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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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The Krill of Antarctica — the richest single species marine resource in the world.

Back Cover:

"Parental care in Antarctica. The newly hatched chick is being cared by a pair of Emperor Penguins"

THE THIRD INDIAN ANTARCTIC RESEARCH EXPEDITION AND THE ROLE PLAYED BY CMFRI

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Introduction

India entered the Antarctica Era when a team of 21 Indian nationals landed in Antarctica on 9th December, 1981. It was a big leap forward for the Indian science and technology and was much acclaimed the world over. It was indeed a tremendous achievement for a developing country like India. The whole programme was due to the initiative and encouragement of Prime Minister Smt. Indira Gandhi.

The pioneering Indian team initiated some useful research works in the continent and in the adjoining seas. Following the success of the first Expedition a second team of 28 men was sent in 1982 to make follow up studies of the programmes already begun during the first Expedition and also to open up new areas of research by staying for a longer period in Antarctica.

The Third Indian Antarctic Research Expedition, in which the author was a scientist member, was unique in several respects. The personnel contingent of 81 was the biggest India had ever sent to the icy continent. The chief task of the Expedition was to build a permanent base station during one Antarctic summer which could house 12-16 personnel during winter. This was quite a big challenge because in the history of Antarctic explorations, no country has achieved such an objective in one Antarctic summer which would last for hardly two months. The Antarctica is notorious for its blizzards and unpredictable weather which could minimise the working days to a great extent.

Besides the above objective the 16 member scientific team had several research programmes to carry out in the Antarctic Ocean and on the continent. The team of scientists included three marine biologists, one oceanographer, one chemist, two geologists, one glaciologist, one seismologist, two meteorologists, one oil and natural gas expert, three communication experts and one amateur radio operator. The author was to carry out investigations on various aspects of 'krill' (*Euphausia superba* Dana) a protein rich and vitamin rich crustacean which looks like tiny shrimp and would grow to about 55 mm in length and has vast resource in Antarctic Ocean with a circumpolar distribution. The article embodies a general account of the experiences of the author during the Expedition with special reference to the various activities undertaken during the Expedition. A detailed report of the work carried out by the author and also the results obtained on the quantitative abundance of zooplankton in the respective study areas is also included.

I. The Expedition in General

Preparations for the Expedition

All members of the Expedition had to undergo a medical checkup at the army hospital in Delhi and a training on the glaciers in the high altitudes in the Himalayas. The scientists had their training from 17–9–1983 to 25-9-1983. The training included walking on ice, climbing vertical ice cliffs, step cutting, rope climbing, crossing crevasses etc. The training was imparted by the High Altitude Warfare School at Sonamarg. (Plate I Fig. 1).

On 2nd November, the members of the Expedition were called to Delhi for briefing about the Expedition. They were addressed by the Secretary, D.O.D., Deputy Chiefs of the three Services and the leader of the Second Antarctic Expedition. The scientists were told to report in Goa in the 3rd week of November with all preparations for their scientific works in Antarctica.

The Task

The objectives of the Third Indian Antarctic Research Expedition were identified as follows.

Logistics

1. To carry out a quick survey of the area to ensure that the site selected for the Base Station by the Second Expedition is stable and capable of taking the weight of the proposed structure.
2. "To erect the building for the Permanent Indian Station and equip it with all essential services like power, water, heating, seawage disposal etc.
3. "To establish direct communication link between India and the Base Station in Antarctica.
4. "To test the reliability of the structure and other essential equipment. If these are found satisfactory, to leave a team of 12 to 16 persons behind for wintering in Antarctica."

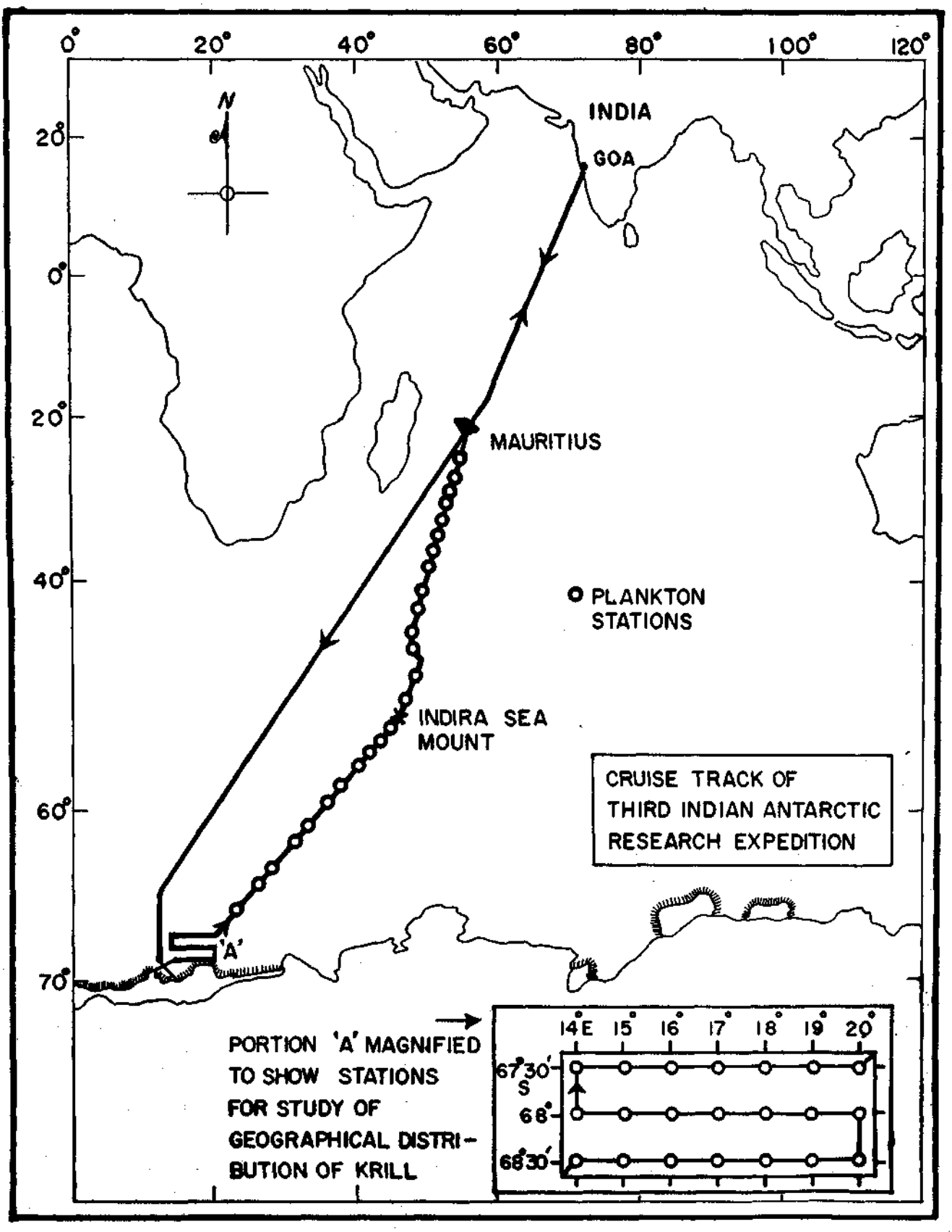


Fig. 1. The cruise track of M.S. *FINNPOLARIS* – the vessel used for the 3rd Expedition

Scientific

a. **Marine Biological and Oceanographic Studies**

1. "Assessment of geographic distribution, composition and biomass of 'krill' and other zooplankton in the coastal and oceanic waters in the southern seas.
2. "Studies on thermocline structures and coastal and oceanic water masses in the southern ocean along a section from Antarctica to Mauritius.
3. "Distribution of and inter-relationships between various chemical constituents of seawater, such as inorganic micronutrients, dissolved oxygen and components of carbon dioxide systems in relation to physical and biological features.
4. "Speciation of phytoplankton involved in primary biochemical end products of photosynthesis.
5. "Microbiological studies in sediments and sea water."

Limnological studies

1. "Physical and chemical studies in the fresh water lake systems in relation to carbon, nitrogen and phosphorous cycles.
2. "Phytoplankton and benthic species and the biochemistry of their photosynthesis in relation to light and temperature.
3. "Zooplankton quantitative studies, speciation and specimen collection.
4. "Microbiological studies in continuation of the earlier work."

Aerosol studies

1. "Sampling for analysis of various radioisotopes for studies on air mass movements and trace elements at Bhaba Atomic Research Centre and microbiological work at Marathwada University."

Soil analysis

1. "Sampling of soil for radioactive analysis at BARC to assess levels of remnants of nuclear explosions in Antarctica.
2. "Chemical analysis of cations, cationic exchange capacity, pH and organic carbon contents."

Chemical studies of other constituents

1. "Chemistry of ice and snow samples.
2. "Analysis of moss and lichen chemistry."

Geological studies

1. "Collection of samples for petrological, geochronological, geochemical, palaeontological, sedimentological and palaeomagnetic studies.
2. "Representative meteorite sample collection.
3. "Geomorphological, glaciological and structural studies.
4. "Coastal shelf area studies with special reference to submarine geology."

Geophysics

1. "Seismic refraction experiments for estimating ice thickness at various sites.
2. "Magnetic profiles extending to several kilometres using two proton precision magnetometres."

Habitat development studies

1. "Investigations of density, strength and deformation profiles of snow cover for foundation and superstructure designing.
2. "Wind movement and direction based on snow deposition studies.
3. "Evaluation and testing of engineering equipment and products."

Communications

1. "Different kinds of antennae to be tried for communication stability in the Antarctic environment, and operation of an Amateur radio."

Meteorological programme

1. **In the ocean**
   a. "Measurement of surface pressure, temperature, humidity and wind velocity.
   b. "Radiosonde/omegasonde measurements of upper air pressure, temperature and humidity".
2. **Over Antarctica**
   a. "Both of the above.
   b. "Surface ozone, snow catch and radiation regime of Antarctica."

Personnel and Facilities for the Expedition

The personnel contingent consisted of 81 Indian nationals selected from the three armed services and from various research Institutes of the country. The scientific team was composed of 16 members of which one was an amateur radio operator.

The Expedition was conducted using a Finnish vessel, *FINNPOLARIS* of 159.22 m length. The ice-strengthened vessel was specially designed for navigation in the polar seas. It could hit and smash sea ice of upto 0.75 m thickness. The main engine had a power of 9900 hp. The Expedition carried with it four helicopters (two larger ones from the Indian Air Force which could carry about 3 tonnes of cargo and two smaller

from the Indian Navy), four snow vehicles each having a load capacity of 10 tonnes, snow scooters, 200 tonnes of building materials, 2,000 barrels of fuel, snow cutting machines, three large generators, many small generators, living containers, boiler, two sets of equipments for satellite communication, many other communication equipments, and a lot many other major and minor items. The food materials and soft drinks amounted to a large quantity. The scientific equipments were in addition to the above.

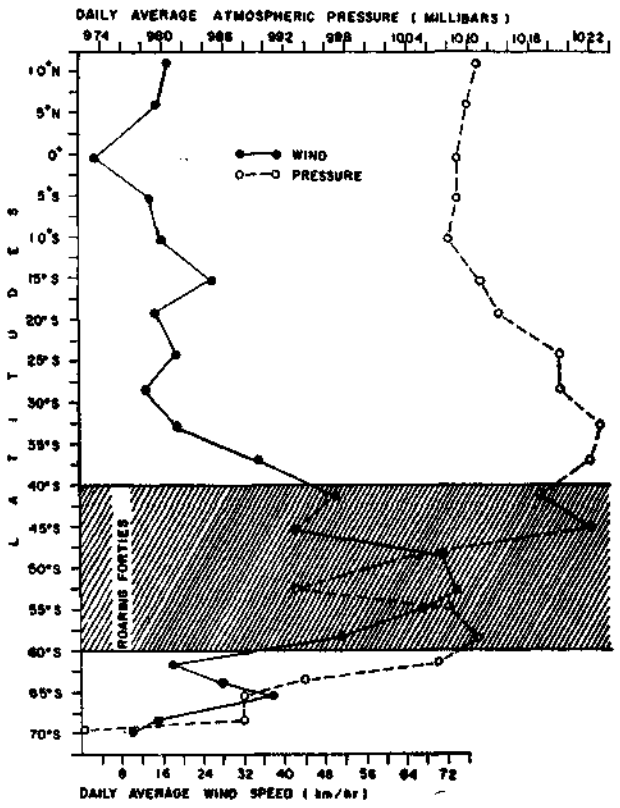


Fig. 2. The daily mean value of wind velocity and barometric pressure from Goa upto Antarctica.

The Voyage to Antarctica

With the above mentioned objectives and facilities the Expedition set sail from Goa on the 3rd December, 1983. The participants were given a heroic send off as the military bands played melodious tunes, the most touching being *'Sare Jahan se acha Hindustan hamara'* (of all countries in the world, our country, India, is the best). After moving out from the port of Goa, the ship took a south southwest course. The Fig. 1 shows the cruise track to and from Antarctica and also the plankton stations. On the way to Antarctica the ship cruised through a rather calm sea, crossed the equator on 6th December and reached Mauritius on 10th. After staying there for four days she sailed off to Antarctica. Passed through the roaring forties without any major storms or rough sea; on the other hand the fifties were quite rough with storms, high swells and breaking waves. The situation was almost the same during the homeward voyage also. Figs. 2 and 3 give the pattern of daily average wind and barometric pressure on way to Antarctica in December, 1983 and on way back in March, 1984 respectively.

Soon after crossing the 40°S latitude, the weather changed dramatically. The atmospheric temperature dropped from 22°C to 8°C in about 24 hour period. The daily average temperature recorded on board the vessel between Goa and Antarctica and back are given in Figs. 4 and 5 respectively. The first ice berg was sighted on 23rd December at 57° 25'S and 28°25'E where the atmospheric temperature was 3°C. (Plate I Fig. 2). Afterwards it was an usual sight.

On 25th of December, the ship started sailing through pack ice. (Plate I Fig. 3). As the ship went ahead the ice blocks on the surface of the sea became larger and thicker and at about 130 km away from the coast the ship had to be stopped on account of multi-year ice and thick sheet ice. One naval helicopter was engaged to find out the way and also a *'polynya' for safe anchorage

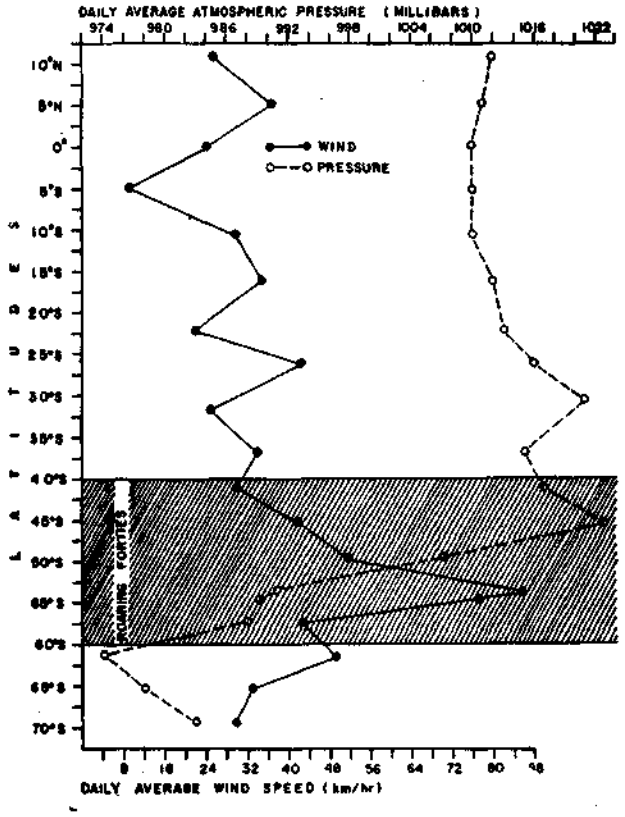


Fig. 3. The daily mean values of wind velocity and barometric pressure from Antarctica upto Goa.

* 'Polynya' is an ice free zone of limited extent in the ice covered sea.

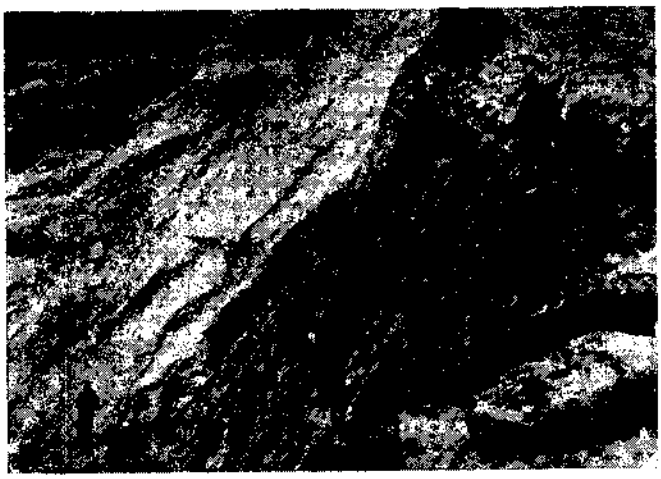


Fig. 1 Training on the glaciers at the high altitudes in the Himalayas was a prerequisite for the Expedition. The author climbs up a vertical ice cliff using rope.

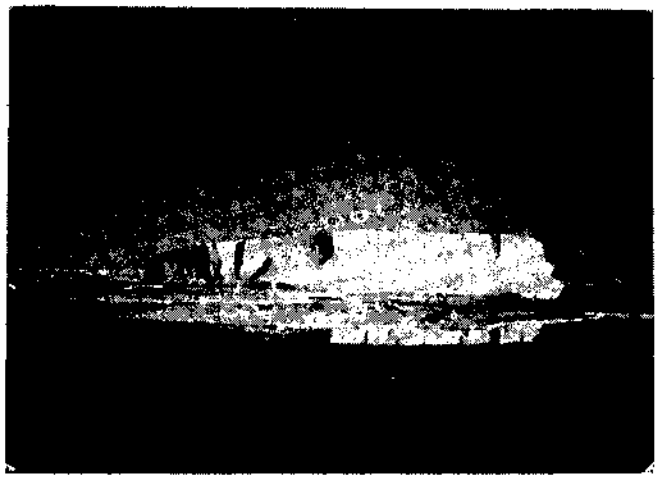


Fig. 2 Ice berg – the floating ice mountain is an usual sight south of 60°S latitude.

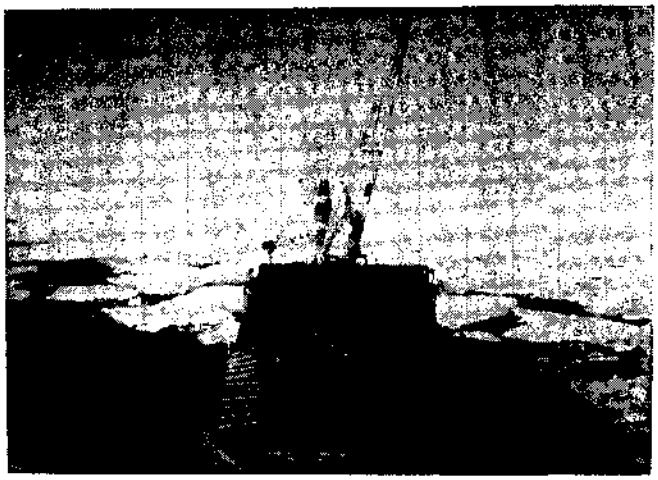


Fig. 3. The ship is now passing through pack ice of about 1 m vertical thickness.

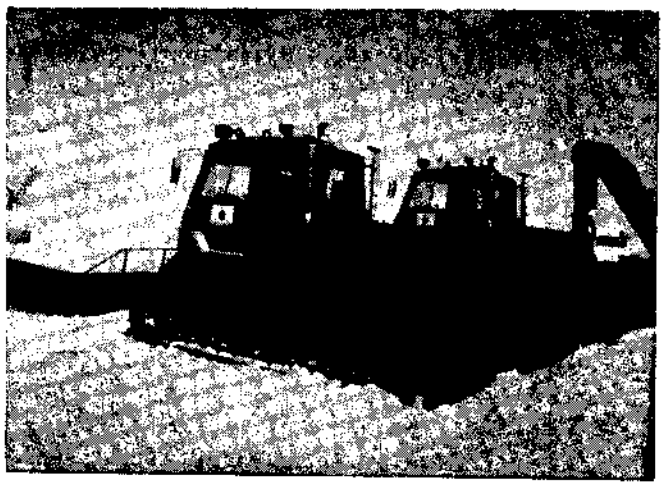


Fig. 4. The snow wolfs are really tough multipurpose snow vehicles which could pull loads of 10 tonnes over the ice.

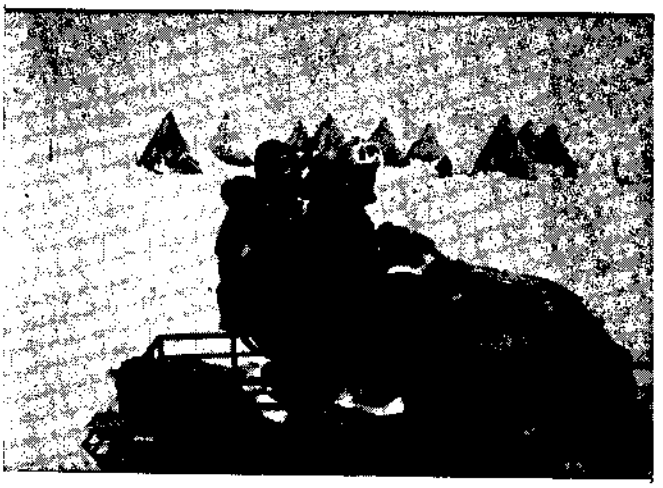


Fig. 5. 'Skidoo' the snow scooter is a convenient vehicle for 2 men to go from place to place. In the background are the tents at the base camp which could withstand heavy storms.

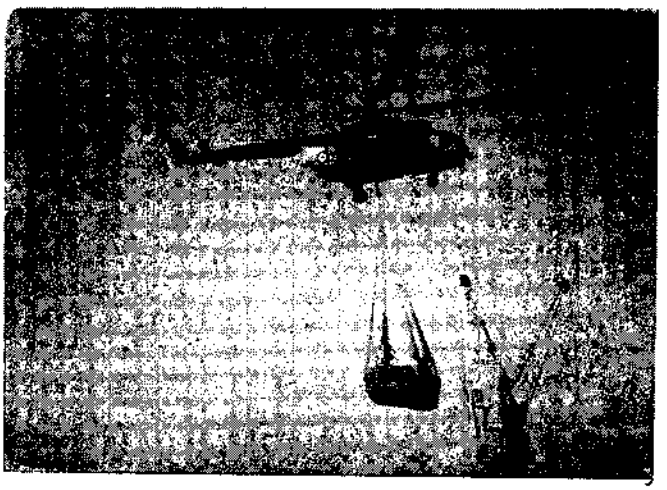


Fig. 6. Underslung operation. The large IAF helicopter MI–8 was the most useful carrier for men and materials.

of the ship. Eventhough the helicopter could guide the ship forward, the vessel could not reach the permanent shelf as there was still thick platforms of sea ice for about half a kilometre in front of the permanent

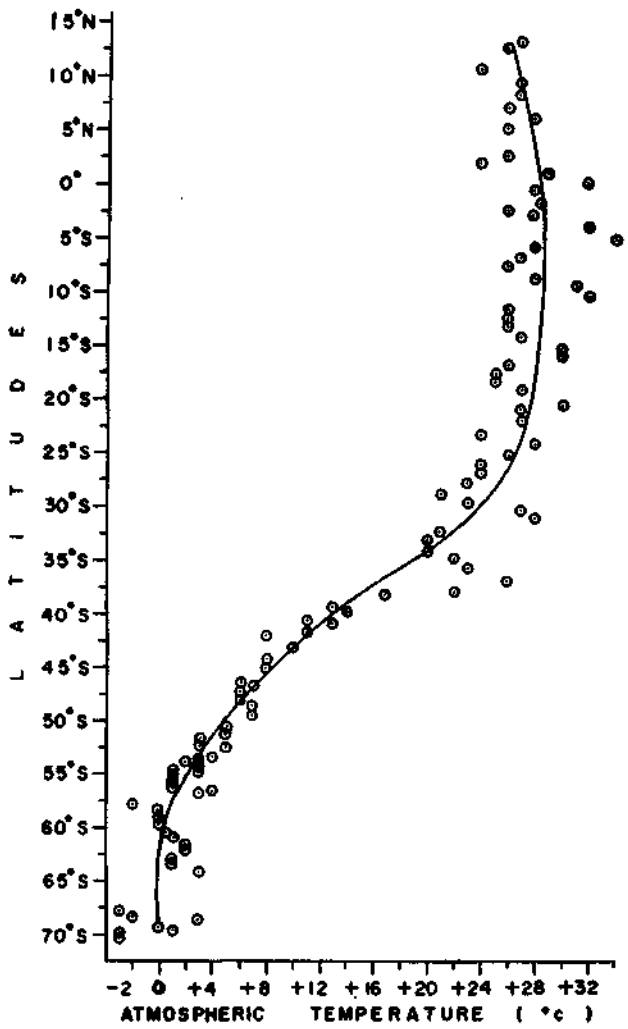


Fig. 4. The daily mean values of atmospheric temperature between Goa and Antarctica.

ice shelf. Therefore on 27th December by 0130 hrs while the sun was still shining in the sky, the ship was moored on to the sea ice and we landed in Antarctica.

Antarctic Continent

The antarctica is the highest, coldest, stormiest and driest continent on earth. The average height from the sea level is three times more than any other continents. It has an expanse of 14 million square kilometres which is roughly equal to India and China put together. 98% of the continent is covered by ice. The average thickness of the ice is 2000 m. The remaining 2% consists of exposed land of hills and mountains. 90% of the ice in the world is in Antarctica.

The continental shelf has a width of 30 km only against a global width of 70 km. At its seaward edge 400

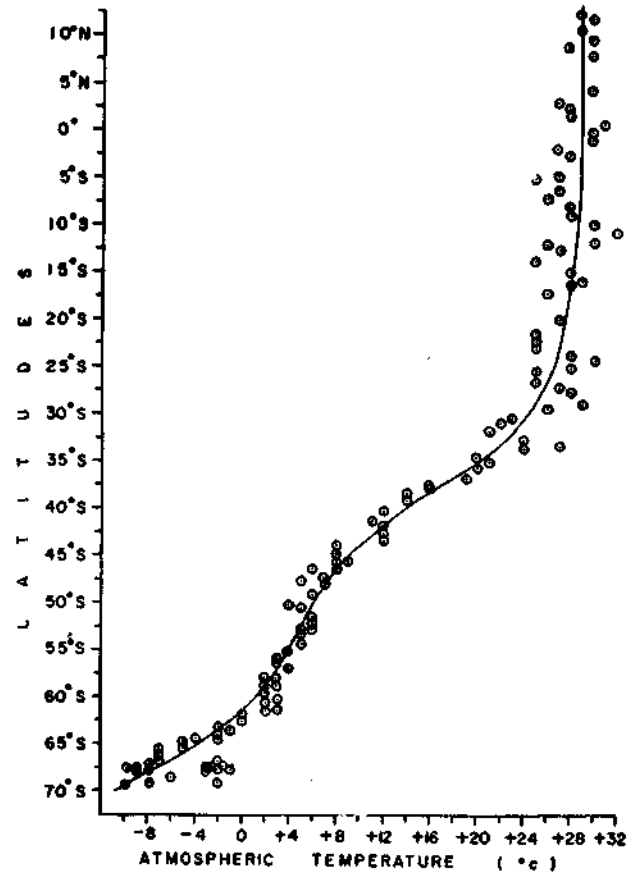


Fig. 5. The daily mean values of atmospheric temperature between Antarctica and Goa.

to 600 m depths are common. The cause of the abnormally deep shelf edge has been attributed to depression of the shelf by the ice load.

The summer average temperature may range between 0°C and – 30°C, whereas the average winter temperature may be between – 20°C and – 65°C. The world's lowest temperature of – 88°C has been recorded on 24th August, 1960 at *VOSTOK*, a Russian station.

The amount of sunlight Antarctica receives is very high. The total annual radiation at the south pole is about equal to that received in equatorial regions despite there being months of total darkness. This is because of the continent's high elevation, and therefore thin atmosphere and by the unusual transparency of the air.

The blizzards of Antarctica are notorious. They are high velocity cyclonic storms associated with snowfall and snow drift. They form over the southern oceans

and move clockwise around the continental coast. The wind speed can go upto 200 km/hr or more. The extreme cold in Antarctica makes it a dry continent. The moisture formed in the atmosphere gets condensed and fall down as snow.

Around the continent there is a vast expanse of sea ice. The ice pack grows from an average minimums of 2.6 million km^2 in March to 18.8 million km^2 in September. 85% of the Antarctic pack ice melts each year which has an average thickness of 1.5 m. The ice bergs, characteristic of the Antarctic seas are parts of the main continent cut away in course of time. Some of them may be gigantic with measurements of 100×60 km. There are ice bergs grounded at depths of 500 m.

Early Explorations

About 500 B.C. the ancient Greek philosphers logically concluded that there should be an antarctic continent to balance the earths weight in the northern hemisphere. Then for 2000 years the idea was lost until Columbus revived it. Later from 1772 to 1775 Captain James Cook sailed around Antarctic continent three times without sighting the continent.

In 1820 and 1823 Nathaniel Palmer of U.S.A. and James Weddel of U. K. respectively discovered the Antarctic Peninsula. In 1895 H. J. Bull of Norway made the first landing in the continent.

On 14th December, 1911 Roald Amundsen of Norway reached the geographic pole, the most spectacular achievement in the exploration of Antarctica. Again on 17th January, 1912 Robert Scott of U.K. also reached the south pole.

The International Geophysical Year of 1957-58 called for a co-operative venture for Antarctic exploration. Twelve interested countries agreed to combine forces and sent to Antarctica. These countries form the original signatories of the Antarctic Treaty.

Between 1900 and 1940 most of the continent had been claimed by seven countries namely U.K., Newzealand, Australia, France, Norway, Argentina and Chile. These countries and five more countries which co-operated during the IGY met and signed a draft Treaty in 1959. Eight more countries including India have been acceded since the Treaty entered into force. Although the Treaty freezes the existing claims, most claimants remain firm about their long term territorial rights out of national pride, possible economic gain and security considerations.

India Goes to Antarctica

It was under such situations that India decided to go to Antarctica and establish a base of her own.

On 9th December, 1981 a team of 21 Indian nationals landed in Antarctica. Followed by this a second Expedition was sent by India which made its landing on the 26th of December, 1982 and did scientific works establishing a temporary base. Following the success of the previous two expeditions, India sent a third expedition in December, 1983 with much wider scope. By this time India had obtained membership in the Antarctica Club but not in the Consultative Council of the Treaty Nations for want of a permanent station in Antarctica. The main objective of the Third Indian Expedition was to construct on ice a permanent station where scientists could stay year round. Besides, the 16 member scientific team had their own programmes to carry out on the continent and in the adjacent sea.

The Activities During The Third Indian Antarctic Expedition

Soon after reaching Antarctica, the team members started with the offloading operations. Among the first items unloaded were the heavy cargo such as the snow vehicles (Plate I Figs. 4 & 5) sledges, living containers etc. which were immediately required at the base camp and which could not be transported by the helicopters. The offloading of them on the sea ice which was about one metre thick involved great risk. But the need of the hour necessitated such an action.

A suitable site (70°05′37″ S 12°00′00″E) which was about 10 km. away from the previous years base camp and about 15 km from the ship was selected for the construction of the permanent station. Fig. 6 is a schematic representation of the ice shelf, sea ice, a

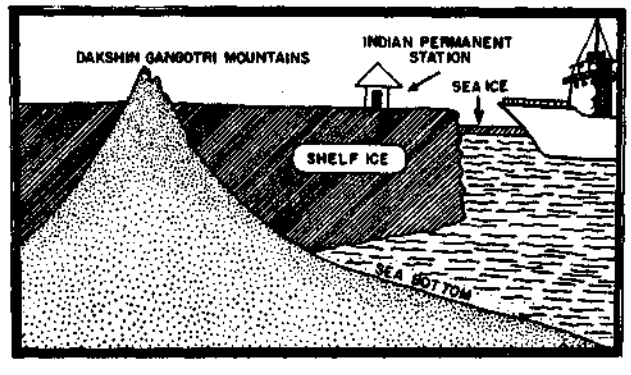
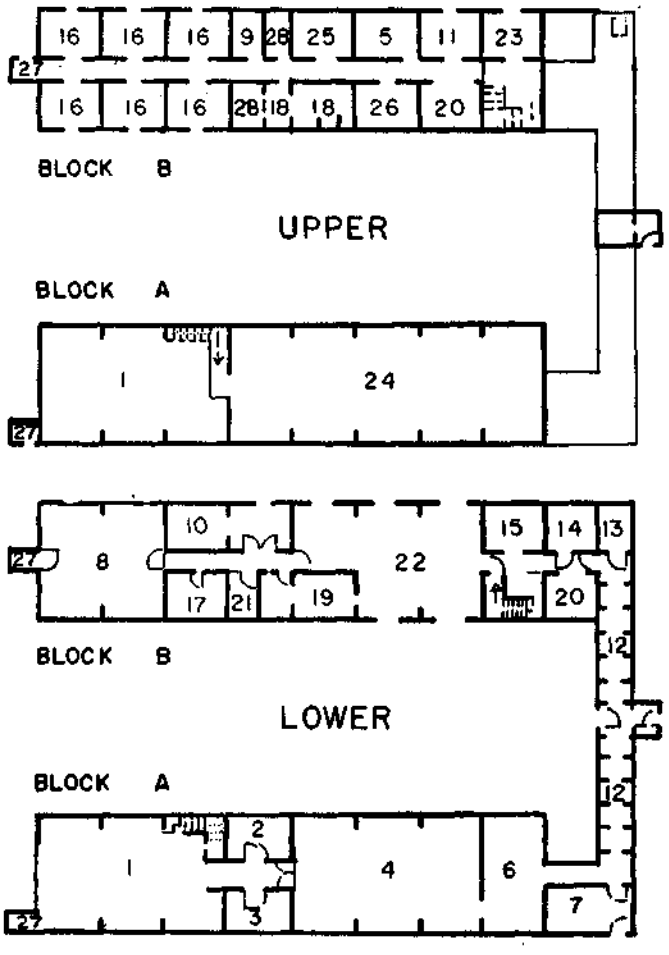


Fig. 6. Vertical profile of a part of the ice shelf and sea where the permanent Indian station is situated.

mountain range and the relative position of the permanent base station (not drawn to scale). Tents for the accommodation were erected by the first advance party. The air force helicopter was put into operation on 27th December itself for transporting the building and other essentials to the base camp (Plate I Fig. 6). Every member of the Expedition was to associate with the construction work in one way or other. Mainly the scientists were responsible for unloading the cargo from the ship. Everyone had to work for 8 to 16 hours or even more a day besides attending to the scientific works. The frequent blizzards, the loss of a large helicopter on the second day of arrival in Antarctica were enough to dampen the spirits of the members. But the rememberance that we were sent to work for a great national cause kept our morale up and gave us strength to work untiringly in such hostile weather and freezing temperatures. The work on the building progressed steadily but with interruption due to blizzards. However, the goal was achieved in 58 days which was a world record.

DAKSHIN GANGOTRI—The Permanent Indian Base Station

The base station consists of 2–two storeyed blocks–Block-A containing the living facilities, communication facilities and general stores in the first floor and a lounge, kitchen, hospital, laboratory and a snow melting plant in the ground floor. (Plate II Figs. 1, 2 & 3). The Block-B houses three generators, the electrical work



PLAN OF *DAKSHIN GANGOTRI* BASE STATION

SCALE 1 : 100

1 GARAGE WORKSHOP
2 ELECTRICIANS WORKSHOP
3 DIESEL MECHANICS WORKSHOP
4 GENERATOR ROOM
5 BOILER ROOM / DAILY OIL STORE
6 CARPENTER'S WORKSHOP
7 WEEKLY OIL STORE
8 LABORATORY
9 DARK ROOM
10 SURGERY
11 BASE COMMANDER'S OFFICE
12 ACCESS LINK
13 MELT TANK
14 SNOW MELT PLANT
15 OUTDOOR CLOTHING STORE
16 TWO MAN BUNKROOM
17 LAUNDRY
18 WASH ROOM AND TOILETS
19 KITCHEN
20 COLD ROOM
21 LARDER
22 DINING ROOM / LOUNGE
23 RADIO ROOM
24 MISC. STORAGE
25 SCIENTIFIC EQUIPMENT STORE
26 FOOD AND GENERAL STORE
27 ESCAPE SHAFT
28 TOILETS

Fig. 7. The lay out of the permanent Indian station – the *Dakshin Gangotri*.

shop and carpentry on the ground floor. In the upstairs are again some of the workshops and the general stores. Connecting the two blocks is the link block which provides the passage from one block to the other. The buildings which are entirely made of wood, asbestose and thermocol are centrally heated. The permanent Indian station has been christined as *Dakshin Gangotri*. Fig. 7 is the lay out of the permanent station put up by the 3rd Expedition.

A team of 12 members of which three being scientists are left behind for wintering. The scientists would carry out investigations on glaciology, meteorology and microbiology.

The Amateur Radio Operation

The amateur radio operator (HAM) of the Expedition could establish contacts all through the Expedition with many amateur radio operators in India through whom many of the members could pass on and receive messages to and from their family members.

The Blizzards

The Expedition was caught in four major blizzards during its stay in Antarctica. The first one started on 6th January and lasted for two days. The wind speed rose to 78 km per hour. This blizzard affected the Expedition adversely in that all the excavations made for laying the foundation of the building were filled up with the drifting snow. The wind and blizzards experienced and the barometric pressure noted by the 3rd Expedition in the Antarctica are presented in Fig. 8.

The second blizzard hit the Expedition from 17th to 18th January. The maximum wind speed during this storm was 80 km per hour. Another blizzard which occurred lasted from 9th to 11th February. This time the maximum wind experienced was of the velocity of 90 km per hour. The severest of the blizzards was towards the end of February when all the construction works were over. The wind speed rose upto 133 km per hour which was the maximum registered at the ship's side during this Expedition. Fig. 9 is the

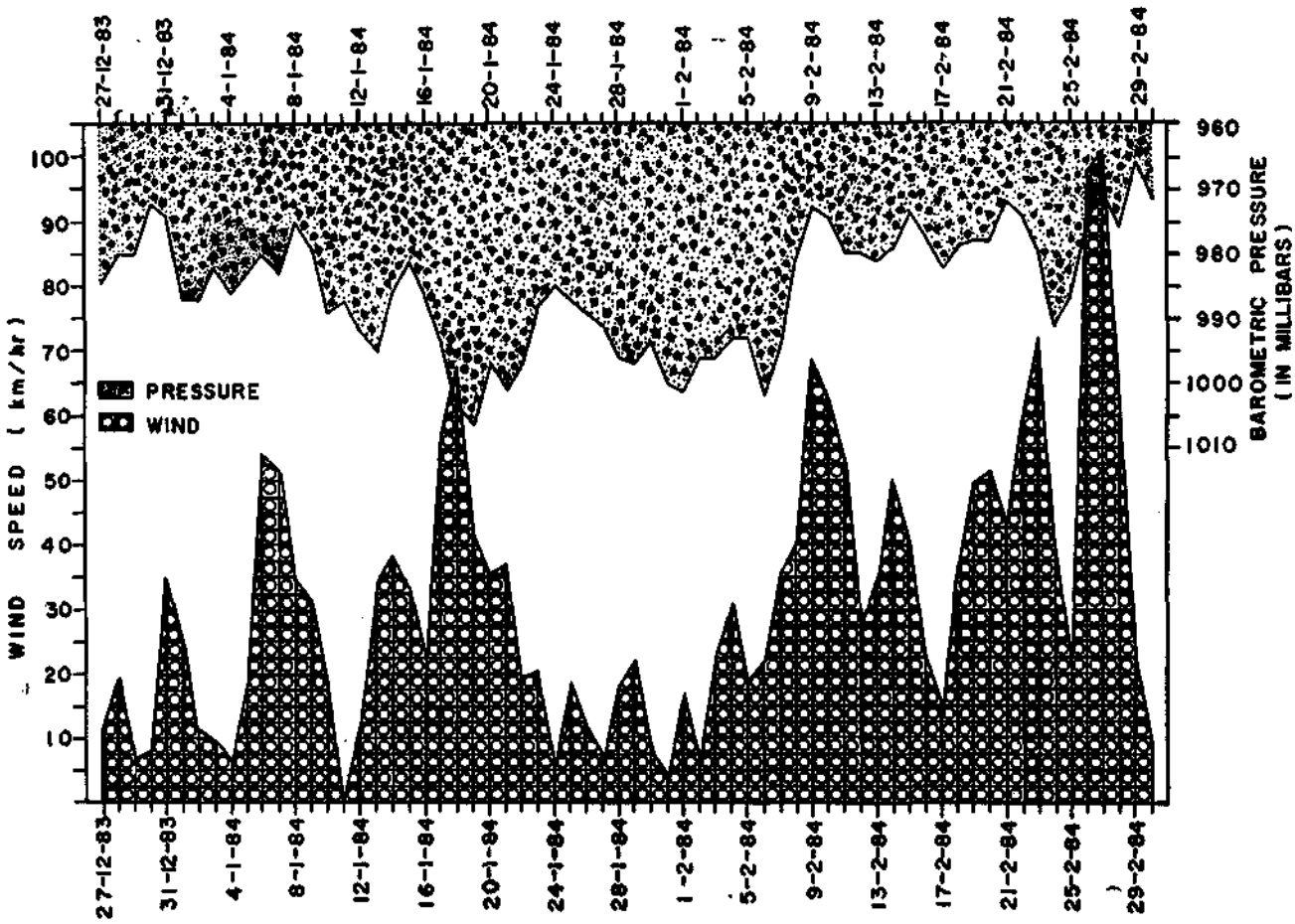


Fig. 8. The wind and blizzards experienced and the barometric pressure noted in Antarctica.

weather chart received by the FAX on board the vessel from the Russian Antarctic station *MOLODYOZHNAYA* on 26–2–1984 when the wind rose to the maximum velocity.

Temperature Conditions

The atmospheric temperature in Antarctica during the stay of the Expedition was below zero except during certain hours on some days in the summer when it went upto + 6°C. The lowest temperature, the 3rd Expedition experienced was –18°C at 0400 hrs on 25–2–1984. The daily average temperature recorded in Antarctica by the 3rd Expedition between 27th December, 1983 to 1st March, 1984 is presented in Fig. 10.

Fauna and Flora

The life forms on the continent are scarce. The plant forms are represented by mosses and lichens. The lower forms of animal life have also been recorded in the fresh water lakes in the rocky areas. The bird fauna is rich mainly with Adelie and Emperor Penguins (Plate II Fig. 4). Several other species of birds have also been recorded in and around the continent.

The depth soundings made in the Antarctic sea

The incidental findings of a deep and steep hole near to the ice shelf adjacent to the abandoned Russian Summer Camp, Lazarev, inspired the Chief Officer of the ship to undertake depth soundings of the nearby sea area. As a result he could make out a detailed depth chart for an area of more than 5,000 km² (Fig. 11).

The Schirmacher Mountains

About 70 km away from the Indian permanent station (70°44'S 11°39'E) is the rocky mountains known as Schirmacher mountains for which the First Indian Expedition has given another name, the *'DAKSHIN GANGOTRI.'* The mountains stretch for 15 to 16 km in length and has a width of ½ to 2 km. The highest peak is 212 m high. Because of the steep elevations,

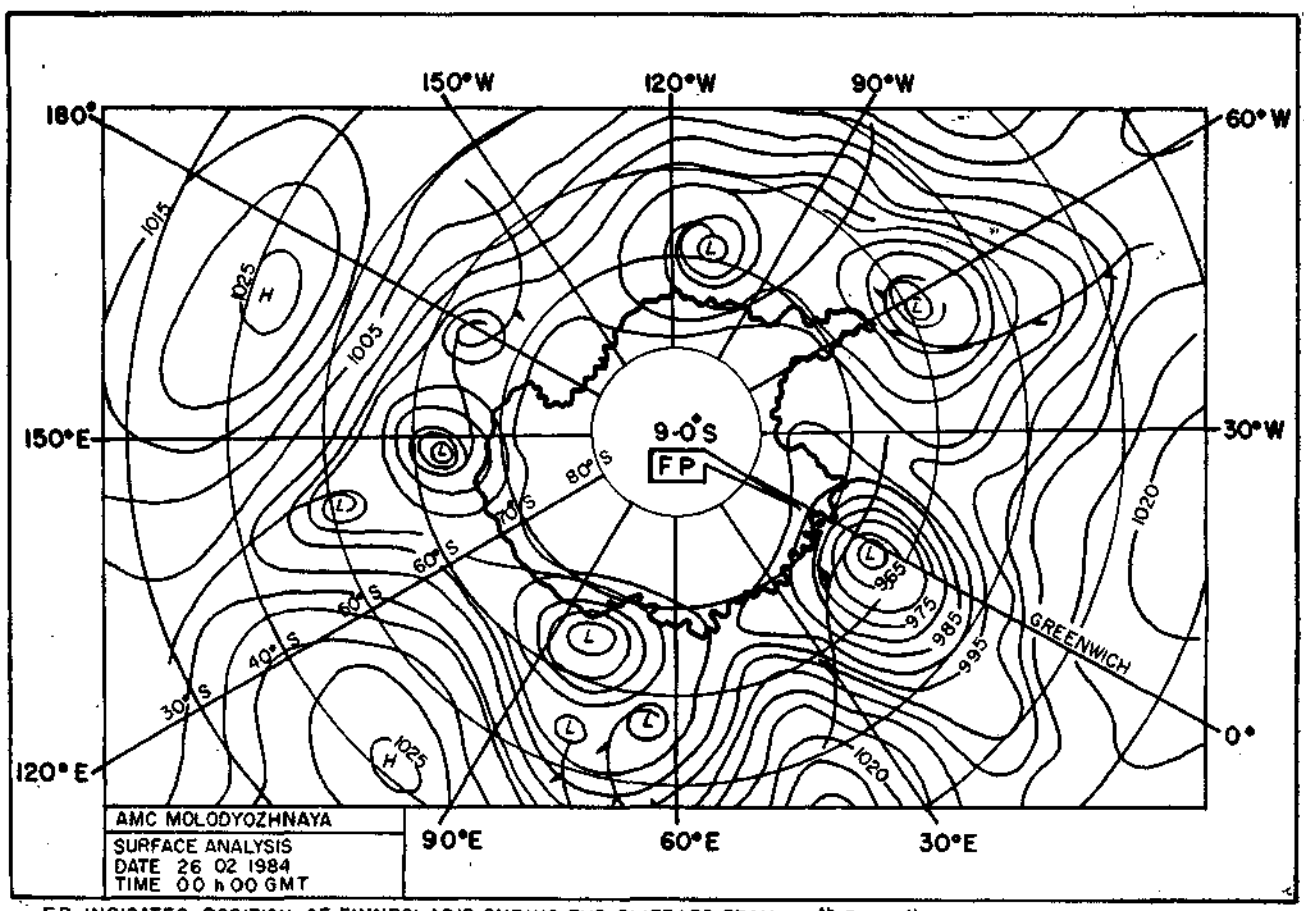


Fig. 9. The weather chart received on board the vessel from *Molodyozhnaya*, a Russian station in Antarctica on the day of severest blizzard.

during the summer, the snow cover on the rocks melts off and the water accumulates in the valleys to form fresh water lakes, pools and streams (Plate II Fig. 5). Even water falls are seen during summer. The rocks remain free of ice during this season. Good amount of geological works have been carried out by the Indian geologists in this area. Remains of dead birds were collected by the author from the Schirmacher mountains (Plate II Fig. 6).

Scientific and related work

The Leader of the Expedition in his report has made the following remarks about the scientific component of the Expedition and their work.

"This was an excellent team of scientists, and I wish to put on record my appreciation of the sincerity, devotion and discipline with which the scientists met with job requirements, both scientific and miscellaneous. Although not used to labour oriented jobs, scientists did not shrug from such work. They actively and effectively carried out loading/unloading operations and other odd jobs."

The scientific work were carried out on voyage to and from Antarctica, at the site where the ship was moored, at the base station and at the Schirmacher mountains. (The work on 'krill' and observations on birds have been given elsewhere in this report.)

1. Geological work

The camp at the Schirmacher mountains, mainly run by the geologists functioned for 24 days in January-February period. A detailed map of the mountain of about 35 km^2 area was prepared on 1:25,000 scale. The dominant rock types of the area were studied. Also samples were collected for minerological studies.

2. Meteorology

Meteorological parameters were monitored on board ship, at Base Camp and at Schirmacher mountains. Many radiosonde and omegasonde were released during the Expedition. A permanent station has been established at the Base Camp for year-round monitoring of the meteorological parameters.

3. Communication

Two satellite communication terminals of INMARSAT system have been installed at the Base Camp. The system provides telephone and telex link on a global basis.

4. Magnetic surveys

Total intensity measurements of earth's magnetic field were carried out at the Schirmacher mountains and on the ice shelf.

5. Biological and microbiological studies

A preliminary survey was carried out in five fresh water system in the Schirmacher mountains. The parameters studied included temperature, pH, chlorophyl *a* and productivity in the water column.

Diurnal and seasonal variations with regard to phytoplankton activity in shelf waters were investigated.

Fifteen stations were occupied on the north-bound transect from Antarctica to Mauritius for Chlorophyll *a* and ATP values and for oceanographic parameters.

6. Study on ionized and unionized atmosphere

This study being important in radio communication system was carried out by means of Riometer tuned to 20 MHZ and a microbarograph.

7. Chemical studies

Investigations of soil chemistry, vegetation and trace elements were conducted at the Schirmacher mountains.

8. Studies on bacteria and fungi

Around 1000 microbiologically distinct colonies have been isolated for further studies. A well equipped biological laboratory has been set up at the Base Station.

The winter starts

The winter started in Antarctica by the middle of February. As the winter set in, the temperature fell suddenly from minus 10°C to minus 20°C. The sea surface started freezing and there were frequent gales and blizzards.

Farewell to Antarctica

The 3rd Indian Antarctic Expedition completed its major task of constructing the permanent station by the 25th of February, 1984. After leaving the

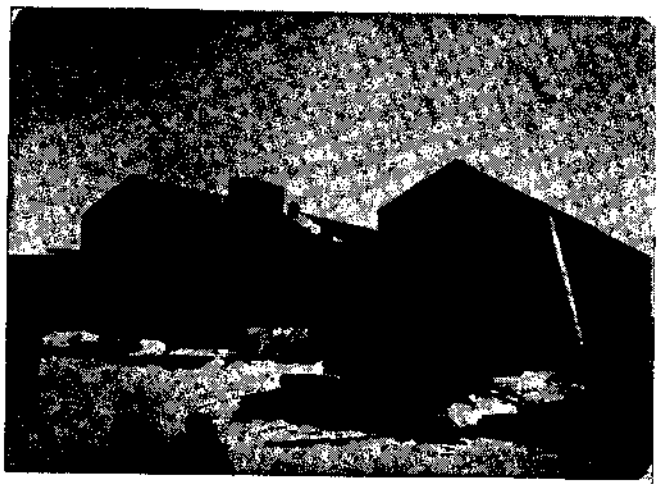


Fig. 1. The construction work progresses against frequent blizzards and white outs.

Fig. 2. The *Dakshin Gangotri* – the 1st Indian permanent base station in Antarctica. Note the dome of satellite communication antenna.

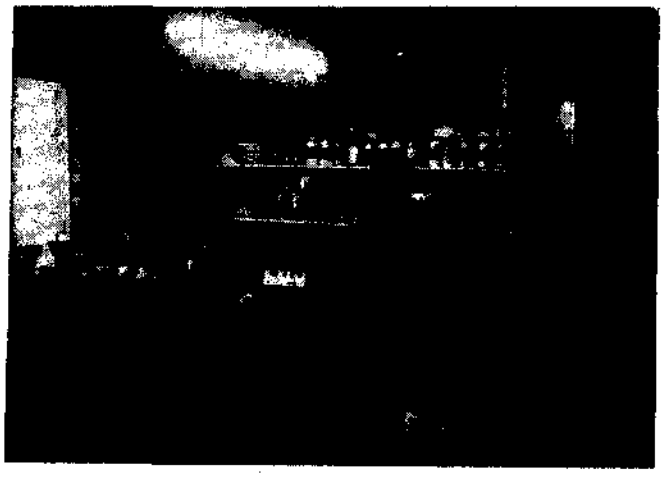


Fig. 3. The laboratory inside base station.

Fig. 4. One among the penguins. The author is on a visit to a small penguin rookery.

Fig. 5. A fresh water lake in the Schirmacher mountain, 70 km away from the Indian station.

Fig. 6. The ventral and dorsal sides of a young skua hunted upon by older birds. Recovered from the mountains.

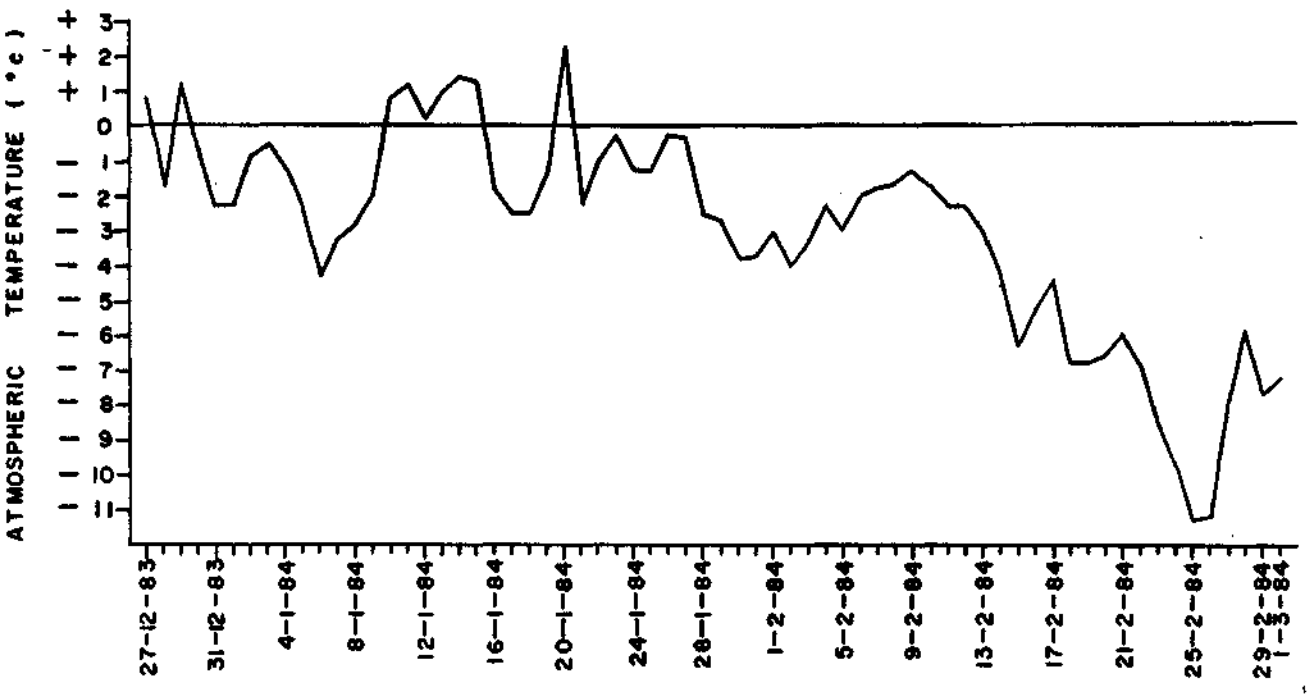


Fig. 10. The daily mean values of atmospheric temperature experienced by the 3rd Expedition in Antarctica.

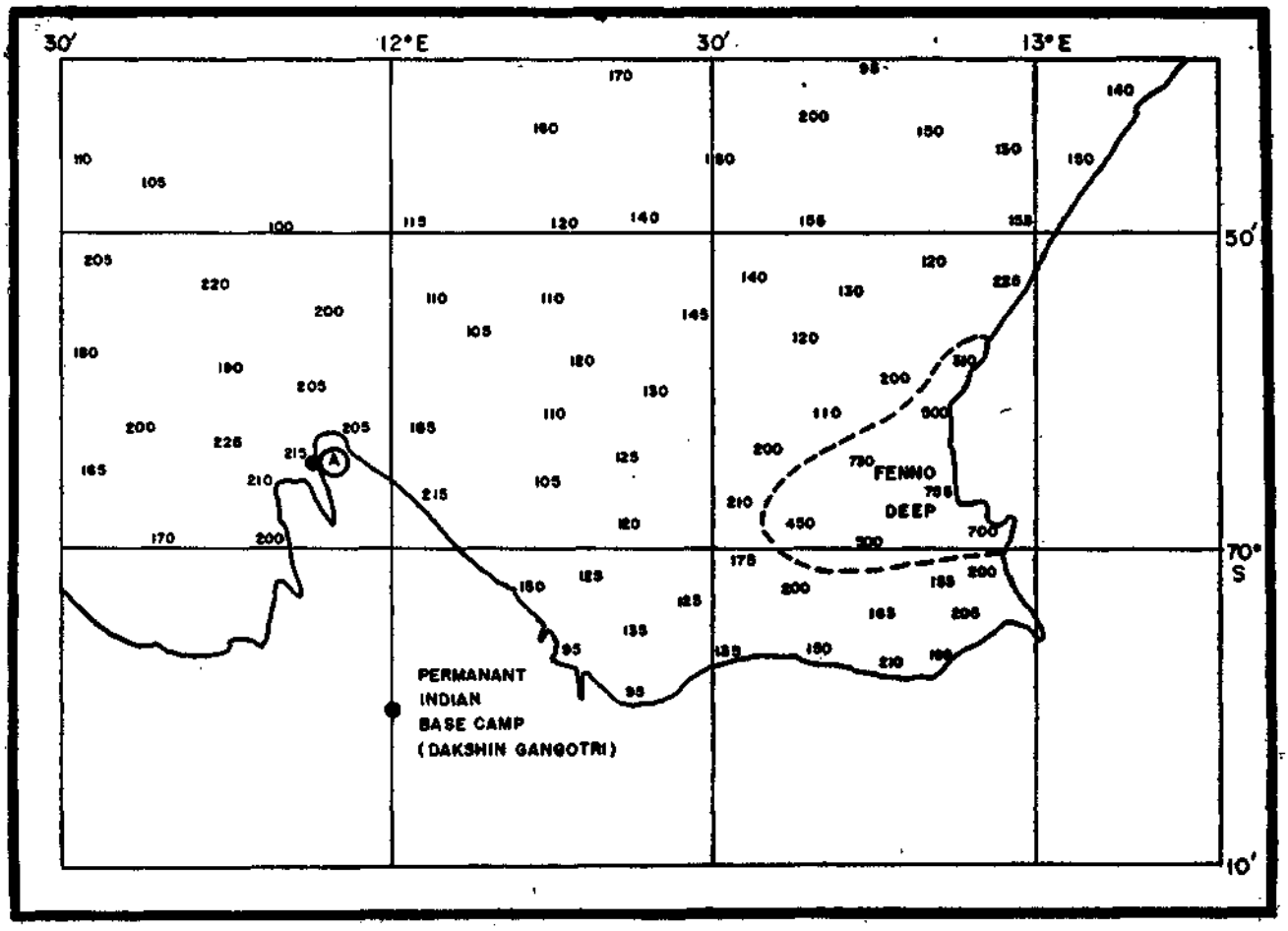


Fig. 11. The ocean depth chart made during the Expedition.

wintering team of 12 personnel at the Base Station the ship remained in Antarctica for four more days making a close watch on how the members of the wintering team managed at the camp. All went well and on the afternoon of 1st March the ship bade farewell to Antarctica. On the way back most of the marine biological and oceanographic works were carried out. The ship reached Mauritius on 19th March from where it left after four days. The Expedition with flying colours reached back in Goa on 29th March where the members were given a heroic welcome with *'AARATHY'* in the traditional Goan style.

II. Investigations carried out on the 'krill' resource of the Antarctic seas

Zooplankton samples for the study of distribution, abundance and biology of 'krill' (*Euphausia superba* Dana) and other zooplankton in general were collected using different types of gears (1) from a polynya, (2) at several localities distributed over a geographical area within the Antarctic convergence and (3) at a number of latitudinal stations enroute from Antarctica upto Mauritius. The whole sampling programme carried out during the Expedition can be considered under five categories that may result in the study of (1) variations in the diurnal abundance of zooplankton with special reference to krill in the euphotic zone in the polynya, (2) diurnal vertical migration of zooplankton with special reference to 'krill' in the euphotic zone in the polynya, (3) daily variations in the occurrence and abundance of zooplankton including the 'krill' in the polynya during the summer months, (4) geographical distribution and abundance of 'krill' and other zooplankton within the Antarctic convergence and (5) variations in the abundance of euphausiids and other zooplankton latitudinally from 68° 30'S upto Mauritius.

Methods

Four different types of nets were used for the sampling, of which two were specially meant for the collection of 'krill' and other macroplankton. The types of nets used were (1) two nets of 50 cm ring diameter having a mesh size of 0.4 mm and 4.0 mm respectively, (2) one Bongo Net of 60 cm mouth diameter having a mesh size of 0.4 mm, (3) one net of 113 cm ring diameter with 2.0 mm mesh size (modified Indian Ocean Standard Net) and (4) one mid-water trawl of 3.0 mm mesh size. The samples collected were preserved in 3% formaldehyde solution for laboratory studies. In the laboratory the displacement volume of total plankton and the numerical counts of euphausiids were taken. The following are the details of the work carried out under different categories. The total zooplankton obtained from the various samplings are also given diagrammatically.

1. Diurnal variations in the occurrence and abundance of 'krill' and other zooplankton in a polynya

A set of experiment running over a period of 24 hours was planned on 25–1–1984. Hourly collection of plankton using two half-metre ring nets of mesh size 0.4 mm and 4.0 mm respectively was made as open vertical hauls from 100 m to the surface. This was to understand the variations, if any, in the diurnal occurrence of 'krill' and other zooplankton in the epipelagic zone when there was sun light throughout the day. The diurnal variations in the abundance of zooplankton in general are given in Fig. 12.

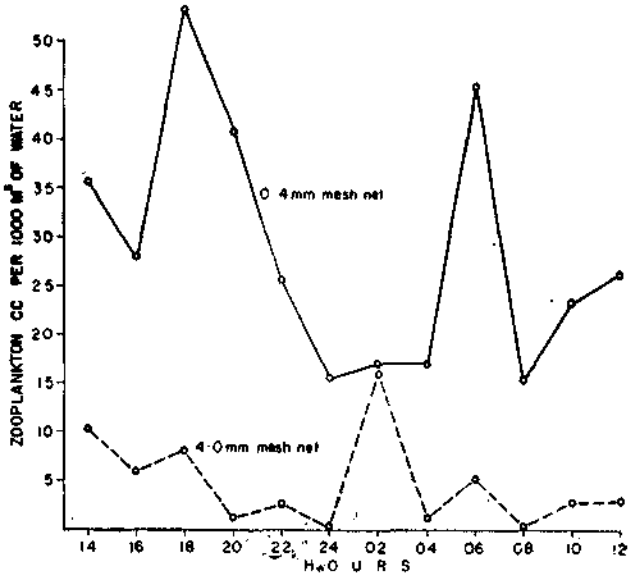


Fig. 12. Diurnal variations in the abundance of zooplankton in a polynya.

2. Vertical migration of 'krill' and other zooplankton in a polynya

A series of three hourly stratified sampling with a half metre ring net of 0.4 mm mesh size, attached with a closing mechanism, was carried out over a period of 24 hours starting on 31–1–1984 to study the vertical migration, if any, of 'krill' and other zooplankton towards the end of summer when there was light throughout the day, with a short period of dusk. The strata selected for sampling were 100 → 75 m, 75 → 50 m, 50 →25 m and 25 → 0 m. Figure 13 gives the pattern of stratified distribution of zooplankton at different times of the day.

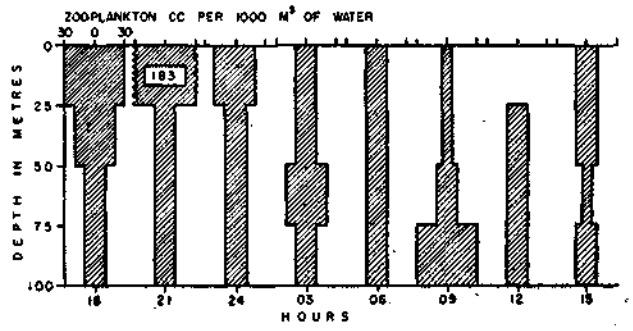


Fig. 13. Pattern of vertical distribution of zooplankton in a polynya.

3. Seasonal variations in the occurrence and abundance of 'krill' and other zooplankton in a polynya during summer

During the summer months when there is sun light for 24 hours a day, the production at the primary level attains the maximum. This was evident when blooms of phytoplankton clogged the nets in the earlier part of the summer. Normally a rich production of phytoplankton would be followed by an abundance of zooplankton. In order to understand the cyclical events taking place at the primary and secondary levels in a polynya, daily vertical sampling for zooplankton was

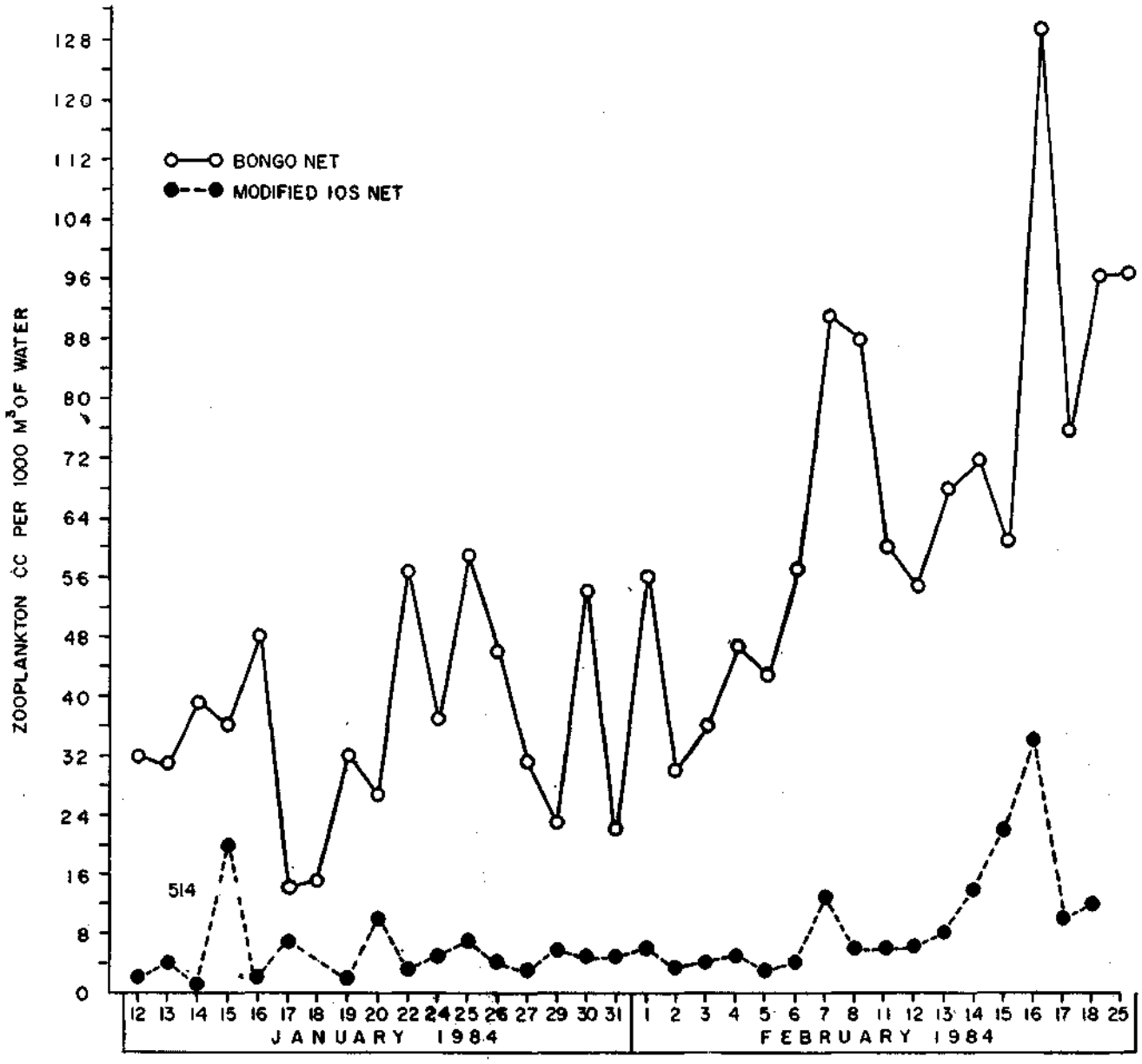


Fig. 14. Daily variations in the occurrence and abundance of zooplankton in a polynya in the summer months.

carried out around 1800 hrs over a period of more than a month. Two nets were employed; one Bongo–60 net and one modified IOS Net. 34 samples were collected from a depth of 150 → 0 m with the former net and 32 samples with the latter from 200 → 0 m. Figure 14 gives the zooplankton biomass obtained during the studies.

4. Geographical distribution of 'krill' and other zooplankters within the Antarctic Convergence

Twenty one sampling stations were fixed in three latitudinal grids of seven stations just north of the pack ice for the study of geographical distribution and abundance of 'krill' and other zooplankton in general. The area covered under the study was about 25,000 square kilometres between latitudes 68° 30'S and 67° 30'S and longitudes 14° 00'E and 20°00'E. The quantitative distribution of zooplankton and the 'krill' in the epipelagic zone of the area covered (150 → 0 m) is shown in Table 1.

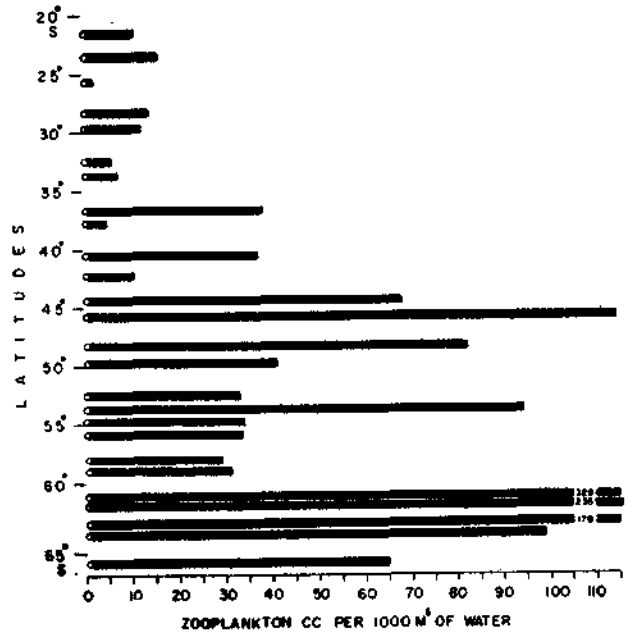


Fig. 15. The latitudinal abundance of zooplankton between Antarctica and Mauritius

Table 1. *Sampling details and displacement volume of zooplankton and the occurrence and abundance of krill in collections made for the geographical distribution*

Gear : Bongo-60 Wire paid out : 150m Type of haul : Oblique

No.	Date	Time (hr)	Position Lat°S	Long.°E	D. stn. (m)	Zoopln. ml/1000 m³ of water	% of euphau slids in pln.	*Krill* No/1000 m³ of water
1.	2–3–'84	1100	68°30'	14°00'	3528	20.95	0.92	136
2.	2–3–'84	1730	68°30'	15°00'	3739	36.53	0.29	50
3.	2–3–'84	2030	68°30'	16°00'	3484	38.49	30.43	171
4.	2–3–'84	2340	68°30'	17°00'	3710	185.13	12.11	148
5.	3–3–'84	0240	68°30'	18°00'	3982	96.12	4.45	307
6.	3–3–'84	0600	68°30'	19°00'	4163	25.42	51.78	89
7.	3–3–'84	1335	68°30'	20°00'	3801	41.29	7.92	237
8.	3–3–'84	1645	68°00'	20°00'	4072	63.44	6.28	194
9.	3–3–'84	1855	68°00'	19°00'	4163	45.51	4.24	10
10.	3–3–'84	2140	68°00'	18°00'	4163	107.85	0.25	116
11.	4–3–'84	0045	68°00'	17°00'	3891	216.35	2.26	240
12.	4–3–'84	0445	68°00'	16°00'	3800	91.66	0.63	316
13.	4–3–'84	0800	68°00'	15°00'	3759	134.91	0.19	115
14.	4–3–'84	1100	68°00'	14°00'	3077	116.53	0.21	118
15.	4–3–'84	1515	67°30'	14°00'	3352	142.15	1.60	1032
16.	4–3–'84	1730	67°30'	15°00'	2996	248.83	0.27	337
17.	4–3–'84	2000	67°30'	16°00'	4072	54.57	0.50	124
18.	4–3–'84	2230	67°30'	17°00'	4525	119.95	11.07	132
19.	5–3–'84	0100	67°30'	18°00'	4344	188.69	5.49	78
20.	5–3–'84	0400	67°30'	19°00'	4549	32.30	0.31	46
21.	5–3–'84	0655	67°30'	20°00'	4254	74.62	0.58	195

5. Latitudinal distribution of euphausiids and other zooplankton in the southern ocean between Antarctica and Mauritius

In order to study the latitudinal limits in the occurrence and abundance of various species of euphausiids (the group of organisms to which the 'krill' belongs) and other zooplankters a series of samples were collected using a Bongo–60 net starting from 68°30'S at an average of 1.5 degree interval upto Mauritius. The total zooplankton obtained from the different latitudinal stations is presented in Fig. 15.

III. Observations made on sea birds of the southern hemisphere

During the course of the Expedition, observations were made by the author on the sea birds of the southern ocean between Mauritius and Antarctica. Sharp limits in the distributional range of species of birds were noticed in most of the cases. While birds of some species have fairly wide geographical range others were found restricted to very narrow latitudinal ranges. On some occasions some species of birds landed on the deck of the ship either for taking rest or after hitting against the communication antennae of the ship.

Broadly, the species identified can be divided into two categories, the birds observed enroute and those found in Antarctica. As a result of the observations 30 species of birds belonging to 22 genera and seven families have been identified. Of these birds eight species were noticed in the sea near the shelf ice.

Methods

A binocular of the power of 50x30 was used for watching the birds. They were watched in flight and some

Table 2. *Geographical range of birds observed with dates of observation and number of birds observed*

Sl. No.	Species	Period	Latitudinal range (S)	No. of birds
1.	Great-winged Petrel	9–12–83	13°50' – 16°07'	4
2.	Sooty Tern	9–12–83 to 10–12–83	13°50' – 19°18'	ca 500
3.	Brown Noody	10–12–83	19°00' – 19°18'	150
4.	Wandering Albatross	16–12–83 to 22–12–83	29°14' – 54°17'	14
5.	Soft-plumaged Petrel	17–12–83 to 18–12–83	35°00' – 41°00'	6
6.	Dove Prion	18–12–83	40°00' – 41°00'	100s
7.	Sooty Albatross	18–12–83 to 19–12–83	40°00' – 45°17'	5
8.	Northern Giant Petrel	18–12–83 to 19–12–83	40°00' – 45°17'	4
9.	Black-browed Albatross	18–12–83 to 19–12–83	40°00' – 45°17'	2
10.	Grey-headed Albatross	18–12–83 to 23–12–83	40°00' – 57°19'	12
11.	White-chinned Petrel	18–12–83 to 23–12–83	40°00' – 57°19'	6
12.	Black-bellied Storm Petrel	19–12–83	42°30' – 47°17'	1
13.	White-headed Petrel	19–12–83 to 22–12–83	42°30' – 54°17'	8
14.	Grey-backed Storm Petrel	19–12–83 to 20–12–83	42°30' – 49°39'	22
15.	Light-mantled Sooty Albatross	19–12–83 to 23–12–83	42°30' – 57°19'	4
16.	Thin-billed Prion	19–12–83 to 24–12–83	42°30' – 61°12'	100s
17.	Kerguelen Petrel	20–12–83	48°00' – 49°39'	1
18.	Broad-billed Prion	20–12–83 to 22–12–83	48°00' – 54°17'	50
19.	Common Diving Petrel	20–12–83 to 24–12–83	48°00' – 61°12'	8
20.	*Cape Pigeon	21–12–83 to 1– 3–84	52°06' – 69°30'	50
21.	Blue Petrel	23–12–83	56°05' – 57°19'	1
22.	Thick-billed Prion	23–12–83	59°38' – 61°12'	1
23.	Southern Giant Petrel	23–12–83 to 25–12–83	59°38' – 61°12'	26
24.	*Snow Petrel	25–12–83 to 1– 3–84	63°27' – 70°01'	100s
25.	*Antarctic Petrel	25–12–83 to 1– 3–84	63°27' – 70°01'	100s
26.	*Emperor Penguin	26–12–83 to 28–12–83	68°16' – 69°58'	3
27.	*Adelie Penguin	26–12–83 to 1– 3–84	68°16' – 70°01'	200
28.	*Southern Antarctic Skua	27–12–83 to 1– 3–84	68°58' – 70°46'	25
29.	*Southern Fulmar	28–12–83 to 1– 3–84	69°58' – 70°01'	15
30.	*Wilson's Storm Petrel	28–12–83 to 1– 3–84	68°58' – 70°01'	10

*The birds found on the Antarctic continent and in the adjacent sea.

of them while resting or swimming in water. The identification of the species was done based on structure of body, colour of plumage, patterns of colour, flight characteristics, structure and colour of beak, and other similar characters. Table 2 gives the list of the sea birds watched along with their observed geographical range.

Recommendations for 'Krill' Research and Exploitation

1. 'Krill' being the first antarctic resource which India can think of exploiting in the near future, immediate attention may be paid for the development of scientific and technical expertise and infrastructure for an early achievement of this goal.

2. In the proposed Indian Antarctic Research Institute, maximum priority may be given for the research and exploitation of 'krill'.

3. Personnel may be trained in locating and catching of 'krill', in countries which are engaged in krilling at present.

4. The ship, that India is proposing to acquire for Antarctic research, should have facilities for the catching, processing, packing and storing of 'krill' and 'krill' products.

5. Intensive surveys using modern 'krill' finding sonars, and sampling over vast geographical areas within the Antarctic convergence have to be carried out for the location of 'krill' swarms.

6. Special sonars for the detection of 'krill' swarms are required on board the ship. Also all facilities (winches, trawls etc.) for catching of 'krill' are needed on board the ship.

7. For carrying out marine research and investigations on 'krill' and other living and non-living resources of the southern oceans, 'Antarctic Support Cruises' may be organised deploying additional vessels that can go upto the Antarctic Circle.

8. Side by side with the exploration and exploitation of 'krill' resources, processing technologies to make suitable for human consumption, food for cattle and poultry or for using in aquaculture, may be developed at the concerned Institutes.

9. One expedition exclusively for marine research may be organised for a better understanding of the ecology and biology of the polar seas in which India has interest. Most of the samplings are to be carried out during the summer months and towards the beginning of the winter.

I am extremely thankful to Dr. E. G. Silas, Director, CMFRI, for nominating me for participating in the Expedition and also for providing all kinds of help for the successful completion of the work assigned to me. My thanks are also due to the Department of Ocean Development for giving me an opportunity to go to Antarctica and carry out my investigations there. The help rendered by Shri D. Vincent, Technical Assistant of the Institute in analysing the zooplankton samples is gratefully acknowledged.

NEWS—INDIA AND OVERSEAS

A research vessel from Goa yard

The *Matsya Vishwa* a deep sea exploratory fishing vessel of 36.37 m built at the Goa Ship Yard has been delivered to the Ministry of Agriculture. This is the 6th and last vessel of the series the yard has built under the Indo-Norwegian Programme. The vessel is equipped for bottom and pelagic trawling and for long lining. Fitted with equipments for oceanographic surveys, an autopilot, electromagnetic log, radar, magnetic and gyro compasses and satellite navigator the ship can be out in the sea for 22 days.

Plywood fishing crafts in big demand

In view of the scarcity of wooden logs for making dugout canoes and 'cattamarans', cheap and alternative material for building fishing canoes are under test. Using good quality Indian plywood, two British firms have designed and made canoes based on stitch and glue technique. In costs these boats are comparable to traditional boats but in performance they have proved superior. The handling problems of the boats are comparatively less. More than 100 of such boats are in use in Kerala and Tamilnadu.

Fishing News International 23 (12) 1984.

Spanish interests on Indian Ocean tunas

Under an agreement with the Republic of Seychelles 15 Spanish tuna ships are to be allowed to operate in the waters of the Indian Ocean archipelago. This further strengthens the movement of Spanish fishing activity into the Indian Ocean. A fishing agreement has already been reached with Mozambique. Further arrangements are being done with Maldives, Tanzania and Madagascar.

Fishing News International 22 (12) 1983.

Breakthrough in processing krill

Machinery for peeling krill for human consumption has been developed in Poland. The technology makes it possible to obtain the product with nearly nil content of chitin. The taste of krill peeled in this way is similar to the taste of shrimp.

Fishing News International 22 (12) 1983.

Extend shelf life of fish by irradiation

Hopes for extending the shelf-life of fiish are now centred on irradiation. This controversial method of processing food products is arousing interest in many countries. Practical application of food irradiation processing including sea food is going on in countries such as Belgium, Japan, Netherlands and South Africa. As a processing technique irradiation could help to produce a safer product. Low dose irradiation would be effective in fish as a means of insect disinfestation. Gamma rays are also effective in eliminating *Salmonella* in human consumption fish as well as fish meal in the final packing.

Fishing News International 22 (12) 1983.

Fish catch to be doubled by the turn of the century

World food fish supplies will need to be doubled by the year 2000 to meet estimated consumption needs, says F A O Director General, Edouard Saouma. This is required to maintain per capita consumption rate at present world levels. However, he feels that this target will be difficult to meet as the world production of fish is growing by only about 1% a year. Therefore, the challenge is to find out additional fish which would require much more than an improvement in present fishery practices. Along with finding out additional fish, we must make better use once it has been harvested. He proposes an all out war on waste, noting that some 10% of the world catch is lost through spoiloge. More is being wasted through dumping back into the sea in operation such as shrimp trawling. He also urges industry to find ways of diverting to direct human consumption a major part of 20 million tons of fish converted each year to animal feed.

Fishing News International 22 (11) 1983.

Compiled and prepared by M. J. George, K. J. Mathew, G. Nandakumar & Jancy Jacob
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