

## THE FIFTH COMMISSION OF THE R.R.S. DISCOVERY II

by

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(Extract from *The Geographical Journal*, Vol. XCVII, N° 4, London, April 1941.

Meeting of the Royal Geographical Society, 3 March 1941.

During the ten years preceding the outbreak of war the R.R.S. *Discovery II* has been almost continually at work in the Southern Ocean. On her first commission she sailed from England at the end of 1929, and the fifth commission was completed in May 1939. On each of these expeditions the ship generally sails from London in October and is away for twenty months, and the first four commissions, as well as the work of the *William*

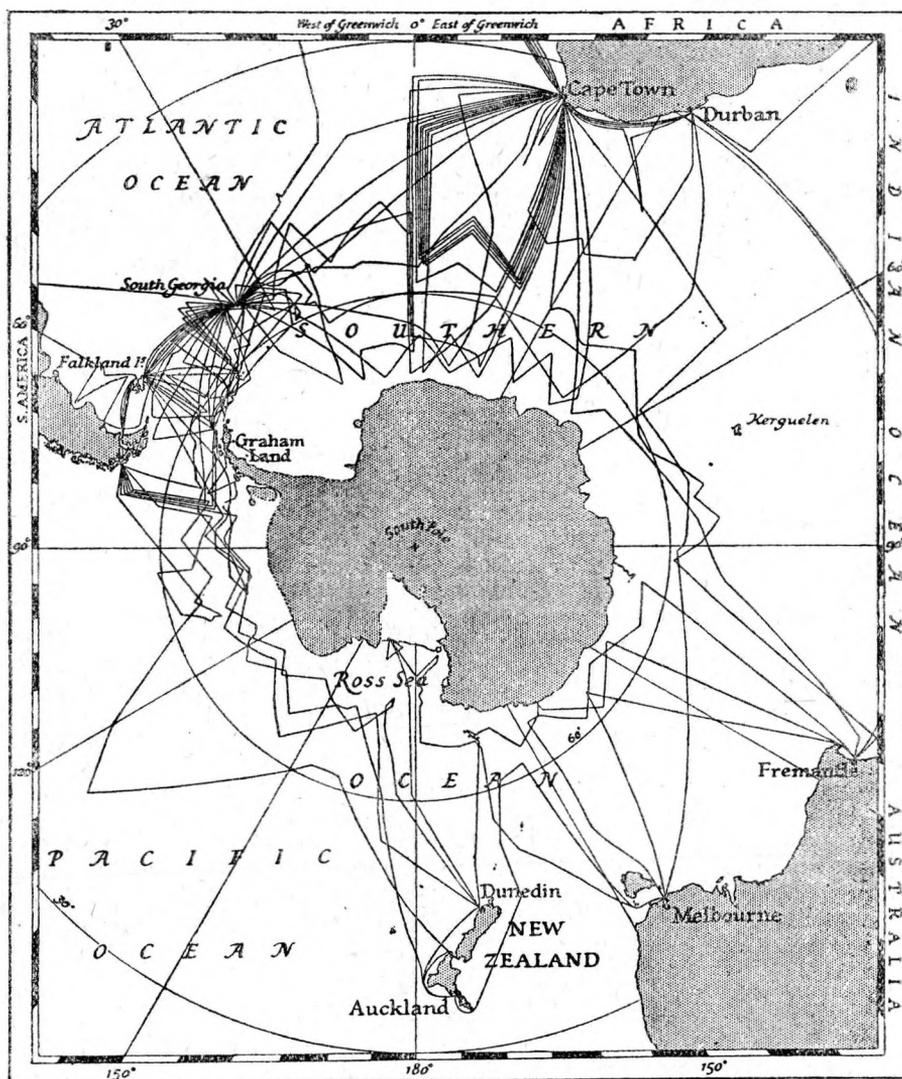


FIG. 1. — Voyages of the "Discovery II", 1929-39.

*Scoresby* and the earlier work of the *Discovery*, have at various times formed the subject of papers read at meetings of this Society. I have now to give an account of the fifth commission.

Fig. 1 shows roughly the routes followed by the *Discovery II* in her different voyages. It does not distinguish the different expeditions, and it is not even an accurate chart, for in many places the ship has steamed along the same route several times over, and here the tracks have been spread a little so that they can be distinguished from one another. Furthermore, there has been much intensive work in the neighbourhood of South Georgia and the South Shetland Islands, and many small deviations from the ship's course which cannot be shown.

Clearly then, a line of observation running north and south will be far more instructive than one running east and west. Moreover the main water movements are in an easterly direction, and a current is best studied by transverse observations. It is for this reason that so many of the ship's longer passages are distributed in a north and south direction in various parts of the ocean.

Of course the pattern is not so evenly and precisely distributed as we should like it to be. Enormous distances have to be covered and fuel is a limiting factor. Stoppages required for routine scientific work limit the ship's cruising range to little more than 5000 miles, and hence many lines of observations during circumpolar cruises must be oblique instead of meridional. The track chart is also complicated by various routes undertaken for special purposes, such as surveying or the investigation of specific local problems.

Broadly speaking, however, the principal observations are on meridional lines for the study of water movements, zones and gradients; on zigzag tracks for more concentrated investigation of a particular zone; on selected lines or in selected areas repeated several times for the study of seasonal variations; and in certain areas where special conditions call for intensive examination.

The ship's track during the fifth commission is shown in Fig. 2. On this occasion there were two big items on the programme which left little time for any supplementary work. First there was to be a circumpolar voyage, and then a long series of repeated observations on the Greenwich meridian and 20° E. A circumpolar voyage had been carried out in 1932 during the second commission when Mr. D. D. John was in charge. This was in the winter months, and a similar cruise in the summer months had been planned for the fourth commission under Dr. G. E. R. Deacon. The relief of Mr. Ellesworth and Mr. Hollick-Kenyon in 1936 had necessitated alterations in the programme, and the circumpolar voyage was postponed until the fifth commission.

The *Discovery II* sailed as usual from London in October 1937, and after refuelling at St. Vincent, proceeded straight to Cape Town. The scientific staff included Mr. Herdman, Mr. Clowes, Dr. Hart and Mr. Nicholson, and Lieut. L. C. Hill, O.B.E., R.N.R., was again in executive command. We did not attempt much scientific work on the outward voyage apart from routine hauls with large tow-nets in deep water.

We reached Cape Town on November 7, and having taken stores and fuel, sailed a few days later on the first long lap of the circumpolar voyage. This passage through the sector of the Antarctic which lies to the south of the Indian Ocean is a very long one. No fuel could be obtained until we reached Fremantle, and the route represents about the

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See *Geographical Journal*, October 1936, page 304. March 1939, p. 185. "Report on the progress of the Discovery Committees, Cambridge 1937".

Note of the I.H.B. — See also: *Hydrographic Review* Vol. VII, N° 1, page 194; Vol. VIII, N° 1, page 23; Vol. IX, N° 2, page 260; Vol. XII, N° 2, page 77; Vol. XV, N° 1, page 85.

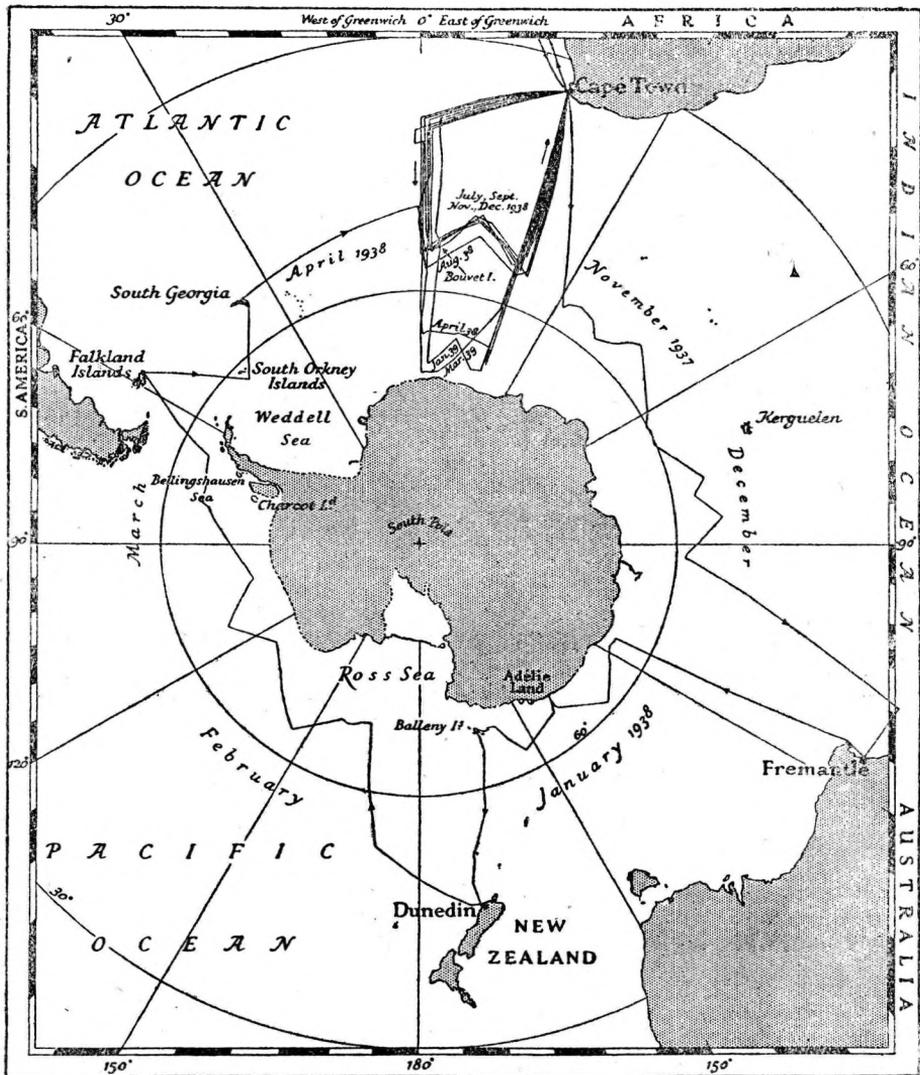


FIG. 2. — The fifth commission, 1937-39.

limit of the ship's cruising range. It should be remembered that a regular routine of observations is carried out during almost the whole time the ship is at sea. The observations are made mostly at full stations (generally once a day) where the ship is stopped for three or four hours. Temperatures are determined and chemical estimations made at many depths from the surface to the bottom, and hauls are made at various levels for studying the distribution of the minute vegetable matter, the crustaceans on which the whales feed, and other forms of plankton. In Antarctic waters, a constant look-out is kept for whales. Thus all the tracks shown in Fig. 2 are lines along which a great variety of observations are constantly being made.

The ship steamed on a south-south-easterly course from Cape Town to the edge of the pack-ice. These passages through the open expanses of the Southern Ocean are seldom very agreeable. The weather is generally abominable, especially between 50° and 60° S., and the work is a monotonous routine. Off the ice-edge, however, better conditions are to be expected, and the appearance of whales and ice provide plenty to arouse the interest of all on board. On this occasion we were troubled with the usual westerly gales on the southward voyage, in the higher latitudes, were delayed by snow and fog. On November 23, the fog cleared suddenly in the morning, Antarctic and snow petrels appeared both of

which indicate the proximity of the ice, and the same evening the pack came in sight. We now turned east, making frequent net hauls to study the distribution of the whales' food or "krill", and began a series of tacks to the north-east and south-east in order to cover as much as possible of the zone in which the majority of whales are to be found. This was continued for a fortnight to a point nearly 2000 miles east of the position at which we first met the ice, and left us with no more than the necessary margin of fuel to reach port. We turned north and proceeded to Fremantle, and this time we were fortunate in having fine, calm weather all the way, which enabled us to make an excellent line of stations. We spent Christmas at Fremantle and started the next section of the voyage on December 29.

We sailed due south from Fremantle, and this cruise was perhaps the most interesting in the whole commission. The passage to the ice was delayed by head winds but was otherwise uneventful, and on January 11 we turned north-east on the usual zigzag route. The weather was now very fine and calm, and Mr. Cornish was able to make observations on wind currents by means of ballons. This involves the use of a theodolite and is therefore a difficult operation on the deck of a small ship at sea. The theodolite, however, was set up in gimbals, and the experiments were carried out quite successfully.

After turning south-east again, we were surprised to find that the pack had cleared away from the coast of the continent, and in the morning of January 16, between  $139^{\circ}$  and  $140^{\circ}$  E., the ice slopes of Adélie Land came in sight. Huge crevasses and ice-cliffs could be plainly seen, but our exact position and distance from the coast were very uncertain. With overcast weather we had had no sights for sometime, and the proximity of the magnetic pole made the compasses almost useless. As we approached the land, we met with an easterly wind which soon increased to gale force. Driving snow came on, the sea became infested with growlers, the coast was lost to sight, and for some time we could only set our course by the wind. This wind was no doubt a sample of the incessant easterly gales which were experienced by the Australasian Antarctic Expedition of 1911-14. The wind appears, however, to operate only in a very limited coastal zone, for on turning north again we regained calm conditions after a few hours' steaming.

There was little time to spare, and in these conditions there was no point in attempting a landing. However, we were able to make a useful comparison of the arrangement of the water layers here at the edge of the continental slope with the conditions in the Ross Sea which were described by Dr. Deacon two years ago in his account of the fourth commission of the *Discovery II*. In this paper (*Geogr. J.* 93, pp. 186, 192) he explained that in the higher latitudes of the Southern Ocean a layer of "warm deep water" moves southward between the cold Antarctic surface water and the cold Antarctic bottom water, both of which move northward. The fate of this intermediate layer when it approaches the continental slope is a point of considerable interest, and hitherto we had no information on it except in the Ross and Weddell seas. Fig. 3, which is a vertical section of the temperature distribution, may be compared with Deacon's Fig. 4. It shows the continental slope rising to a ridge, on the south (right hand) side of which is a basin lying between the ridge and the continental coast. It is seen that as in the Ross and Weddell seas, the warm deep water in

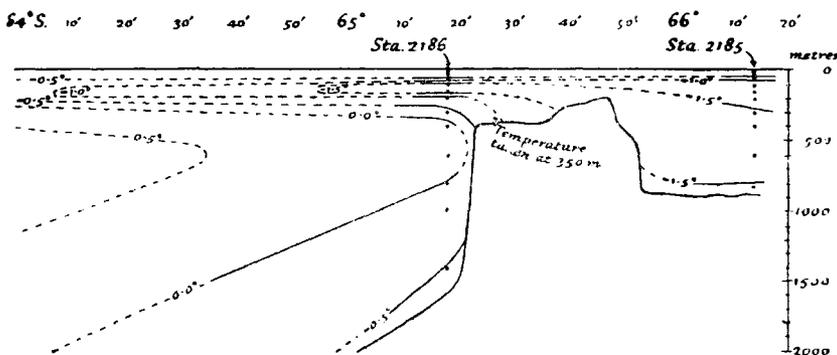


FIG. 3. — Isotherms at edge of continental shelf off Adélie Land.

this more typical part of the coastal region comes close to the edge of the slope, but does not penetrate to the basin beyond it. Such observations have a bearing on the origin of the Antarctic bottom water and on the distribution of the krill which appears to pass the early stages of its life cycle in the warm deep water.

Constant echo soundings were taken at this time, and it was interesting to note that the ridge was marked by a number of the usual tabular icebergs which were almost certainly grounded on it. The ship passed close to one which had in general a fresh, new appearance, with clearly cut vertical cliffs. The height was found by sextant to be 126 feet, and the echo soundings showed a very regular flat bottom at 104 fathoms. The maximum depth of the berg below water should therefore be 624 feet or 4.9 times the height above water.

Having completed our observations on the shelf we continued on the next north-east track, and after two days turned to the south-east again. Here we met with one of those exceptionally large icebergs which are generally called ice islands. This one was of irregular shape and probably about 10 miles across. Considerably bigger ones have been reported in the Weddell sector, but I do not know that such large ones have been seen in other parts of the Antarctic. The weather was calm and clear, the spouts of many whales could be seen, often at great distances, and the cliffs of the ice island made an unusually impressive spectacle against a fine sunset.

Next day, January 20, we reached the pack-ice about 100 miles west of the Balleny Islands. We skirted it eastwards and came up to Young Island, the most northerly of the group, the following morning. Here was an opportunity for Captain Hill to add a little to the very brief survey he had made in 1936 during the ship's fourth commission. Weather conditions were now more favourable and we were able to spend two days in a running survey with constant sun sights, steaming closely round all except Sturge Island. The latter was cut off by pack-ice of which the edge lay about half-way between it and Buckle Island. Young Island and Buckle Island are covered by ice-sheets, rising in most places by moderate slopes to no very great height. Sturge Island seen at a distance is clearly higher than the others but did not seem to be much over 5000 feet. Dr. Deacon, in his paper referred to above, comments on some inaccuracies in the older charts, and we were now able to amplify the corrections made in 1936. The echo-sounding machines were in continuous use. There is deep water close to the islands, and the echo recorder revealed some remarkably steep submarine slopes. It is noteworthy that great numbers of Blue, Fin, and Humpback whales were concentrated in the neighbourhood of the islands, in greater abundance perhaps than any of us had seen before.

The sea was not quite calm enough for us to attempt a landing, and having done as much as we could without an altogether more ambitious surveying programme, we left the islands and proceeded northwards to New Zealand. Campbell Island lay on our course, and on January 28 we anchored there in the south harbour while a collecting party went ashore. Campbell Island was at the time uninhabited, but many sheep were to be seen. It is a nesting place for the wandering albatross and is covered, at least around this anchorage, by a very dense low scrub which made heavy going for the shore party.

We sailed again the same evening and reached Dunedin on January 31. At this point it was necessary for me to leave the ship and return home. Of the rest of the commission, therefore, I cannot speak at first hand, but with the help of the reports sent home by Mr. Herdman. I hope to be able to give an adequate account of the activities which followed.

The *Discovery II* left Dunedin on February 8 to begin another very long section of the circumpolar voyage, this time through the Pacific sector. Here again the programme had to be adapted to the ship's bunker capacity, for no more fuel could be obtained until she reached Port Stanley, in the Falkland Islands. Mr. Cornish had also disembarked at Dunedin, and his place was taken by Mr. A. M. Rapson, of the Fisheries Branch of the Marine Department of New Zealand. After some sounding and dredging off the Antipodes Islands the ship turned almost due south on the meridian of 170° W., and reached the ice edge on February 18 in 68°39' S. Then began the usual north-east and south-east tacks based on the edge of the pack. There is not very much to be said of this part of the voyage. The pack-ice is comparatively stagnant in the Pacific sector, and no ship has been able

to reach or even sight the continental coast between the Ross Sea and Charcot Land in the Bellingshausen Sea. The work was impeded by head winds and fogs, but some interesting observations were made on whales in spite of the generally bad visibility. The Pacific sector is the only part of the Antarctic which has not yet been worked by the whaling industry, and at the International Whaling Conference of 1938, it was agreed to close it as a whale sanctuary, in the first place for a period of two years. It was generally supposed that whales are scarce in this sector, but although they are probably less abundant than in some other regions, our observations on this occasion showed that in some parts there are very considerable numbers of them, and that if the sanctuary is maintained it will at least have the effect of protecting a fairly substantial part of the southern stocks of whales.

Owing to the continual head winds the tacks off the ice edge had to be stretched a little towards the end of this cruise, and the ship reached Port Stanley in the Falkland on March 15. Five days were spent here, and then the voyage was continued on a south-easterly course towards the South Orkney Islands. A glance at Fig. 1 will show that this was on and across well-beaten tracks. Additional observations however are always of value since they help us to ascertain the extent to which conditions vary from year to year. The ship did not call at the South Orkneys where a good deal of surveying had been done in previous commissions, but continued until she met the pack about 90 miles south of the islands. Course was then set for South Georgia, and she anchored there in Grytviken harbour on March 28. South Georgia has generally been our most important base in the Southern Ocean, and in previous commissions we have made frequent calls there. Fuel can be obtained at the whaling stations at Grytviken and Leith Harbour, there are facilities for minor repairs, and our shore laboratory at Grytviken, though no longer occupied by our own staff, was still useful for storage and for the preparation of certain chemical standards which require more accurate weighing than is possible in a floating laboratory.

After a week here the *Discovery II* began the last section of the circumpolar voyage. Since the second part of the commission was to be spent in a series of observations repeated as many times as possible on the meridians of  $0^{\circ}$  and  $20^{\circ}$  E., it was arranged that the final part of the circumpolar cruise should include a preliminary set of observations on these meridians. The ship therefore steamed slightly north of east until she reached the Greenwich meridian in  $50^{\circ}$  S., and then turned south to the ice edge. In April the ice still lies well to the south, but it has begun its winter advance towards the north and young ice is generally forming. The ice was now found in  $64^{\circ}52'$  S., and new pancake ice was forming rapidly. The ship turned eastwards, skirting the ice edge as far as  $20^{\circ}$  E., and then turned north on the long run up to the Cape.

In previous commissions we have generally set aside a month in the summer for surveying work, generally in the Falkland Islands Dependencies, where there are many harbours and anchorages and where correction and improvement of the charts were much needed. There is still much to be done in this field, but in the fifth commission we could not sacrifice a month in the summer (for surveying needs the best weather conditions) without upsetting the general programme of work. It was desirable that the circumpolar voyage should be completed within the summer months November to April, in order to obtain the full benefit of a comparison with the similar winter voyage of 1932, and we needed as long a period as possible to carry out an uninterrupted series of the repeated observations which were to occupy the second part of the commission. Surveying was therefore restricted to the short period spent at the Balleny Islands.

The whole of the ship's programme was planned in considerable detail before the *Discovery II* left London. With the experience of four previous commissions we were able to work out with some confidence the distances to be covered, and the time required for the different sections of the circumpolar cruise, and to make due allowance for bad weather and ice conditions; seven months after leaving London the ship reached the Cape, at the completion of the voyage, within four days of the scheduled date.

The *Discovery II* reached the Cape on 4 May 1938, and was now due for a refit. After a season's work in the south an overhaul is always necessary, and it has generally been found convenient to have this done at the naval dockyard at Simonstown. As usual two months were spent in port. This gives time for dry docking and a variety of repairs, the scientific staff are able to deal with arrears in routine laboratory work, and to make a preliminary examination of the results, and there is a period of recreation and change of scenery for

all hands, which is a much needed break in the year and a half spent almost entirely at sea and out of sight of land.

The ship sailed again on July 1, and the work now before her was not quite like any programme we had undertaken previously, for it was simply to spend nine months sailing round the same course as often as possible, and making observations in exactly the same way each time — a monotonous and exacting task, only mitigated by slightly more frequent calls at a civilized port.

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The sixth and seventh cruises, January to March 1939, which concluded the series, were more interesting for the ice had now receded and allowed the ship to reach much higher latitudes.

The sixth began on January 6, and Mr. Englebrecht, of the Meteorological Office at Pretoria, and Mr. Ladell, of the University of Cape Town, joined the ship for this cruise, so that a new line of soundings could be established, the southward route was set a little to the east of the previous routes. This took the ship close to Bouvet Island, and a small party succeeded in making a landing, a feat which has rarely been accomplished.

Bouvet Island is a small island covered by a thick ice sheet and fringed in parts by high rocky cliffs and elsewhere by ice-cliffs. There is no sheltered anchorage and the only landing places are two or three small exposed beaches. In one sense it is perhaps the most isolated island in the world, for there is no other land of any sort within nearly 1000 miles of it in any direction. Mr. Herdman, in his report, says that on approaching the island "it was easily seen that a landing at either of the known landing places (i.e. at Cap Circoncision or on Lars Islet) would be out of the question on account of a moderate westerly swell and a W. x N. wind of force 4/5, so we steamed round to the lee side where we luckily found a small beach at the N.E. corner. The ship was anchored close-to, in 15 fathoms, and Mr. Englebrecht was landed successfully at 16.00 hrs. He made two sets of observations with pilot balloons". Cape Circoncision and Lars Islet appear to be the best landing places, but they are exposed to the prevailing winds and suitable conditions for a landing must be rare. The "*Norvegia*" expedition made several landings at these places, but it seems that they did so when the island was partly surrounded by pack-ice which would have the effect of damping down the swell. Bouvet Island lies somewhere near the mean northern limit of the pack and is likely to be surrounded by ice in the late winter and spring.

Between about 30° E. and 30° W. the ice-edge generally retreats very suddenly towards the end of December. It appears that the cold current flowing eastwards from the northern part of the Weddell Sea maintains a belt of ice in this region until the summer is well advanced, while a warmer current, whose origin is in the Indian Ocean, flows westwards in a higher latitude, and causes the central part of the ice-belt to melt and break up. In December whaling vessels can sometimes force their way through the outer belt of ice and emerge into comparatively clear water about 60° S. Fig. 4 shows this rapid break up of the ice in December in the Atlantic sector. The monthly ice limits shown here were derived from many records made both by the Discovery Committee's ships and by whaling vessels, but the observations made during the *Discovery II's* repeated cruises were specially helpful, particularly where they were outside the normal whaling season.

After calling at Bouvet Island the ship continued on her southward voyage. It was now late in January, the outer belt of ice had vanished, and she was able to proceed on this course for several hundred miles until she reached the beginning of the Antarctic continental slope, where she was stopped by pack in 69°39'S. She turned as usual to the north-east, back to the ice again in 20° E., and without any noteworthy incident steamed north again to Cape Town. This sixth cruise was remarkable for exceptionally fine weather which was maintained almost throughout and enabled a very full routine of observations to be successfully carried out.

The seventh and last cruise which began on February 15 was in many respects similar to the sixth. The pack-ice seems generally to be at its lowest ebb about late February and

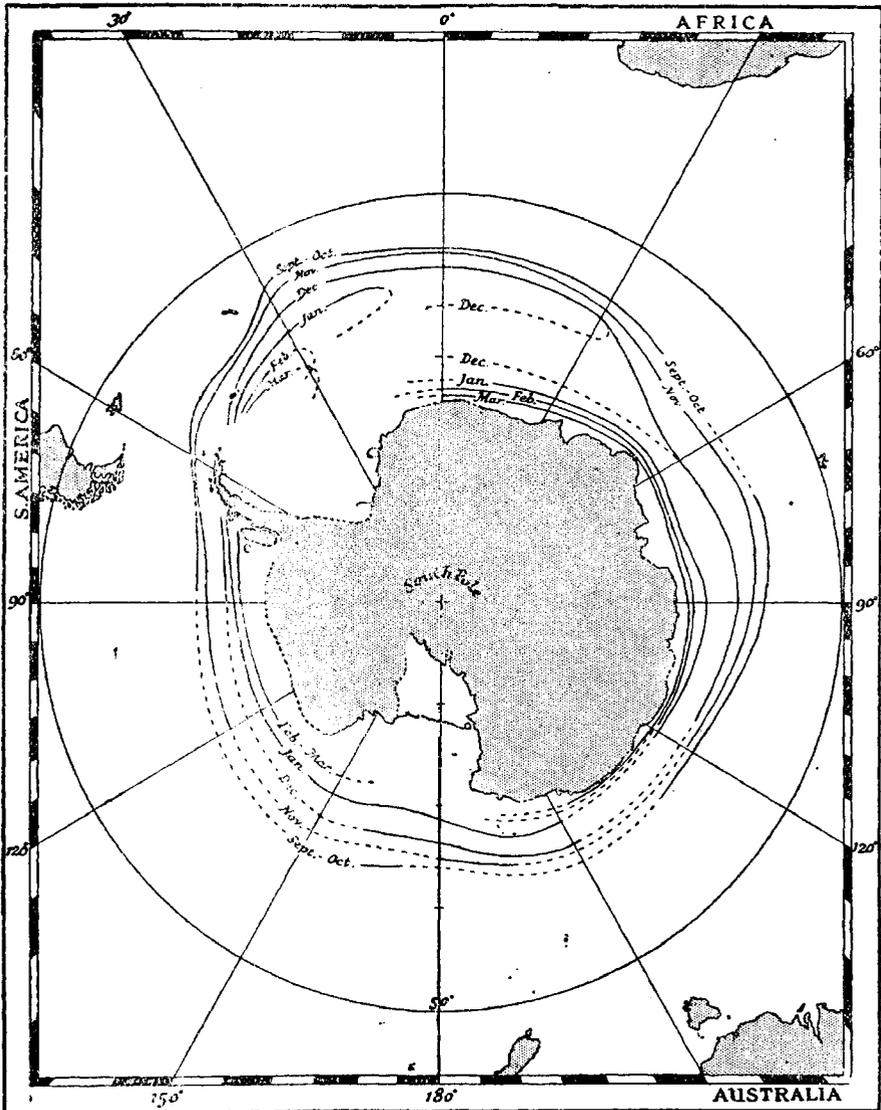


FIG. 4. — Mean positions of northern fringe of the pack-ice in summer.

early March. The middle of February is thus an ideal time to leave Cape Town for a straight run down to the Antarctic continent, and on this cruise the ship did in fact find clear water up to the continental barrier.

The southward passage went according to plan, though the weather was not quite so favourable as on the previous occasion. On March 3 barrier ice was sighted in  $69^{\circ}15' \text{ S.}, 00^{\circ}15' \text{ E.}$  The ship lay-to that night; her position was fixed by stellar observations, and next morning she proceeded to follow the edge of the barrier towards the east. The course taken is shown in Fig. 5, which needs little explanation. At first it was uncertain whether this was in fact the fixed barrier or a detached ice island, but in the afternoon of that day, when the ship was close alongside the ice-cliff, land was clearly seen about 5 miles to the south. About 25 miles farther east a patch of heavy pack-ice necessitated a detour to the north, but the barrier was found again in  $03^{\circ}30' \text{ E.}$ , and the land was sighted at intervals during March 5 between  $03^{\circ}40' \text{ E.}$  and  $04^{\circ}20' \text{ E.}$

During these two days soundings were carried out continuously, and it is specially remarkable that there was practically no sign of any continental shelf such as was found

off Adélie Land and expected in some form off any coast bordering the open ocean. Where the barrier was first encountered some distance from land it was floating in 1114 fathoms, and as it was followed towards the land the soundings shoaled rapidly to 160 fathoms, part of the slope being as steep as 1 in 6.

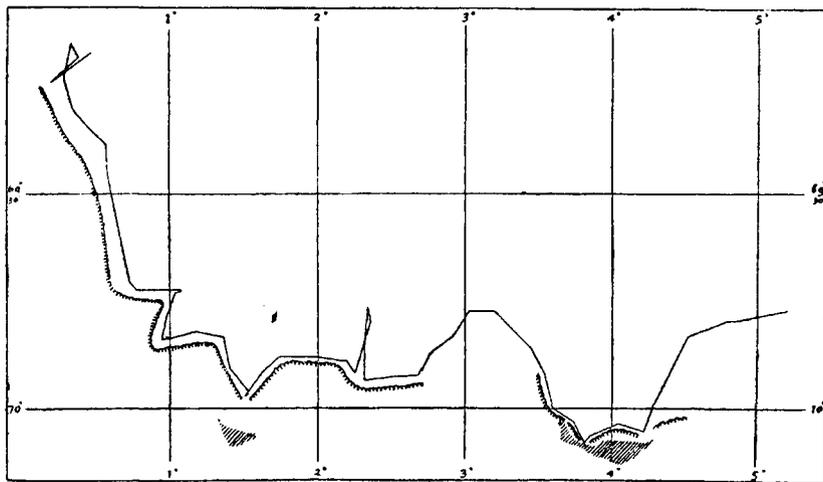


FIG. 5. — The ice-barrier in  $70^{\circ}$  S. between  $0^{\circ}$  and  $5^{\circ}$  E.  
Thin line is ship's track, land shaded.

The height of the barrier cliffs varied from 70 to 120 feet, and at some points many large tabular bergs were packed against it in a chaotic mass, but there were no off-lying rocks. Captain Hill says in his report that there were no mountains or peaks where the continent was first seen, but the land rose gently to the south as snow-covered plateau, and was lost to view in the distance at height of about 2000 feet. The land seen on the following day was similar. Here several snow-covered nunataks were visible and some morainic material or rock was seen at the base of one of the slopes. To make a landing on such a coast would have been extremely difficult. It was thought to be possible at one point, but there was an accident to the engine of the motor boat, fuel was running low, and it was thought better to move on to examine more of the coast to the east. On the night of March 5 however the weather broke up, pancake ice was forming rapidly, and further exploration had to be abandoned.

It does not appear that this can be claimed as newly discovered land. According to the Handbook and Index to accompany the Australian Government's Map of Antarctica, the German ship "*Schwabenland*", with two aeroplanes, was in that neighbourhood a few weeks earlier. The ship herself did not apparently come quite up to the land, but flights were made between  $1^{\circ}$  and  $7^{\circ}$  E., during which some of the same land was probably seen. Land had also been charted some years earlier in this part of the Antarctic by the "*Norvegia*", though it does not appear that they saw the same part of the coast as the "*Discovery II*". Perhaps the most important of the "*Discovery II's*" visit lie in the soundings, the charting of the position of the barrier at that time, and a fairly accurate determination of the position of a part of the coast.

After a few days at the Cape the ship began the homeward voyage on March 29.

Fuel was taken at Dakar and the ship reached London on 9 May 1939.

The circumpolar voyage and the repeated cruises have provided a very large body of data, and even in peace time a long period would be needed for its detailed examination. In war time of course we are able to make little progress, but some of the material has been subjected to a preliminary examination.

