The AUSTRALIAN MUSEUM MAGAZINE

VOL. XII, No. 8 Price—TWO SHILLINGS

Surveying the night sky at Macquarie Island with a photo-theodolite.

SPECIAL "ANTARCTIC" ISSUE.

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THE AUSTRALIAN MUSEUM

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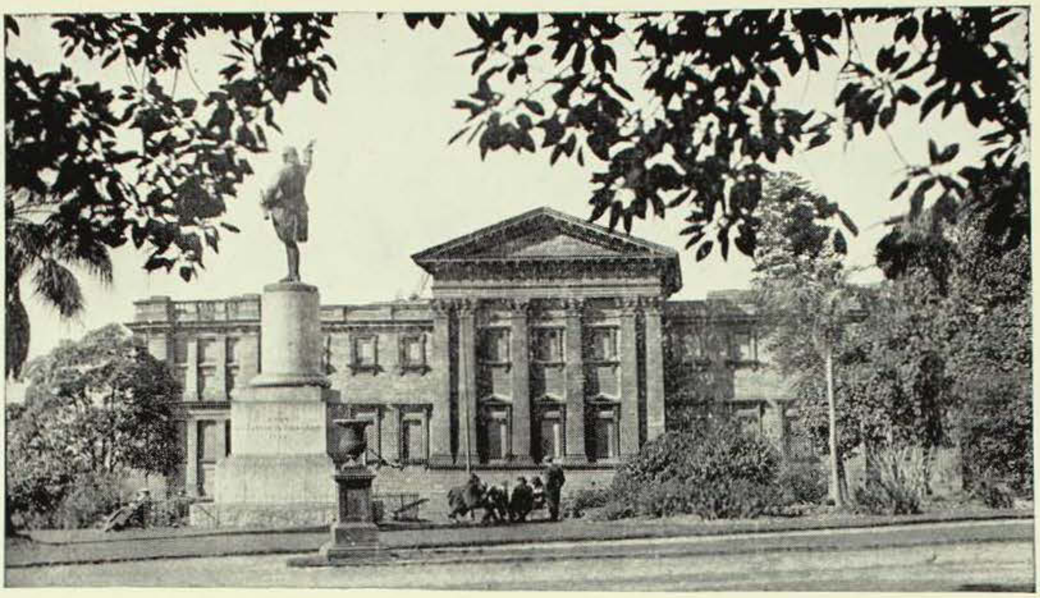

THE AUSTRALIAN MUSEUM MAGAZINE

(Photography, unless otherwise stated is by Howard Hughes, A.R.P.S.)

● OUR FRONT COVER.—A physicist of the Australian National Antarctic Research Expedition surveys the night sky at Macquarie Island with a photo-theodolite. Auroral displays are photographed from Buckles Bay simultaneously with another camera 20 miles away at Hurd Point at the south end of the Island. Simultaneous photographs are used to determine the position of the aurora in the upper atmosphere.—ANARE photo.

VOLUME XII, NUMBER 8 DECEMBER 15, 1957

IN the December, 1956, issue of this Magazine particulars were given of plans to increase the interest of the Museum's periodical. These included the publication each year of an issue devoted to a single topic. The first of such issues had "Australia" as its subject. The present number is concerned with Antarctica, which has been chosen not only because of the many investigations now in progress on that continent which are associated with the International Geophysical Year, but because of its extreme interest from so many points of view.

THE EDITOR.

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Antarctica—A Vital Link in the International Geophysical Year

By G. de Q. ROBIN

MOST large enterprises have small beginnings, and the vast scientific experiment known as the International Geophysical Year is no exception. Undoubtedly it may be traced to several sources but the most ancient line in its ancestry goes back to the very early explorers.

By the nineteenth century, when the ends of the earth had become fixed as the polar regions, the simple urge to find new habitable lands was difficult to satisfy, and expeditions gradually took on an increasingly scientific aspect. Men such as Sir James Clark Ross, who made the major geographical discoveries in the Ross Sea Sector of the Antarctic, took an equal interest in studying the magnetic field of the earth. Ross was the first to visit the North Magnetic Pole, and he also located the South Magnetic Pole with reasonably accuracy during his outstanding southern voyage.

As more scientific expeditions travelled to the polar areas, particularly in Arctic regions, it became increasingly obvious that the value of the data collected in various fields by different expeditions would be greatly enhanced if their studies were co-ordinated. For instance, the strength and direction of the earth's magnetic field were known to vary a little with time. It was important to find out whether such variations were due to relatively local effects or were widespread. These changes also appeared to occur when aurora were seen, and similarly it was desirable to find out whether the auroral displays were produced simultaneously over much of the Arctic region, or whether each display was comparatively local. The study of the weather was another problem requiring widespread observations.

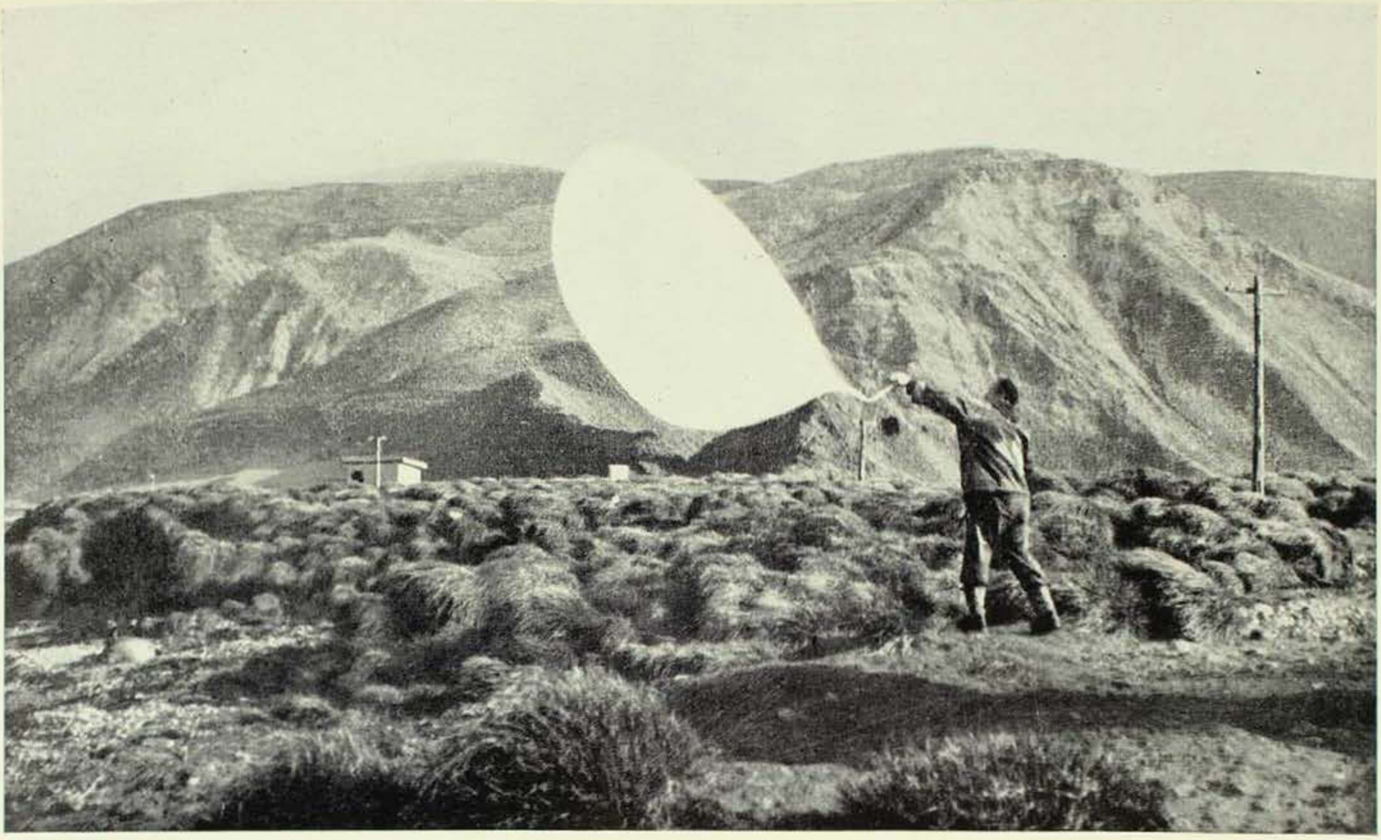
The first person to emphasize the need for such co-ordination was an Arctic explorer, Count Weyprecht, of Austria, in 1875. The International Meteorological Organisation followed up his suggestion by organising the " First International Polar Year of 1882-3 ". Fourteen expeditions took the field, two in southern latitudes and twelve around the Arctic. Reports of this work filled twenty volumes in addition to many scientific papers.

Fifty years later a similar effort was made on a greater scale in 1932-33. Greatly improved instruments and the emergence of new fields of study provided the impetus for the Second Polar Year. The propagation of radio waves, the meteorology of the upper atmosphere, the radiation from the sun, maritime meteorology and tidal studies were all included in the programme, as all needed co-ordinated observations over the surface of the earth in order to advance knowledge in their respective spheres. On the other hand investigations such as the measurement of gravity were not included as there was no apparent advantage in making simultaneous observations at different localities. During the Second Polar Year, in spite of difficulties due to the financial depression, twenty-three special stations were set up both in polar and other regions and investigations at existing observatories were intensified. Once again a good harvest of scientific results showed the value of international co-ordination in the scientific sphere.

It is scarcely surprising therefore that in 1950 the proposal was made that a Third International Polar Year be held twenty-five years after the previous one, instead of waiting for the former interval of fifty years to elapse. Various international bodies gave enthusiastic support to the idea, and financial help from UNESCO helped convert the proposal into reality. Owing to the necessity for world-wide rather than purely polar observations, and perhaps in order to avoid the suggestion of a mixture of adventure, science and politics that the word " Polar " now holds for the layman, the name of the project was changed to the " International Geophysical Year ". Whatever the motives of various governments may be in granting large sums of money to support the project, there is no doubt that the project is in the hands of senior scientific bodies in different countries. In Australia the Academy of Science is the controlling body, in the United Kingdom it is The Royal Society, and in the U.S.S.R. the Russian Academy of Sciences is using some of its vast resources to co-operate in this work.

It had become increasingly evident by the Second Polar Year, that the radiation from the sun and disturbances near the surface of the sun, such as sunpots and solar flares, were closely related to disturbances of the earth's magnetic field and the occurrence of auroral displays and radio blackouts. As 1932-33 was near a period of minimum sunspot activity, it was therefore desirable to choose a period of maximum sunspot activity for the International Geophysical Year (I.G.Y.), and 1957-58 fits this requirement. Originally the I.G.Y. aimed at making a co-ordinated study of those sciences affected by the activity of the sun. Such subjects do in fact account for the main body of the investigations although other studies have been added. One such addition is the study of the value of gravity at fixed points on the earth's surface. Although gravitational studies were excluded from the Second Polar Year, instruments have improved so much in the intervening years that periodic changes in the value of gravity of the order of one part in ten million can now be measured. These changes can be used to determine the deformation of the earth as a whole which is produced by the same forces as produce the oceanic tides.

As our understanding of the nature of the radiation and of particles emitted from the sun has increased, it has become increasingly evident that the polar regions are vital areas for the study of many of the geophysical problems being tackled during the I.G.Y. It is now known that during a solar flare the sun emits particles, such as the nuclei of hydrogen atoms, which travel out at a relatively slow velocity compared with the velocity of light. Whereas a burst of light from the sun reaches the earth in about eight minutes, these slower particles take more than a day to cover the distance. It is these slower particles, which are electrically charged, which produce radio blackouts, aurora and magnetic storms. Such particles are guided in by the magnetic field of the earth towards the earth's magnetic poles. However the guiding effect of the magnetic field decreases when the velocity of the particles increases, so that particles of sufficiently high velocity can reach the earth at any point. These higher velocity particles are the cosmic rays of the physicist, and their intensity at the surface of the earth is known to increase after some solar disturbances, although their origin is not at all clear. These streams of particles of varying velocities appear to be the key to many of the geophysical studies



Meteorologist releasing a radiosonde balloon at the Australian National Antarctic Research Expedition's station, Macquarie Island. This balloon takes aloft a small transmitter which signals back the temperature, humidity and pressure of the upper atmosphere.

The ANARE Station, Mawson, in spring, situated on a horseshoe-shaped area of rock jutting out from the Antarctic continental ice sheet into the frozen sea where a number of rocky islets lie off-shore. The aircraft hangar is seen at the edge of the sea-ice in the background.

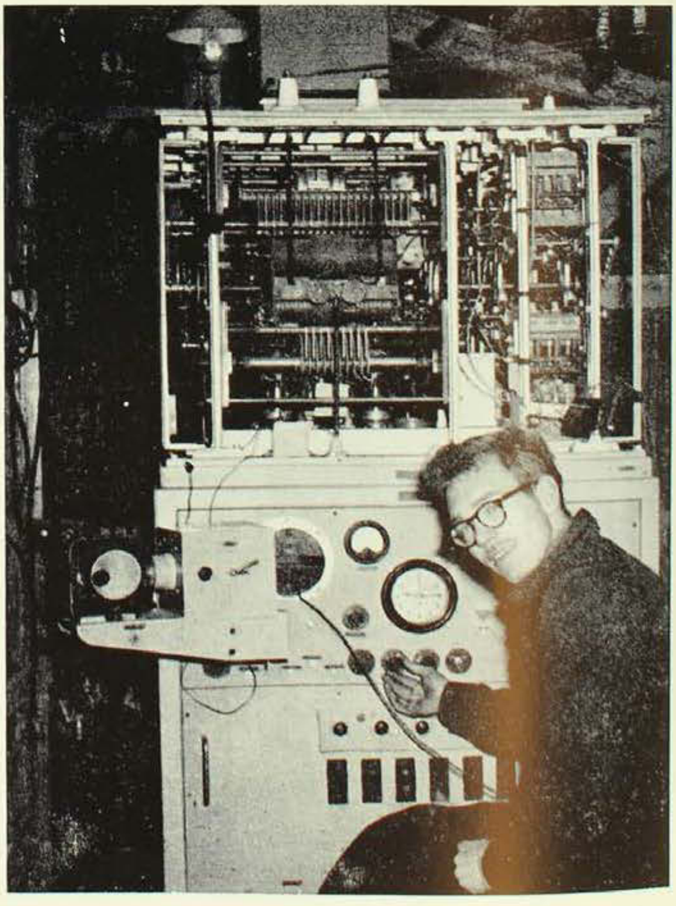
ANARE photos by Ivan Fox and G. Johansen (1956).

of the I.G.Y., and a great deal remains to be learned about their behaviour. The astronomers have taken over the role of principal watchdogs on the activity of the sun. A number of observatories are photographing the sun at half-minute intervals through special filters which show solar flares clearly. The observatories are distributed around the world so that the effect of cloud and darkness can be largely overcome. When a large flare is observed, radio messages are sent out to warn observers all over the world to step up their observations in all the studies likely to be affected. Such a message may go out from a European centre often *via* relay stations in the southern continents, to the radio operators at the various Antarctic bases within the space of a few hours.

Some eighteen bases have been set up on the Antarctic Continent especially for the I.G.Y., while observations at the existing twenty-three bases in Antarctica, mostly in the Graham Land sector, will be increased. For the first time, a good network of geophysical observatories around the southern continent will make it possible to determine which phenomena such as aurora and magnetic storms, occur simultaneously over the Arctic and Antarctic.

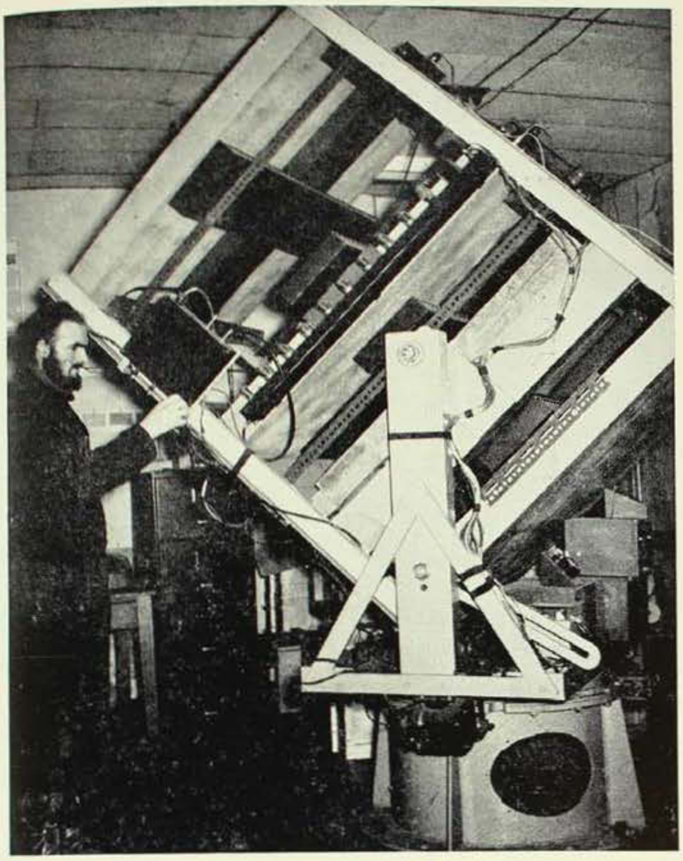
It is in the Antarctic bases that the spirit of the I.G.Y. is most in evidence. It is not a very pleasant occupation taking meteorological observations when the temperature is minus sixty degrees centigrade, and an observer must believe in the value of the work he is doing if he is to do the job conscientiously. Nor is it much fun handling instruments out of doors, or keeping a watch on the aurora, or in doing the various chores around an Antarctic base at the coldest spot on earth. Undoubtedly the inland bases flown in by the U.S.A. and the U.S.S.R. far from the relatively inaccessible coastline are colder than anything Siberia can offer. Only these countries can afford to finance the expensive logistic effort needed to establish such bases, but they and a number of other countries are also running equally efficient bases around the coastline. The conditions there are still very unpleasant by normal standards, and the isolation from families and friends is just as great.

The planning and running of these bases is a large task in itself. A well planned and efficiently staffed base can be quite comfortable and homely inside, even though an Antarctic blizzard may be raging out of doors. However if a hut should collapse or a fire break out one very soon finds that one's foothold on this alien continent is rather precarious. Again if the electricity supply fails, it is not the responsibility of some distant authority to rectify the matter, but it is an urgent local problem for the diesel mechanic or electrician, who may be the scientist himself, to rectify the trouble. It is no use calling for outside help or extra spare parts when there is no prospect of them reaching the base for months.



An ionospheric sounder, a special type of "variable frequency" radar, used at Macquarie Island to automatically record the changing characteristics of the ionosphere. The records are used in predicting best frequencies and times for overseas communications using shortwave radio signals reflected from the ionosphere; also for studying the complicated processes in the upper atmosphere which produce auroras and magnetic disturbances associated with "blackout" on radio communications.

ANARE photo by R. H. Wilkinson.



This giant cosmic ray telescope at Mawson operates by recording automatically for one hour the cosmic ray particles which strike the earth in a given direction; at the end of the hour the telescope automatically rotates 180° and records for the next hour facing in the opposite direction.

ANARE photo by G. Johansen.

However the tradition of competent planning of polar expeditions has been built up during the previous Polar Years, and by many expeditions during the intervening periods.

It is thus practicable for an Antarctic base to make useful contributions to most of the disciplines being studied during the I.G.Y., including those involving quite complex instrumentation. Obviously it is not necessary to go to the Antarctic to watch the sun, but in the fields of cosmic rays, ionospheric measurements, auroral observations, magnetic measurements and meteorological studies the polar regions provide information of vital importance to our understanding of the world-wide phenomena. Indeed it is perhaps a pity that the title, " Third Polar Year " has been dropped. In addition to the above studies closely related to the activity of the sun, advantage is being taken of the presence of many expeditions in the Antarctic to collect information in other fields. Mapping, geology, gravitation, earthquake seismology and glaciology are all receiving special attention. Among the glaciological projects, a series of journeys making periodical soundings of ice thickness will help to show how much water is bound up in the Antarctic ice mass. Present estimates indicate that this may be sufficient to raise sea level over the whole world by around 200 ft.

Australia is well to the fore in these Antarctic studies with well equipped bases at Mawson and Macquarie Island and the newer base at Davis. As a result of several years' experience in overcoming the technical difficulties of operating complicated instruments under Antarctic conditions, the Australian contribution in certain disciplines is likely to be as important as that obtained by any other Antarctic expedition. The main spirit of the I.G.Y. is not, however, one of competition to produce better results than that of any other base. Instead it is one of co-operation to produce the best possible total result. This co-operation cuts across political boundaries, and one finds such features as the exchange of scientific observers between the main bases run by the U.S.A. and the U.S.S.R. Finally, all results obtained by all expeditions will be freely exchanged and secrecy has no place in the International Geophysical Year.

G. de Q. Robin is at present a Senior Fellow in the Department of Geophysics, Australian National University, Canberra. Dr. Robin spent one year in the South Orkneys with the Falkland Islands Dependencies Survey and two years in Queen Maud Land with the Norwegian-British-Swedish Antarctic Expedition, 1949-52. Next year he will be taking up the post of Director, Scott Polar Research Institute, Cambridge University, England.

The Antarctic Continent

By H. O. FLETCHER

NEVER before in the history of Antarctica has the great ice-clad continent been populated to the extent it is today. Trained personnel, representing eleven nations, are at present operating more than forty widely distributed research stations in Antarctic and sub-Antarctic regions. Many of these stations have been specially established for the International Geophysical Year, 1957-58, but some were in existence and operating long before plans were made for the concentration of scientific research which has marked the current year and which will be continued.

An American research station has been established in the very centre of the continent at the South Geographical Pole, while two other remote stations are the Russian "Sovetskaya" in lat. 82° S., long. 55° E., and a United Kingdom station 300 miles inland from the "Shackleton" base which is in lat. 77° S., long. 37° W.

Australian research activities in the Antarctic have been organised by Mr. P. G. Law, Leader of the Australian National Antarctic Research Expedition. An extensive scientific programme is being carried out at previously established bases at Macquarie Island and "Mawson", while a new station has been erected and is operating in the Vestfold Hills area of Princess Elizabeth Land, approximately 400 miles east of Mawson, in lat. 69° S., long. 78° E.

Australian Territory in Antarctica consists of "that part of the territory in the Antarctic seas which comprises all the islands and territories, other than Adélie Land, situated south of the sixtieth degree south latitude and lying between the one hundred and sixtieth degree of east longitude and the forty-fifth degree east longitude."

This territory was created in 1933, when the Commonwealth Government passed an Act accepting the area from the United Kingdom. It consists of 2,472,000 square miles and British sovereignty vested in Australia was declared on the basis of discoveries ranging in time from the discovery of land in the sector by Biscoe in 1831 and Kemp in 1833, to the mapping of the coastline by Mawson in 1929-31. During this latter expedition, officially known as the British, Australian, New Zealand Antarctic Expedition, several new lands were discovered and claimed. Altogether the record of exploration and scientific research carried out by Australians in the Australian sector is most impressive and includes the extensive work of the Mawson 1911-14 expedition.

The programme of scientific research planned for the International Geophysical Year in Antarctica is most comprehensive and includes (as main objectives) studies in meteorology, geomagnetism, cosmic rays, solar observations, ionospheric investigations, air-glow and sodiacal light, glaciology, oceanography and so on.

The Australian base at Mawson in MacRobertson Land is firmly established as an observatory and is well fitted to assist in most of the planned researches. Already synoptic meteorological observations (including radiosonde) and continuous cosmic ray, geomagnetic and auroral records have been obtained, while a great deal of fieldwork in geology, glaciology and marine biology has been carried out. Additional equipment, including seismographs and a radiotheodolite for upper wind measurements, has been installed.

The three stations planned by the Academy of Sciences of the U.S.S.R. are in Australian Antarctic Territory. One of these, called "Mirnyy", was established in January, 1956, in lat. 66° 37′ S., long. 92° 57′ E., on the mainland opposite Haswell Island. The other two stations are well inland and were established by aircraft.

Adélie Land is a thin slice of land lying within the limits of the Australian sector of Antarctica and extends on the coastline from 136 to 142 degrees east longitude.

The Australian base at Mawson, showing Horseshoe Harbour frozen over and the rising ice slopes of the Antarctic Continent on the left.
ANARE photo by J. A. Seaton.

France had always claimed this territory but some time ago the French Government agreed to move back its eastern frontier so that Cape Denison would be included in Australian territory as it was realised it had sentimental and historical associations with Australia.

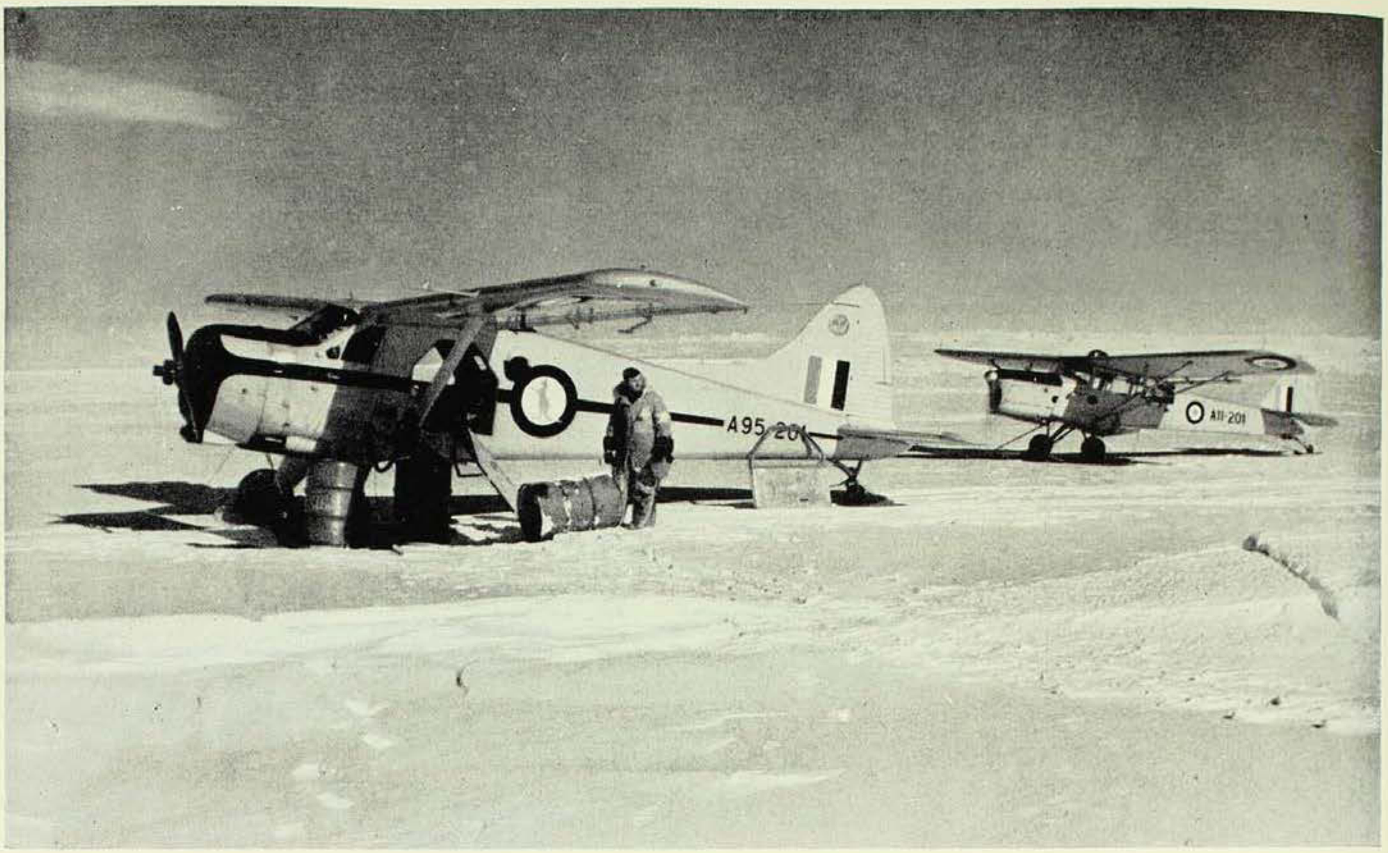
France will have two stations operating in the Antarctic during the International Geophysical Year. One was established at Adélie Land in 1955-56 and an additional inland station is now operating in the vicinity of the South Magnetic Pole.

The large scale activity now being carried out in all parts of the Antarctic Continent, including the hinterland, leaves no doubt that our knowledge of this little-known land will be vastly increased. It is a unique continent with an area, excluding islands and ice-shelves, of 5,058,356 square miles and a coastline of about 20,000 miles.

The Antarctic Continent assumes the role of a giant refrigerator and, with two-thirds of its topography towering to heights of 10,000 ft. or more, exerts an important influence on the weather of Australia, South America and South Africa. It is still in the grip of an ice-age and the whole of the vast land surface is covered with an immense ice-sheet through which project to heights of more than 14,000 ft. the peaks of great mountain ranges. Areas free from ice are restricted to the coastline where occasional rocky headlands and ice-free spaces show out in marked relief from the rapidly ascending ice-cap to the south.

It is generally considered that the exposed rocks of Antarctica are restricted to one-fifth of one per cent. of the rock mass buried beneath the ice-cap. The known rocks prove the continent to be no different from other continental masses. In fact they are closely related to rocks present in Australia and other neighbouring continents and constitute a connecting link, both in materials and structure, between these lands.

The ice-cap, which in places must exceed several thousand feet in thickness, is continually but imperceptibly moving from the high lands to the coastline, where it forms an ice-front or ice-cliffs more than 200 ft. high. Pushed out to sea as vast floating ice-rafts, the ice finally breaks up into the huge tabular-shaped icebergs so abundant in Antarctic waters. Some icebergs have



The R.A.A.F. refuelling depot at King Edward VIII Gulf, 160 miles west of Mawson.

The Australian expedition's relief ship, Kista Dan, with the polar ice-cap in the background.

ANARE photos by J. A. Seaton and Phillip Law.

been recorded more than a hundred miles in length, with a height above sea-level of almost 200 ft.

During the dark winter months the continent is effectively sealed off by the freezing of the sea for some hundreds of miles to the north. As the summer season advances this sea-ice or pack-ice begins to break up, and it is then that ships specially strengthened for ice-breaking may push their way to the coastline.

Antarctic weather is recognised as the most severe in the world and temperatures are constantly below freezing point even at midsummer. Wind velocities are almost unbelievable and during blizzards travel is impossible. It is generally accepted that Adélie Land and King George V Land are the windiest in the world. The average wind velocity recorded for the month of April, 1912, was 50 miles an hour and for one 24-hour period it averaged 90 m.p.h., with occasional gusts of up to 160 to 180 miles.

The continent offers inconceivable difficulties for explorers and it is amazing to what extent Antarctica had become known prior to the new era of exploration which was brought about by aircraft and mechanical land vehicles.

Early Exploration

Voyages of exploration with the south polar lands as their objective have been almost continuous since the fifteenth century. To describe them all is impracticable and therefore only a few of the more noted geographical discoveries will be mentioned.

The presence of a great southern continent was firmly believed by the learned men of the fifteenth century and it was considered to be as large as the habitable world of that time. The early globes of Leonardo da Vinci and Schoner, and the sixteenth century maps of Cronteus Finne and Ortelius illustrated the popular ideas of the extent of the then hypothetical southern land; its northern limits were even extended into the tropics.

Southern geographical history began in 1486 when Bartholomew Diaz, after surviving very heavy weather, found that his ship had been swept to the east and past the southern part of the African continent. For the first time the presence of a southern sea was established and, more important, it was learned that the south land was not connected with Africa.

On the other side of the globe Magellan, in 1520, discovered the passage which now bears his name. The land he charted to the south as Terra del Fuego was in his opinion the northern limit of the great south land *Terra Australis*. About fifty years later Sir Francis Drake passed through the Strait of Magellan into the Pacific Ocean where he encountered severe gales and was blown to lat. 57° S., the most southerly point reached up to that time. The vast extent of the southern sea, its stormy nature, and the continual danger from pack-ice and icebergs as large as small islands was now known.

Voyages of exploration in search of the south land continued throughout the seventeenth century and several discoveries were recorded. Tasman, in 1642, after circumnavigating Tasmania and proving it had no connection with the southern continent, sailed east and discovered New Zealand, which he named Staten Land. He considered this land to be a northern extremity of *Terra Australis*.

Almost a century later a French navigator, Lozier Bouvet, discovered an island (which now bears his name) in lat. 54° 28′ S., long. 3° 24′ E. This island, only 45 miles in length, was named Cap de la Circoncision and hailed as a northern cape of the still elusive southern continent. Most of these sub-Antarctic islands were sighted in thick fog and usually in bad weather. It is not to be wondered at that these early navigators did not relish making close investigations of such new landfalls. Consequently, Marion de Fresne, in 1772, named the Marion and Crozet Islands as *Terra d'Esperance*, symbolic of the hope that at last the great south land had been reached.

In the same year Chevalier de Kerguelen-Tremarec discovered what is now known as Kerguelen Island and without further investigation returned to France with the news that he had discovered the long-sought southern continent.

It was not, however, until the second voyage of Captain James Cook that the coastline of the south land, although not yet sighted, was virtually given its correct limits. At the conclusion of three years' exploratory work Cook was able to report that he had circumnavigated the continent in high latitudes and on January 17, 1773, his ship was the first to cross the Antarctic Circle. His "farthest south" was 67° 15′ and when only 70 miles from the coastline of what is now Crown Prince Olav Land further progress was barred by thick and impenetrable pack-ice. The voyages of Cook successfully exploded the centuries-old myth of an enormous, habitable, southern land which teemed with the good things of life, and with this incentive gone, many nations temporarily lost interest in further exploration.

Early in the nineteenth century the history of Antarctic discoveries was to a great extent synonymous with the rise and mushroom growth of the southern sealing and (later) whaling industries.

In 1823, James Weddell sailed south into the sea which now bears his name and reached a point 214 nautical miles nearer to the South Pole than Cook's "farthest south". Seven years later the Antarctic Continent was sighted for the first time by Captain Biscoe when he saw the black tips of mountains projecting through the ice-cap at what is now Enderby Land, the most western area of Australian Antarctic Territory. Heavy pack-ice prevented a landing, but in 1840 the French navigator Dumont D'Urville made a landing on new territory he discovered and named Terre Adélie.

In 1841, Sir James Clark Ross sailed into the Ross Sea and attained the "farthest south" by reaching lat. 78° 10′ south. Bounding this sea on the west was the magnificent chain of snow-clad mountains named South Victoria Land. On this voyage Ross determined the position of the South Magnetic Pole with great accuracy but, being inland, he made no attempt to reach it.

With the advent of steam late in the nineteenth century it was possible to explore Antarctic waters more freely than with sail alone; shorter routes could be taken and vessels were not dependent on favourable winds.

Using steam power *Belgica*, under the command of M. Gerlache, steamed south into pack-ice in February, 1898, and was eventually caught in the pack and frozen in. For thirteen months the ship drifted between the 85th and 103rd degrees of west longitude. Her farthest south was lat. 72° S., and the men of her complement were the first human beings to experience a long and dark Antarctic winter.

The following year *Southern Cross*, with C. E. Borchgrevink in command, was cruising in the Ross Sea area. A scientific party was landed on South Victoria Land and for the first time men spent a winter on the continent itself. Interest in the Antarctic was now intensified and plans were made to gain knowledge of the hinterland.

Early in 1902, *Discovery*, under the command of Captain Robert Scott, anchored in McMurdo Sound in the Ross Sea, where is was decided to winter. The following spring, Scott, Shackleton and Wilson sledged to lat. 82° 17′ S., just failing to reach Mt. Markham (15,100 ft.). The time taken on the trip was ninety-three days and members of the party had practically hauled their own sledges 760 miles as the dogs proved worthless in their inexperienced hands. Knowledge of the interior of the Antarctic continent was increased in 1907 when Shackleton and his party sledged within 19 miles of the South Pole. Shackleton's great ambition was to reach the Pole but he wisely refrained from continuing, owing to slight sickness in the party, and he returned to his base after an absence of four months. In the meantime other members of his expedition, Mawson, David and Mackay, had made the first ascent of Mt. Erebus, 13,200 ft., and had also reached the South Magnetic Pole.

Amundsen, in 1910, sailed south in *Fram* and established a base at the Bay of Whales at the head of the Ross Sea. The following summer Amundsen left for the Pole on October 19, 1911, with four men and four sledges hauled by dogs. Favoured with good weather the party averaged four-and-a-half miles per hour on the polar journey.

They reached the Pole on December 14, and six weeks later were back at the Bay of Whales, with the number of dogs reduced to 12; 28 had been killed to provide food for others.

The same year Scott, on his second expedition, attempted the polar journey with his party hauling their own sledges. The world knows the results of Scott's South Pole journey. The party met continuous bad weather but persevered and reached their objective—only to find that Amundsen had forestalled them by thirty-four days. Retracing their steps on the 800-miles return journey Scott and his party perished 141 miles from the main base and only 11 miles from the safety of One Ton Depot.

At this time the southern land was no longer a continent veiled in mystery, but stood revealed as a great land mass half again as large as Australia. Its gradual discovery down the years was due to great feats of human endurance and courage. Early voyages were undertaken in ships which today would be refused a certificate for coastal trade, while some of the sledging journeys would now appear to be beyond the scope of human endurance.

Recent Expeditions

The more recent expeditions, including the Mawson expeditions of 1911-14 and 1929-31, are well known. Then, with the rapid development of aircraft, both scientific and commercial interests played their part in furthering our knowledge of Antarctica. Aircraft attached to whaling fleets and research vessels added considerably to knowledge of the coastline in areas not previously investigated. Antarctica may now be likened to a gigantic iced cake of which various nations have claimed segments. These nations have exhibited an increasing concern, apart from the International Geophysical Year, in their Antarctic possessions and scientific and exploratory expeditions have sailed south to carry out intensive surveys and scientific research in all parts of the continent. It would appear that the intense interest displayed in Antarctica is not only a natural desire of nations to consolidate their land claims, but also expresses an intention to carry out extensive and ambitious scientific programmes, as permanent bases are established. The culmination of such research will be reached when the nations active in Antarctica during the International Geophysical Year pool their results to make possible the elucidation of many problems which have been waiting to be solved in the far south.

It is also possible that Antarctica may develop into an area of high strategic importance and who is to say it will not play an important part in the event of further world-wide hostilities.

Vertebrate Fossils

Mr. Richard Tedford, of the Museum of Palaeontology, University of California, Berkeley, spent a week at the Australian Museum during September, examining the collection of vertebrate fossils. Mr. Tedford visited Australia in 1953 with Professor R. A. Stirton and spent three months collecting vertebrate fossils from Lake Callabonna and the country east of Lake Eyre, South Australia. On his recent trip Mr. Tedford continued this work with considerable success at several new localities in the Lake Eyre country.

Wall Mural

Australian Museum artist John Beeman has completed a wall mural in the Aboriginal Gallery, the first of a series of cave paintings to be reproduced in this gallery. It depicts mythical heroes, called the Lightning Brothers by the Wardaman tribe, which are recorded in a cave painting at Delamere, on the upper Daly River, Northern Territory.

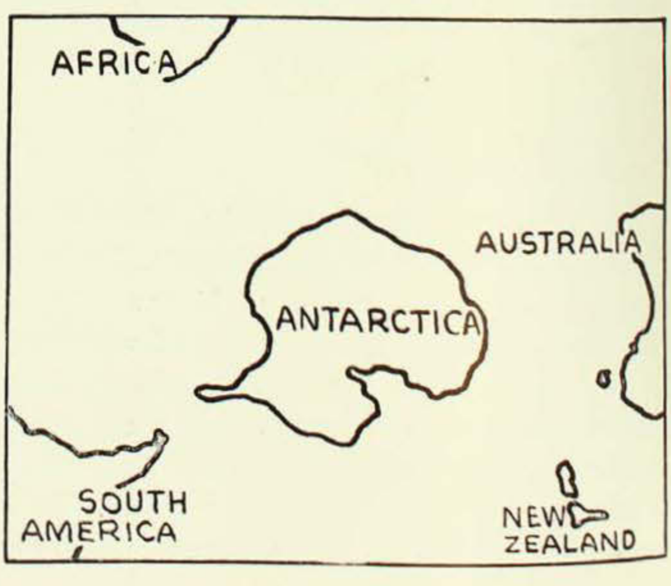
Mineral Possibilities of the Antarctic

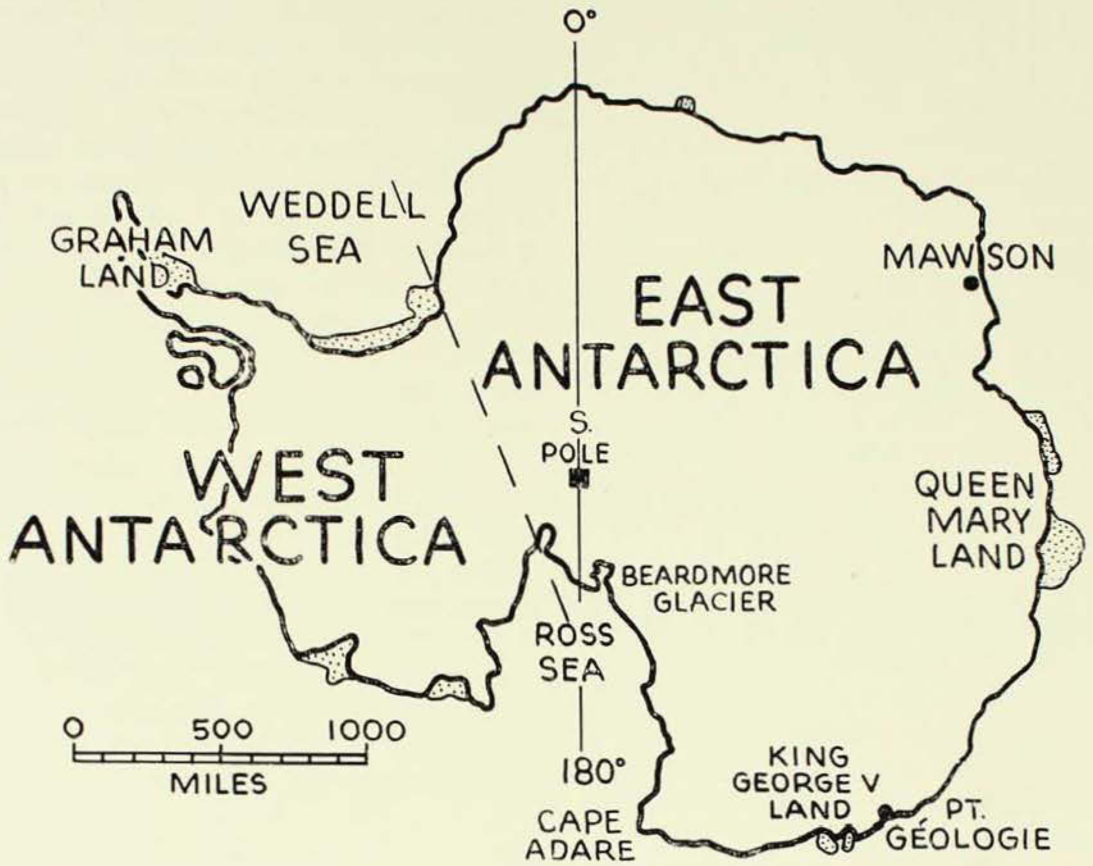
By R. O. CHALMERS

BEFORE the mineral resources of a continent can be estimated something must be known about the geological background. Everyone knows that Antarctica is a huge land mass almost as large as Australia and Europe put together, but this was not always realised. Various official national expeditions in the first half of the nineteenth century charted much of the ice-bound coastline. Contributions were also made by such individual concerns as the whaling firm of Enderby Brothers. Knowledge of the rock types was first gained when icebergs were found to contain erratic boulders of rocks that must have been carried from a continental land mass. Dumont D'Urville, in January, 1840, landed on islets only 450 to 550 yards from the Antarctic mainland but was prevented by ice from going further. These islets consisted of gneiss, specimens of which were collected. The day before, fragments of this identical rock had been found in the gizzard of a penguin. That part of the Adélie Land coastline nearest the landing on the islets, was very appropriately named Pointe Géologie, which is the site of one of France's present Antarctic stations. The first landing on the continent itself was made at Cape Adare on 24th January, 1895, by a party from the whaler *Antarctic*, commanded by a Norwegian, H. J. Bull. Specimens of basaltic lava, volcanic tuff and schist, collected by C. E. Borchgrevink, who had signed on as a seaman, were acquired by the Australian Museum in 1896 and are still in the collections.

It should be clearly understood that the only rocks examined *in situ* are those exposed in odd places along the 20,000 mile-long coastline, or in the few places where mountain ranges stand out above the general level of the ice-cap. The main evidences we have of what is in the interior of the continent are the great masses of erratics brought by glaciers and ice sheets that continually move out to the coastline. A magnificent collection of 1,800 rocks mostly erratics consisting mainly of Pre-Cambrian schists and gneisses, was collected in King George V Land, Adélie Land and Queen Mary Land by the Australasian Antarctic Expedition under Mawson (1911-1914), the scientific results of which are second to none. The collection, which is now in the Australian Museum, also includes rocks collected *in situ* in and around the expedition's base camp at Cape Denison, in Adélie Land, and the base camp of the Western Party of this expedition in Queen Mary Land, 1,200 miles from Cape Denison, within 200 miles of the present day Russian base at Mirnyy. Several fine specimens from this collection are to be seen in the display of metamorphic rocks in the Museum's Mineral Gallery.

Enough is known to show that the basic geology of Antarctica is not unlike that of other major continents. The large bulk of the continent, which lies directly to the south of Africa and Australia and includes the Pole itself, is known as East Antarctica and makes up two-thirds of the whole mass. It is a stable "shield" area consisting principally of highly altered Pre-Cambrian schists and gneisses. Similar shield areas





exist in many other parts of the world, one notable example being the whole western half of Western Australia. Overlying the Pre-Cambrian of East Antarctica are great thicknesses of younger rocks, the most notable being the Beacon sandstone deposited over a long period extending from Devonian to Triassic. One of the most puzzling features of this great formation is that it affords no evidence of the great Permian Ice Age which covered India, South Africa, Australia and South America with ice sheets, and might have been expected to have affected Antarctica as well. Evidence of the existence of even earlier Palaeozoic rocks was provided by Shackleton's party on its unsuccessful attempt to reach the South Pole in 1908. They found limestone containing the ancient Cambrian coral Archaeocyathinae, one of the earliest recognizable forms of life, near Mount Darwin in the region of the Beardmore Glacier some 360 miles from the Pole. Dolerite sills up to 1,500 ft. thick have intruded the Beacon sandstone and dominate the topography as do their counterparts in Central Tasmania.

West Antarctica is quite different geologically. In fact unanimity of opinion has not yet been reached on whether it is not actually a separate land mass. It consists mainly of Mesozoic and Tertiary sediments folded into mountain ranges which are actually a continuation of the Andes. This is suggested by the relatively close proximity of the long, sinuous promontory of Graham Land and Cape Horn.

Antarctica is the highest of all the continents, due mainly to the great thickness of the ice sheet. There is considerable difference of opinion on the maximum and average thickness of the ice sheet, and this is one of the problems it is hoped to solve during the International Geophysical Year. The maximum general level of the East Antarctic ice sheet is 13,000 ft. and the ice is considered to be more than 7000 ft. thick in places. Above the general level several peaks emerge to heights of 14,000 and 15,000 ft. These are in the Queen Alexandra and Queen Maud Ranges that lie on either side of the Beardmore Glacier. These ranges are part of the great mountain chain that towers above the Ross Sea and marks the boundary between East and West Antarctica. The maximum height of the ice sheet in West Antarctica is probably well under 10,000 ft. and, especially in Graham Land, many more mountain ranges are to be seen than in the eastern half of the continent.

One hundred and seventy-four minerals have been noted in various parts of the Antarctic. It is generally conceded that the most promising of them all, from the economic point of view, is coal. Coal seams occur in the Beacon sandstone at various places along the scarp of East Antarctica, including the Beardmore Glacier. Scott's party on their fateful journey from the Pole in 1912, found time, despite their pressing difficulties, to collect 35 lb. of specimens from Mount Buckley on the Beardmore Glacier. These the men retained right to the time of their death. They were subsequently studied and found to contain coal and the fossil plant *Glossopteris*. This proved that Antarctic coal is Permian, which is the age of the most important Australian coal seams. It also indicated that for at least part of the Permian period Antarctica enjoyed a temperate climate.

Other minerals include chalcopyrite, bornite, malachite and azurite, all well known ores of the metal copper; cassiterite, the chief ore of tin; galena, the chief ore of lead; sphalerite, the chief ore of zinc; molybdenite, the chief ore of molybdenum; stibnite, the chief ore of antimony; chromite, the chief ore of chromium; and magnetite and hematite, important ores of iron. Most of these were recorded by Mawson on the 1911-1914 expedition but it should be stressed that they have been found as mere traces and in no sense are any of them in quantities of economic significance. The one radioactive mineral noted is monazite, which contains thorium. Most of these minerals are from the Pre-Cambrian shield area of East Antarctica, and this ancient group of rocks (approximately 1,000 million years old) is characterised the world over by the presence of important mineral deposits. In Australia, ore bodies of Pre-Cambrian age include those of Broken Hill, Mount Isa and Kalgoorlie. Our two most important iron ore deposits, in the Middleback Ranges and Yampi Sound, and all our economically important uranium deposits, are Pre-Cambrian. What indication would we have of these if the whole of Australia were ice-clad save for an occasional fringe of coastline? Most of the large uranium deposits of the world occur in the Pre-Cambrian and for this reason it is more than mere speculation to say that uranium deposits most probably occur in East Antarctica even though as yet no uranium minerals have been found.

The majority of the minerals recorded are the rock-forming minerals both common and rare. Of these, mica can be of economic importance if it occurs in large enough deposits, but so far in the Antarctic it occurs only as small flakes in metamorphic rocks. A recent find of tephroite has been announced in the press. It is a somewhat rare manganese silicate that is found as an accessory mineral in two important but rare types of ore deposit, one a zinc deposit at Franklin Hill, New Jersey, U.S.A., and the other a manganese deposit at Langban, Sweden. It has also been recorded as a constituent of minor manganese ore deposits in the Tamworth district of New South Wales. This indicates how impossible it would be to estimate the economic significance of tephroite in the Antarctic on the evidence of one specimen.

There is certainly active interest in the possibility of mineral exploration in the Antarctic. Sir Raymond Priestley, in his recent presidential address to the British Association for the Advancement of Science, envisaged prospecting and exploitation on a national scale and the whole enterprise, not only the actual mining, being carried on underground in the event of finding valuable deposits. We read in the journal *Discovery* of discussions on mining problems between Russian and Australian experts in Adelaide, though little news of this seems to have filtered through to Sydney.

It is difficult to see how we will ever be able to assess the mineral possibilities of the Antarctic until it returns to its normal ice-free condition. We are living in what may be an interglacial period of the Pleistocene Ice Age so that the future may bring increased glaciation and the encroachment of ice sheets once more over northern Europe and North America. If, on the other hand, the Ice Age is on the wane, the climate may gradually become warmer the world over, in which case the existing ice-caps may melt and reveal the rocks of Antarctica. If this happens the rocks will be in an ideal state to reveal mineral deposits. Ice action will have smoothed the land surface and there will be no cover of soil or vegetation to mask the nature and structure of the rocks. This could be some compensation for the present frustrations we undergo in wondering what lies beneath the impenetrable ice-sheet of the vast Antarctic continent.

Another effect of the melting of the ice-caps would be a rise in sea-level of about 100 to 200 ft. the world over. In this event people who now live at or near sea-level, such as the majority of the inhabitants of the world's great sea-ports, might be forced to migrate to the shores of a temperate Antarctica.

The Wildlife of Macquarie Island

By **ROBERT CARRICK**
C.S.I.R.O. Wildlife Survey Section, Canberra

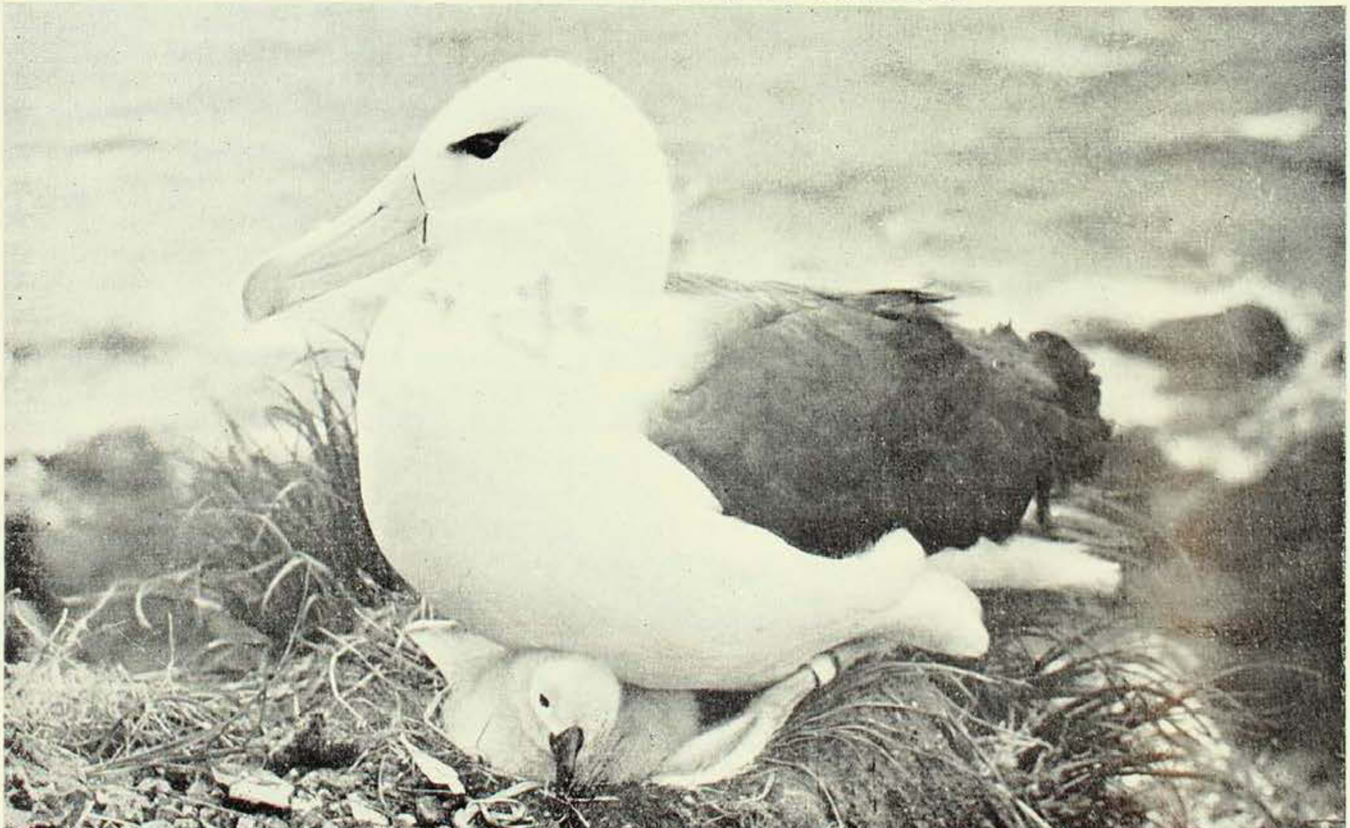
MACQUARIE Island lies in the middle of the Southern Ocean, 54½° S and 159° E; it is some 900 miles from the eastern sector of Australian Antarctic Territory, 800 miles from Tasmania, and 650 miles from New Zealand with Campbell Island and the Auckland Islands intervening. Its isolation from other land, and its strategic position just north of the Antarctic convergence, combine to make it one of the richest wildlife sanctuaries in the world. These waters, rich in nitrates, phosphates and oxygen, teeming with diatoms, crustacea, squids and fish, support enormous numbers of seals and sea-birds, whose only landfall, and breeding-place, in thousands of square miles of ocean is this small island about 22 miles long and 2 to 3 miles wide.

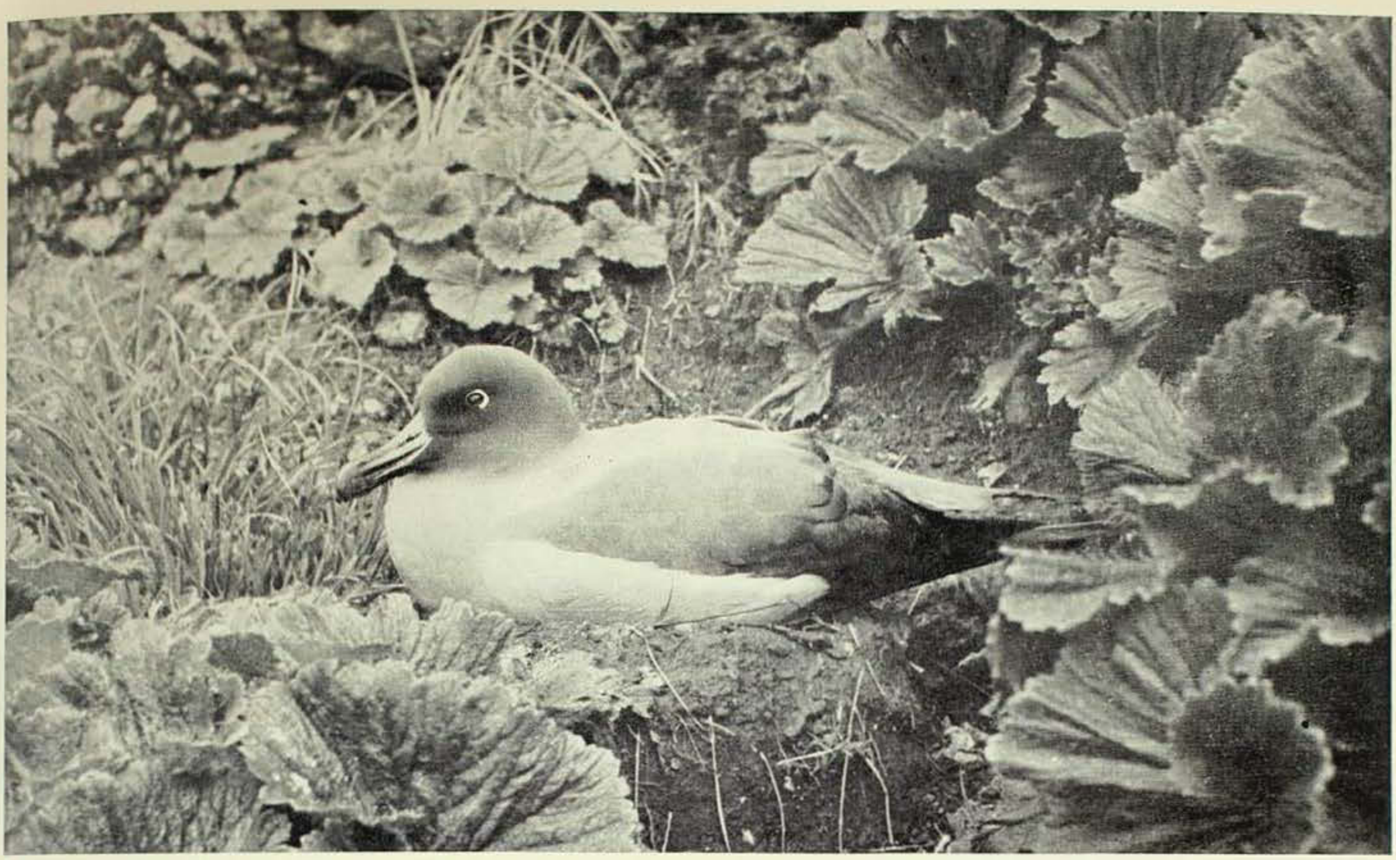
Since Captain Hasselborough first sailed the brig *Perseverance* into the bay which now bears his name, on July 11, 1810, Macquarie Island has had a chequered biological history. Its discovery stemmed directly from the exhaustion of the Fur Seal, *Arctocephalus forsteri*, on the New Zealand islands, and a party was left on Macquarie Island to begin the exploitation of these valuable animals while Hasselborough hastened back to inform his Sydney employers of the rich find. By April 1811, 56,974 Fur Seal skins had been taken; by 1813, the figure exceeded 180,000; and in 1820 the Russian explorer Bellingshausen reported their extermination. The sealers then turned their attention to the Elephant Seal, *Mirounga leonina*, and in 1826 and 1827 over 1000 tons of oil were procured. By 1834, even this vast source of supply from the many thousands of Elephant Seals which litter the island's beaches had been so depleted that the trade continued only intermittently during the next forty years. In the final phase, up to 1919, when the last licence to kill seals and penguins was given, both the King Penguin, *Aptenodytes patagonica*, and the Royal Penguin, *Eudyptes chrysolophus schlegeli*, were taken in large numbers, and the digesters still stand at several places as rusty monuments of the trade. A large colony of King Penguins at the Isthmus, the narrow neck of land near the north end which is flanked by the anchorages and landing-beaches of Buckles Bay and Hasselborough Bay, was wiped out, but the other colony at Lusitania Bay near the south end still flourishes. More by convenience than good judgment, the Royal Penguin was harvested in more economical fashion. It was done only at Nuggets Bay where some of the largest colonies are conveniently situated, and only a proportion of the

(*Continued on Page* 258.)

Southern Skua, *Catharactaskua lonnbergi*, and two chicks which have just been banded. The rosette-shaped plant, common on the plateau of Macquarie Island, is *Pleurophyllum hookeri*.

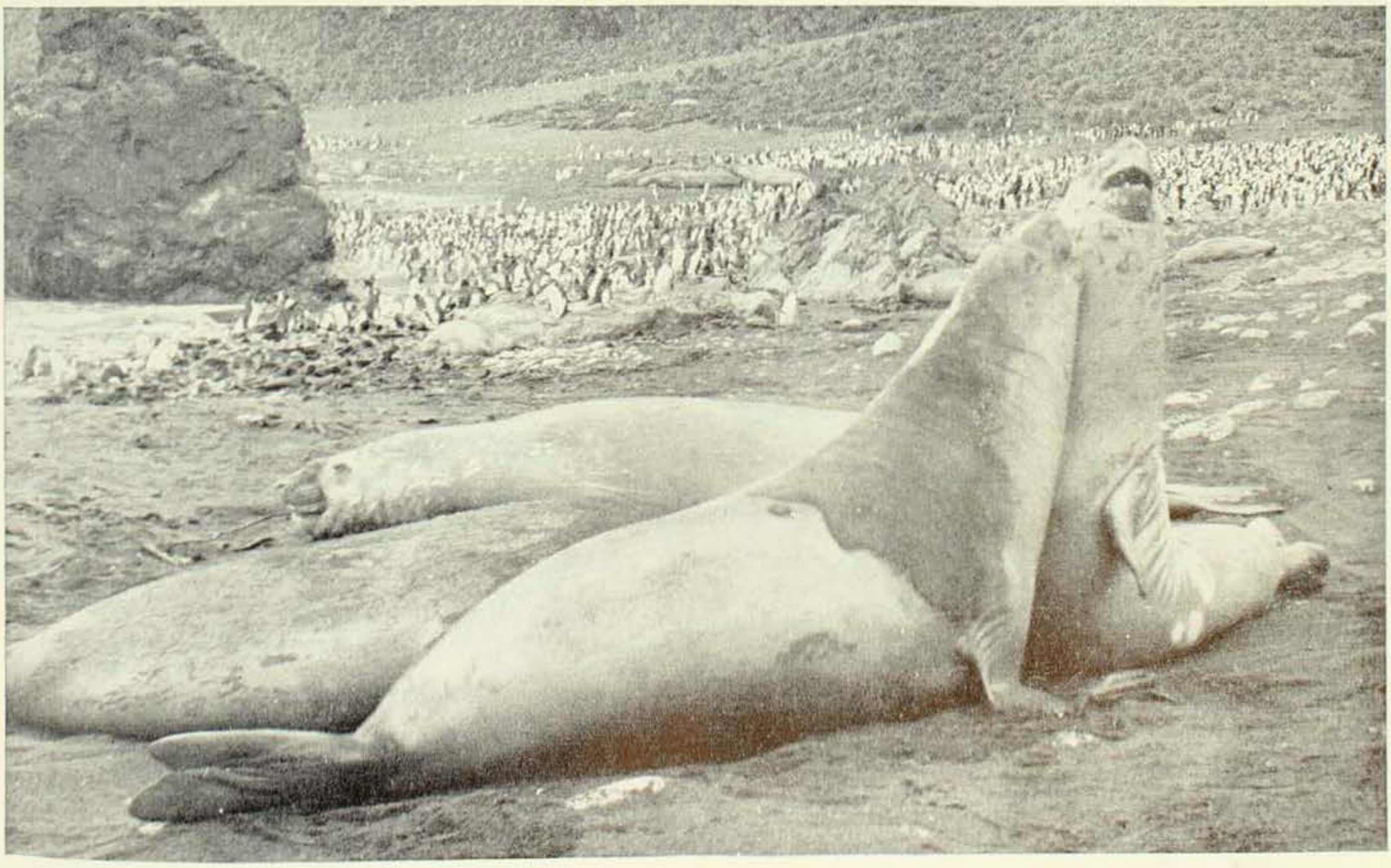
Black-browed Albatross, *Diomedea melanophris*, and chick at North Head, Macquarie Island. The adult bird has two celluloid colour-bands on its leg, for identification.

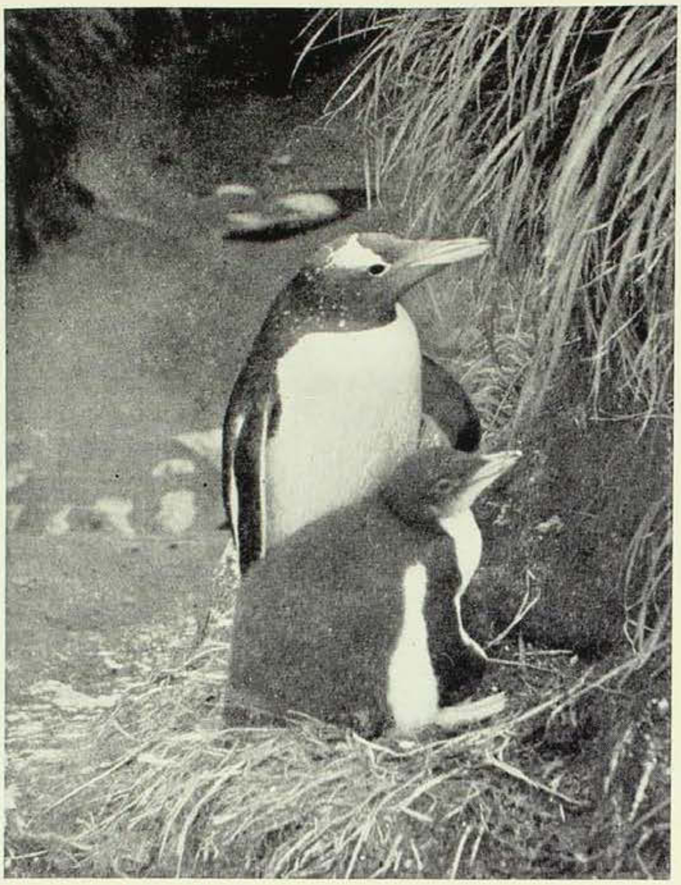




Light-mantled Sooty Albatross, *Phoebetria palpebrata*, on its large cup-shaped nest of mud among Macquarie Island "Cabbage", *Stilbocarpa polaris*.

Young bull Elephant Seals, *Mirounga leonina*, practising fighting, with a colony of Royal Penguins, *Eudyptes chrysolophus schlegeli*, in the background.





Gentoo Penguin, *Pygoscelis papua,* and chick, in tussock grass, *Poa foliosa.*

"fats" or yearlings, plus some adults, were taken as they returned fat-laden to moult after the breeding-season ended. Thus, although some 100,000 to 300,000 birds were destroyed annually, a large part of the breeding stock, some of the immatures, and all the young were spared each year.

What, then, has been the overall effect of the impact of man on the wildlife of Macquarie Island? The effects of the direct depredations of the sealers on species of economic value are easy to assess. The Fur Seal has suffered most and after uncontrolled exploitation had exterminated it in the first decade of sealing there, any that appeared were killed on sight. The Australian Antarctic Expedition party which lived on the island during 1911-13 saw none, and it was not until the Australian National Antarctic Research Expeditions established a permanent base in 1948 that the Fur Seal was again reported. Up to 1955 the number of immature seals, year-old pups and a few cows had increased to over 200, and in that year the first pup born on the island for well over a century was found by Dr. S. Csordas. One or two are now born each year, and the eventual recuperation of the Fur Seal to its former breeding numbers on Macquarie Island seems only a matter of time.

The Elephant Seal was decimated, but not exterminated, by the sealing gangs, and with an estimated production of some 50,000 pups a year the island's population may again have reached its limit. Three other seals which visit Macquarie Island in small numbers but do not breed there have been unaffected by man; these are the Leopard Seal, *Hydrurga leptonyx*; the Weddell Seal, *Leptonychotes weddelli*; and Hooker's Sea Lion, *Phocarctos hookeri.*

The penguins fared better than the seals during the century of economic exploitation. The King Penguin colony on the Isthmus has not re-established, but the Lusitania Bay colony now produces about 5,000 chicks a year. Any effect of the harvesting of Royal Penguins must now have disappeared, and there are more than thirty large colonies, including the enormous assembly at Hurd Point, the southern tip of the island, which covers over 20 acres and totals more than half-a-million birds. The two other breeding penguins, also numerous and well distributed round the island, are the Gentoo Penguin, *Pygoscelis papua,* and the Rockhopper Penguin, *Eudyptes chrysocome.* As in the seals, there are occasional visits by other species of penguin, such as the Adélie Penguin *Pygoscelis adeliae,* and Ringed Penguin, *P. antarctica,* from the south, and several crested penguins of the genus *Eudyptes* from New Zealand.

The lessons of fauna conservation which emerge from the story of sealing at Macquarie Island are evident enough. Harvesting of a portion of the population, with selection of appropriate age-groups, can be practised at a considerable level, without adverse effect even at the time. Depletion of numbers to a low level will be followed by recovery once the pressure is relieved, provided that the resources, especially food, and the breeding habitat are left intact. Even local extinction, inexcusable as it is from every point of view, including the industry's, may not mean permanent loss if re-colonisation is possible and the habitat is unimpaired.

The animal life of Macquarie Island has altered in other ways as the result of human activities. Unfortunately, no survey of the original fauna was made before the sealers operated, and endemic species may have disappeared during the nineteenth century without ever being recorded. Up to 1880, there exist only occasional observations by sealers and passing visitors; in that year, Dr. Scott, of Otago University, wrote the first description. Hamilton, of the same university, published a list in 1894, and Wilson of the *Discovery* landed at Lusitania Bay in 1901. Hamilton and Ainsworth of Mawson's Australian Antarctic Expedition made two years' observations during 1911-13, and Falla of Mawson's British, Australian and New Zealand Antarctic Research Expedition visited Macquarie Island in December, 1930. The latter's volume on the birds, based on the 1911-13 and 1930 data, is still the only full and authentic reference, and an account of the studies of A.N.A.R.E. biologists on seals and birds is in course of preparation.

Sealers and shipwrecked mariners, of which there have been several, may have had another direct effect on the bird life of Macquarie Island by taking albatrosses for food. This applies particularly to the Wandering Albatross, *Diomedea exulans*, only two nests of which were found in 1911-13 and which now numbers about thirty breeding pairs along the west coast. Like the King Penguin, it rears its young one throughout winter and, if successful, breeds only every second year. Hence it is an easy source of winter food, and the collection of skeletons recently found in a west coast cave is suggestive. The Black-browed Albatross, *D. melanophris*, now breeds in two small colonies at each end of the island, and the one at NorthHead is accessible and vulnerable, but there is no evidence that it was breeding before 1948, though Falla reports it as plentiful off Macquarie Island in 1930. Its close relative, the Grey-headed Albatross, *D. chrysostoma*, is more numerous but much less accessible in the only colony on the steep slopes of Petrel Peak at the south-west corner of the island. As in the Light-mantled Sooty Albatross, *Phoebetria palpebrata*, which nests in more scattered fashion on coastal slopes all round the island, the arrival of man seems to have had little effect on numbers.

However, the indirect effects of human interference with the indigenous wildlife of Macquarie Island are more destructive and permanent than those of man the predator. Alteration of the composition of the fauna by the introduction of alien species has been followed by disastrous results, especially in the case of the smaller burrowing petrels. The sealers released the European rabbit, *Oryctolagus cuniculus*, which now covers the whole island and is most abundant in the southern half, and the Weka, *Gallirallus australis scotti*, a flightless rail from Stewart Island, New Zealand, which is abundant in all habitats except the top of the plateau. These were intended to provide food for the sealing gangs, but they now serve to sustain a considerable population of feral cats, especially during winter when these latter would be short of food. The domestic dogs, which ran wild for a time, died out eventually, presumably because they are less able to capture the rabbits, rats and mice when the petrels and penguins are at sea during winter. The Weka is a tough and adaptable species; it wreaks havoc with the eggs and chicks of pengiuns and petrels, and I have even seen it kill and drag off a Giant Petrel, *Macronectes giganteus*, chick almost as large as itself. Nine species of burrowing petrels are known to have occurred on Macquarie Island, but the colonies are now greatly reduced in numbers and breedplaces of only three are known. These are the Dove Prion, *Pachyptila desolata*, Sooty Shearwater, *Puffinus griseus*, and White-headed Petrel, *Pterodroma lessoni*. Specimens of the Blue Petrel, *Halobaena caerulea*, Fairy Prion, *Pachyptila turtur*, Grey-backed Storm-petrel, *Garrodia nereis* and South Georgian Diving-petrel, *Pelecanoides georgicus*, were obtained in the beam of a strong light on misty nights in the spring of 1956 by K. Keith, and these species presumably still nest as the gonads were in breeding condition and some birds had soil on the feathers.

For the rest, the Giant Petrel is abundant, and banding of young has shown that they disperse widely round the Southern Ocean soon after fledging; the Cape

Pigeon, *Daption capense*, is represented by a colony on a small island off North Head; the Grey Petrel, *Procellaria cinerea*, and White-chinned Petrel, *P. aequinoctialis*, are of doubtful occurrence. The Macquarie Island Cormorant, *Phalacrocorax albiventer purpurascens*, and Southern Skua, *Catharacta skua lonnbergi*, are common; the latter is an indigenous predator of the smaller petrels and the penguins, and recoveries of banded skuas from Macquarie Island have been made off the east coast of Australia in winter. Dominican Gull, *Larus dominicanus*, and Antarctic Tern, *Sterna vittata*, continue to breed. Three birds which have colonised the island during the present century, and now breed, are the Grey Duck, *Anas superciliosa*, Lesser Redpoll, *Carduelis flammea cabaret*, and European Starling, *Sturnus vulgaris*. Finally, ten other species of birds have been reported as occasional visitors, and three which were present but disappeared during last century are a presumed teal duck, the Banded Rail, *Hypotaenidia philippensis*, and the New Zealand Red-fronted Parrakeet, *Cyanoramphus novaezelandiae*.

Macquarie Island possesses a rich, varied and abundant seal and bird life, and its declaration as a sanctuary in 1933 ensures that the seals and penguins will never again be exploited by the sealing gangs, but little can now be done to halt the continuing depredations of well-established alien predators.

ROBERT CARRICK graduated B.Sc. in Zoology at Glasgow, Ph.D. in Edinburgh, and lectured in zoology in Leeds and Aberdeen. Left last of these universities in 1952 to come to Australia. Now Senior Principal Research Officer in Wildlife Survey Section, C.S.I.R.O. Present research interests are bird ecology (principally the factors regulating numbers) and economics; also methods of rabbit control and the breeding ecology of the rabbit. As adviser on wildlife studies of A.N.A.R.E. has made three summer relief trips to Macquarie Island.

SCHOOL VACATION FILM PROGRAMMES

Films will be screened in the Lecture Hall of the Australian Museum, College Street, Sydney, during the January, 1958, school vacation. Admission is free. The films have been chosen especially for children but parents and teachers are also invited to attend. The 30-minute programmes, which commence at 2.30 p.m. daily (Monday to Friday), are recommended for primary school children and for secondary biology and social studies classes.

Monday, 6th January.—*Fish are Interesting*—Colour. *Monarch Butterfly*—Colour. *Deadly Spiders* (the venomous red-back and funnel-web spiders).

Tuesday, 7th January.—*The Navy Goes North*—Colour. (Royal Canadian Navy on an expedition to the Arctic Sea).

Wednesday, 8th January,—*Beware Snakes* (Poisonous snakes of Australia). *Everything from Nature*—Colour. (Daily life of the Australian Aborigines in Arnhem Land). *How Animals Defend Themselves*.

Thursday, 9th and Friday, 10th January.—*Keith the Wombat* (the story of a pet wombat at a Wild-life sanctuary). *The Woodpecker*.

Monday, 13th January.—*Spiny Anteater; Inland with McDouall Stuart* (a history of the Northern Territory of Australia).

Tuesday, 14th January.—*The Chameleon*—Colour. (The amazing habits of this South African lizard). *The Mutton Birds of Bass Strait*—Colour.

Wednesday, 15th January.—*Reptiles are Interesting*. —Colour. (Snakes, lizards, tortoises and crocodiles). *Bird Migration*—Colour. *The Beaver*—Colour.

Thursday, 16th and Friday, 17th January.—*Grey Squirrel* (the story of a lively little squirrel in the woods). *The Canada Goose*—Colour.

Monday, 20th January.—*Fine Feathers*—Colour. (Some of Australia's most colourful birds). *Foothold in Antarctica*—Colour. (The establishment of a base on the Antarctic Continent).

Tuesday, 21st January.—*The Nasturtium; Birth of a Florida Key*—Colour. (Formation of a coral island, and the animals and plants that live on it).

Wednesday, 22nd January.—*Rocks and Minerals*—Colour. *The Ladybird*—Colour. *The Notornis Expedition* (The search for this famous New Zealand bird).

Thursday, 23rd and Friday, 24th January.—*Life in the Ocean*—Colour. *Lives of their Own*—Colour. (The water birds of Florida).

The films have been made available by Australian Instructional Films, the Canadian Film Council, the N.S.W. Film Council and Commonwealth Oil Refineries.

Antarctic Birds

By R. A. FALLA
Director, Dominion Museum, Wellington, N.Z.

PENGUINS of the Antarctic have received more notice and study than the other birds of this southern continent. This is understandable because, as a family, penguins are practically confined to the Southern Hemisphere and the habits of the Antarctic species are highly specialised. With the exception of the Sheathbills of West Antarctica all other birds known to breed south of the Antarctic Circle are merely the southernmost representatives of such widely ranging seabird families as the skuas, terns and petrels, with one group of more sedentary cormorants on the fringe. They are none the less an interesting assemblage, for the whole of their oceanic feeding range consists of deep water, workable only because its surface conditions are varied by the presence and movement of pack-ice. This provides temporary perching places, but much more important is its effect in confining masses of food in temporary shelter of lanes and pools, as well as crushing, disabling, and stranding a considerable quantity of small organisms that are picked up by scavengers. Not a great deal has been recorded of the range and feeding habits of birds in Antarctic seas as the passage of the pack-ice usually finds expeditionary parties too preoccupied with the job of getting through it.

Antarctic land itself plays no part in the economy of birds except to provide a very limited choice of nesting sites. A few of the summer bird foragers in the pack-strewn seas do not attempt to nest at all. They are simply migrant visitors—from as far away as the region of the North Pole in the case of the Arctic Tern. They are comparatively small, and are the least conspicuous birds in the Antarctic with their grey and white plumage which makes them look like a faint smudge as they perch on the pack-ice, or a wisp of smoke when a flock rises in the air. They are equally unobtrusive on the migration flight, which is the longest recorded for any bird, and it is only a little more than half a century since the Scottish and German South Polar expeditions of 1904 obtained and identified specimens in the Antarctic.

Other non-breeding visitors plentiful in and beyond the pack are two petrels breeding in southern New Zealand—the Sooty Shearwater (*Puffinus griseus*) and the Mottled Petrel (*Pterodroma inexpectata*). It is not very clear whether they are breeding birds foraging 2000 miles or so from their nests or a non-breeding section of the population. The breeding birds which are completely circum-polar are the Antarctic Skua (*Catharacta maccormicki*) and the following petrels: Giant Petrel (*Macronectes giganteus*), Antarctic Petrel (*Thalassoica antarctica*), Silver-grey Petrel (*Fulmarus glacialoides*), Cape Petrel (*Daption capensis*), Snow Petrel (*Pagodroma nivea*), Wilson Storm Petrel (*Oceanites oceanicus*).

The Antarctic Skua has a time-table which corresponds with the arrival dates of the first and the departure dates of the last Adélie Penguins. Soon after arrival pairs of skuas take up territory near penguin rookeries which provide most of their food requirements for the season in the way of eggs, chicks or the carcases of older birds. They are bold in defence of their own nests and territory and resourceful in hunting. The female bird lays two eggs and quite often two chicks are reared. There is a short period during which the young birds, somewhat darker in plumage than their parents, remain flying about before the final departure at the end of summer. There is known to be a migration of some of the skuas, at least to the North Pacific, and it is possible that most of the young birds of the year migrate in this way. Skuas are great wanderers and have been recorded on the south polar plateau and at other points many miles from the coast.

Snow petrel in typical nesting crevice.

Antarctic petrels sheltering behind brash in a blizzard.

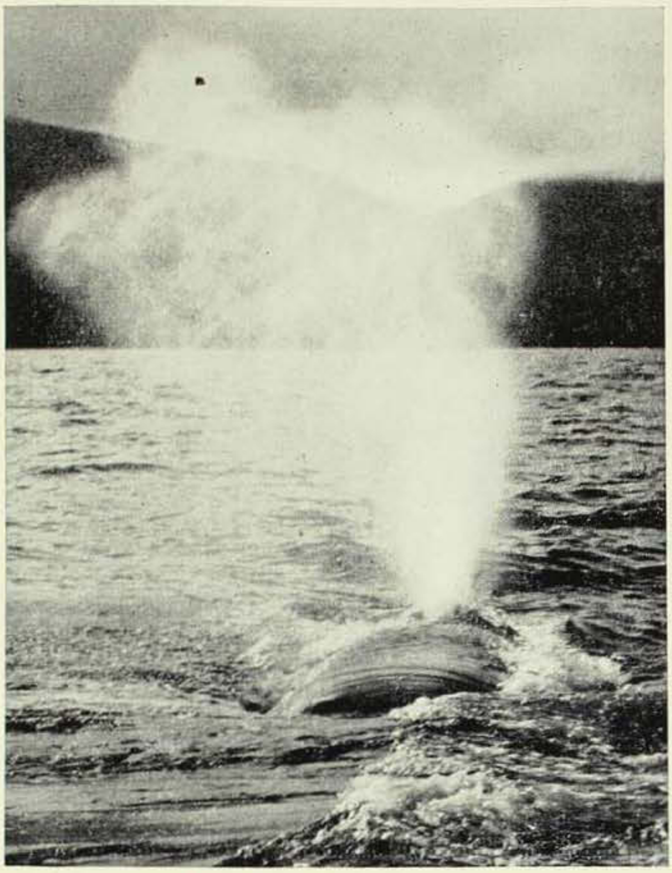
It would be hard to say which of the breeding petrels of Antarctic seas is the most common, but the tiny Wilson Petrel gives the impression of being more abundant than the larger species. They are able to find nesting crevices under loose rock debris, but such sites are well hidden and very little is seen of the birds. They are conspicuous as they fly about along the lanes in the pack-ice and considerable concentrations of them are reported from the neighbourhood of whaling operations. Like the skua they are long distance migrants in the off-season and occur in the Northern Hemisphere, but on migration only. Much more closely associated with the pack-ice are the pure white Snow Petrels, the silver-grey Antarctic Fulmar and the Antarctic Petrel which, structurally, is also a Fulmar. With them are to be found the better-known Cape Pigeon and usually a few of the Giant Fulmar, or Giant Petrel. These birds might all be described as semi-scavengers for they are to some extent dependent on offal or stranded and disabled marine organisms. Of these there are always plenty in the pack-ice and along the shore-line and flocks of Cape Pigeons, especially, congregate in the neighbourhood of any such food supply. Snow Petrels are often more solitary. They afford one of the most pleasing sights in the Antarctic where the setting seems singularly appropriate for a pure white bird.

Not all exposed rock parts of Antarctica are suitable for the nesting requirements of these birds, and there are few places where all the species are to be found together. If the cliffs and ledges are exposed and narrow it is likely that only the Antarctic Petrel will be found using them, with Cape Pigeons here and there as less successful competitors. Silver-grey Petrels seem to require some degree of shelter even if it is only an overhang of rock, and Snow Petrels prefer to be completely out of sight, sometimes in fairly deep clefts. With this slight variation in nesting requirements, direct competition is to some extent avoided, and large numbers of birds are nesting on some parts of the coastline. Australian Antarctic territory has a number of such suitable areas and it may be appropriate to conclude this account with some field notes made by the writer on the occasion of an early visit to the area with Sir Douglas Mawson's BANZARE Expedition in 1930.

" The first two hundred feet (on Proclamation Island, MacRobertson Land) took us through the most crowded part of and Adélie penguin rookery. A few birds were still incubating eggs, but the majority had chicks; some two, mostly only one. Dead nestlings lay everywhere, having been killed by skuas or trodden on by the old penguins during some community riot. Beyond the last few nests on these lower slopes we came to an area of great boulders with snow wedged between them. In the tunnels and cavities thus formed were Snow Petrels, and in two cases the birds were tending their single chicks, still in down but showing signs of feathering. The defensive jets of odoriferous red oil were squirted at us by all the parent birds when disturbed. From the summit of the island the eastern face was found to be steeper, and here Antarctic Petrels were nesting on the ledges and in crevices. Their chicks, in pale grey down, were not more than a few days old. On ledges slightly lower on the eastern face were Cape Pigeons with eggs almost ready to hatch. A few Silver-grey Petrels were also seen flying about ledges still nearer the sea, but inaccessible in the time at our disposal. At all levels the Wilson Petrels flitted like black and white butterflies about the rocks, changing guard on their deeply-hidden nests; while half-a-dozen McCormick Skuas soared watchfully over all ".

Shells from New Guinea

Large collections of land, freshwater and marine molluscs were made for the Museum by Dr. D. F. McMichael, Curator of Shells, during four months field work in New Guinea. Dr. McMichael visited many localities in both Dutch New Guinea and the Australian territories and, besides molluscs, obtained several interesting series of mammals, insects and ethnologic specimens.



A Humpback Whale spouting.

Whales and the Antarctic

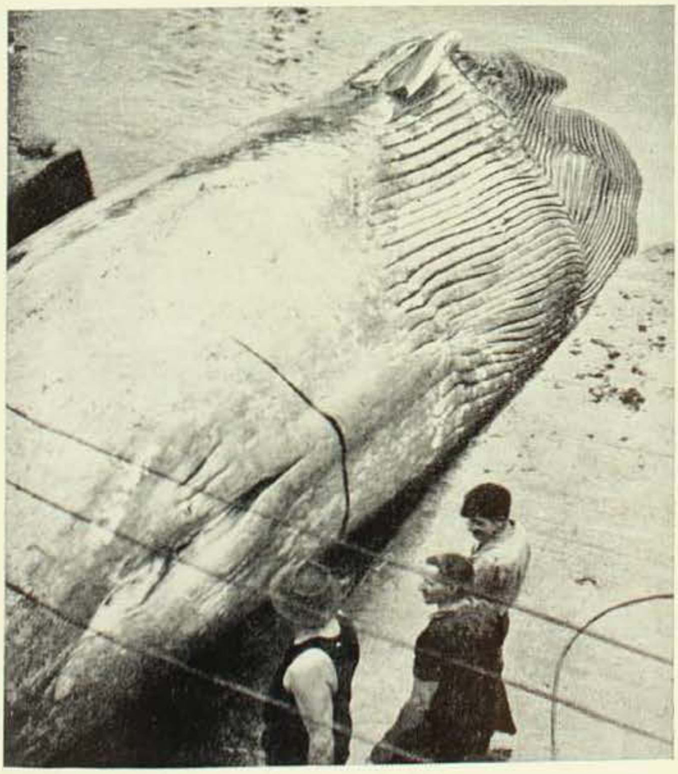
By W. H. DAWBIN
Department of Zoology, University of Sydney

THE ice covered Antarctic Continent has not yet proved suitable for economic development but the great area of the Southern Ocean surrounding it has become the region of the world's greatest whaling activity. Since the late 1920's the whale oil production from the oceans around Antarctica has been several times as great as that from all other regions in the world combined. This position has been reached extremely rapidly after a very brief interval in the history of whaling.

In Western Europe whaling has occurred continuously since about 900 A.D. and there is evidence that Japanese and Eskimos may have been whaling still earlier. Small whales were hunted by Neolithic men of northern Europe thousands of years B.C. and others were caught in the Arabian Sea and Indian Ocean by the Phoenicians between 3,000 and 500 B.C. However the capture and processing of large whales became fully established by the Basques from southern France and northern Spain about 1000 years ago and their skills and traditions with hand harpoons, lances and open boats were passed on to other nations in turn—first the Dutch, then British, American and Norwegian.

Initially the 50 to 60 ft. Right whale was the main objective of all these nations, as it was relatively slow moving, very buoyant after death, had a high oil yield per whale, and the meat was edible. Later the long whalebone or baleen plates, which fringe the upper jaw to sieve out plankton from the sea, became highly valued for their strength and elasticity in umbrella struts, upholstery and corsets. However the long continued onslaught against this species, in its coastal breeding grounds in particular, led to a decline from which it has still not recovered, and Right whales are now totally protected by International Agreement. Before this decline set in, American whalers from the New England ports had commenced pursuit of the Sperm whale by methods immortalised in "*Moby Dick*". They extended their searches in ever extending range down the Atlantic and finally into the Pacific Ocean in the late eighteenth century. Their main objective the bull Sperm whale, grows to 60 ft. in length while the cows, which are herded into schools or harems by master bulls, reach no more than 40 ft. Both are equipped with massive teeth in the lower jaw and feed on giant squid which occur in the deep or intermediate layers of all oceans. The massive barrel-shaped head contains a huge reservoir of spermaceti wax valued for high quality candles, special lubricants and cosmetics. Like the Right whales, Sperm whales are buoyant and relatively slow moving and they became the main quarry for the huge American fleet of sailing ship whalers throughout the nineteenth century and until the cessation of American whaling early this century.

There still remained a group of very large whales known as the rorquals which could not be exploited by slow moving vessels and hand harpoons. The rorquals include the Blue, Fin and Sei whales and are related to the Humpback which forms almost the entire catch from Australian shore stations. All are whalebone whales dependent on rich plankton for sustenance, and all are fast swimmers difficult to catch without high-powered chasers. They are streamlined and liable to sink on death unless special air spears are available to pump them up ready for towing. Of them all, the Blue whale, reaching 100 ft. in length and up to 160 tons in weight, is the largest, being equivalent in weight to 40 elephants or about 2,000 humans. The oil yield has reached 30 to 40 tons for a single Blue whale but this species was nevertheless completely safe until after the development of powered catching vessels fitted with explosive harpoons. Svend



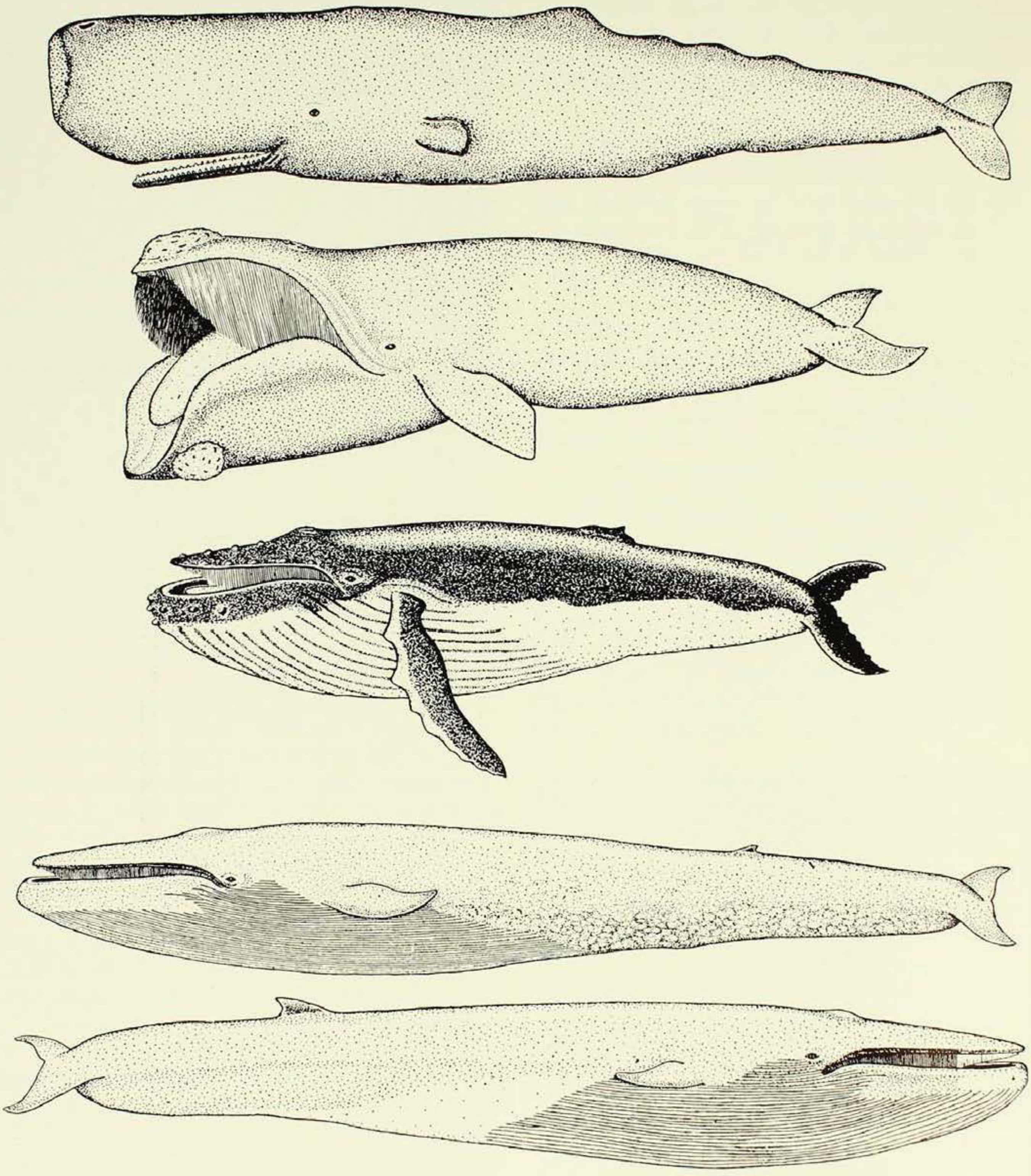
A 90 ft. Blue Whale hauled partly out of the water and showing the small flipper and numerous throat grooves.

Foyn, a Norwegian, developed this equipment in 1868 and first used it with success on Blue and the related Fin whales in Norwegian home waters.

In the meantime three Norwegian expeditions investigated waters around the Antarctic in 1892-4 in search of the huge schools of Right whales reported there by Sir James Clark Ross in 1840. Possibly due to the 250,000 Right whales killed in warmer latitudes during the nineteenth century, the three expeditions found very few but did note huge numbers of unexploited rorquals in this region. Their equipment was unsuitable for capturing any, but in 1905, C. A. Larsen founded a station at South Georgia, and this was the first whaling station in the Antarctic area. It was financed by Argentina and equipped with Norwegian equipment and Norwegian manpower familiar with its use. The station proved an immediate success. The oil yield from Humpbacks, Blue and Fin whales was so good that many other Norwegians started whaling in South Georgia, South Sandwich, South Orkney and other islands in the Falkland Islands Dependencies.

However it was not until some means of processing very large whales on board ships at sea had been devised that Antarctic whaling spread from this region into other areas around the Antarctic Continent. A floating factory was tried successfully in 1925 by C. A. Larsen. He operated in the Ross Sea which had been hitherto unexploited for whales. Other factory ships with accompanying fleets of chasers were built and eventually operated in most of the waters around the Antarctic. Nearly all were Norwegian owned and manned, with Britain in second position, but other nations such as Germany and Japan became important in prewar years. Since World War II Japan has expanded its whaling activities still further and Holland, Russia and Panama have maintained a fleet each in Antarctic waters.

The combined catch for all nations operating in the Antarctic reached a peak of 46,000 whales giving an oil yield of approximately 600,000 tons in 1938. Several serious signs of depletion were evident in the Blue and Humpback stocks, but



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Sperm whale: Maximum length of males, 60 ft.; females 40 ft.

Right whale: Maximum length, 60 ft.

Humpback whale: Maximum length 50 ft.

Blue whale: Maximum length 100 ft.

Fin whale: Maximum length 85 ft.

World War II gave both a temporary respite and allowed some recovery. However in 1946 the main whaling nations agreed to a series of self imposed regulations and an overall quota per season designed to protect the stock and ensure a continuing crop of whales in the future. The regulations fixed a late starting date for Antarctic operations to allow the whales to fatten on the very abundant plankton occurring in summer months and to ensure a higher oil yield per whale. They imposed minimum size limits on each kind of whale, protected calves and cows accompanied by calves, compelled full utilisation of the entire carcase and most important of all, fixed an upper limit to the number of whales which could be taken by the combined fleets of all nationalities. The quota is expressed in Blue whale units with 2 Fin whales or 2½ Humpbacks counted as equal to one Blue whale. The latter species has declined and now makes up only about 2,000 of the quota of 14,500 allowed per season. The remainder is made up largely of Fin whales and a small number of Humpbacks so that the total catch of whalebone whales now amounts to about 31,000 whales. Sperm whales are not included in the quota but old males only are encountered in Antarctic waters and the killing of these is unlikely to affect stocks. In 1956, 7000 Sperm whales were killed making a total of 38,000 whales taken in the Antarctic Ocean.

The products of this catch are of enormous value as raw material for margarine, soaps, detergents, lubricants, glycerine for explosives, vitamin oils, hormones, meats and meat meal. The Antarctic Ocean provides about 80 per cent. of the world's total of whale products and it is vital to ensure a continuing supply of these much needed raw materials. The agreements between the whaling nations and the systems of inspection have worked surprisingly effectively to date but are likely to be subjected to increasing strain with the entry of more whaling fleets in competition for the same overall quota of whales. For the sake of the whales, which are themselves of intense interest to most people, as well as for the industry itself, it must be hoped that future control will maintain satisfactory stocks for posterity. The Antarctic Ocean is the last great area to be exploited for whales and there remain no other untapped stocks in reserve if the balance in the Antarctic populations should be upset.

After graduating in Zoology in New Zealand, W. H. Dawbin spent fifteen months in the Sub-antarctic, based mainly at the Auckland Islands. While lecturing in the Zoology Deparment, Victoria University College, Wellington, N.Z., he commenced a study of the whales caught at the Cook Strait Whaling Station and later extended this to studies of whales in Tonga, Fiji, New Hebrides, New Caledonia, Norfolk Island and other parts of the Pacific Ocean. In 1950 he was on the R.R.S. *Discovery II* during a scientific cruise to the Antarctic and in 1956 was appointed Senior Lecturer in Zoology at Sydney University.

Minerals from north-western Queensland

Mr. R. O. Chalmers, Curator of Minerals, visited north-western Queensland in July. A large number of mineral specimens was collected from the Mt. Isa Mines and from the Mica Creek pegmatites, 15 miles south of the town. At Mary Kathleen, Australia's newest mining town, specimens of rich uranium ore were collected. Full co-operation from the management and staff of both companies greatly facilitated his work.

Mr. O. le M. Knight, an Honorary Correspondent of the Museum, accompanied Mr. Chalmers and collected trilobites from the classic areas near Mt. Isa and implements from an aboriginal axe factory in the district.

Mrs. Lee Woolacott

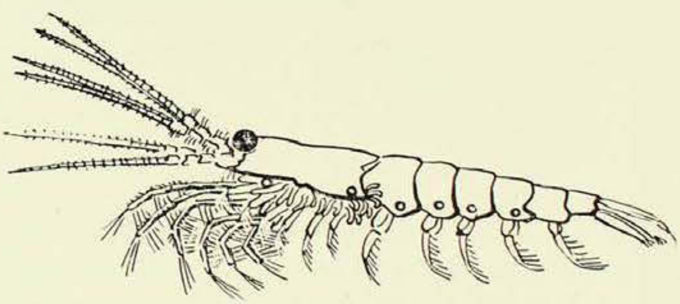
We regret to record the death of Mrs. Lee Woolacott, an Honorary Correspondent of the Australian Museum, who for some years gave voluntary assistance in the Department of Molluscs. Mrs. Woolacott published several papers on Australian mollusca and possessed a fine collection of marine shells.

Teeming Life in Antarctic Seas

By ELIZABETH C. POPE

INTERTIDAL rocks of the Antarctic Continent do not carry the heavy populations of oysters, mussels or barnacles found on temperate shores because such shore organisms cannot survive the intensely cold air temperatures or the grinding and shearing action of the great sheets of ice which scrape over these southern rocks for the greater part of the year. Nevertheless it would be quite wrong to suppose that animals are missing from the open sea around Antarctica, or even that they might be much reduced in numbers. Both open sea and sea bottom are teeming with life for it is in Antarctic surface waters, in the summer months, that diatoms (minute floating plants) find almost ideal conditions of sunlight and nutriment. In consequence they grow and multiply so rapidly that they are able to provide the basic pasture for a hoard of other planktonic organisms. These in turn flourish greatly and serve as food for vast numbers of larger animals living either in the sea proper or creeping over the seabed. Even when dead, plankton "rains" down to the depths to form the nutritious detritus on which some of the benthic animals feed.

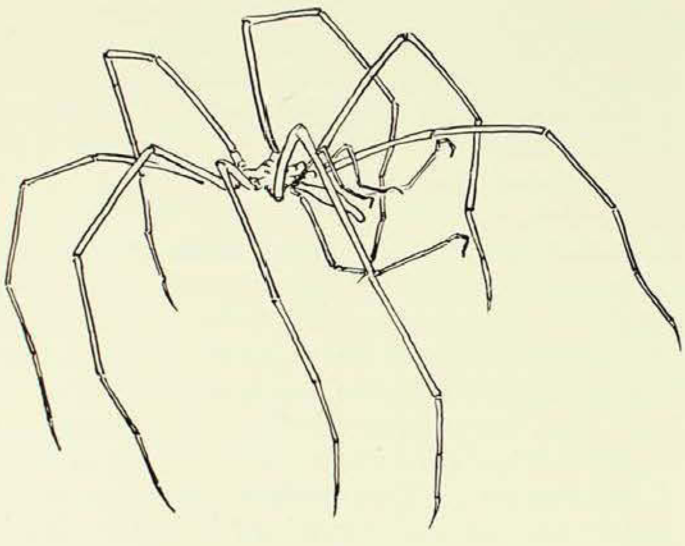
Most famous of the planktonic organisms which consume the huge crop of diatoms in the Southern Ocean are the small shrimps known as "krill" (*Euphausids*) which swarm in such countless millions that they can easily satisfy the food requirements of the whalebone whales and the voracious penguins. The presence of these hordes of krill in Antarctic waters is well known because it accounts for the annual summer migration of whales to these cold seas, but what is not generally realised is that hosts of other invertebrate animals are also found there. Owing to the abundance of the food supply and the fact that cooler temperatures tend to delay the onset of sexual maturity (thus permitting a prolonged period of growth) many of these animals attain a giant size compared with their relatives in temperate and tropical seas. Notable exceptions are the shellfish or molluscs; generally these reach greater size in the tropics and thus it is along the coral reefs that one seeks for giant clams and other heavy-shelled molluscs. In this connection it may be mentioned that the giant squid (largest of the invertebrates and a denizen of cold water) does not have calcareous matter supporting its body (it has instead the "horny" pen) for the metabolism of calcium salts, necessary for the laying-down of a mollusc shell, can only proceed slowly in cold Antarctic seas. It is for this reason that many of the shellfish in southern seas are delicately thin in the shell or, alternatively, tiny.

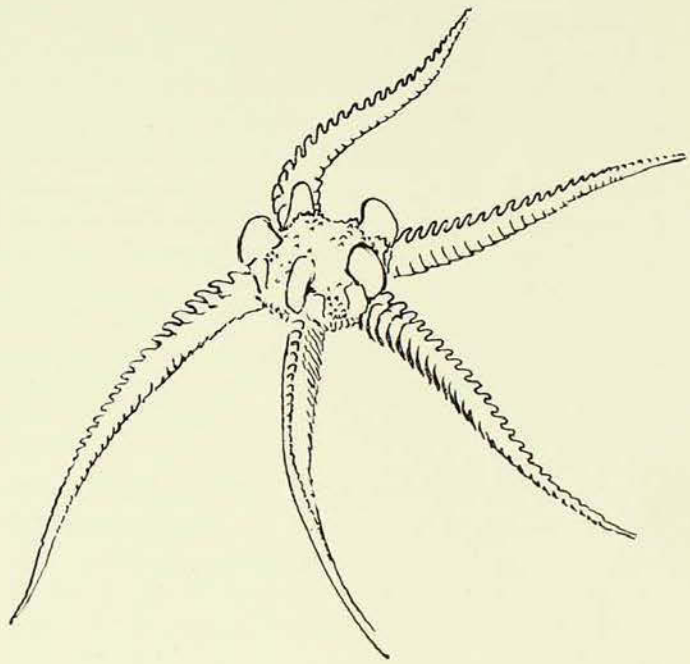


One species of "krill," *Euphausia superba*, which occurs in teeming millions in Antarctic seas. A giant of its kind it ranges right round the edge of the continent and even under the pack ice. Blue and Fin Whales in the course of their feeding sieve tons of these tiny crustaceans from the sea. (Shown natural size).

Most of the famous expeditions to the Antarctic have paid special attention to collecting the more lowly organisms of the seas there and to studying their life habits, for such work is just as fascinating and rewarding as that with vertebrates. Among its more treasured collections the Australian Museum holds a great many representatives of widely differing animal groups, ranging from the tiny one-celled protozoans from the bottom deposits, through worms of many kinds, Sea Mosses and Sea Mats (*Bryozoa*) and Arrow Worms (*Chaetognatha*), to shellfish, and that very important group, from the commercial point of view, the *Crustacea*.

These specimens are seldom displayed in the galleries but are kept among the great reference collections for the use of research zoologists. Four representatives of these Antarctic animals are pictured here and have been chosen because they illustrate some of the points mentioned above. The majority of the marine collections in the Museum are the result of work by two expeditions—the Australasian Antarctic Expedition, 1911-14, and the B.A.N.Z.A.R. Expedition of 1929-31, both of which were led by Sir Douglas Mawson. All the collections from the first of these expeditions, and some of those from the second, are housed in The Australian Museum. Some collections are still being worked upon by experts in various parts of the world. Australia's contribution to the knowledge of the zoology of the Southern Ocean has been considerable and it is hoped that it will continue to be so in the future.

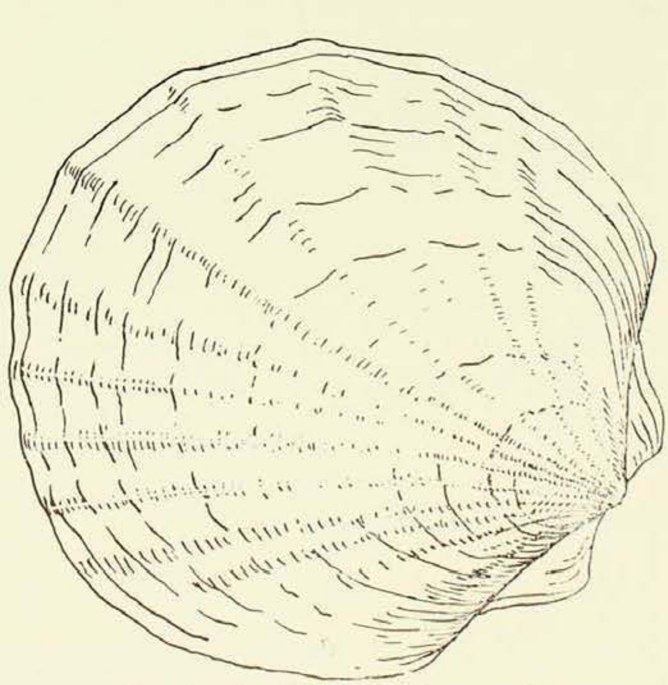




Above: A large sea spider or pycnogonid (*Collossendeis frigida*) whose long, spindly legs (to raise it above the ooze of the sea bottom) and peculiar tubular proboscis for sucking the juices out of its prey (mostly coelenterates) make it one of the most grotesque creatures of the open seas. The body and abdomen are so thin and small that outgrowths of the stomach are accommodated in the bases of the legs. (Half natural size).

Right: Ophiosteira echinulata, a brittle star which is representative of a genus found only in Antarctic seas. It occurs at depths of from 45 to 400 fathoms. The disc is unusually thick and armed with five prominent, keel-like bosses on its upper surface, one opposite the base of each arm. The cross-section of the arms is sharply triangular and heavily armoured. Like the other animals illustrated, it is red or pink in colour, as are many deep-sea species. (Natural size).

Bottom: The Antarctic Scallop, *Chlamys colbecki*, has a paper-thin shell in sharp contrast with the heavier shells of scallops from more temperate seas. When the first living specimens were taken, Charles Hedley recounted: "On account of the delicacy of its valves it was removed from the bucket and placed on the ice for safety. The temperature was low, and it showed its disapproval of its first experience of a temperature forty degrees below that to which it was accustomed by snapping angrily for some time." (The air temperature, —10° F., was much colder than that of the sea). (Shell two-thirds natural size).



Drawings by B. Bertram from specimens in the Museum collections.

The Distribution of Animals and Plants of the Southern Hemisphere

By J. W. EVANS

ANTARCTICA to day is a desolate continent. Apart from a few mammals and birds which live on its fringes and obtain their food from the sea, it supports no life, but this may not always have been the position. Long ago, as time is measured by historians, but quite recently by geological standards, Antarctica may have supported an abundant fauna and flora. Many of its presumed former inhabitants, both animal and plant, are doubtless extinct, but several which may have lived there still survive in lands bordering the Antarctic Ocean, that is to say in South Africa and Madagascar, Australia, Tasmania and New Zealand and in cool, temperate South America.

The evidence on which this suggestion is based is at present of a circumstantial nature, but before long, as a result of research now in active progress in several fields, facts may be established which will provide the answers to several intriguing questions having some bearing on the problem. These include the following: Is the Antarctic continent as shown on maps really a single land mass, or two? Has it formerly been considerably more extensive and been connected to other southern continents? Finally, and possibly alternatively, has all or part of the land area known as Antarctica always occupied its present position on the globe, or was it at one time situated elsewhere in respect to the South Pole and the other southern continents?

The two last questions have puzzled biologists and geologists for over a century, ever since the great botanist, J. D. Hooker, drew attention in 1847 to the occurrence in southern lands of closely related animals and plants and sought an explanation to account for their distribution.

Most people take for granted the occurrence of similar, or different, animals and plants in the various countries of the world and give no thought as to how this may have come about.

Oak trees, as is well known, grow in Europe, Asia and North America, but not, except as recent introductions, in Australia and New Zealand. Elephants inhabit India and Africa, but again they do not live in Australia and New Zealand. The explanation for this pattern of distribution is simply that since the time that oaks first evolved as such, Eurasia and North America will have been joined to each other by land and likewise India and Africa. It can also be presumed that the climate of Arabia will have been different from what it is today. The reason the particular plant and animal mentioned do not live in Australia or New Zealand is the lack of land access.

Direct land access is not of course necessary to explain all occurrences of animals and plants everywhere and it is known that many small oceanic islands have been colonised by adventitious means, that is, seeds and insects have been transported by wind and other inhabitants by such means as logs, or rafts of floating vegetation. The fauna and flora on such islands is in consequence a sparse one and limited to those organisms able to survive transport and to establish themselves on arrival.

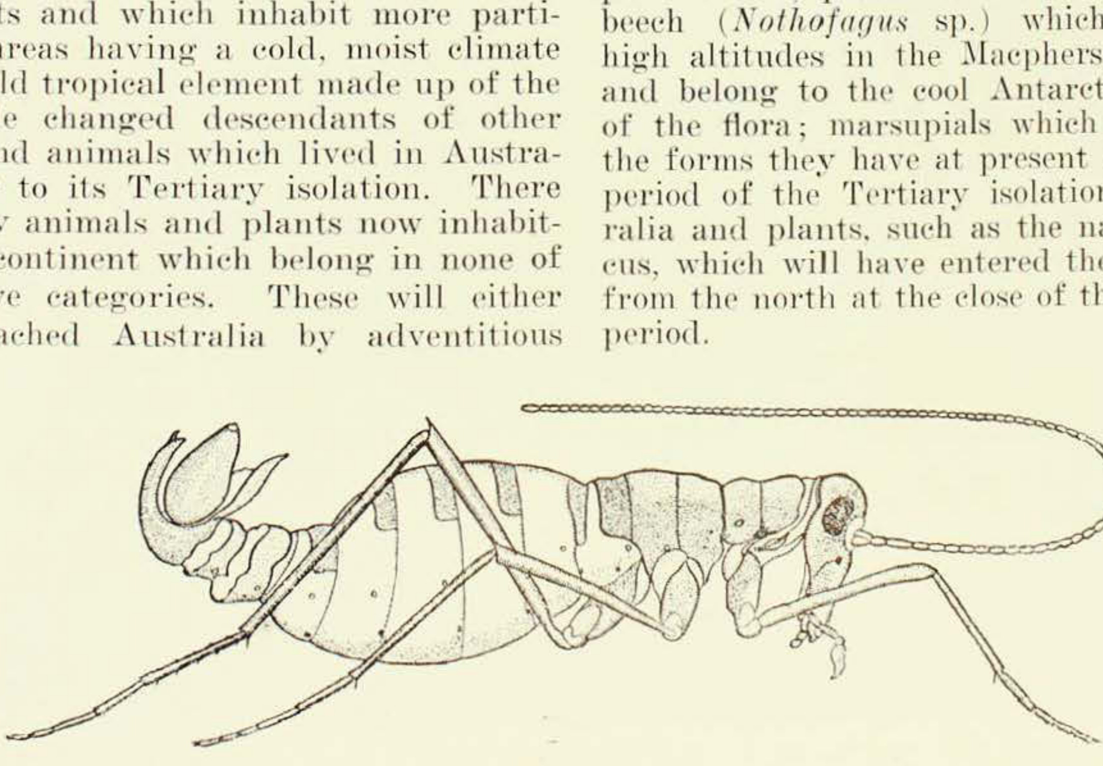
Generally speaking, it is true to say that land areas which are reasonably close to each other, even if at present they may be separated by sea, will have similar animals and plants, while the fauna and flora of widely separated countries will differ considerably.

The fauna and flora of Australia comprise several distinct elements which, working backwards in time, are broadly as follows: a late Indo-Malayan element which

Beech Trees (*Nothofagus*) on the shores of Lake St. Clair, Tasmania.

entered the north-eastern sector of the continent in, geologically speaking, comparatively recent times; the endemic Australian element which developed during the 60 or 70 million years of the Tertiary period during which the continent was isolated from the rest of the world; an Antarctic element, which consists of plants and animals largely restricted to the southern continents and which inhabit more particularly areas having a cold, moist climate and an old tropical element made up of the but little changed descendants of other plants and animals which lived in Australia prior to its Tertiary isolation. There are many animals and plants now inhabiting the continent which belong in none of the above categories. These will either have reached Australia by adventitious means or else have been introduced and established through the agency of man.

There is one region in Australia where representatives of all the major components of the fauna and flora occur and this is southern Queensland. Here are to be found the lung fish (*Neoceratodus forsteri*) which belongs to the old pre-Tertiary tropical fauna; plants such as the southern beech (*Nothofagus* sp.) which grow at high altitudes in the Macpherson Ranges and belong to the cool Antarctic element of the flora; marsupials which developed the forms they have at present during the period of the Tertiary isolation of Australia and plants, such as the native hibiscus, which will have entered the continent from the north at the close of the Tertiary period.



A wingless Scorpion Fly (*Apteropanorpa tasmanica*) which runs actively over snow in Tasmania and may have been a former inhabitant of Antarctica. (Natural size: ½-in.).

Here, we are concerned only with the Antarctic element in the fauna and flora of Australia. Beech trees belonging to the genus *Nothofagus* as well as growing in southern Queensland grow elsewhere in Australia in the following places: at high altitudes in certain isolated localities in New South Wales, as for example on Barrington Tops; at Beech Forest in Victoria and in Tasmania. They have an easily recognised characteristic pollen and from an examination of fossil pollen, botanists have discovered that formerly, during Tertiary times, when the climate must have been moister than it is at present, they were widespread and grew in South, central and Western Australia. Elsewhere, they grow at high altitudes in New Guinea and New Caledonia, in New Zealand and in cool, temperate South America, but they grow nowhere in the Northern Hemisphere, nor is there any evidence that they have ever done so.

It has already been mentioned that oceanic islands are colonised by animals and plants transported by wind and sea currents. Could the seeds of these trees have been carried to Australia in this way? New Zealand lies at a distance of approximately 1,200 miles from Tasmania and Patagonia is some 4,500 miles from the South Island of New Zealand. The seeds are not of a nature that they could be wind-borne and it is difficult, though perhaps not impossible, to suppose that they could survive such a long period of immersion in sea water as would be involved in being carried from one country to another. However, wherever *Nothofagus* grows it is accompanied by a peculiar fungus (*Cyttaria*) which lives only on these trees and the spores of the fungus certainly could not withstand long immersion in sea water.

If beech trees alone had this puzzling pattern of distribution it might not be of great significance. However it is not confined to them, but shared with a host of other plants and animals. Furthermore, many of these have representatives occurring in South Africa and Madagascar as well as in Australia, New Zealand and South America. There are only two possible explanations which can account for these facts: either that all the several plants, insects, crustacea, worms, molluscs, frogs and fishes which inhabit solely the southern continents and which are closely related to each, though now living on land areas separated by thousands of miles of sea, were formerly universally distributed and for some reason have failed to survive in the Northern Hemisphere, or else that the southern continents were at one time, and as late as the Cretaceous geological period, in direct land contact with each other.

It is known from the fossil record that some organisms which are now confined to the Southern Hemisphere lived in Europe during the Tertiary period, but there is no evidence that all did. The second alternative involves the theory of Continental Drift which at present, though supported by many geologists and biologists, is regarded by others as completely untenable. If continents have in fact become changed in position (and evidence now being made available by geophysicists suggests that this may have happened) then many puzzling features of animal and plant distribution would be solved.

Such a solution would necessitate the inference that Antarctica or part of it was the centre of dispersal for many of the animals and plants which now live only in the southern continents and hence that it has not always been the lifeless continent it is at present.

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