JOINT BIOLOGICAL EXPEDITION ON RRS JOHN BISCOE, FEBRUARY 1982

(Gemeinsame biologische Expedition mit RRS „John Biscoe", Februar 1982)

by G. Hempel and R. B. Heywood

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Zusammenfassung

Im Rahmen der deutsch-englischen Zusammenarbeit in der Antarktisforschung beteiligte sich die Bundesrepublik Deutschland im Südsommer 1981/82 an einer Expedition mit dem RRS "John Biscoe" des British Antarctic Survey. Der dritte Abschnitt dieser Expedition war bestimmt vom deutschen Programm, an dem sich Wissenschaftler des Alfred-Wegener-Instituts für Polarforschung, Bremerhaven, und der Arbeitsgruppe für Polarökologie, Kiel, beteiligten.

Auf 4 Dauerstationen wurden kurzfristige Änderungen in der Verteilung von Phyto- und Zooplankton untersucht. Zur Erfassung der großräumigen Verteilung von Phyto- und Zooplankton, Krill und Fischlarven wurden mehrere Schnitte im Raum der antarktischen Halbinsel und der Scotia See gefahren. Gleichzeitig wurden physiologische und biochemische Experimente, Fütterungsversuche an Copepoden und populationsgenetische Untersuchungen am Krill durchgeführt.

Dieser Bericht enthält eine Beschreibung des Fahrtverlaufes sowie Berichte der einzelnen Arbeitsgruppen über durchgeführte Arbeiten und erste Ergebnisse.

Summary

In the framework of the German-English cooperation in Antarctic research, the Federal Republic of Germany participated, in the austral summer 1981/82, in an expedition of RRS John Biscoe, of the British Antarctic Survey. The third leg of this expedition was determined by the German programme, in which scientists of the Alfred-Wegener-Institute for Polar Research in Bremerhaven, and of the Working Group on Polar Ecology in Kiel, participated.

At 4 permanent stations, short-term changes in the distribution of phyto- and zooplankton were examined. In order to understand the large-scale distribution of phyto- and zooplankton, of krill and fish larvae, several profiles were run in the region of the Antarctic Peninsula and Scotia Sea. At the same time, physiological and biochemical experiments, feeding tests with copepods, and population genetic experiments with krill were made.

This report contains a description of the cruise track as well as reports of individual working groups on work done, and on first results.

JOINT BIOLOGICAL EXPEDITION ON RRS JOHN BISCOE, FEBRUARY 1982

by

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Introduction

The British Antarctic Survey carries out a comprehensive annual Offshore Biological Programme (OBP) mainly around South Georgia. Institutions in the Federal Republic of Germany investigate a wider geographic area, mainly between the South Orkney Islands and the west coast of the Antarctic Peninsula, but at less frequent intervals. Both programmes contribute to the international programme BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks). For scientific, logistic and financial reasons it was thought that close links between the British and German programmes could be mutually advantageous. A joint project of research in waters south of 60° using the BAS vessel, RRS John Biscoe, was envisaged, with the Alfred-Wegener-Institute for Polar Research making a contribution towards the running costs of the vessel. German scientists would also come from the Working Group on Polar Ecology of the University of Kiel (Arbeitsgruppe für Polarökologie der Universität Kiel) which is mainly sponsored by the Federal Ministry of Science and Technology.

Provisional plans for the joint venture were discussed in May and December 1980. However, these plans had to be revised after the 1980/81 austral summer when the British scientists could not carry out their regular OBP programme or participate in the First International BIOMASS Experiment (FIBEX) because of technical failure of their vessel, but the Germans gained experience in FIBEX from two vessels. Consequently, it was agreed that in 1981/82 a normal OBP programme would be carried out, consisting of a South Georgia Zone Survey and a South Georgia Shelf Krill Patch study (John Biscoe, cruise 3, Leg 1 and 2), followed by a separate joint research study on waters around the Antarctic Peninsula (Leg 3). It was agreed that there would be some German participation in OBP; A. Keck would study the moulting physiology and fluoride metabolism of krill (Euphausia superba), and W. Hagen would study the general biology of Chaetognaths. Major emphasis during Leg 3 would be on a German programme, consisting of comparative studies on phyto- and zooplankton community structure in various areas around the Antarctic Peninsula and Scotia Arc, and of studies on early life stages of krill and fish species, krill biochemistry and population dynamics, and copepod trophodynamics. Five areas were selected to give the wide geographic range necessary (Fig. 1).

These were
- Scotia Sea, including the Elephant Island region,
- Bransfield Strait,
- Seas west of the Antarctic Peninsula,
- Northern Weddell Sea,
- South Georgia region.

A reduced BAS team would study the hydrography of these areas and carry out acoustic surveys of krill concentration. BAS personnel would also remain responsible for the deployment of sampling equipment.

The programmes consisted mainly of 4 time-stations for the study of diurnal variations in phyto- and zooplankton distribution and physiology. Furthermore, the large scale distribution of watermasses, krill and plankton was studied en route and at short stations along several profiles. Live specimen had to be collected for studies in physiology and biochemistry.

Some minor alterations to the ship were required to provide the additional laboratory space made necessary by the change of emphasis to more experimental studies. These would include the temporary installation in the forward hold of a biochemical laboratory built into a cargo container.

Objectives of the Joint Biological Expedition

Physical Oceanography

To identify and describe the horizontal and vertical distribution of water masses in the area, and relate to areal and temporal variation in plankton community composition. Particular interest would be paid to the Bransfield Strait area where water from the Weddell Sea gyre enters during the summer to mix with Bellingshausen Sea/Drake Passage waters. Five STD transects were planned for this area. A Plessey salinity-temperature profiler (STD) with a General Oceanics water bottle rosette system would be used on most stations.

Phytoplankton, Microzooplankton

To estimate the total biomass in certain parts of the area by means of chlorophyll measurements and cell counts. Dominant species and community composition would be related to water mass distribution and the occurrence of krill.

Inventory of Macrozooplankton

To study large- and small-scale areal and temporal variation in total macrozooplankton abundance, and in community composition ratios of the major component groups - krill, other euphausiids, salps, copepods, chaetognaths, fish larvae, etc. There appears to be considerable variation in Antarctic waters, with dense concentration of krill and most other groups being mutually exclusive. Particular attention would be given to the area west of the Antarctic Peninsula, for which data is currently very sparse, and to repeating some stations worked by RV Walter Herwig and RV Meteor at this time in previous years, using similar gear - the rectangular midwater trawl (RMT1+8). Discrete hauls taken from 3 depth strata with the multiple closing RMT1+8 m at various times of the day at time stations would be used to study diurnal vertical migration and microscale variability. Information on fish larvae is very sparse for the area, especially south of the Bismarck Strait and the Weddell Sea. Particular emphasis would be placed on obtaining material for improving current larvae identification keys and investigating feeding habits. The deeper RMT1+8 m hauls should provide material to extend the Chaetognath study begun during Legs 1 and 2 with regard to geographical and vertical distribution.

Biology of Chaetognaths

To study the nutritional ecology of Antarctic Chaetognaths. Feeding experiments would be conducted to find out about prey selection, prey detection and capture, feeding process, digestion times and food requirements.

Distribution and Population Genetics of Krill

To study the geographic distribution of krill in relation to water masses by (a) comparing the acoustic signal strength of krill concentration from different geographic locations with net samples. Patterns of aggregation and vertical migration would be related to environmental features. The wide geographic range of Leg 3 would present an excellent opportunity for this BAS project. A standard SIMRAD EK-S120 Scientific Echosounder with hull-mounted transducer would be used, interfaced to a QM MkII Echo-integrator and a SIMRAD NL Doppler Log providing analogue speed indication and reset pulses at 1 n mile or 0.1 n mile intervals. The echosounder and integrator would be calibrated at the start of the Leg and monitored at regular intervals. (b) by taking samples of krill for length frequency, sex and maturation stage analysis at frequent intervals for the Federal Institute for Fisheries Research, Hamburg. Diurnal variation in catch composition would be investigated by sampling three depth strata on each occasion by RMT1+8 m.

To study krill population genetics. Fresh material would be used to investigate the variability in protein structure of suitable enzymes. The results would be compared with biological and morphometric characteristics.

Studies on Krill Eggs and Larvae

To continue work carried out in the area by German scientists since 1975, which has revealed wide annual variation in abundance, and in seasonal and areal distribution. Further data on eggs and larvae would be obtained with related hydrographic and spawning condition data. A number of deep vertical hauls would be taken with 70 cm closing nets to give more insight into the vertical distribution of life stages during the developmental ascent.

To continue work begun on RV Meteor in 1981 on larval appendages, and their functions in food particle collection and ingestion. Larvae would be kept alive beyond moulting to provide perfect specimens for a subsequent scanning-electron-microscope survey of appendage morphology in different developmental stages. These studies on functional morphology would be combined with filmed live observations.

To determine the rate of development and duration of each larval stage by keeping larvae under standard conditions for extended periods of time. Onset of feeding would be established on the basis of the ontogenetic development of the gut and the presence of food particles.

Physiology and Biochemistry of Phytoplankton, Zooplankton and Krill

To investigate the physiology and biochemistry of adaptive mechanisms in Antarctic organisms. Monocultures of dominant phytoplankton species would be established under natural low temperature conditions and transported to Kiel for studies on growth rates, enzyme kinetics and other physiological activities.

During Leg 3, krill and other zooplankters would be incubated at various temperatures, and respiration rates measured immediately and over a period of at least two weeks to assess adaptation capabilities. Chemical methods for enzyme kinetics would be used to assess how the metabolism works at near-freezing point temperatures.

Moulting Physiology and Fluoride Metabolism of Krill

To study and quantify the process of fluoride uptake. Krill would be maintained in natural or artificial seawater with various fluoride concentrations. Survival and moulting would be studied. The fluoride content of different organs would be measured potentiometrically.

Trophodynamics of Herbivorous Copepods

To study the feeding biology of the dominant species by means of concurrent field observations and laboratory experiments. The abundance of various herbivorous copepod species, and diurnal rhythms in feeding activity as indicated by stomach contents, stomach chlorophyll a levels, digestive enzymes, would be related to horizontal and vertical variations in the standing stocks of phytoplankton and krill throughout the area. Data on faecal pellet production would be obtained from in situ sediment trap collections. Various indicators of secondary production, such as grazing, ingestion, assimilation, excretion and respiration rates, would be measured in flask experiments.

Ornithological Studies

To provide data for the SCAR Seabird Mapping Scheme which is designed to record the distribution and feeding zones of seabirds in Antarctic and sub-Antarctic waters. BAS personnel would record data throughout each day according to the procedure defined for this international research programme.

Scientific Complement

British team (all of British Antarctic Survey)

D Bone	Technician, nets
Dr I Everson	Krill biologist
Dr R B Heywood	Oceanographer, Co-Chief Scientist
M Pilcher	Krill biologist
M Roscoe	Technician, Electronics
J Warren	Technician, Electronics
M G White	Fish biologist
M J Whitehouse	Technican, chemistry

German team (of Alfred-Wegener-Institut für Polarforschung - AWI, and Arbeitsgruppe für Polarökologie der Universität Kiel - APÖ)

C Dieckmann	Technician, chemistry (APÖ)
Dr G Hempel	Biologist, Chief scientist (AWI)
Dr H-J Hirche	Biochemist (AWI)
G Janssen	Technician, biochemistry (AWI)
A Kellermann	Fish biologist (APÖ)
P Marschall	Krill biologist (AWI)
U Piatkowski	Planktologist (AWI)
Dr S Schnack	Planktologist (AWI)
A Schneider	Planktologist (AWI)
Dr R Schneppenheim	Biochemist (APÖ)
M Venzmer	Planktologist (APÖ)

Cruise Report

Itinerary

30th Jan - 1st Feb	Passage to Elephant Island
1st Feb - 8th Feb	Time stations north and south of Elephant Island, and a meridional section across the Weddell-Scotia Confluence
9th Feb - 12th Feb	Bransfield Strait and Antarctic Sound
13th Feb - 18th Feb	Off the west coast of the Antarctic Peninsula with a time station off Matha Strait
19th Feb - 22nd Feb	Bransfield Strait and Antarctic Sound
23rd Feb - 1st Mar	Northern Weddell Sea with a time station, and Scotia Sea
2nd Mar	South-west shelf of South Georgia
3rd Mar - 23rd Mar	BAS logistic duties and passage to Montevideo

27th January. RRS John Biscoe arrived at Ushuaia, Argentina, to collect the German team, and the container laboratory which had been transported from Hamburg by commercial cargo vessel.

30th January. The vessel sailed at 1530 GMT for the vicinity of Elephant Island, passing eastwards through the Beagle Channel.

1st February. AWI nets were deployed on successful trials, during which it was found necessary only to adjust bridle lengths for the N70 closing net. Time station I, north of Elephant Island, was centred on 60°52'S 55°10'W after the krill distribution in the immediate area had been quickly examined during a 3 hrs acoustic survey. The time station was started at 2130 GMT and ran for 66 hrs, during which time the various sampling events (STD, water bottle rosette casts, RMT1+8 m, shallow vertical phyto- and zooplankton nets) were repeated over 6-8 hr cycles. During

the hours of darkness the RMT1+8 m hauls were supplemented by concurrent neuston and frame net hauls deployed in the surface water from the foredeck. Deep (2000 m) N70 vertical net hauls for krill eggs and larvae were deployed at 12 hr intervals. Sediment traps were deployed for three 8-15 hr consecutive periods. The routine was broken on 3rd February by a 6 hr excursion into the shallow coastal water north of Elephant Island for an acoustic survey, phytoplankton vertical net and RMT1+8 m net hauls. The surface waters were of Drake Passage origin and the phytoplankton consisted mainly of Corethron spp. Krill was abundant in small deep patches scattered over a wide area unlike the thick layers discovered during FIBEX. Zoo- and ichthyoplankton was relatively poor. Large copepods were particularly scarce. Some krill eggs and earlier krill larvae were caught in the deep vertical hauls. Large numbers of krill faeces were caught in the sediment traps. The area north of Elephant Island is still a preferred fishing ground for Soviet factory trawlers and up to 17 vessels could be counted at a time.

4th February. Wind speeds remained between 14 and 16 knots and no time was lost on the time station which was completed at 1500 hrs GMT. RRS John Biscoe steamed eastward towards the Weddell-Scotia Sea Confluence. The acoustic survey run was broken during the night for surface frame net hauls to collect live crustacean material for experimental purposes.

5th - 6th February. A meridional transect of the Weddell-Scotia Sea Confluence was carried out in longitude 51°00'W. It consisted of 4 stations across the Scotia Arc, spaced at 30 n mile intervals from 59°15'S to 60°45'S. The surface temperature of the Scotia Sea water was 2.66°C, but fell quickly crossing the Confluence to -0.01°C. The corresponding salinity change was from 33.97°/oo to 34.47°/oo. The area was of interest to the expedition because it is a transitional zone for phyto- and zooplankton communities, and proved to be an area of krill larvae abundance in February 1981. However, few larvae were caught this year. Phyto- and zooplankton were richest in the Confluence zone.

7th - 8th February. An acoustic run back to Elephant Island was carried out through the night of 6th/7th February. It was followed by a near-shore station south of Elephant Island and Time Station II in 700 m water centred on 61°30'S 55°00'W, the position of a previous time station, carried out by RV Walter Herwig, 6th-10th February 1976. The programme for this 34 hr Time Station was similar to that of Time Station I, except that because of the shallower depth of water, time was available for some near bottom RMT1+8 hauls which were taken for chaetognaths and myctophid fishes. The weather and sea state continued to be favourable

with wind speeds less than 10 knots. On this side of Elephant Island the water is derived from Bellingshausen Sea and Weddell Sea water mixed during passage through the Bransfield Strait. The phytoplankton and zooplankton were more abundant and richer in species than at Time Station I. Small quantities of adult and early larval krill were caught in all smaples.

9th - 10th February. Time Station II was completed at 0230 GMT and the vessel moved south-westwards towards the eastern entrance of the Bransfield Strait, carrying out one station halfway between Elephant Island and King George Island. The first transect across Bransfield Strait started at 1828 GMT, 9th February, and ran from the vicinity of Admiralty Bay into the Antarctic Sound with stations over the narrow northern shelf, the central basin and the broad southern shelf. A short excursion into the Erebus and Terror Gulf was made on 10th Februry. Fog impeded operations on the southern shelf and in the Antarctic Sound where also ice restricted RMT1+8 m hauls to daylight hours. The STD profiles revealed locally produced cold saline bottom water in the Erebus and Terror Gulf and Antarctic Sound. Krill eggs and larvae were found in considerable numbers at the deep central Bransfield Strait station and in the Antarctic Sound.

11th - 12th February. The vessel re-entered the Bransfield Strait from the Antarctic Sound and steamed south-west to work a station on the southern shelf in the vicinity of Cape Legoupil. The second transect of Bransfield Strait was started at 0100 GMT, 12th February, and consisted of 3 stations between the edge of the southern shelf off Cape Roquemaurel and Snow Island. A detour was made to sample the waters of the crater lagoon of volcanic Deception Island.

The temperature and salinity profiles changed dramatically across the Bransfield Strait, reflecting the influence at each station of relatively warm, low salinity water flowing northwards from the Bellingshausen Sea along the east coast of the South Shetland Islands, and cold, saline Weddell Sea water flowing southwards along the west coast of the Antarctic Peninsula. The variety of diatoms and dinoflagellates was considerably greater than in the phytoplankton around Elephant Island. Krill was found at every station in the Bransfield Strait but never in large quantities. However, the pelagic amphipod Parathemisto gaudichaudii was often abundant. Large numbers of short, compact faecal pellets, presumably from the Parathemisto, were caught in vertical net hauls.

The surface temperature of the sheltered waters within the Deception Island lagoon was slightly higher than outside in the Bransfield Strait, being 1.61°C and 1.39°C respectively. However, below 27 m the Deception Island waters were much colder and the temperature fell gradually

to -1.68°C at the bottom (153 m). Water at this depth in the Bransfield Strait had a temperature of 0.12°C. A bloom of chain forming diatoms coloured the surface water within the crater, and a substantial number of extremely large amphipods, mysids and Euphausia crystallorophias were caught in RMT hauls.

13th - 14th February. From South Island the vessel steamed 120 nm westward into the southern Drake Passage and the start of a third transect of 5 stations across the southern approaches to Bransfield Strait from 62°59'S 66°35'W to Anvers Island. The vessel then steamed southwards along the shelf break and worked 5 stations between Bismarck Strait and Adelaide Island.

Data from the transect would permit comparison of oceanic and coastal krill populations, related to water mass differences, and with data obtained by German scientists in previous years. The largest numbers of krill were caught on the continental slope within the 1000 m line. Gravid females of two size groups were frequently found, but few eggs were caught, even in vertical net hauls from near the bottom.

15th - 16th February. The Antarctic Circle was crossed on 15th February and the southernmost station of the expedition worked in 66°38'S 68°28'W. Time Station II, of 36 hours duration was worked in excellent weather off Matha Strait, Biscoe Islands, centred on 66°10'S 68°12'W. The RMT hauls made at the southerly sations should make a valuable contribution to the sparce knowledge of the zooplankton and fish larvae communities of the area. Krill, mainly pre-adult stages, were abundant at the time station, and a small number of krill larvae, krill eggs and fish larvae were also caught.

17th February. RRS John Biscoe completed the time station at 0342 GMT on the 150th Anniversary of the discovery of the Biscoe Islands by her namesake, the British explorer John Biscoe. The vessel sailed north in weather which, for the first time during the expedition, deteriorated into a full gale with low visibility. An attempt to celebrate the anniversary with members of the British Antarctic Survey Research Station, Faraday, on Argentine Islands failed because of ice in the anchorage, and gale force winds driving more ice in and threatening to trap the ship. The vessel moved north into open water and worked two stations in Bismarck Strait overnight.

18th February. In now splendid weather, the vessel travelled through the Neumayer Channel and southern Gerlache Strait to work two stations in Dallmann Bay.

19th - 21st February. Starting in poor conditions of gale force winds and low visibility, which gradually ameliorated, another transect of 4 stations was worked across the Bransfield Strait from Croker Passage to Livingston Island.

Phytoplankton was sampled intensively at the middle stations. A very large catch of adult krill was taken from the northern end of Croker Passage at the surface by ring net at night. In contrast, few krill were caught in RMT hauls from deeper water at this and the central stations of the transect. Virtually no copepods or krill larvae were taken in the vertical nets.

The vessel diverted to work the interesting waters of the lagoon of Deception Island, for the second time. The surface temperature had risen by 0.2°C, with a concomittant deepening of the layer warmer than 0°C, a considerable change in only 7 days. The temperature of the Bottom Water remained the same. The phytoplankton bloom was less pronounced, but rich RMT hauls of large crustacean specimens and of post-larval fish were again obtained. Zooplankton was relatively abundant at the shelf station off Livingston Island and at a similar station worked immediately afterwards off Nebron Strait. Even copepods were collected in large numbers.

RRS John Biscoe then went into Admiralty Bay and a brief visit was made to the Polish Research Station, Arctowski, which was occupied by 19 scientists and technicians, including 2 American ornithologists. The research programme of the Polish station covers a wide field, but is mainly centred on the ecosystem of Admiralty Bay. Current studies were on the bird and seal populations, and on the effect of glacial melt. The weather was poor, but many people went ashore to visit the chinstrap rookeries, elephant seal colonies and the various laboratories. The station personnel afterwards came on board for a short complimentary visit.

The vessel moved to anchor for a night of social entertainment and rest in the shelter and outstanding beauty of Potter Cove. The Instituto Antártico Argentino had recently taken over an old Argentine refuge, Teniente Jubany. A small delagation from RRS John Biscoe was invited ashore to meet the Director and Logistic Officer of the Institute, and 8 biologists and geologists who were starting the research programme. It is planned to transfer the scientific work of the Institute from Almirante Brown to Teniente Jubany, which would serve as an overwintering station and a base for field excursions in summer. The Director, Martinez-Abal, paid a brief courtesy visit to RRS John Biscoe during the morning of 21st February, accompanied by 8 of his scientists. Afterwards the vessel proceeded to the Chilean Research Station, Teniente Marsh, where Dr Hempel, to his great regret, had to disembark to fly back to Germany.

The vessel steamed northwards from King George Island to the small, deep (2000 m) trench, north-east of Bridgeman Island. The stations worked here formed the starting point for the fifth transect of Bransfield Strait.

22nd February. The final transect, of 4 stations, ran almost due south to Antarctic Sound where a further station was worked in the southern deeper section during the night of 22nd/23rd February.

Many krill eggs, nauplii and some calyptopis were caught in deep vertical hauls on the Antarctic Sound station. Less were caught at the deep, northernmost station in the Bransfield Strait. Large numbers of copepods were caught at all stations on this northernmost transect.

23rd - 26th February. The vessel worked a 3 station transect westwards across the northern Weddell Sea from 62°36'S 55°15'W to 63°58'S 49°58'W. The latter station was Time Station IV which was abandoned after 24 hours as pack ice encroached from the east driven by near gale force winds. An attempt to start another time station 30 miles north failed when increasing windstrength forced the vessel to heave-to at 2250 GMT on 25th February.

Eighteen hours were lost overnight because of 40 knot winds and 6.0 m swell. At 1200 GMT on 26th February the vessel was able to steam towards the South Orkney Islands, stopping to work a station at 62°08'S 49°05'S. The new AWI multiple release for the RMT1+8 m was tested at this station and faults were found in the design and engineering.

The surface water temperatures were very low at the southernmost Weddell Sea stations and ranged from -1.56°C to -1.46°C. The zooplankton was dominated by copepods and pre-adult krill, but catches were not large.

27th - 28th February. A deep (2000 m) trench through the ridge of the Scotia Arc permits some mixing of Weddell Sea and Scotia Sea Warm Deep and Bottom Waters west of the Inaccessible Islands (Fig 2). The vessel worked a station here before turning west to work a station on the South Orkney Islands shelf.

Both stations produced few krill, krill larvae and very few copepods. No larval fish were caught and even deep RMT hauls between 1300 m and 200 m in the trench produced few fish.

1st - 3rd March. The vessel completed its final transect of the expedition in near-gale force winds. The transect consisted of a mid-Scotia Sea station and 3 stations in the south-western approaches to South Georgia, corresponding to stations 27, 26 and 25 of the OBP South Georgia Zone Survey carried out in November/December 1981. Gravid krill and krill eggs were caught on the Scotia Sea station.

Few krill were obtained from the South Georgia stations, but the amphipod Parathemisto gaudichaudii was very abundant. Relatively large numbers of fish larvae and Mysidacea were caught over the South Georgia shelf. Comparison of this data with the earlier OBP data will indicate the changes that can occur over a three-months period in the same season.

3rd - 23rd March. The vessel was engaged in BAS logistic duties which included visits to Bird Island (South Georgia) and Signy Island (South Orkney Islands) and passage to Montevideo where British and German scientists disembarked. Live material for experimental studies was caught en route while the vessel remained south of the Convergence.

27th April. The vessel unloaded the samples including some live krill, and equipment of the German team in Bremerhaven.

The cruise statistics and station data are presented in Tables 1 and 2.

Preliminary Scientific Findings

Oceanography

Temperature and salinity profiles recorded for the time stations in the vicinity of Elephant Island reflected the different origins of the water masses at the two sites. North of the island the surface water was of Bellingshausen Sea origin, flowing through Drake Passage towards the Scotia Sea. It lay over Warm Deep Water flowing out of the Scotia Sea along the line of the Scotia Arc. The temperature changed gradually from 1.54°C (34.08°/oo) at the surface to -0.36°C (34.57°/oo) at 700 m, before rising to 0.25°C (34.67°/oo) at 1300 m. The southern station was in less than 700 m of water on the southern slope of the Scotia Ridge. There was no evidence of Warm Deep Water here and the water was a mixture of Bellingshausen Sea and Weddell Sea waters produced in the Bransfield Strait. The temperature fell steadily from 1.56°C (34.17°/oo) at the surface to -1.12°C (34.58°/oo) at 656 m (bottom).

The effectiveness of the Scotia Ridge in separating the waters of the Circumpolar Current from the Weddell Sea Water could clearly be seen in the temperature and salinity profiles taken on the meridional transect of the Weddell-Scotia Confluence (Fig 2). The core temperature of the Scotia Warm Deep Water was 1.74°C at 292 m (salinity 34.63°/oo), whereas within an inter-station distance of 30 nautical miles the core temperature of the Weddell Warm Deep Water was -0.03°C at 600 m (salinity 34.64°/oo). Similarly, the surface temperature fell from 2.66°C to -0.01°C with a corresponding change in salinity from 33.97°/oo to 34.47°/oo. Gaps in the Scotia Ridge permit some mixing of Scotia Sea and Weddell Sea waters as could be seen from profiles recorded in 2000 m of water at a station west of the South Orknez Islands shelf. The core temperature of the Warm Deep Water was 0.15°C at 600 m and the surface temperature was 1.25°C.

Warm Deep Water does not penetrate into the shallow Erebus and Terror Gulf and Antarctic Sound where cold saline bottom water (-1.33°C to -1.46°C; 34.46°/oo to 34.54°/oo) is formed locally through the process of ice formation. Water passes into the Bransfield Strait over a 300 m sill at the entrance to Antarctic Sound and flows south-west along the broad shelf of the Antarctic Peninsula. The presence of the cold saline water could be detected to 200 m as far south as Cape Roquemaurel, beyond where its identity was lost through mixing with waters flowing north-east from Bellingshausen Sea and Gerlache Strait.

Temperature and salinity profiles of stations in the straits and nearshore waters off the west coast of the Antarctic Peninsula differed considerably as each reflected a unique contribution of local influences such as bathymetry, ice formation or melt, glacial water input, etc. These factors also produce the unique waters of Deception Lagoon, the drowned volcano of Deception Island (Fig 3). Water exchange is limited by the narrow, shallow (14 m) entrance. Consequently, recorded profiles differed considerably from those of the Bransfield Strait. The locally produced Bottom Water was very cold (-1.68°C), but of low salinity (34.21°/oo).

The waters were extremely cold at the southernmost Weddell Sea station visited (63°56.0'S, 49°57.2'W). The surface Water was almost isothermal down to 30 m at -1.5°C and had a core temperature of -1.72°C at 50 m. The core temperature of the Warm Deep Water was 0.38°C at 300 m. The Bellingshausen Sea (southern Drake Passage; 62°59.8'S, 66°34.9'W) and mid-Scotia Sea (57°59.9'S, 43°05.5'W) stations were also isothermal down to 30 m with temperatures of 2.4°C and 2.3°C respectively. Equivalent core temperatures for the surface Waters were -1.06°C (81 m) and 0.56°C (75 m) and 1.84°C (610 m) and 1.56°C (275 m) for the Warm Deep Waters.

The coastal waters of South Georgia had gained a considerable amount of heat from solar radiation during the three-months interval since the BAS zone survey. Surface temperatures were approximately 2.5°C higher (e.g. 10 m, 3.12. 81, 1.42°C; 3.3.82 3.92°C) and the effect reached as deep as 50 to 100 m. Glacial melt from the land had also reduced the salinity of the surface waters from 33.87°/oo to 33.63°/oo.

R B HEYWOOD

Phytoplankton and Microplankton

Not all stations were sampled. Stations were selected to cover the expedition area in sufficient detail to give a comprehensive picture of variation in dominant species and community structure within a sensible period of microscope study on return to Germany. Paired net hauls consisted of a 55 um mesh haul from 100 m - 0 m and a 20 um mesh haul from 50 m - 0 m, except in areas of very low phytoplankton concentration where the 20 um mesh net could be hauled from 100 m - 0 m. A total of 55 hauls were made with the fine net and 37 hauls with the coarser net. Only part of each haul was preserved for taxonomic studies. The remainder was

mainly used to establish cultures for growth rate and other physiological studies in Bremerhaven. Eight different natural populations were established in mixed cultures and 16 diatom species, 2 chlorophyte species and 1 dinoflagellate species were obtained in monoculture. Some experiments were attempted on board. Three natural populations were used to study respiration rates at 5 different temperatures, using the Winkler technique. Unfortunately, it proved impossible to control the temperature levels consistently and the experimental data was not reliable. However, it was possible to measure the respiration electron transport system activity (ETS) of 8 plankton community samples over a temperature range of -0.5°C to 41°C. Maximum activity occurred between 20°C and 30°C, a range which is more than 10°C lower than that recorded for the maximum electron transport activity of plankton from lower latitudes.

Quantitative estimates of phytoplankton and microzooplankton concentration will be calculated from Utermöhl counts made on subsamples of water taken by STD-Rosette water bottles from 10 standard depths between 10 m and 200 m at 44 stations. Samples were taken from 3 m depth at the same stations using the laboratory sea-water pumped supply. Subsamples for plant pigment analysis were extracted by glass-fibre filters and stored deep-frozen. Phytoplankton concentrations were generally not very high. The largest and most diverse populations were found in Antarctic Sound and Deception Lagoon. Concentrations tended to be higher in the Bransfield Straits than elsewhere. Species of Corethron were dominant in most areas, and often formed 98% of the species present. Dinoflagellates were rarely found. Radiolarians were also scarce (in contrast with the findings of RV Meteor 1981 in the same area), but the number of tintinnids and naked ciliates found was remarkably high.

A SCHNEIDER and M VENZMER

Macrozooplankton

The samples were obtained by standard oblique hauls over the range of depths given in Table 3. The hauls made within the upper 30 metres were horizontal. The multiple-release rectangular midwater trawl (RMT1+8 m) was yeered to the lowest depth before the first pair of nets ($1m^2$ and $8m^2$), were opened, and the gear hauled in at 0.2 to 0.5 m sec^{-1} while the vessel steamed ahead at 2 to 3 knots. The third pair of nets in the shallow series was opened to sample above the thermocline, the position of which having been previously determined by the STD. A standard depth of 70 m was adopted for waters in which the thermocline was

indistinct. In most hauls, each net pair was open for 15 minutes. Forty-seven hauls were made during the day, 21 were made at night, 7 were made at dusk and 4 were made at dawn. Catch volumes (Tables 4 and 5) were measured as accurately as practical prior to the separation of the major groups. Samples were stored in 4% chalk-buffered formaldehyde solution for detailed analysis in Germany.

Preliminary observations have revealed variations in the biomass of macrozooplankton, especially krill (Euphausia superba), at different depths, at different times of day and in different regions. The highest concentration occurred in surface water above 70 m. The largest catches were generally obtained at night when most fish were also caught. Krill were found at all but four of the stations, and formed the highest percentage of the total catch volume. The largest numbers of krill were always caught at night. Sub-adult krill were predominant in the 200 m to 70 m layer and adult krill were most numerous nearer the surface. Geographic variations noted were:

Elephant Island. Daytime catches of krill were poor at both time stations, but frequently rich at night, especially in juvenile forms. This presumably reflected a diurnal vertical migration pattern of behaviour. A large number of krill exuviae were caught in one haul at the southern station. The pelagic amphipod, Parathemisto gaudichaudii, the euphausid, Thysanoessa sp, were also abundant, as were Euphausia triacantha and various salps during the night.

Bransfield Strait and adjacent western waters. The largest variety of species was obtained here, although catch volumes were small. Different size classes of krill, including larvae, were caught and other important species were P. gaudichaudii and the Thysanoessa sp. Euphausia crystallorophias was found in shallow shelf areas. Salps and chaetognaths occurred frequently in night hauls. Remarkably large specimens of mysids, amphipods and E. crystallorophias were obtained from the lagoon of Deception Island.

Bellingshausen Sea. The largest catches were obtained in this region. Juvenile krill was especially dominant in both day and night hauls. Occasionally gravid females were caught. Considerable numbers of the pelagic amphipod, Parathemisto gaudichaudii, the euphausids, Euphausia triacantha and Thysanoessa sp, salps and copepods were also found.

Weddell Sea. Juvenile krill were particularly dominant in all catches.

South Orkney Islands. Large numbers of krill including some larvae were obtained in two of the catches. P. gaudichaudii and the Thysanoessa sp were also caught.

South Georgia. Very few krill, but large numbers of P. gaudichaudii were caught at these stations. Mysid species were also abundant in shallow water.

The deep hauls produced many mesopelagic species which could not be identified on board.

U PIATKOWSKI

Ichthyoplankton

A total of 1943 fish larvae and post-larvae were caught, of which 650 were from the $1m^2$ nets of the RMT. The material consists of at least 14 species of Nototheniidae, Channichthyidae, Myctophidae, Trichiuridae, Harpagiferidae and Paralepididae. (The mesopelagic fish and larvae from the deep hauls are discussed in a separate section by WHITE). Notolepis coabi Dollo 1908 was the most widespread species, although only 2 adult specimens were obtained. The most abundant species were Pleuragramma antarcticum Boulenger 1902 and Notothenia (Lepidonotothеia) kempi Norman 1937, the latter being particularly numerous in the Bellingshausen Sea.

Elephant Island. Relatively few larvae and post-larvae were caught north (42 in 9 hauls) and south (84 in 12 hauls) of the island.

Bransfield Strait. The greatest concentrations of larvae and post-larvae were found on the shelf of the Antarctic Peninsula, including the Antarctic Sound and the Gerlarche Strait (783 specimens in 10 hauls), and at the eastern entrance (286 specimens in 6 hauls). No larvae were found at 2 of the central stations. Few specimens were caught over the South Shetland shelf (72 specimens in 6 hauls) and only Pleuragramma antarcticum larvae were obtained from the lagoon of Deception Island.

Bellingshausen Sea. (southern Drake Passage). Notothenia kempi was predominant in the 8 hauls which produced 185 specimens. Another 49 specimens were caught in 3 hauls made on passage to the time station off Matha Strait.

Weddell Sea. Three hauls were made on the time station before it was abandoned and a further haul was made on the passage north. Only 58 specimens were obtained, which were mainly Pleuragramma antarcticum and a Notolepis sp. No specimens were caught in the 2 hauls made south of the Weddell-Scotia Confluence, but 49 specimens were obtained from a single haul north of this frontal zone.

South Orkney Islands. No larval fish were caught over the shelf, but the deep RMT from 1300 m to 200 m through the trench west of the Inaccessible Islands produced 12 specimens of Notolepis sp and Pseudochaenichthys geogianus Norman 1937.

South Georgia. The 3 hauls produced 180 specimens of mainly myctophid larvae and post-larvae. The largest number was caught at the shallow inshore station where a near-bottom haul also caught some Channichthids and Nototheniids.

A KELLERMANN

Mesopelagic Fish

The mesopelagic fish were identified where possible, and weight, total length and standard length of each specimen measured while in fresh condition. Blood, tissue and otolith samples were taken from selected specimens before each catch was preserved in 4% buffered formaldehyde solution for detailed analyses of biometry, diet and reproductive condition in Cambridge. Nearly all the specimens were caught in the routine 0-200 m combination RMT1+8 hauls made during hours of darkness, reflecting the diurnal vertical migratory behaviour of many mesopelagic fish. Night hauls which did not produce specimens were usually at shallow water stations where the fish would have had to migrate horizontally as well as vertically from deeper water.

Only 11 specimens of mesopelagic fish have been identified in the samples so far, and 7 of these were members of the family Myctophidae. There was little indication of regional variation. Previous observations in these areas had also shown restricted species diversity and regional differences. Electrona antarctica (Gunther, 1864) dominated the catches and Gymnoscopelus nicholsi (Gilbert, 1911) and Protomyctophum bolini (Fraser-Brunner, 1949) were the next most frequent species. Gymnoscopelus braueri (Lonnberg, 1905) and Krefftichthys anderssoni (Lonnberg, 1905) occurred in most geographic areas visited, although specimens were not caught at every station. Krefftichthys anderssoni normally colonizes the upper 500 m and was the only myctophid species

taken from the surface 200 m layer during daylight. Adult Notolepis coabi Dollo 1908 were caught at only 2 stations, but larvae were collected by most RMT1+8 hauls indicating that the species was widely distributed. Electrona carlsbergi (Tanning, 1932) was locally abundant near island groups in different geographic areas, and its distribution may be associated with a specific combination of physical and biological factors.

A more detailed analysis of the specimens will attempt to relate the horizontal and vertical distribution of the mesopelagic fish to specific water masses. Comparison will also be made with the findings of the South Georgia zone survey and South Georgia shelf krill patch study.

M G WHITE

Biology of Chaetognaths

Live specimens were caught using a slowly towed vertical net (Ø 70 cm, 335u) with a 5 liter cod-end. In spite of successful preceding experiments in the Baltic Sea, it became apparent that Antarctic Chaetognaths caught with the same method were damaged by the net walls or by surrounding plankton in the net. Specimens - mainly Eukrohnia hamata - removed from the bucket by scoop and transferred to culturing devices showed abnormal behaviour and were not suited for feeding experiments. Probably their delicate external sensory hairs had been affected. The animals expired in a rather short time. A modification of the plankton net and a very careful sampling procedure did not improve the results. Thus, feeding experiments proved to be impracticable and more careful catching methods have to be developed. Other plankton organisms, such as krill, amphipods, copepods and even ctenophores were in very good condition after catching and stayed alive for weeks.

Besides these efforts Chaetognaths from the RMT material have been studied under the microscope for identification and gut content analysis.

The samples collected during OBP I-III will be analyzed in Kiel to study distribution and ecology of Antarctic Chaetognaths.

W HAGEN

Distribution of Krill

Hydroacoustic recordings were made whenever the vessel was proceeding at constant speed between stations (at 10 knots) and during net hauls (at 2 to 3 knots). Due to the wide dynamic range of echosignals resulting from swarms of different densities, both integrator channels were operated on the same depth range but with different gain settings. Estimates of mean volume backscattering strength will be obtained from the echocharts and will be converted to krill abundance by comparison with RMT8 catch data supplied by U Piatkowski.

Krill indications were seen on the echosounder over most of the study areas. A large krill concentration was detected north of Elephant Island in approximately the same location as one recorded during the FIBEX survey. This year the patch extended for at least 30 n miles north of the island. Extensive krill patches were also found in the Bellingshausen Sea west of Adelaide Island and in the Scotia Sea north of the South Orkney Islands. Two areas were investigated twice during the cruise and should provide useful time series comparisons - Bransfield Strait and South Georgia (investigated itensively during Leg 1).

I EVERSON

Population Genetics of Krill

Population genetics investigations were carried out by enzyme electrophoresis on Cellogel^{R} and by isoelectric focusing. At least 250 specimens were required from each geographic area. These were generally caught by a ring trawl towed horizontally through the surface waters at night. This method often yielded sufficient material within a few minutes. If krill could not be obtained from the surface waters, specimens were carefully selected from RMT8 catches. The 17 samples of Euphausia superba obtained provided a very good coverage of the wide geographic region under investigation. Most of the 13 enzymes which were screened and isolated on board are polymorphic. The work on board was concentrated mainly on 3 of the enzymes which could be isolated very easily. About 2000 specimens were used for this work. Several thousand specimens are also deep-frozen at -80^{o}C for investigation of the other enzymes which will take place in the Arbeitsgruppe für Polarforschung der Universität Kiel, in co-operation with C M MacDonald. The statistical analysis of all the experimental data will also be done in Kiel.

R SCHNEPPENHEIM and G JANSSEN

Distribution, Development and Behaviour of Early Life Stages of Krill

Spawning appeared to have started 3-4 weeks later than in 1981. Gravid females were found in the Scotia Sea on 1st March and freshly laid eggs were caught north of the South Orkneys on 10th March (during the logistics run). Eggs were caught south of Elephant Island and in the Bellingshausen Sea (southern Drake Passage). Nauplii were also taken south of Elephant Island and in Antarctic Sound. Calyptopis were found on the second visit to the Sound and in the northern Bransfield Strait on the previous day (22nd/23rd February). Only a few 1st and 2nd stage calyptopis were obtained and 3rd stage calyptopis and furciliae were extremely rare. Consequently, the experimental studies were restricted to the early life stages.

Freshly laid eggs from females in RMT8 and ring trawl samples were used to determine:

- the incubation times of eggs under two temperature regimes; the development was documented by still photography
- egg dry weights, respiration rates and electron transport activity (in co-operation with H-J Hirche)
- the development of the nauplius through 3 stages, recording the changes by still photography
- the speed of swimming nauplii and orientation related to light direction; video-filming techniques were used
- sinking speeds of eggs, living and freshly killed nauplii

Individuals of various larval stages were preserved for scanning and tansmission electron microscopy studies of external and internal morphology.

P MARSCHALL

Moulting Physiology and Fluoride Metabolism of Krill

Neuston hauls and vertical net hauls proved to be best for the supply with fresh and vital krill. Individual maintenance was accomplished by:

- keeping in separate - aerated or not - 1 liter jars in a constant temperature room
- keeping in a special open/closed flow-through circuit system.

The following studies were performed:

- Quantification of fluoride uptake via seawater
- Survival and moulting of krill in artificial and fluoride free sea water
- Toxicity of sodium fluoride on krill
- Gradual leakage of fluoride from exuviae, dissected cuticles and dead individuals and its quantification.

As part of the "Feeding/Swarming Study" on Leg 2 ca 200 krill were moult staged and assessed for stomach and hepatopancreas colour and gut fullness (joint project with BAS). Within a joint research programme with D J Morris the time course of the moulting cycle of krill was determined during a ten day stay at Grytviken, South Georgia.

A KECK

Physiology and Biochemistry of Zooplankton and Krill

The specimens used were mainly collected from the surface waters at night using the ring trawl. Respiration rates of freshly caught organisms were measured at 4 and sometimes 5 different temperatures over the range -1.7°C to 10.0°C. Oxygen concentration was measured by the Winkler technique. Data was obtained for the copepods, Calanoides acutus, Paraeuchaeta antarctica, the euphausid, Euphausia superba, the amphipod, Parathemisto gaudichaudii, and a polychaete, Tomopteris sp. There appeared to be no immediate, short-term adaptation to temperature and all respiration rate changes were according to the Arrhenius equation.

The enzyme kinetics of the electron transport system, an enzyme involved in end oxydation, were studied in 18 species of zooplankton. The enzyme activities were measured using a temperature-gradient block which gave 10 different temperatures. The energy of activation and the temperature optimum will be calculated from the data in Bremerhaven

Long-term adaptation processes were studied in Euphausia superba. The animals were kept over 2 weeks at 4°C and fed regularly on phytoplankton and/or artificial food. Respiration at 5 different temperatures and enzyme kinetics of the electron transport system at 10 different temperatures were measured at set intervals. The culture was then maintained at 9°C and the series of experiments repeated. The data will be analysed in Bremerhaven.

Additional zooplankton material was deep-frozen at -80°C for further enzyme studies in Bremerhaven.

H-J HIRCHE

Trophodynamics of Herbivorous Copepods

Copepod abundance and population composition varied considerably between the geographic areas. Major concentrations were recorded for the Weddell Sea, the northern Bransfield Strait, and the Bellingshausen Sea (southern Drake Passage). Virtually no copepods were found around Elephant Island and the South Orkney Islands. The dominant species recorded for the Bransfield Strait, Bellingshausen Sea and Weddell Sea were Metridia curticauda, Rhincalanus gigas and Calanoides acutus respectively.

Twenty-seven experiments on feeding, ingestion, assimilation and respiration were carried out - 16 with copepods, 4 with copepods and krill and 7 with krill (to investigate the effect of competition). Copepods were sorted according to species, sex and life stages, and krill according to 3 size classes for the experiments. The animals were kept without food for 4 to 10 hours before being transferred to experimental chambers containing fresh sea-water enriched with known concentrations of phytoplankton caught by 20um mesh net at the same sampling site as the animals. The experiments were of 8 to 10 hours duration at a constant temperature of 0^{o}C. In general, Metridia curticauda and Calanus propinquus had higher feeding and respiration rates than Rhincalanus gigas and Calanoides acutus. The latter were probably already in the overwintering stage in the Bellingshausen Sea. They were lethargic, had empty guts, produced no faecal pellets and had extremely low respiration rates (about 1/5th to 1/10th of the rates recorded for the animals from the Weddell Sea).

S SCHNACK and C DIECKMANN

Sedimentation

Sediment traps were deployed at 50 m and 100 m for 6 to 12 hrs during the time stations. A large portion of the material collected consisted of faecal pellets from krill and amphipods. The material will be identified in Bremerhaven and the dry weight and carbon-nitrogen content measured. The data will be analyzed in conjunction with the hydroacoustic data for each area.

S SCHNACK and H-J HIRCHE

Acknowledgement

The Chief Scientist wishes to put on record great appreciation for the excellent co-operation between all groups on the vessel. In spite of the fact that the British research team and most of the officers and crew had already been at sea for several months of hard and strenuous work, no fatigue was shown. The oceanographic and biological gear was extremely well kept and was handled with great skill so that no time was lost by faulty techniques or equipment failure. The Co-Chief Scientist and the Master of the ship were very willing to adjust all operations necessary for a flexible programme which followed the various needs of the different disciplines. The German team adapted itself very quickly to working in a foreign language and to the environment of a British research vessel.

Table 1 - Cruise Statistics

Time from Ushuaia to South Georgia	33 days
Time vessel engaged in research	31 days

Stations worked	55
Events - total	497
STD profiles	72
(Phytoplankton profiles from STD-Rosette water bottles 44)	
Phytoplankton vertical net hauls	95
55u vertical net hauls (for Foramenifera)	4
Vertical closing N70 zooplankton net hauls	
- 2000 m/1000 m to 500 m	30
- 500 m to 200 m	37
- 300 m/200 m to 0 m	66
Horizontal ring net hauls from foredeck	29
Horizontal frame net hauls from foredeck	9
Neuston net hauls	7
RMT1+8 m net hauls	
- sets of 3 strata within surface 250 m	76
- sets of 3 strata above 1300 m	4
Deployments of sediment traps (periods over 6 hrs)	9
Acoustic runs (total mileage 3054 n m)	59

Table 2 - Station Statistics

Station Co-ordinates		Start		Finish		Events								
latitude S	longitude W	time GMT	date	time GMT	date	STD	Light Profile	Nets RMT1+8 m	Ring	Frame	Neuston	Vert Zoo	Vert Phyto	Sediment Traps
60°52'	55°08'	2130	1.2.82	1437	4.2.82	*	*	*	*	*	*	*	*	*
59°15'	51°00'	0530	5.2.82	1435	5.2.82	*		*				*	*	
59°43'	50°57'	1818	5.2.82	0202	6.2.82	*				*		*	*	
60°14'	50°59'	0402	6.2.82	1222	6.2.82	*		*		*		*	*	
60°47'	50°59'	1620	6.2.82	2244	6.2.82	*		*	*			*	*	
61°14'	54°45'	1056	7.2.82	1317	7.2.82	*		*	*			*	*	
61°30'	54°59'	1447	7.2.82	0218	9.2.82	*		*	*			*	*	*
61°56'	56°48'	0726	9.2.82	1208	9.2.82	*		*				*	*	
62°16'	58°18'	1624	9.2.82	1927	9.2.82	*		*					*	
62°30'	57°58'	2118	9.2.82	0437	10.2.82	*		*	*			*	*	
62°45'	57°37'	0619	10.2.82	1025	10.2.82	*		*				*	*	
63°00'	57°19'	1158	10.2.82	1546	10.2.82	*		*				*	*	
63°36'	56°24'	1936	10.2.82	2027	10.2.82	*								
63°27'	56°42'	2203	10.2.82	0851	11.2.82	*			*			*	*	
63°19'	56°49'	1136	11.2.82	1258	11.2.82			*						
63°01'	58°25'	1759	11.2.82	1950	11.2.82	*		*						
63°07'	59°08'	2200	11.2.82	2304	11.2.82			*						
63°17'	59°44'	0105	12.2.82	0330	12.2.82	*		*				*	*	
63°06'	60°29'	0554	12.2.82	0955	12.2.82	*		*				*	*	
62°57'	60°39'	1121	12.2.82	1407	12.2.82	*		*				*	*	
62°56'	61°11'	1725	12.2.82	1915	12.2.82	*		*					*	
63°03'	62°09'	2207	12.2.82	0105	13.2.82	*		*				*	*	
62°59'	66°35'	1335	13.2.82	1756	13.2.82	*		*				*	*	
63°23'	66°10'	2055	13.2.82	2157	13.2.82			*						
63°45'	65°42'	0042	14.2.82	0330	14.2.82	*		*	*			*	*	
64°07'	65°17'	0557	14.2.82	0737	14.2.82	*		*						
64°30'	64°50'	1014	14.2.82	1324	14.2.82	*		*				*	*	
64°57'	64°11'	1553	14.2.82	1802	14.2.82	*		*				*	*	
65°24'	66°07'	2140	14.2.82	2354	14.2.82	*		*				*	*	
65°49'	67°10'	0302	15.2.82	0446	15.2.82	*		*						

63°23'	66°10'	2055	13.2.82	2157	13.2.82			*					
63°45'	65°42'	0042	14.2.82	0330	14.2.82	*		*	*		*	*	
64°07'	65°17'	0557	14.2.82	0737	14.2.82	*		*					
64°30'	64°50'	1014	14.2.82	1324	14.2.82	*		*			*	*	
64°57'	64°11'	1553	14.2.82	1802	14.2.82	*		*			*	*	
65°24'	66°07'	2140	14.2.82	2354	14.2.82	*		*			*	*	
65°49'	67°10'	0302	15.2.82	0446	15.2.82	*		*					
66°10'	68°11'	0737	15.2.82	1033	15.2.82	*		*			*	*	
66°37'	68°29'	1242	15.2.82	1604	15.2.82	*		*			*		
66°07'	68°11'	1912	15.2.82	0342	17.2.82	*		*	*		*	*	*
64°57'	64°22'	2215	17.2.82	0100	18.2.82	*		*					
64°52'	63°55'	0812	18.2.82	1055	18.2.82	*		*			*		
64°33'	62°36'	1430	18.2.82	1704	18.2.82	*		*			*	*	
64°11'	62°50'	2025	18.2.82	2230	18.2.82	*		*					
63°55'	61°40'	0337	19.2.82	0630	19.2.82	*		*	*		*		
63°32'	61°05'	1000	19.2.82	1235	19.2.82	*		*			*	*	
63°14'	60°37'	1430	19.2.82	1845	19.2.82	*		*			*	*	
62°58'	60°38'	2040	19.2.82	2227	19.2.82	*		*	*			*	
62°44'	59°51'	0117	20.2.82	0440	20.2.82	*		*		*	*		
62°29'	59°03'	0702	20.2.82	0912	20.2.82	*		*					
61°58'	56°23'	2055	21.2.82	0418	22.2.82	*		*		*	*	*	
62°20'	56°38'	0632	22.2.82	1048	22.2.82	*		*			*	*	
62°43'	56°50'	1328	22.2.82	1537	22.2.82	*		*			*	*	
63°05'	57°08'	1907	22.2.82	2021	22.2.82	*					*	*	
63°27'	56°43'	2310	22.2.82	0420	23.2.82	*		*	*		*	*	
62°36'	55°15'	1736	23.2.82	1925	23.2.82	*		*			*	*	
62°30'	53°45'	2347	23.2.82	0210	24.2.82	*				*	*	*	
63°58'	49°58'	1637	24.2.82	1542	25.2.82	*		*	*		*	*	*
62°08'	49°05'	2310	26.2.82	0257	27.2.82	*		*	*			*	
60°33'	48°04'	1410	27.2.82	2335	27.2.82	*		*			*	*	
60°29'	46°42'	0620	28.2.82	0855	28.2.82	*		*	*		*	*	
58°00'	43°05'	0410	1.3.82	1327	1.3.82	*			*		*	*	
55°18'	39°24'	1230	2.3.82	1653	2.3.82	*		*			*	*	
54°52'	38°57'	2004	2.3.82	2328	2.3.82	*		*			*	*	
54°26'	38°32'	0406	3.3.82	0700	3.3.82	*		*	*		*	*	

Table 3 - RMT1+8 m

Type	Number	Depths		
		RMT-1	RMT-2	RMT-3
Standard	68	200-140	140-70*	70*-0 m
Deep	8	750-500	500-300	300-200 m
	1	1300-815	815-500	500-200 m
Shallow	2	within surface 30 m		

* or upper level of thermocline

Table 4 - Estimated RMT8 Catch Volumes

Each net was open for 15 mins and towing speed was always between 2 and 3 knots. Consequently, water volume filtered is assumed to be similar for all catches.

Volume (cm^3)	RMT8-1		RMT8-2		RMT8-3		RMT8	
	n	%	n	%	n	%	Σn	%
$<10^2$	9	14	12	18	11	17	-	-
10^2-10^3	46	67	43	64	28	41	26	39
10^3-10^4	11	17	12	18	20	30	32	48
$>10^4$	1	2	-	-	8	12	9	13
Total	67	100	67	100	67	100	67	100

Table 5 - Estimated RMT1 Catch Volumes

Volume (cm^3)	RMT1-1		RMT1-2		RMT1-3		RMT1	
	n	%	n	%	n	%	Σn	%
<10	-	-	1	2	3	5	-	-
$10-10^2$	50	77	43	66	32	49	11	17
10^2-10^3	15	23	21	32	28	43	51	78
$>10^3$	-	-	-	-	2	3	3	5
Total	65	100	65	100	65	100	65	100

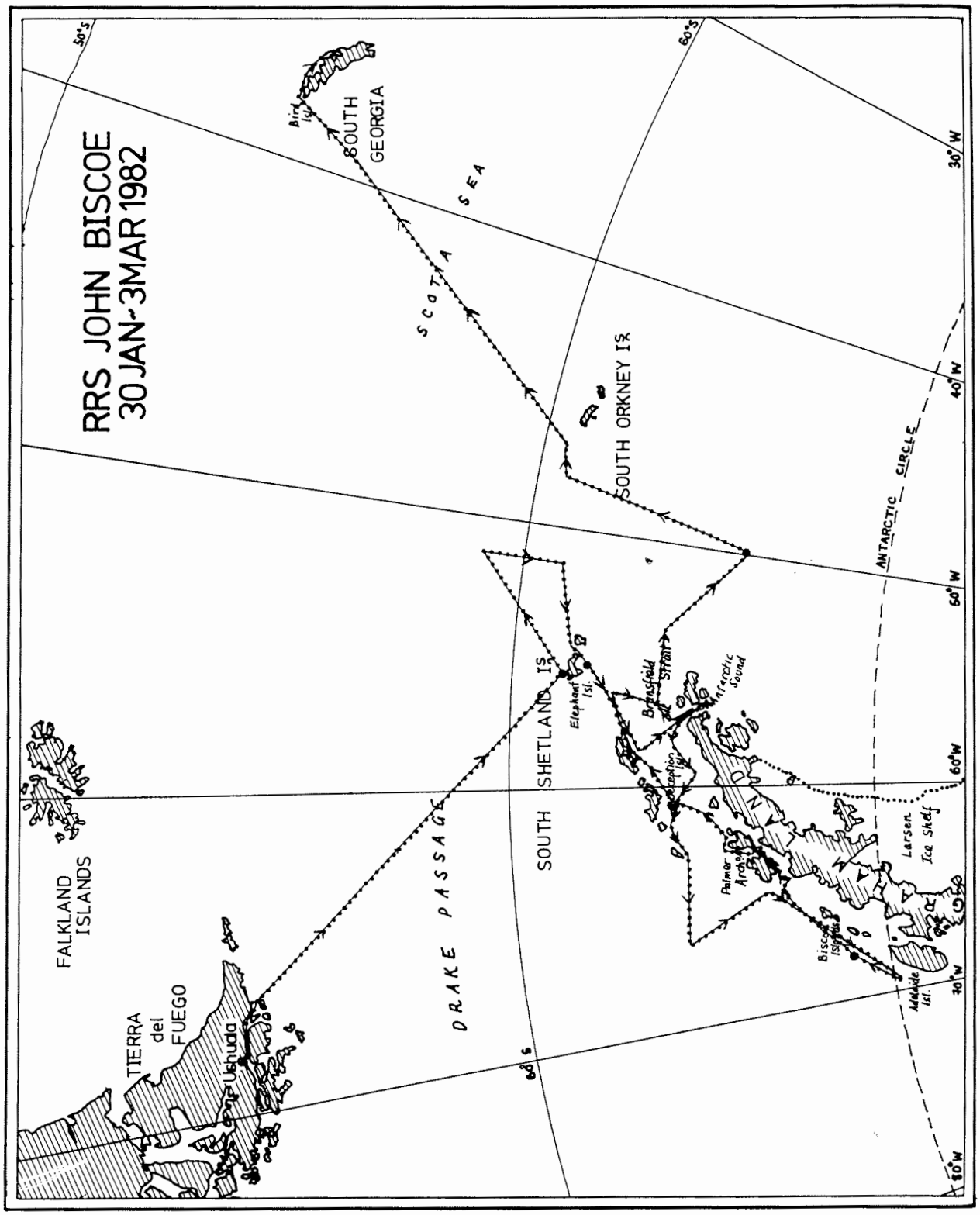

Fig.1: Cruise track of RRS John Biscoe during the Joint Biological Expedition

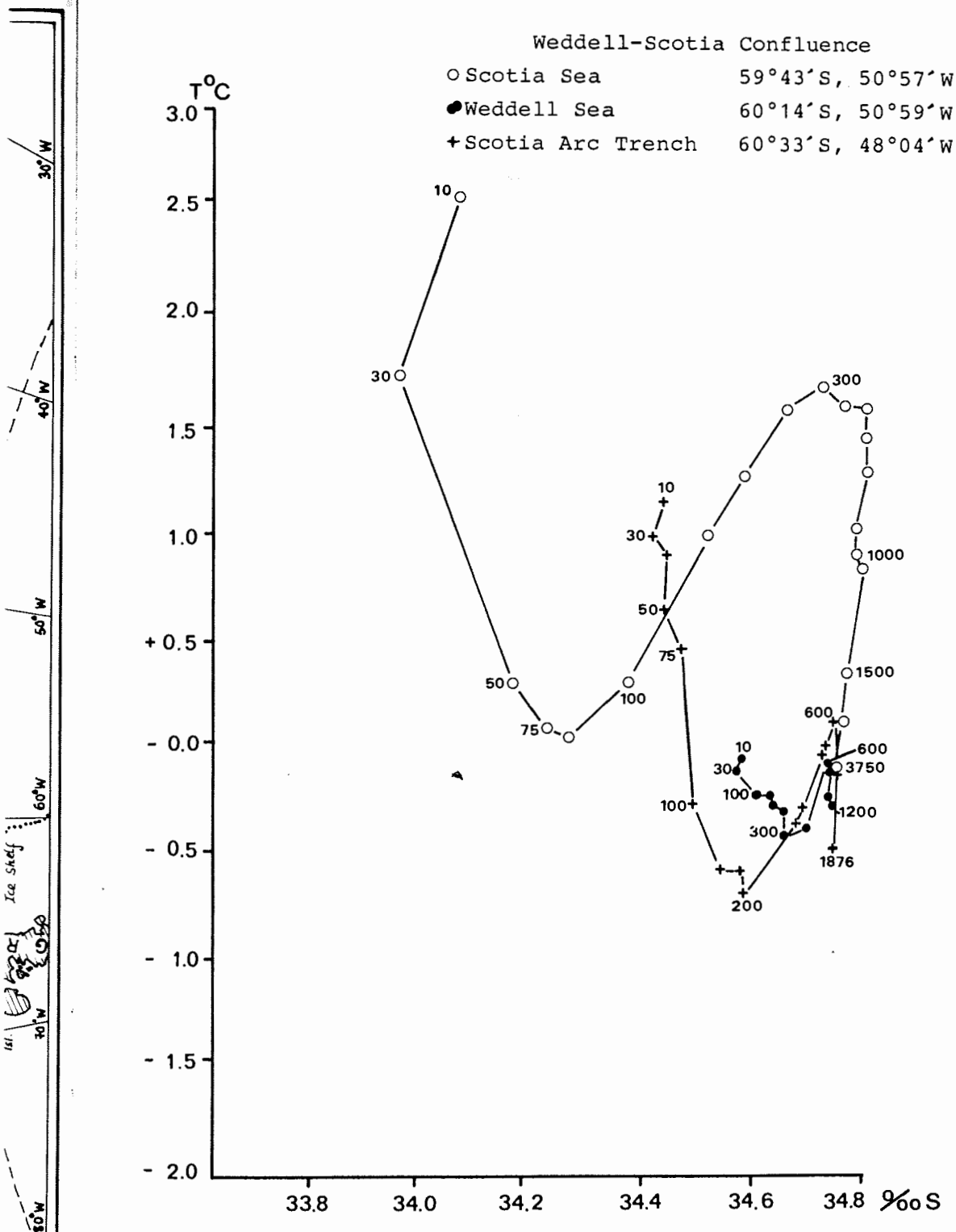

Fig.2: Temperature-salinity diagrams for the Weddell-Scotia Confluence in 51°W longitude, and for a station in a trench through the Scotia Arc

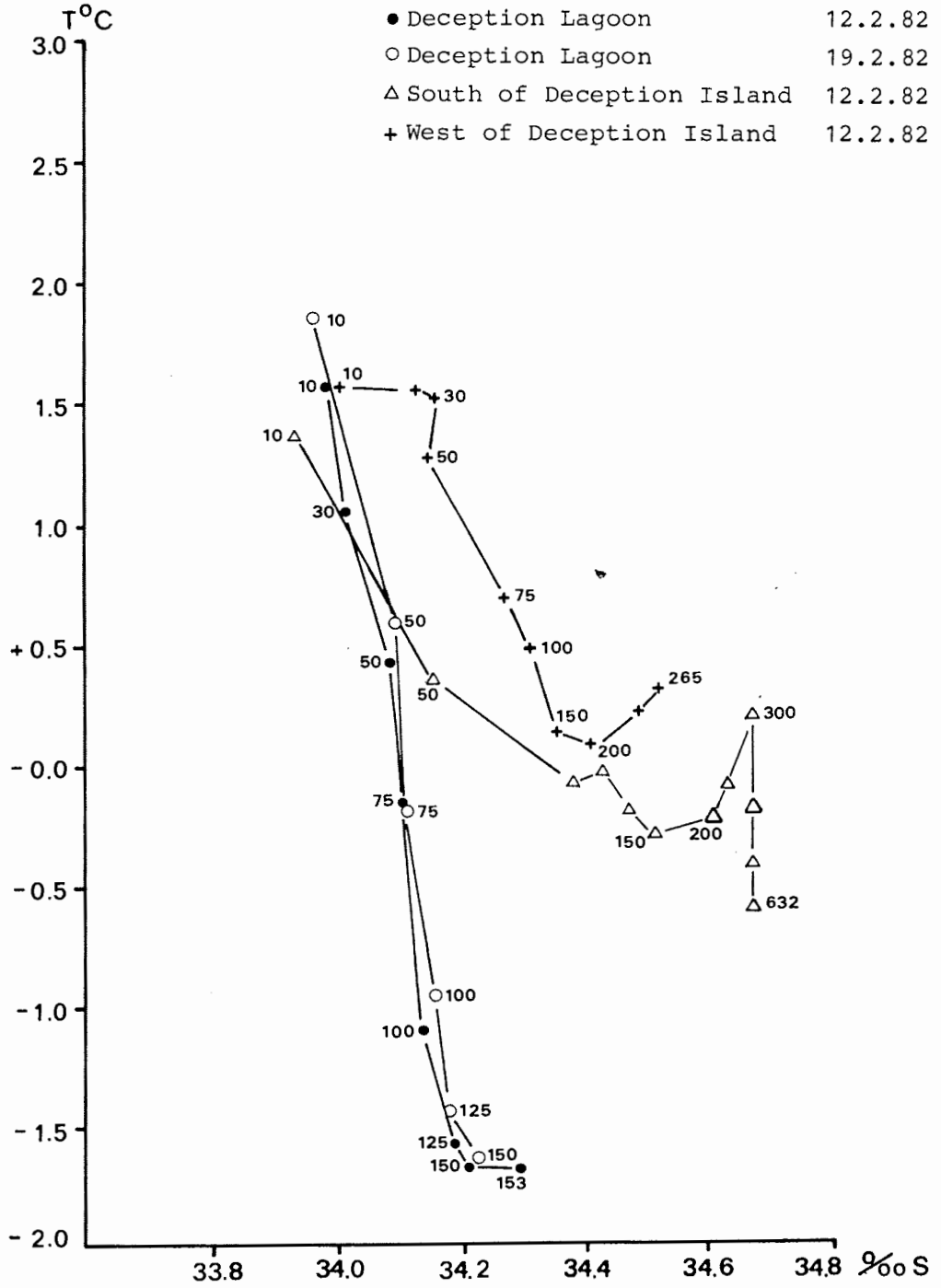

Fig.3: Temperature-salinity diagrams for Deception Lagoon and stations nearby in the Bransfield-Strait

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