Fleischer-Peter, B.	Doctor	D
Koch, Georg	R. Offc.	D
Erreth Monostori, G.	2. Eng.	D
Fleischer, Martin	2. Eng.	D
Ziemann, Olaf	2. Eng.	D
Dimmler, Werner	Electron.	D
Greitemann-Hackl, A.	Electron.	D
Lembke, Udo	Electron.	D
Muhle, Heiko	Electron.	D
Muhle, Helmut	Electron.	D
Roschinsky, Jörg	Electron.	D
Clasen, Burkhard	Boatsw.	D
Reise, Lutz	Carpenter	D
Bindernagel, Knuth	A. B.	D
Burzan, Gerd-Ekkeh.	A. B.	D
Gil Iglesias, Luís	A. B.	E
Kreis, Reinhard	A. B.	D
Moser, Siegfried	A. B.	D
Pousada Martínez, S.	A. B.	E
Pulss, Horst	A. B.	D
Schulz, Ottomar	A. B.	D
Müller, Klaus W. H.	Storek.	D
Grafe, Jens	Mot-man	D
Hartmann, Ernst-Uwe	Mot-man	D
Ipsen, Michael	Mot-man	D
Preußner, Jörg	Mot-man	D
Voy, Bernd	Mot-man	D
Haubold, Wolfgang	Cook	D
Martens, Michael	Cooksmate	D
Völske, Thomas	Cooksmate	D
Jürgens, Monika	1. Stwdess	D
Dähn, Ulrike	Stwdess/Kr	D
Czyborra, Bärbel	2. Stwdess	D
Deuß, Stefanie	2. Stwdess	D
Mui, Kee Fung	2. Steward	CH
Neves, Alexandre	2. Steward	P
Tu, Jian-Min	2. Steward	CH
Yu, Chung Leung	Laundrym.	CH

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zusammengestellt von Gerd Hubold und H. Eberhard Drescher

* **Heft Nr. 5/1982** – "Joint Biological Expedition on RRS 'John Biscoe', February 1982"
by G. Hempel and R. B. Heywood

* **Heft Nr. 6/1982** – „Antarktis-Expedition 1981/82 (Unternehmen ‚Eiswarte‘)“
zusammengestellt von Gode Gravenhorst

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zusammengestellt von R. Schneppenheim

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by I. Hempel, G. Hubold, B. Kaczmaruk, R. Keller, R. Weigmann-Haass

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zusammengestellt von Dieter Adelung

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Data of micronecton and zooplankton hauls, by Uwe Piatkowski

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Stationslisten der Plankton-, Benthos- und Grundschleppnetzfänge und Liste der Probennahme an Robben und Vögeln, von H. E. Drescher, G. Hubold, U. Piatkowski, J. Plötz und J. Voß

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