DEPARTMENT OF SCIENCE
AUSTRALIA

AUSTRALIAN NATIONAL ANTARCTIC RESEARCH EXPEDITIONS

ANARE SCIENTIFIC REPORTS

SERIES B (I) ZOOLOGY

PUBLICATION No. 123

THE BIOLOGY OF THE VESTFOLD HILLS, ANTARCTICA

by

G. W. JOHNSTONE, D. J. LUGG and D. A. BROWN

ISSUED BY THE ANTARCTIC DIVISION
DEPARTMENT OF SCIENCE, MELBOURNE, AUSTRALIA
1973

Registered at the G.P.O. Melbourne
for transmission by post as a book.

Printed in Australia by
Brown Prior Anderson Pty Ltd 5 Evans Street Burwood Victoria

CONTENTS

LIST OF PLATES

LIST OF FIGURES

LIST OF TABLES

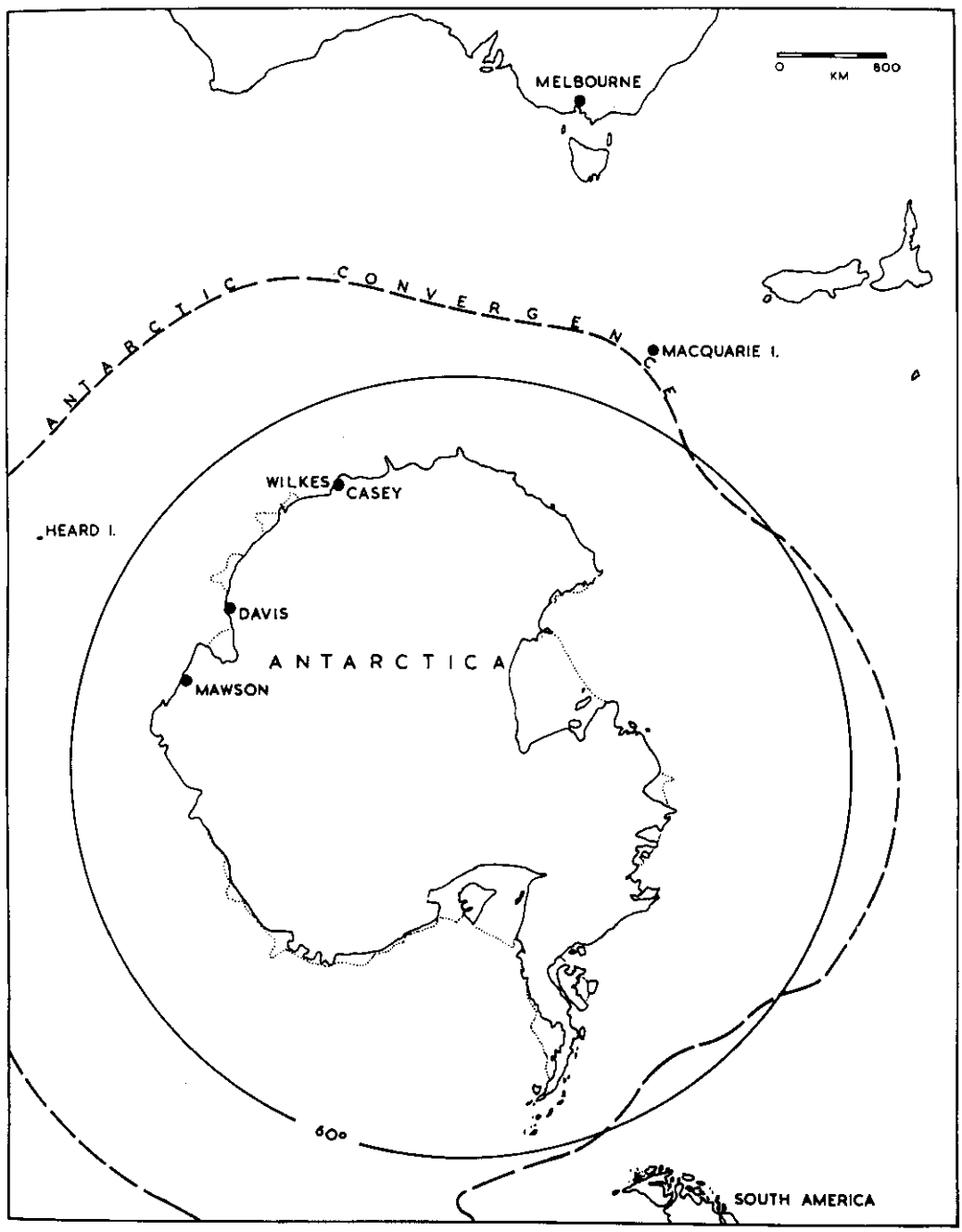


FIGURE 1. Outline map of Antarctica showing location of Davis in relation to other Australian stations.

THE BIOLOGY OF THE VESTFOLD HILLS, ANTARCTICA

by

G. W. JOHNSTONE, D. J. LUGG and D. A. BROWN*

Antarctic Division, Department of Science, Melbourne, Australia

**Present address: Department of Civil Aviation, Melbourne*

ABSTRACT

This report reviews the biology of the Vestfold Hills, Princess Elizabeth Land, Antarctica, from information obtained up to 1973 by Australian National Antarctic Research Expeditions (ANARE) and other expeditions. The Australian station Davis was established there in 1957.

As a background to the report on the biology, the geography of the area is described with special emphasis on its two unusual features: the extensive area of snow- and ice-free land, and the numerous saline and freshwater lakes.

The biology of the area is then described in detail, listing all species so far recorded. Few invertebrate species have been found, reflecting the comparative youth of this ecosystem and the difficulty of colonising such a remote area. Extensive fossil-beds occur on relict marine beaches surrounding the saline lakes. Six species of birds breed there and the area includes the most southerly known colony of Giant Petrels. Amongst the four species of seals which occur, especially interesting is the large non-breeding herd of Southern Elephant Seals which occupies the beaches during summer.

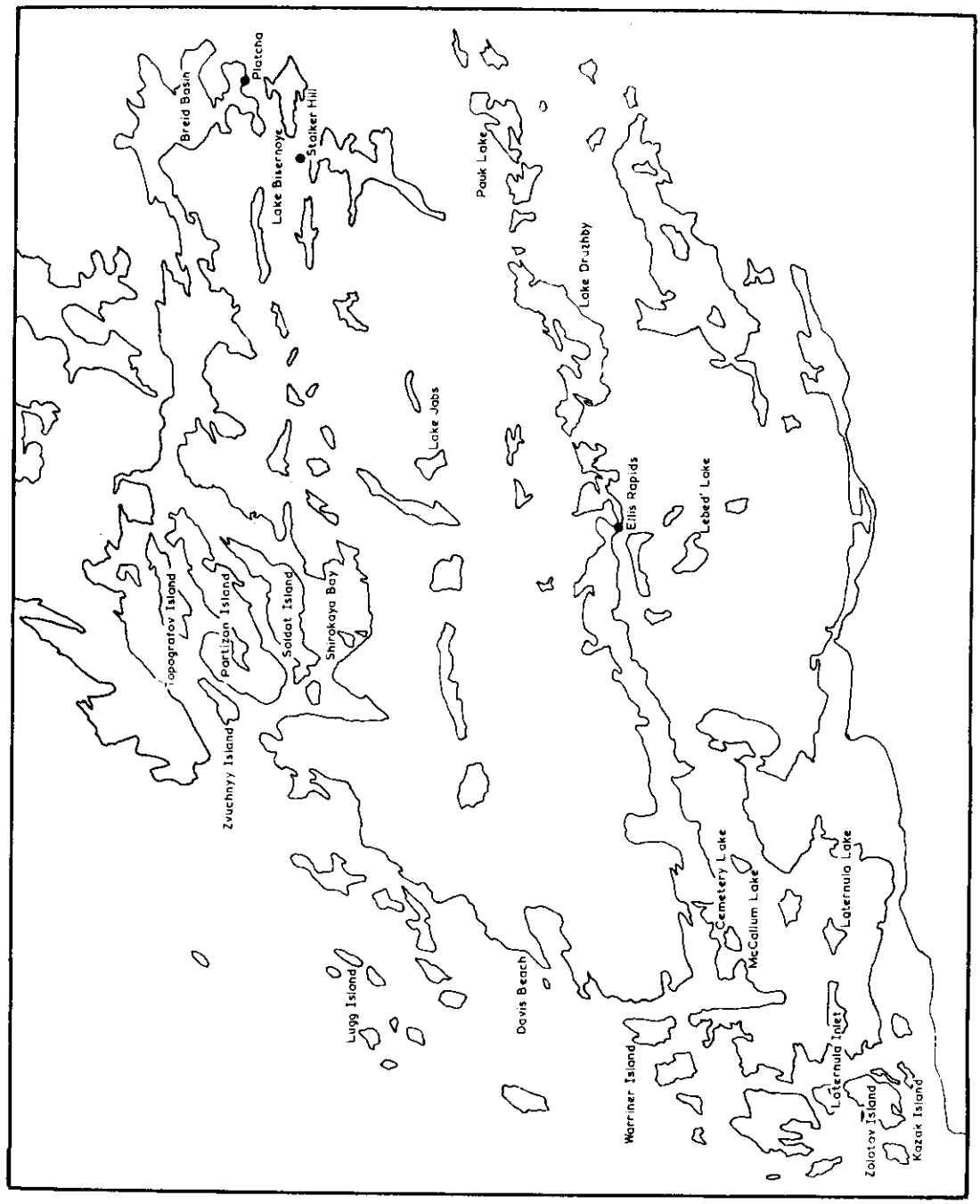


FIGURE 2. Map of Vestfold Hills with place-names not shown on insert map.

0. INTRODUCTION

The Vestfold Hills (see insert map, Fig. 2 and Plate 1) occupy about 400 sq km at the eastern side of Prydz Bay on the coast of Princess Elizabeth Land between latitudes 68°22′S and 68°40′S, and longitudes 77°49′E and 78°33′E. The area is an ice-free enclave of rock and water, a triangle bounded by the Sørsdal Glacier in the south, by steep ice-covered slopes leading up to the continental plateau to the east, and by sea to the north-west. It is bare, low-lying, hilly country, deeply indented by sea-inlets and studded with lakes and tarns of varying salinity. Numerous small islands fringe the coast up to five kilometres offshore.

A history of expeditions to the area is given by Law (1959). The Vestfold Hills were first sighted in 1935 by Captain Mikkelsen, leader of a Norwegian

Antarctic Division photograph

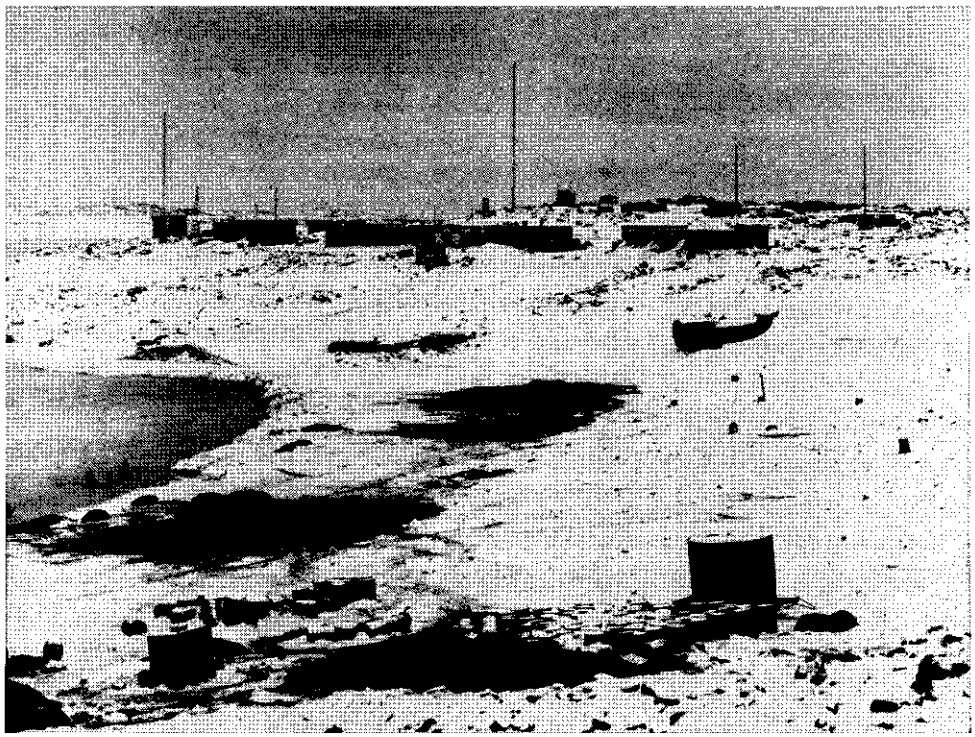
PLATE 1

Aerial view of the Vestfold Hills looking east. Long Fjord is on the left and the northern edge of the Sørsdal Glacier on the right. The Antarctic ice-sheet rises behind. Magnetic Island and Bluff Island are in the left foreground.

expedition. The area was named by him after Vestfold, a county in Norway to which it bears some resemblance. In 1937 the Norwegian explorer Lars Christensen visited the area. Christensen also carried out aerial photography in 1937 which was the basis of the first map of the Vestfold Hills. Lincoln Ellsworth (U.S.A.) and Sir Hubert Wilkins (Australia) made a brief visit in 1939, and in 1947 aerial photographic surveys were carried out by the U.S. Navy Operation Highjump. Members of the U.S.S.R. Antarctic Expedition made a brief landing in December 1956.

The first Australian National Antarctic Research Expedition to the area was in early March 1954 when an exploring party led by P. G. Law landed at the Vestfold Hills. They revisited the area in late January 1955, and the Australian station Davis (Plate 2) was established in January 1957. Apart from a temporary closure during 1965-68, the station has been in continuous operation since then with an annual complement of up to 14 men.

This Report reviews biological data collected by members of ANARE stationed at Davis and by other visitors to the area. It is intended to provide the groundwork for a continuing biological study of the region begun by the Antarctic Division in 1973. Although a reasonable body of information about the Vestfold Hills has



Antarctic Division photograph R. McLean

PLATE 2

Davis Station from the south, in late summer, with Elephant Seals on Davis Beach. In winter, snow-drifts accumulate to the height of the buildings.

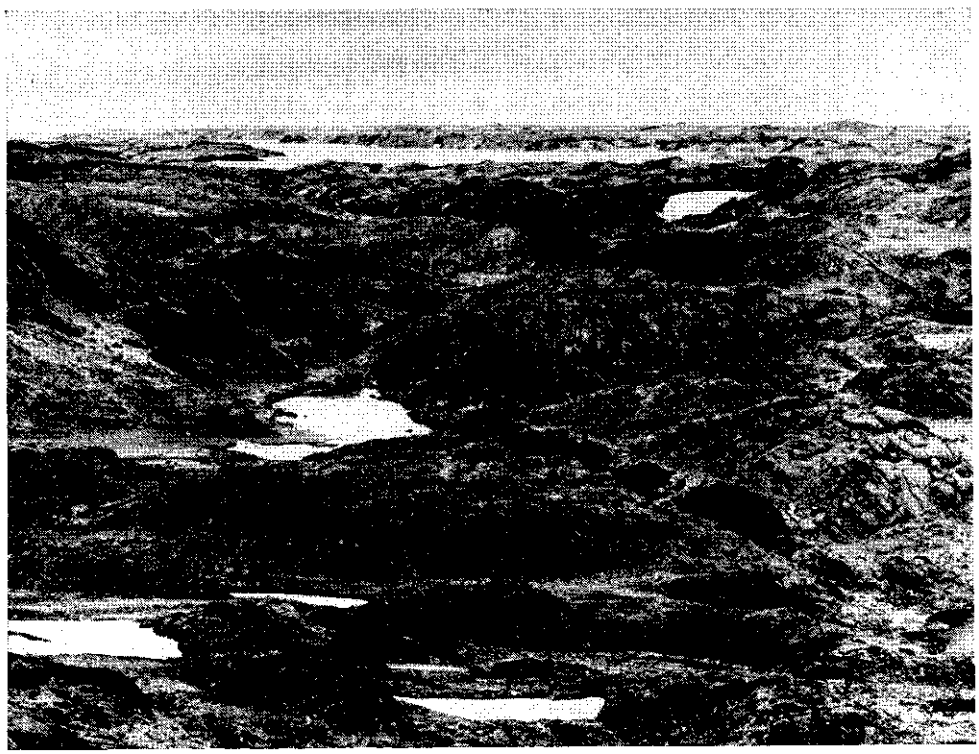
accumulated over the years, no continuing systematic study of the biology of the area has previously been undertaken. A great deal, therefore, remains to be investigated. Field studies during 1973 have already produced significant findings and some of these are included in this report.

D. A. Brown was stationed at Davis as Radio Supervisor in 1961/62, D. J. Lugg was Medical Officer for the year 1963/64, and G. W. Johnstone, Biologist, conducted a biological survey in the Vestfold Hills in summer 1971/72.

1. GEOGRAPHY, GEOLOGY AND CLIMATE

1.1. TERRAIN

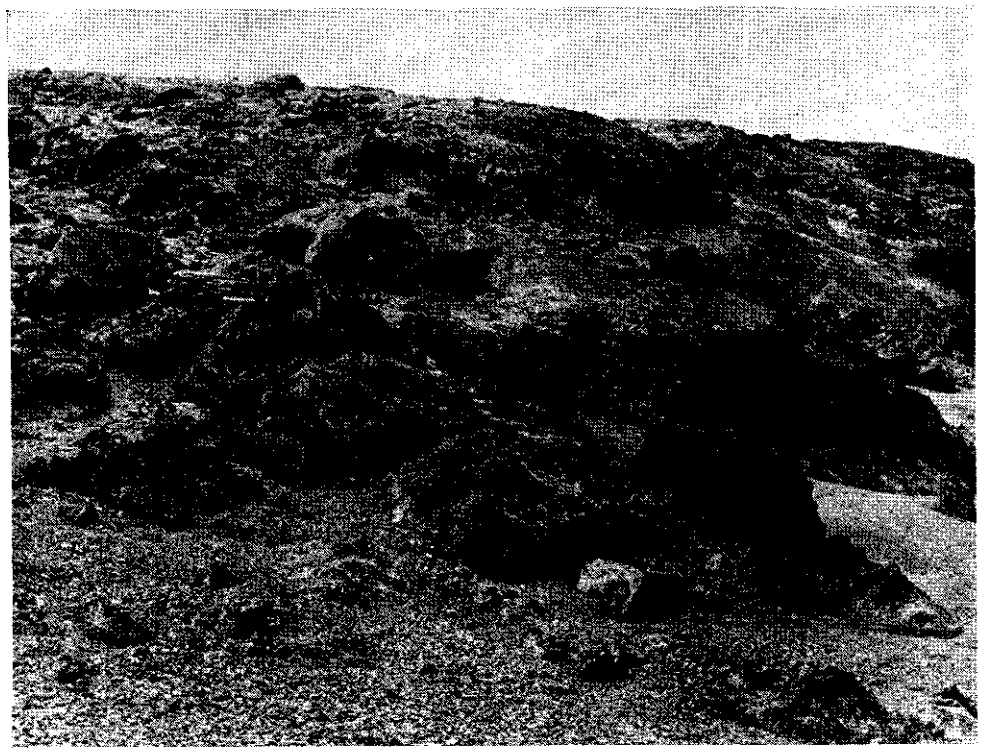
Physical descriptions of the Vestfold Hills have been given by Law (1959) and McLeod (1963a). The relief of the area is moderate (Plate 3), formed from ridges and hills rising to 158 m above sea-level, and separated by narrow valleys filled to various depths by glacial drift and moraine ranging in size from large boulders to sand and silt. Wind-blown sand is a major erosive agent (Plate 4) and sand-drifts occur in sheltered locations, often mixed with ice formed from snow-drifts. In some parts moraines form low hills completely covering the country rock. Lakes are numerous and vary in size from small pools to bodies of water



Antarctic Division photograph G. W. Johnstone

PLATE 3

Typical terrain in the eastern part of the Vestfold Hills. A view to the north-west from Stalker Hill. Long Fjord is in the middle distance. A broad dolerite dyke crosses the picture diagonally.



Antarctic Division photograph G. W. Johnstone

PLATE 4

Erosion of country rock caused largely by wind-blown sand.

up to nine kilometres long. The majority are freshwater, but some thirty are saline (Tolstikov, 1966) with surfaces lower than sea-level, the extreme being Deep Lake, 56 m below sea-level. In general, there is an increase from the coast towards the continental ice-cap in the altitude, degree of relief and ruggedness of the country, and a transition from saline towards freshwater lakes.

Place-names used in this report have been approved by the Antarctic Names Committee of Australia, but are subject to confirmation.

1.2. GEOLOGY

The geology of the area is described by Crohn (1959 and in Law (1959)) and McLeod (1963b). The country rock consists of a variety of gneisses (Plate 5), including pyroxene-quartz-feldspar, garnet-quartz-feldspar and biotite-quartz-feldspar types, as well as garnetiferous quartzite and pyroxenite. Pyroxene-quartz-feldspar rocks predominate. Pegmatites of various types also occur in a few small exposures. Swarms of basic dykes intrude the country rock (Plates 3 and 6). They are mostly of a fine-grained plagioclase-pyroxene dolerite, up to 10 m wide; in many cases the dykes can be traced on aerial photographs for 10 km or more. Most of the glacial debris is similar in type to the country rock.

1.3. CLIMATE

As at other coastal locations in these latitudes, the climate of the Vestfold Hills is cold, dry and windy. Summer temperatures rise to just above freezing-point, but for most of the year are well below. However, there is a general amelioration of conditions from east to west across the hills, from the edge of the polar ice-sheet to the sea-coast 20 km away.

Meteorological data for Davis station are summarised in Table 1. Observations were also made at the head of Long Fjord where the Vestfold Hills "Satellite Station" (Platcha) is located at the foot of the ice-slopes leading up to the plateau (Plates 8 and 9). Data were recorded here during May 1961 to January 1962 (Lied, 1963). Katabatic winds from the ice-cap, so dominant a feature at other Antarctic coastal stations, are vigorous from the east at Platcha and similar in strength to those recorded at, for example, Mawson; but they are only occasionally evident at Davis where the wind has a greater northerly component. During summer, air warmed by the ice-free rocks rises and induces sea-breezes at Davis (Streten, 1969). Cloud-cover and precipitation are greater at Davis than at Platcha, but drift-snow has a much higher incidence at Platcha. Precipitation is almost always in the form of snow, although rain has been recorded in summer.

Antarctic Division photograph G. W. Johnstone

PLATE 5
Exfoliation of gneiss, a common process at ground-level.

TABLE 1
Meteorological data for Davis Station, 1958-63

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mean maximum temperature (°C)	+1.6	-0.9	-5.8	-10.6	-12.4	-13.7	-14.7	-15.5	-13.7	-10.0	-3.2	+1.3
Mean minimum temperature (°C)	-2.2	-5.1	-10.8	-15.2	-18.0	-19.4	-20.3	-20.5	-19.8	-15.9	-7.9	-2.7
Mean daily sunshine (h)*	8.8	6.3	2.5	1.5	0.8	0.0	0.1	1.8	4.0	4.4	7.0	8.7
Mean wind speed (m/s)	4.8	5.3	5.5	4.4	4.9	4.7	5.5	4.5	4.6	4.0	5.5	5.8

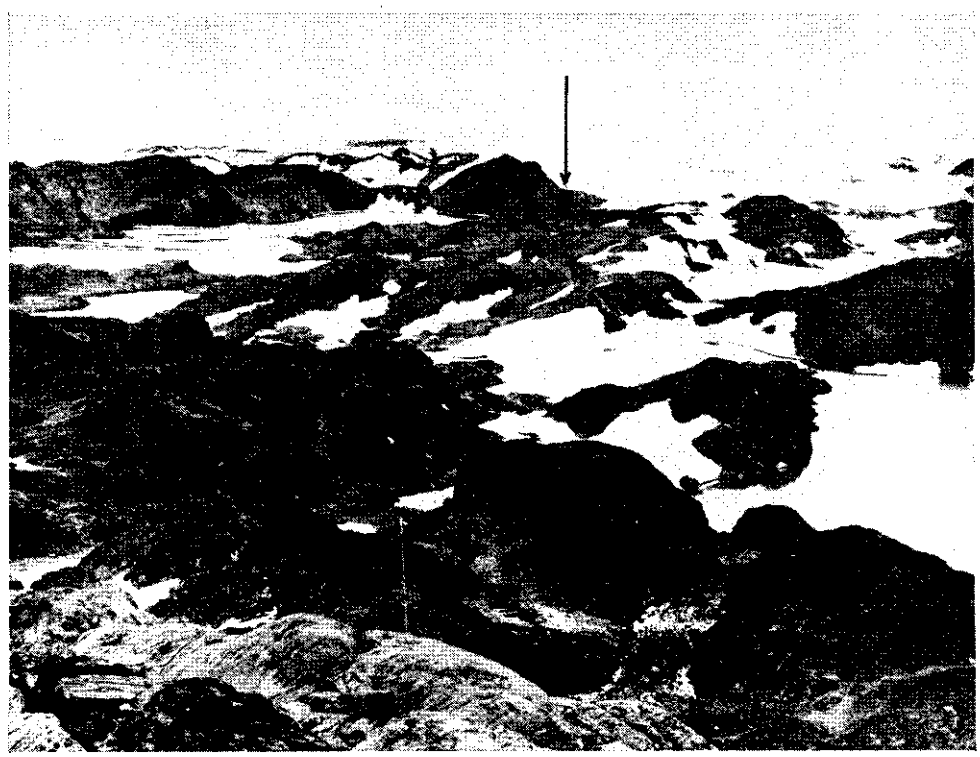
*Recording of sunshine started in August 1959.

Data derived from ANARE Data Reports, Series D,
Meteorology, Publications Nos. 60, 66, 67, 68, 81 and 87:
"Meteorology: Davis, Macquarie Island, Mawson and Wilkes, 1959-63".
Prepared by the Bureau of Meteorology, Melbourne.

Snow falls mostly in winter but accumulates only where shelter from the wind reduces ablation (*cf.* Plates 6 and 7). In summer, these drifts dwindle through sublimation and melting, providing the only significant source of moisture for the land-surface. Mean annual relative humidity is 62% (Heywood, 1972).

1.4. SEA-ICE REGIME

Mellor (1960) has described the annual growth and break-up of sea-ice in the Davis region and additional details are given by McLeod (1967). Prydz Bay appears to remain free of fast ice throughout the year. Stable ice forms in the fjords of the Vestfold Hills and out from the coast to the islands, but beyond the islands breakouts can occur at any time through the winter, often under the influence of blizzards. Icebergs move rapidly southwards along this coast, indicating strong currents in the region; these may also hinder the formation of fast ice. North of a line roughly west from Gardner Island, there are many large bergs stranded on the comparatively shallow sea-floor; these tend to prevent the breakout of sea-ice in this area, as opposed to south of Gardner Island where it breaks away more frequently.



Antarctic Division photograph G. W. Johnstone

PLATE 6

A view from Stalker Hill north-eastwards to the head of Long Fjord and the ice-plateau, February 1972. Several dolerite dykes appear in the middle distance. The position of Platcha is indicated.

Sea-ice forms during March and by April it may be strong enough to allow access to the islands. Through the winter it gains a snow-cover preventing appreciable ablation of the actual ice which may continue to grow in thickness until November, exceeding 1.5 m. During December and January, strong radiation and relatively high air temperatures cause rapid melting; the ice generally becomes unsafe for travel during December. Fast ice may persist between Anchorage Island and the coast until mid-January, and it may be held in by Trigwell I., Flutter I., Lake I. and Plough I. into February; in some sheltered bays in the fjords it may remain throughout the summer.

1.5. THE LAKES

The Vestfold Hills area is one of several ice-free "oases" around the coast of Antarctica. There are smaller areas further south along the coast of Prydz Bay, but the only oasis of similar size is at the Bunger Hills (66°18′S, 100°45′E). Along the western coast of the Ross Sea, glaciers have retreated up the valleys of the Transantarctic Mountains to produce similar conditions. The Vestfold and Bunger oases are thought to have originated during the recession of the continental ice-cap; those in the Transantarctic Mountains may be much older. That the ice-cap

Antarctic Division photograph D. A. Brown

PLATE 7

A view similar to that of Plate 6, taken in September 1961. Even after the coldest month of the year there is very little snow-cover.

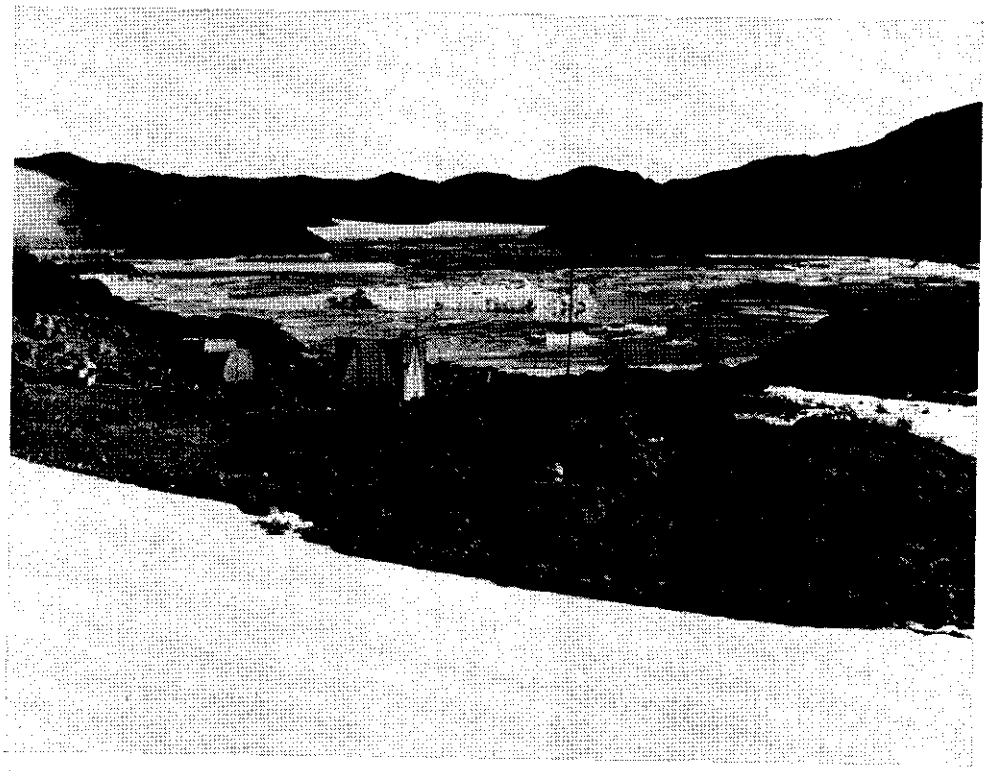
Antarctic Division photograph D. A. Brown

PLATE 8

Platcha in winter from the north-west. The ice-slope provides vehicular access to the plateau.

had previously covered the Vestfold Hills is demonstrated by the presence of pavement rock bearing glacial striae (Plate 10), numerous erratics, hillocks in the form of roches moutonnées, and extensive deposits of glacial drift and moraine. The recession probably occurred during the last post-glacial optimum, possibly 4,000-7,000 years ago (Gill, 1955); it was associated with an isostatic uplift of the land in response to the removal of a vast mass of ice from its surface. Arms of the sea, similar to the present day "fjords" of the Vestfold Hills, would have become isolated from the sea during this process, and this is thought to have been the origin of many of the saline lakes in the area (McLeod, 1963a). Subsequent evaporation has reduced them to their present levels.

These saline lakes are rimmed by terraces (Plate 11) at approximately present sea-level. Many of these terraces bear extensive deposits of the remains of sub-littoral organisms. Probably the terraces were formed from material collected from the hillsides above, as they gradually rose out of the sea, and mark the level at which cut-off from the sea occurred. Subsequent fall of the level of the lake-surface by evaporation would have been rapid in comparison with the previous rate of emergence of the submerged land. The original water-levels were possibly reduced at a rate of some 30 cm per year (P.A. Arriens, personal communication) decreasing as the progressive concentration of dissolved salts reduced the vapour



Antarctic Division photograph G. W. Johnstone

PLATE 9

Platcha in February 1972, looking in the opposite direction to Plate 8. The water of Long Fjord has melted, although this may not occur every summer.

pressure of the water until the (present) equilibrium level was reached. There is no evidence that successive beaches were formed during this process. The present water-regime of these lakes is the result of input from direct precipitation and meltwater from the surrounding catchments, balanced by evaporation; they have no outlets. Seasonal fluctuations in their surface-levels are small, of the order of five centimetres (McLeod, 1963a).

The solubility characteristics of the constituent ions at low temperatures result in sulphate and sodium ions crystallising from saturated brine before others. Shining white deposits of mirabilite ($Na_2SO_4.10H_2O$) fringe many of the saline lakes (Plate 12). Several processes are probably involved in transporting water up the beaches to produce these deposits: capillary action through sand or over the surfaces of stones and rocks, deposition as spray by wind-action and the slow ebb of annual changes in water-level. The ionic content of these waters represents concentrations up to eleven times that of sea-water after allowance is made for loss of sodium and sulphate ions due to this crystallisation. Table 2 summarises data for six saline lakes. Two of the most saline, Deep Lake and Club Lake, have not been known to freeze over, although a fringe of ice a few centimetres wide

Antarctic Division photograph G. W. Johnstone

PLATE 10

Dolerite pavement with glacial striae, and lichens (right centre).

may form along sheltered edges. Lake Stinear is ice-covered from July to November, and Lake Dingle for a few weeks longer (Plate 13). Surface-water temperatures may reach a winter minimum of –20°C and a summer maximum of 8°C. Freshwater lakes have usually thawed by mid-January, but they may remain frozen throughout the summer depending on weather conditions.

Meltwater trickles, some brackish, occur in valleys. Salts in them are derived from silt, a sample of which contained 12% water-soluble salts presumably originally derived from sea-water (McLeod, 1963a).

TABLE 2

Summary of data for six saline lakes, Vestfold Hills.
Information for five lakes from McLeod (1963a)
and for Lebed' Lake from Korotkevich (1964)

Name	Location	Salt content min. and max. total dissolved salts	Depth (maximum measured) m	Level of surface relative to sea level m
Dingle	68°34′S, 78°04′E	105–226 g/l	11	–10
Stinear	68°34′S, 78°07′E	226–245 g/l	15	–16
Deep	68°34′S, 78°11′E	248–273 g/l	>100	–56
Club	68°33′S, 78°14′E	262–274 g/l	–	–33
Jabs	68°33′S, 78°16′E	–	–	–27
Lebed'	68°37′S, 78°12′E	210 °/oo	27	–31

2. BIOLOGY

Compared with other parts of the world, including Arctic regions, the Antarctic oases such as the Vestfold Hills support a biota of remarkably few species. This probably reflects the youth of these ecosystems and the difficulty of colonising places so isolated and where physical conditions are so extreme.

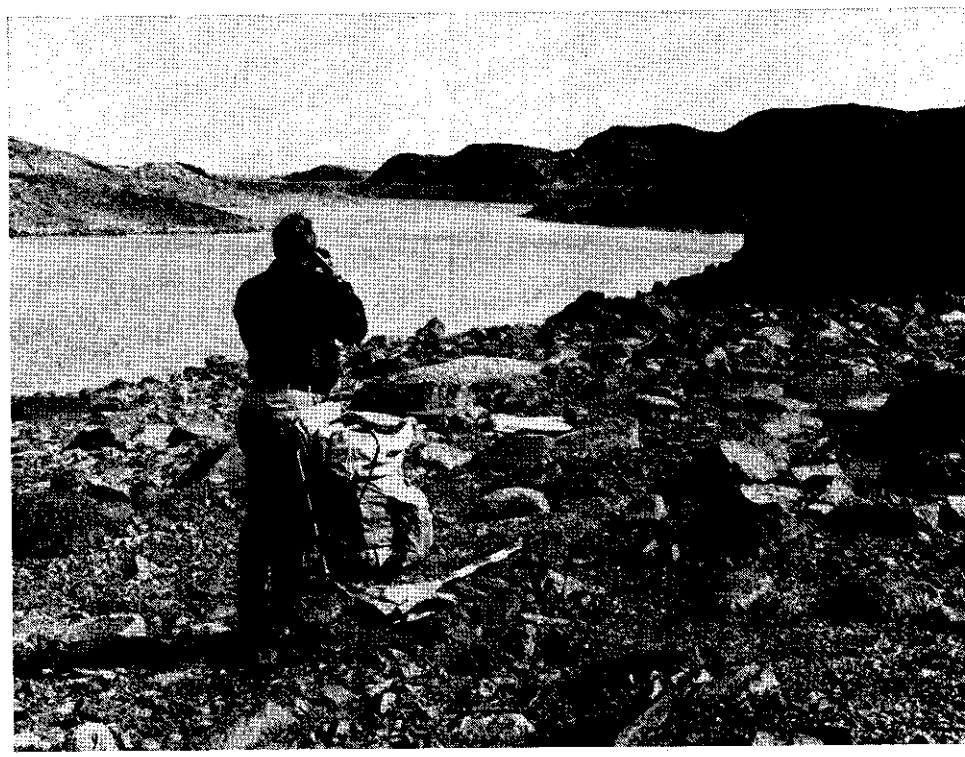
The terrestrial community consists of bacteria, fungi and algae, often associated with a sparsely distributed flora of lichens and one moss; and an invertebrate fauna of few species, notably nematode worms and mites.

In the lakes the communities appear to be at a similarly simple level of organization, with micro-organisms predominating and few larger invertebrates such as crustaceans present. At least some of the organisms present in the saline lakes may have evolved from forms present in the sea at cut-off, which have adapted progressively to their changing environment as salinity increased and other physical parameters changed accordingly.

2.1. FLORA

2.1.1. *Bacteria*

Korotkevich (1964) implied that, as in lakes in the Bunger Hills, bacteria



Antarctic Division photograph G. W. Johnstone

PLATE 11

Lake Stinear, looking west. The photographer is standing on the terrace which rims the lake at 16 m above the present water-level.

formed a crust on the bottom of lakes he examined in the Vestfold Hills. Bacteria have now been found also in moss-cushions and soil (D. E. Rounsevell, personal communication).

2.1.2. *Algae*

1. Marine

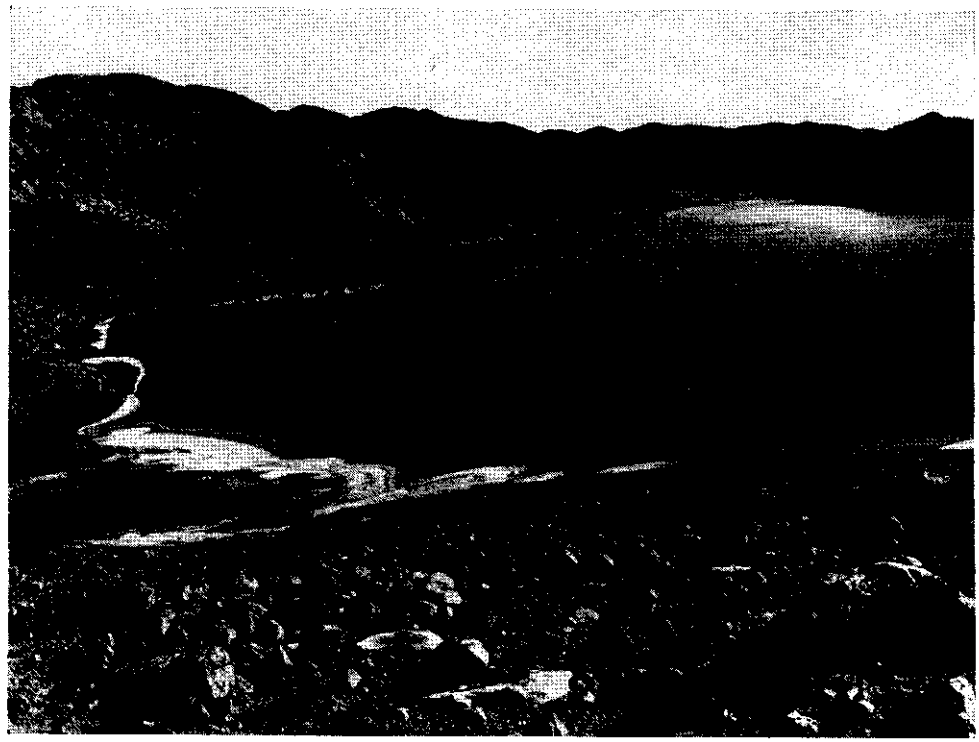
Several types of brown, red and green marine algae grow around the coast, but none has as yet been identified.

2. Lakes

Greenish and brownish slimy deposits washed up on the shores of several freshwater lakes, and sometimes seen floating free, are thought to be blue-green algae. Korotkevich (1964) implied that Crooked Lake contained unicellular diatomic algae and filamentous algae. D. R. Grace (personal communication) has recently found pennate and centric diatoms and *Chlamydomonas*-like flagellates in the surface-waters of Lakes Stinear and Dingle.

3. Terrestrial

A green growth noted under stones in the station area may be a unicellular



Antarctic Division photograph G. W. Johnstone

PLATE 12

Club Lake from the north-east, showing white crystalline mirabilite (sodium sulphate).

alga. Various soil algae have been noted (D. E. Rounsevell, personal communication). A green (presumably nitrophilic) alga was found beside Adélie Penguin colonies on Magnetic Island, growing where a snowmelt trickle crossed rocks amongst guano and feathers. *Prasiola* sp., similar in form, was collected from Lichen Island (69°20′S, 75°32′E) at the Larsemann Hills (Law, 1959).

2.1.3. *Fungi*

Fungal spores occur in the soil. A white crust occurring on moss-cushions may be a symbiotic algal-fungal association (D. E. Rounsevell, personal communication).

2.1.4. *Lichens*

Seventeen species of lichens have been recorded from the Vestfold Hills (Appendix I), the result of incidental collections. No intensive collections have been made and it may be expected that the list will be considerably lengthened in the future. In general, lichens are least common near the coast, especially in the vicinity of Davis station and the western part of Broad Peninsula. Further inland, and particularly near fjords and at the edge of the ice-cap, they become

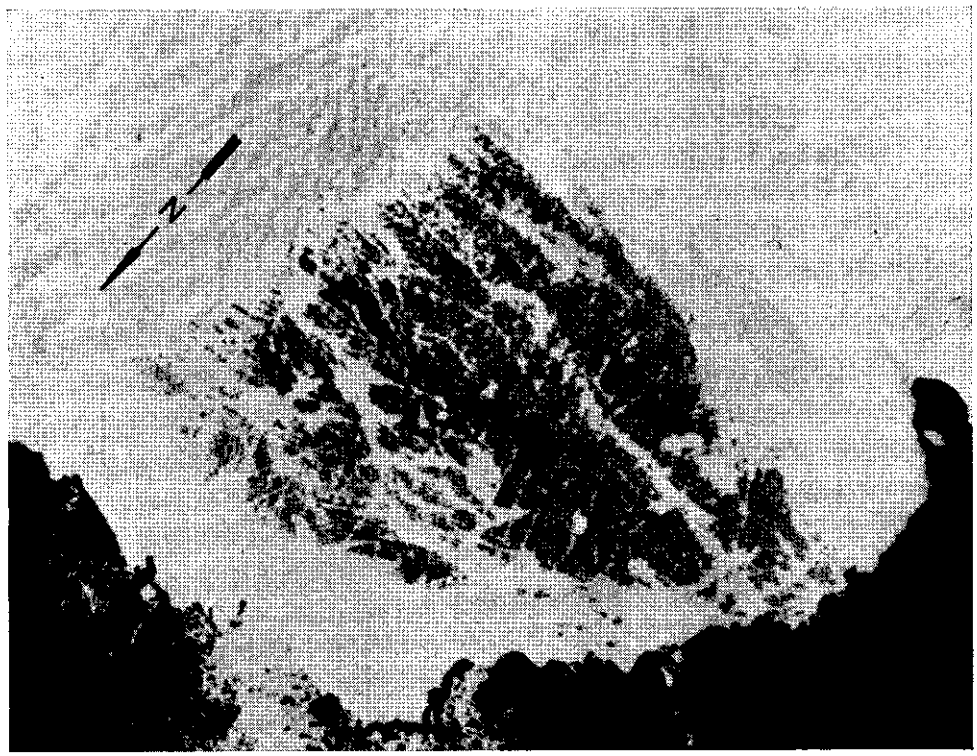


PLATE 13

Satellite photograph taken on 12 December 1972, showing ice-cover remaining on Lake Dingle and freshwater lakes, but saline lakes such as L. Stinear, Deep L., Club L., Lebed' L., Cemetery L., Laternula L. and a small unnamed lake at the western end of Mule Peninsula are ice-free.

much more abundant, growing on both gneisses and dolerites, as well as on sand, bones and dead cushions of moss.

2.1.5. *Bryophytes*

Only one species of moss, *Bryum antarcticum* Hook., Fil. & Wils., has been reported (Filson, 1966). It grows in cushions (Plate 14) in the vicinity of Ellis Rapids at the head of Ellis Fjord where it may at times be submerged by meltwater flowing from Lake Druzhby. It has also been recorded from near the north-eastern end of Lake Druzhby, the southern side of Lake Stinear, the western side of Club Lake and near The Lookout; probably it occurs at many sites throughout the Vestfold Hills where there is an adequate water-supply from melting snow.

2.2. INVERTEBRATES

Prior to 1973 little was known of the terrestrial and lacustrine invertebrate fauna of the area. Recently the work of D. R. Grace and D. E. Rounsevell is providing new information in this field. However, to date no Platyhelminthes nor representatives of the arthropod groups Collembola, Diptera and Tardigrada have been recorded in the Vestfold Hills, although they have been found elsewhere in Antarctica.

Antarctic Division photograph K. R. Kerry

PLATE 14

A carpet of the moss *Bryum antarcticum* near Ellis Rapids.

Remains of marine invertebrates are found stranded on beaches. Others are found on or in the ice of fjords and other areas. Dayton and others (1969) have described how ice in the form of large platelets 2-5 mm thick may freeze on the sea-floor at depths down to 15 m or more, forming mats up to 50 cm thick. Portions of this "anchor" ice may become detached and float to the undersurface of the sea-ice, carrying with them any benthic organisms that have become trapped amongst the platelets. In a region such as Crooked Fjord where the surface water may remain frozen through several successive summers, ablation of the upper surface and continual freezing of new ice on the undersurface could eventually bring organisms trapped in this way to the surface of the ice. This provides an explanation for the presence of various organisms referred to below, found in and on the ice at Crooked Fjord and elsewhere. Their location on the ice indicates regions where the various organisms may be living on the sea-floor below.

2.2.1. *Protozoa*

Gymnodinium-like dinoflagellates have been found in Lake Stinear, their abundance decreasing with depth (D. R. Grace, personal communication).

2.2.2. *Porifera*

Clusters of material resembling fibreglass found on the shores of Crooked Fjord on 4 February 1972 were probably siliceous spicules from stranded sponges. Remains of sponges were found in the frozen ice of Ellis Fjord on 13 August 1971.

2.2.3. *Coelenterata*

Three types of jellyfish have been recorded:

(1) pale mauve, ribbed, 20 cm diameter (Law, 1959);
(2) reddish, "like the bladder of a small rugger ball", 15 cm long and 8 cm wide, in a tide-crack on 27 March 1970;
(3) colourless apart from a few brown markings, 50 cm diameter, two specimens on 16 and 21 January 1972.

In addition, a small coelenterate, possibly a ctenophore, about 2.5 cm diameter, was found in a tide-crack on 27 March 1970.

2.2.4. *Annelida*

Two types of marine tubicolous polychaetes have been noted: a small spiral type, possibly *Spirorbis* sp., occurs on the fronds of marine algae, and the elongate tubes of a larger type are washed up on the beaches. Other worms have been observed wriggling in the holdfasts of kelp pulled up from the sublittoral zone.

2.2.5. *Nematoda*

Terrestrial nematodes have recently been found in moss-cushions (D. E. Rounsevell, personal communication).

2.2.6. *Rotifera*

Korotkevich (1964) collected two rotifers, *Proales reinhardti* and *Philodina* sp., from the surface-water of Crooked Lake (freshwater). Bdelloid rotifers have now

been found amongst blue-green algae from a freshwater tarn, and in moss-cushions (D. E. Rounsevell, personal communication).

2.2.7. *Arthropoda*

1. Marine

Many types of Crustacea occur in the coastal waters of this area. Gammarid amphipods are abundant all round the coast and in shallow water offshore. Many individuals become stranded on the beaches and in rock-pools at high tide, and their dried tests commonly litter the strand-line. Dried tests of other crustaceans are found occasionally on the beaches. The largest is the isopod *Glyptonotus acutus* Richardson, 4-5 cm in length. Several examples of this, together with remains of many amphipods (Lysianassidae sp., Gammaridae spp.), *Antarcturus* cf. *franklini* Hodgson, and of a species of euphausiacean *Euphausia* sp. were found along a 300 m stretch of beach at the western end of Mule Peninsula on 5 February 1972. Tests of two species of marine arachnids, pycnogonids of the families Ammotheidae and Callipallenidae, were found nearby and on the shore of Crooked Fjord on 4 and 5 February 1972.

2. Lakes

Plankton samples taken from lakes in December 1956 yielded three species of crustaceans (Korotkevich, 1964). Juveniles of a harpacticoid copepod and the cyclopoid copepod *Acanthocyclops mirnyi* were found in the freshwater Crooked Lake, and the latter also in the saline Lebed' Lake (Borutskii, 1962). In addition, Crooked Lake yielded the cladoceran *Daphniopsis studeri* (Akatova, 1964), previously reported only from the subantarctic Kerguelen and Marion Islands.

3. Terrestrial

Prior to 1973 the only terrestrial invertebrates recorded from the Vestfold Hills were found in samples of dried green algae and guano collected by D. J. Lugg at two sites at Mule Island on 7 December 1963. They proved to be a new species of prostigmatic mite *Tydeus erebus* (Strandtman, 1967). Work currently in progress is showing that this mite is widespread and abundant in the area, together with another mite *Nanorchestes* sp. (D. E. Rounsevell, personal communication).

2.2.8. *Mollusca*

Empty valves of the clam *Laternula elliptica* King and Broderip are very common round the shore, and a few valves of *Pecten* sp. have also been found. Some small dark gastropods about 1-2 mm long were noted crawling on a *Laternula* shell in shallow water. Valves of the pelecypod *Philobrya* sp. and the small gastropods *Eatoniella* sp. and *Laevilitorina antarctica* Smith were found amongst debris washed out of a *Laternula* shell collected on the sea-ice near Hawker Island in January 1973. *Pecten* shells were found on, and embedded in, the ice of Crooked Fjord beside the Sørsdal Glacier on 13 August 1971. A relatively large gastropod shell found near the western end of Cemetery Lake on 4 February 1972 was identified as *Chlamidota* sp.; it could have been carried there by a skua,

but it might have remained *in situ* after the lake became cut off from the sea. Cemetery Lake is separated from the sea by only a low neck of land and its surface is only slightly below sea-level; probably it became cut off relatively recently.

2.2.9. *Ectoprocta*

Unidentified colonial Polyzoa have been found encrusting stones and shells around the shore.

2.2.10. *Echinodermata*

Beach-washed specimens of the asteroids (starfish) *Henricia* sp., *Perknaster* sp. and others have been found. Several specimens of the echinoid (sea-urchin) *Sterechinus neumayeri* have been found on beaches, one still alive and one being eaten by a skua. Remains of another echinoid *Noticidaris* sp. were found on the sea-ice near Davis Station in January 1973.

2.2.11. *Protochordata*

A species of colonial tunicate occurs commonly in the surrounding waters and is occasionally washed ashore or into shallow water. It forms sausage-shaped gelatinous colonies up to 30 cm long and 3 cm in diameter, yellowish in colour. It probably lives attached to the bottom but is often seen detached and floating near the surface.

Antarctic Division photograph M. Navin

PLATE 15

Bed of worm-tubes beside north-eastern shore of unnamed lake 150 m south of Ellis Rapids.

2.2.12. *Fossil remains*

Organic remains in the terraces surrounding the saline lakes have been identified. Samples from the southern terrace of Lake Dingle and a terrace on the north-western side of Deep Lake contained 30 species of Foraminifera, the dominant genus being *Cassidulina.* In addition, sea-urchin spines and shells of *Pecten* were identified (Crespin, 1960). Voronov (1964) recorded diatoms, Foraminifera, worm-tubes, ostracods, molluscs and the spines of sea-urchins. Material from near Lake Dingle and Lake Stinear and Deep Lake contained well-preserved valves of the bivalve molluscs *Laternula elliptica* King and Broderip, *Lima hodgsoni* Smith, *Malletia pellucida* Thiele, *Pecten colbecki* Smith and *Thracia meridionalis* Smith, and of the gastropod mollusc *Nacella depressa* Hedley and a small vermetid gastropod, perhaps *Stoa,* found on worm-tubes (McLeod, 1963a). Recent collections from about three metres above the present water-level in the north-eastern corner of Lake Stinear included the additional gastropods *Trophon longstaffi* Smith and *Chlamidota* sp., masses of siliceous sponge spicules and an unidentified polyzoan encrustation on a small stone. All these forms are still living around the Antarctic coastline.

A bed of worm-tubes more than one metre deep was found recently beside the north-eastern shore of the unnamed lake 150 m south of Ellis Rapids (Plate 15). It was exposed in a gully, possibly produced by water flooding out from above

Antarctic Division photograph G. W. Johnstone

PLATE 16

Beds of *Laternula* shells on the northern shore of Laternula Lake.

Ellis Rapids and into the lake during periods of rapid melting in early summer, when the rapids may be partially dammed with ice.

Laternula elliptica is most conspicuous amongst these deposits, and at a saline lake near the western end of Mule Peninsula, now known as Laternula Lake, its shells occur in successive beds up the sandy beach from the water's edge (Plate 16); there are also numerous shells on the bed of the lake. This lake appears to have become cut off from the sea relatively recently and its level is probably only 2-3 m below sea-level. Within each bed the shells lie side by side, each oriented similarly, in the position in which they must have been living (Plate 17). They are extremely fragile, but many still retain parts of the nacreous interior. The beds appear to represent successive recolonisations as the water-level fell prior to the lake being isolated. Possibly periods of rapid deposition of sand annihilated whole populations of the molluscs, which then recolonised the area at a slightly lower level. Study of the ecology of living populations of *L. elliptica,* together with radiocarbon dating studies of these deposits, should throw light on their mode of origin.

2.2.13. *Ectoparasites of vertebrates*

Three species of ectoparasites, all arthropods, have been recorded in the Vestfold Hills. Brown (1966) found the mallophagan biting louse *Pseudonirmus*

Antarctic Division photograph G. W. Johnstone

PLATE 17

A *Laternula* shell *in situ* on the northern shore of Laternula Lake.

charcoti on the feathers of adult Snow Petrels. The nests of these birds contained pupal and adult Antarctic Fleas *Glaciopsyllus antarcticus,* the only flea known from the Antarctic and originally found in the nests of Antarctic Fulmars at Ardery Island near Casey Station in 1961 (Murray and others, 1967). Lugg (1966) found the anopluran blood-sucking louse *Antarctophthirus ogmorhini* infesting Weddell Seals near Davis. Pups were not infested until about five weeks old when their natal coat had been shed. The ecology and physiological adaptations of this louse, which occurs also on Leopard Seals, have been described (Murray and others, 1965).

2.3. BIRDS

The twelve species of birds which have been recorded at Davis are listed in Table 3, with brief notes on their status. They are dealt with in detail below.

TABLE 3
Status of birds at the Vestfold Hills

		Estimated breeding population (pairs)
Emperor Penguin *Aptenodytes forsteri*	Regular visitor (nearest rookery 85 km to SW)	0
Adélie Penguin *Pygoscelis adeliae*	Breeds on at least 17 islands and at several locations on Long Peninsula	130,000
Southern Giant Petrel *Macronectes giganteus*	Breeds at Hawker Island only	40
Antarctic Fulmar *Fulmarus glacialoides*	Infrequent in summer (nearest colony 22 km to SW)	0
Antarctic Petrel *Thalassoica antarctica*	Occasional visitor (nearest colony 22 km to SW)	0
Cape Petrel *Daption capensis*	Breeds on 12 islands	500
Snow Petrel *Pagodroma nivea*	Breeds on many islands and at several localities on mainland	5,000+
White-chinned Petrel *Procellaria aequinoctialis**	One probable record of several	0
Wilson's Storm-petrel *Oceanites oceanicus*	Breeds throughout area	40,000
South Polar Skua *Catharacta skua maccormicki*	Breeds throughout area, mostly near Adélie Penguin colonies	150-200
Brown Skua *C. s. lonnbergi*	At least one record	0
Dominican Gull *Larus dominicanus*	One record of a single bird	0
(Arctic) Tern *Sterna (macrura)*	One record of six birds	0

* This record is now considered doubtful.

2.3.1. *Emperor Penguin*

The occurrence of Emperor Penguins at Davis Station is summarised in Table 4. They are probably present in the area throughout the year, but it seems that they seldom move far from the outermost edge of the fast sea-ice. Consequently they are most often seen in the summer months when the ice-edge is close to the station: they occasionally come ashore onto the beaches at this time. During

TABLE 4
Occurrence of Emperor Penguins in the vicinity of Davis

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1957	+	+	+	+				+				4
1958												2
1959	1											
1960	1, 1		1					1				
1961		1							7, 3			7, 1
1962	1, 1										7	5
1963	4, 2			+								14
1964	2, 2											
1969										1, 6		1, 1, 5
1970	+				2*	39*	20, 3, 8*	3, 5, 5*	1	7		1
1971	1								1	8, 5		5
1972	1									1		

\+ Recorded, numbers not specified
* At edge of fast ice beyond islands

several visits to the ice-edge beyond the islands in winter 1970, emperors were often seen swimming nearby and resting on the ice. Most of the birds recorded in summer have been in varying stages of moult, and a fledgling with some down still adhering was seen on 13 January 1962.

The nearest known breeding place of this species is on the fast ice of Amanda Bay (69°15′S, 76°50′E) at the foot of ice-cliffs, some 85 km south-west from Davis (Budd, 1961). The colony was viewed from the air in August and September 1957. On the first occasion the population was estimated at 3,000-5,000 birds, and the second time the estimate was 1,000-2,000 (Willing, 1958). The only recorded landing was on 21 May 1960 when 3,500-4,000 birds were recorded in two groups, occupying a total area of about 100 m x 500 m. About 40-50% were carrying eggs.

The cycle of the Pointe Géologie colony (66°40′S, 140°05′E) has been described (Prévost, 1961) and appears to be roughly synchronous with that at colonies in Australian Antarctic Territory (Budd, 1962). Laying occurs from early May to early June. Thus, by 21 May more than half the eggs should have been laid, and would be in the care of the male of the pair to whom the female transfers the egg 6-12 hours after laying. According to the figures given, 1,400-2,000 birds had eggs. This leaves 1,500-2,600 without eggs, comprising a further 750-1,300 pairs which had not laid. This indicates that the breeding population there in 1960 was 2,150-3,300 pairs, similar to the *c.* 3,000 pairs suggested by Budd (1961). The emperors seen at Davis are presumably associated with this colony.

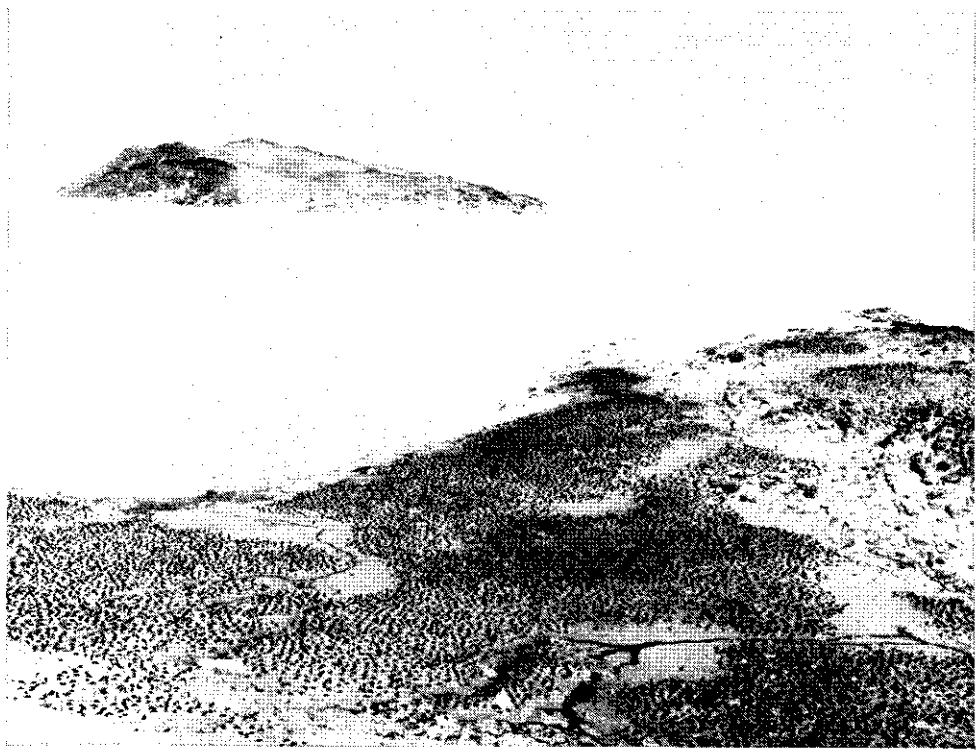
The dehydrated carcase of an Emperor Penguin was found beside Deep Lake, 2 km from the sea, in 1957. Although live emperors have not been seen inland, this finding demonstrates that they stray away from the sea occasionally.

2.3.2. *Adélie Penguin*

The Adélie Penguin is probably the most abundant species of bird in the Vestfold Hills. Colonies occur on most of the outer islands (*e.g.* Plates 18 and 19), from an unnamed island north of the Wyatt Earp Islands in the north to the

entrance of Crooked Fjord in the south (Fig. 3). Mainland colonies are found only on Long Peninsula. Sites chosen as colonies range from rocky beaches to exposed ridges, up to 70 m above sea-level on Magnetic Island. Population estimates made at different times through the summer vary from year to year, but the breeding population appears to be of the order of 130,000 pairs, roughly equally divided between the areas north and south of Lucas Island.

The location of colonies does not appear to be related to the accessibility of open water during the chick-feeding period; penguins may need to cross up to one kilometre of ice between the sea and the Long Peninsula colonies in January, while other untenanted islands and parts of the mainland may be completely ice-free. Another possibility is that preferred localities are most accessible when the birds return from the sea in October. During winter the sea-ice frequently breaks out along the outer edge of the islands south from Gardner Island to the Sørsdal Glacier, but north of this it is to some extent held in by many stranded icebergs to the west (which indicate that the sea is shallower here than in the southern part near the glacier). Consequently, the most accessible areas at the end of winter for penguins returning from the sea could be the southern islands west of the entrances to Crooked and Ellis Fjords. Although there are several colonies on



Antarctic Division photograph R. McLean

PLATE 18

Part of the Adélie Penguin colony on Magnetic Island in November 1964, with Turner Island behind. The islands are still surrounded by fast sea-ice.

these islands there are many more in the northern part. It seems that proximity to open water is not a major factor in determining the location of Adélie Penguin colonies in this region.

There is evidence on some islands (*e.g.* Turner I., Warriner I., Hawker I.) that colonies, or breeding groups within colonies, have moved their locations by up to one kilometre. The deserted areas are marked by deep deposits of guano, frozen eggs and the dehydrated carcases of chicks (Plate 21). Similar situations have been described at other Adélie Penguin colonies, for example at Cape Royds on Ross Island where it appeared that the birds had moved into more sheltered areas (Taylor, 1962). Deposits about 1.5 km from the present colony at Cape Royds are thought to mark the site of a breeding area deserted 300-400 years ago, possibly during a period of climatic deterioration (Spellerberg, 1970a). The factors responsible for the changes in locations of colonies at Davis are not known. In view of the high fidelity to nest-site normally shown by Adélies from one season to the next (*cf.* Plates 18 and 20 A and B) (Penney, 1968), and the low mortality rate of breeding adults, overall changes in the locations of colonies should occur slowly. Alternative explanations involving catastrophic events cannot be discounted but lack evidence.

Antarctic Division photograph G. W. Johnstone

PLATE 19

Adélie Penguins in the colony on Gardner Island on 15 January 1972, with Turner I., Magnetic I. and Bluff I. behind. By this time the sea-ice had broken out from the mainland.

Antarctic Division photograph D. J. Lugg

PLATE 20 A

View, similar to Plate 18, of the Magnetic Island Adélie Penguin colony in November 1963 and (Plate 20 B) in January 1972, showing similar distributions of birds.

The first Adélie is usually seen near Davis by the middle of October (Table 5). Numbers increase rapidly and the first egg is laid about four weeks later. The last moulted adult departs by the end of March. These dates are similar to those recorded at Haswell Island 700 km east (Pryor, 1968). Records kept at 28 nests in 1957 showed that the interval between the laying of the first and second eggs was 2½-4½ days, and the incubation period (time from laying of second egg to hatching of second chick) for 15 clutches was in the range 32-35 (± 1) days with a mean of 33.7 (± 1) days. These data agree well with those of other studies (Taylor, 1962).

Dehydrated carcases of Adélies have frequently been noted inland: up to seven at Deep Lake, several at the western end of Lake Stinear and occasional ones elsewhere. There are several records of live Adélies being seen up to three kilometres from open water during late October until early January, especially at Lake Stinear where 16 were seen on 29 December 1962, and where others have been seen swimming. Fresh Adélie pad-marks in the sand were observed throughout the western halves of Broad Peninsula and Mule Peninsula in January 1972. Live Adélies have also been recorded on the ice-plateau up to one kilometre east of Platcha (one on 23 November 1969, two on 29 October 1971). It appears that

Antarctic Division photograph G. W. Johnstone

PLATE 20 B
See caption of Plate 20 A.

TABLE 5
Annual calendar for Adélie Penguins in the vicinity of Davis

Year	First penguin seen October	First egg November	First chick December	Last penguin seen March
1957-58	14	8	10	18
1958-59	15	9		31
1959-60	17	5		
1960-61	14			
1961-62	15			25
1962-63	10	11		
1963-64	11	13	14	10
1968-69				27
1969-70	13	8		
1970-71	4	15		
1971-72	10	10	14	
1972-73	13	7	16	

at the beginning of the season each year a small number of Adélies, possibly young birds returning to the breeding area for the first time, miss the colonies and wander inland.

2.3.3. *Giant Petrel*

The first record of Giant Petrels breeding in the area was in 1961, when a fledgling was found dead on the sea-ice on 1 May. The breeding colony on Hawker Island was discovered in December 1963. At 68°38′S this is the most southerly known breeding location for this species. Three other breeding localities

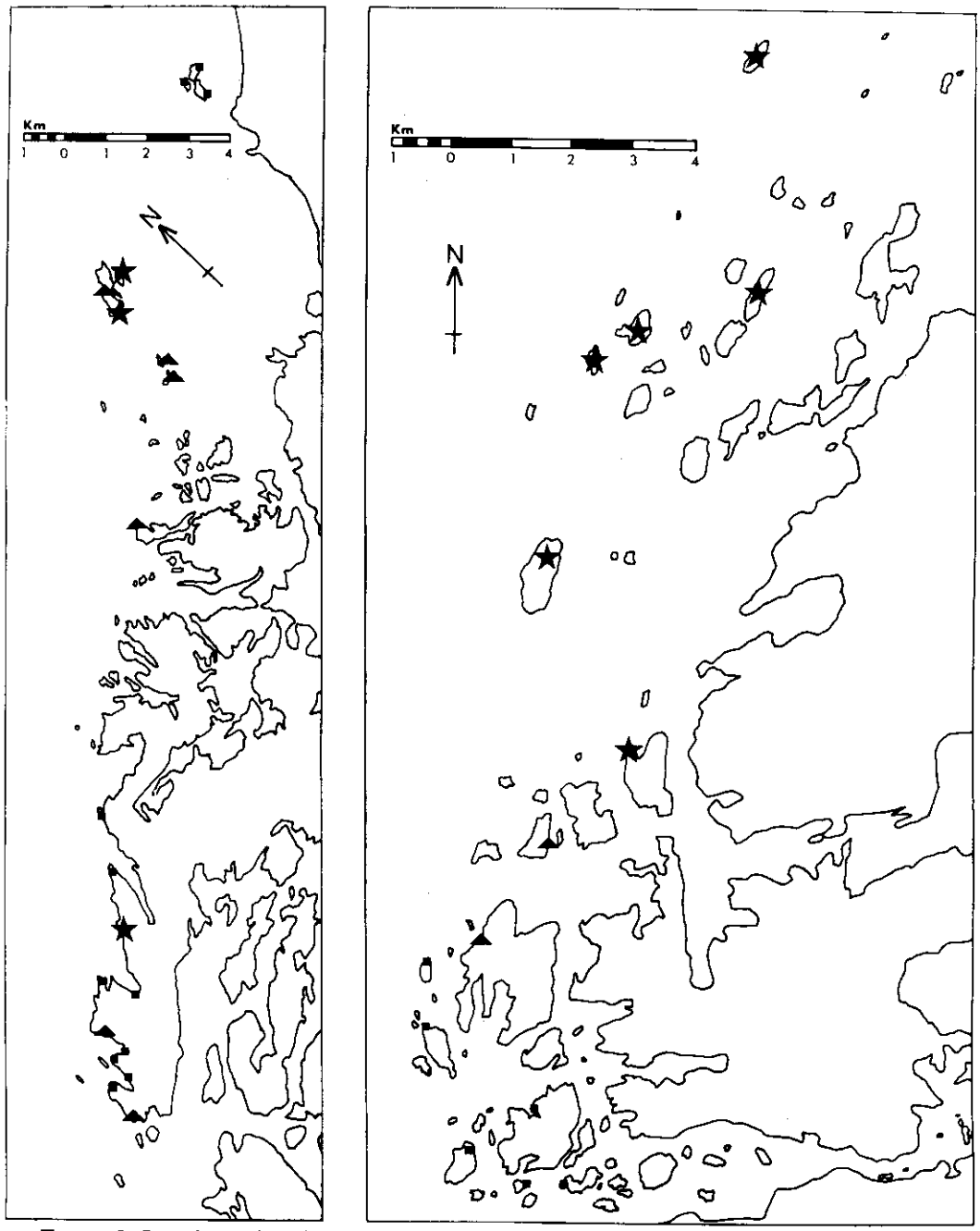


FIGURE 3. Locations of Adélie Penguin colonies in 1963 (the year for which most complete records exist) on Long Peninsula and adjacent islands (left) and islands from Long Fjord to Sørsdal Glacier (right). Their approximate populations are indicated:

■ small (<2,500 pairs)
▲ medium (2,500–7,500 pairs)
★ large (>7,500 pairs)

have been recorded on islands close to the Antarctic mainland: in Terre Adélie at the Pointe Géologie Archipelago (66°39′S) (Prévost, 1953), near Casey Station at the Frazier Group (66°13′S) (Law, 1958), and near Mawson Station at Giganteus Island (67°35′S) (Ingham, 1959). Giant Petrels also breed at three localities on the western side of the Antarctic Peninsula, the most southerly being at Avian Island (67°46′S) (Watson and others, 1971).

The Hawker Island colony (Plate 22) is situated on level ground about 20 m above sea-level. Rocks and boulders break the relief but provide little shelter. The same area has been used at least since 1963-64, although the discovery of at least seven old carcases of Giant Petrels on the western shore of Cemetery Lake in February 1972 suggests that there might have been a breeding colony near here at the western end of Mule Peninsula in the fairly recent past. The eastern side of the breeding area forms a slight ridge with the ground dropping away below, providing a good area for take-off into the prevailing north-easterly winds. Nests are built from pebbles and are relatively widely dispersed, about five to ten metres apart. Estimates of breeding numbers are shown in Table 6. The annual breeding population appears to be about 30-40 pairs, except in 1970-71 when at least 90 breeding pairs were recorded.

Antarctic Division photograph G. W. Johnstone

PLATE 21

Part of the Adélie Penguin breeding area on Turner Island which had been abandoned by 1971. Dehydrated carcases of chicks litter the ground.

Antarctic Division photograph G. W. Johnstone

PLATE 22

Part of the colony of Giant Petrels on Hawker Island.

The breeding cycle can be inferred from a few records spread over several years, assuming constancy from year to year (Table 7). Laying starts during the second half of October and, with an incubation period of about 60 days, hatching starts in the second half of December. Hatching continues over a period of about three to four weeks until mid-January (although in 1970 all eggs had apparently hatched by 27 December) and, with a fledging period of 3½-4 months, the young probably leave from late March to early May. This cycle is very similar to that described for the Pointe Géologie population (Prévost, 1953). Surprisingly,

TABLE 6

The size of the breeding population of Giant Petrels at Hawker Island

1963-64	8 December	40-50 nests, some with egg. 100 birds in area
1970-71	20 December	150 occupied nests, 60% with egg (= 90 nests with egg). Another 100 birds in area
	27 December	100 nests occupied, 30 unoccupied, 70 chicks, no intact eggs. Total 200 adults
1971-72	16 January	30 nests each with a chick (one just hatched), 1 nest with addled egg. 83 adults
1972-73	4 November	*c.* 50 on nests, *c.* 50% with egg (= *c.* 25 nests with egg)
	10 January	25 nests with chick, 1 nest with egg. 90-95 adults
	28 March	25 young present

TABLE 7
Breeding cycle of Giant Petrels at Hawker Island

	Date	Year	
Laying period	22 October	1972	First egg recorded
	4 November	1972	*c.* 50% of occupied nests have eggs
Hatching period	20 December	1970	First egg hatching
	27 December	1970	"No intact eggs remain"
	10 January	1973	Only one intact egg remains
	16 January	1972	Last chick newly hatched; no fertile eggs remain
Fledging period	28 March	1973	All 25 young still present
	1 May	1961	Fledgling dead on sea-ice

it is about 10 days earlier than for Giant Petrels breeding in the South Orkney Islands at Signy Island, eight degrees of latitude further north (Conroy, 1972).

Up to four white-phased Giant Petrels have been reported at Davis, but none has been recorded breeding. The white phase is rare at other Antarctic colonies but may comprise up to 15% of the population in colonies elsewhere (Shaughnessy, 1971).

Giant Petrels are recorded at Davis every month of the year but are scarce in June, becoming more common thereafter. The extent to which the breeding area is

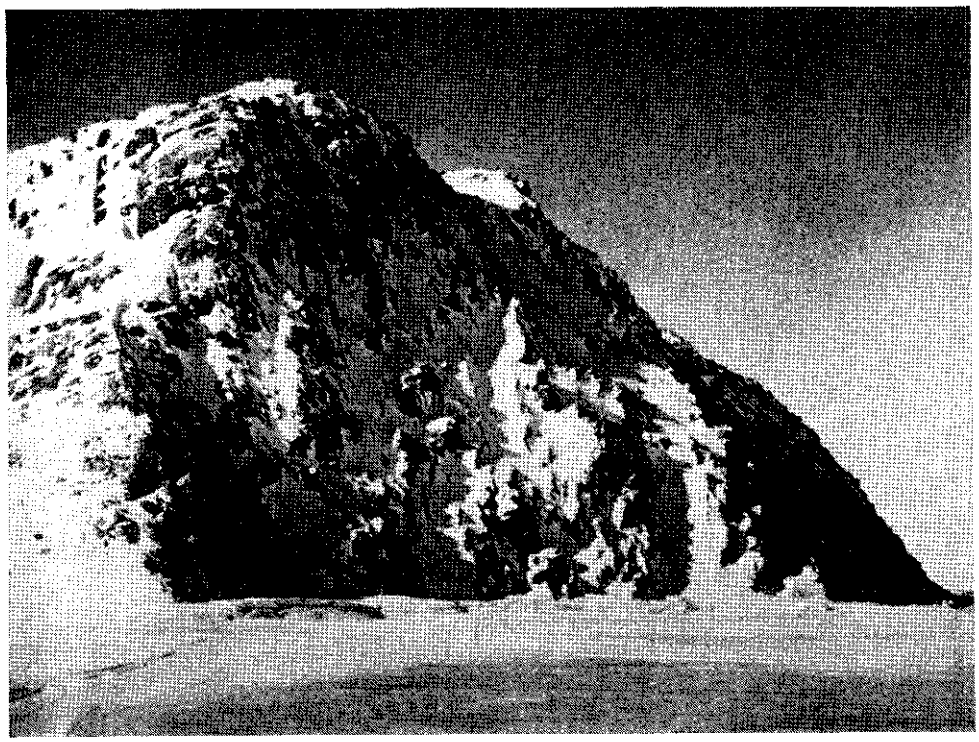
Antarctic Division photograph D. J. Lugg

PLATE 23
A group of Giant Petrels disturbed on the sea-ice in Heidemann Bay.

frequented after the young have left is not known, but about 50 birds were present on 13 August 1972. In January and February large groups occur at seal-carcases and at favoured roosting places (Plate 23); the five biggest groups recorded were estimated at 67 (26 February 1957), 68 (25 January 1960), 100 (3 January 1969, 3 January 1970) and 200 (7 January 1964). Many of these birds may be transient visitors, or possibly young non-breeding adults returning to the breeding area for a short period during the summer.

Young were banded in 1972 and 1973 and there have been two recoveries: a chick banded on 28 March 1973 was drowned on a fishing line in Cook Strait, New Zealand (41°22′S, 174°29′E) on 31 May 1973; another banded at the same time was recovered alive at Northland, New Zealand (35°00′S, 173°27′E) on 3 July 1973. An adult female guarding a small chick in January 1972 had been banded at sea 2,500 km to the north-west in December 1958 (see Appendix II).

Regurgitated pellets of undigested food found in the colony in January 1972 contained the feathers and other parts of penguins, beaks and pens of squid, and legs and feet of several bird species probably including Cape Petrel, Antarctic Petrel, Antarctic Fulmar and prions *Pachyptila* sp. (Johnstone, in preparation).



Antarctic Division photograph D. A. Brown

PLATE 24

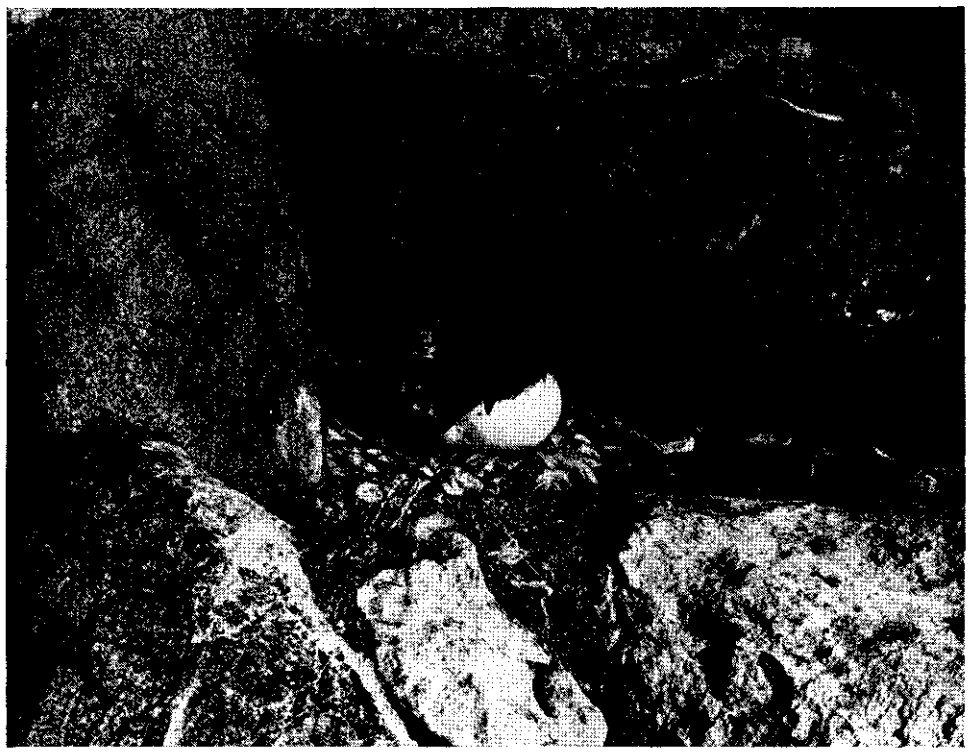
The cliffs at the southern end of Bluff Island, especially favoured by nesting Cape Petrels, photographed in winter.

This last record is of special interest since no prions have been recorded in the Davis area; they occur commonly north of the pack-ice zone, so presumably some Hawker Island Giant Petrels are covering considerable distances to obtain food.

2.3.4. *Cape Petrel*

Cape Petrels have been recorded breeding on 13 islands near Davis (Fig. 4). The largest colony is at the southern end of Bluff Island (Plates 19 and 24) with 200-300 pairs; Turner and Magnetic Islands have about 50 pairs each and the other colonies are all quite small, with from one or two to about 30 nests each. The total breeding population of the area is of the order of 500 pairs. Nest-sites are in partly protected recesses on steep rocky slopes, often at the foot of walls or boulders (Plate 25). Most colonies have southern, south-western or south-eastern aspects, providing shelter from the prevailing northerly and north-easterly winds.

Cape Petrels are absent from the area in winter, although there are a few records in May, one in August and one in September. The annual cycle is outlined in Table 8. The main return to the nesting areas occurs during October,



Antarctic Division photograph G. W. Johnstone

PLATE 25

A typical Cape Petrel nest-site on Bluff Island, partly protected by a boulder.

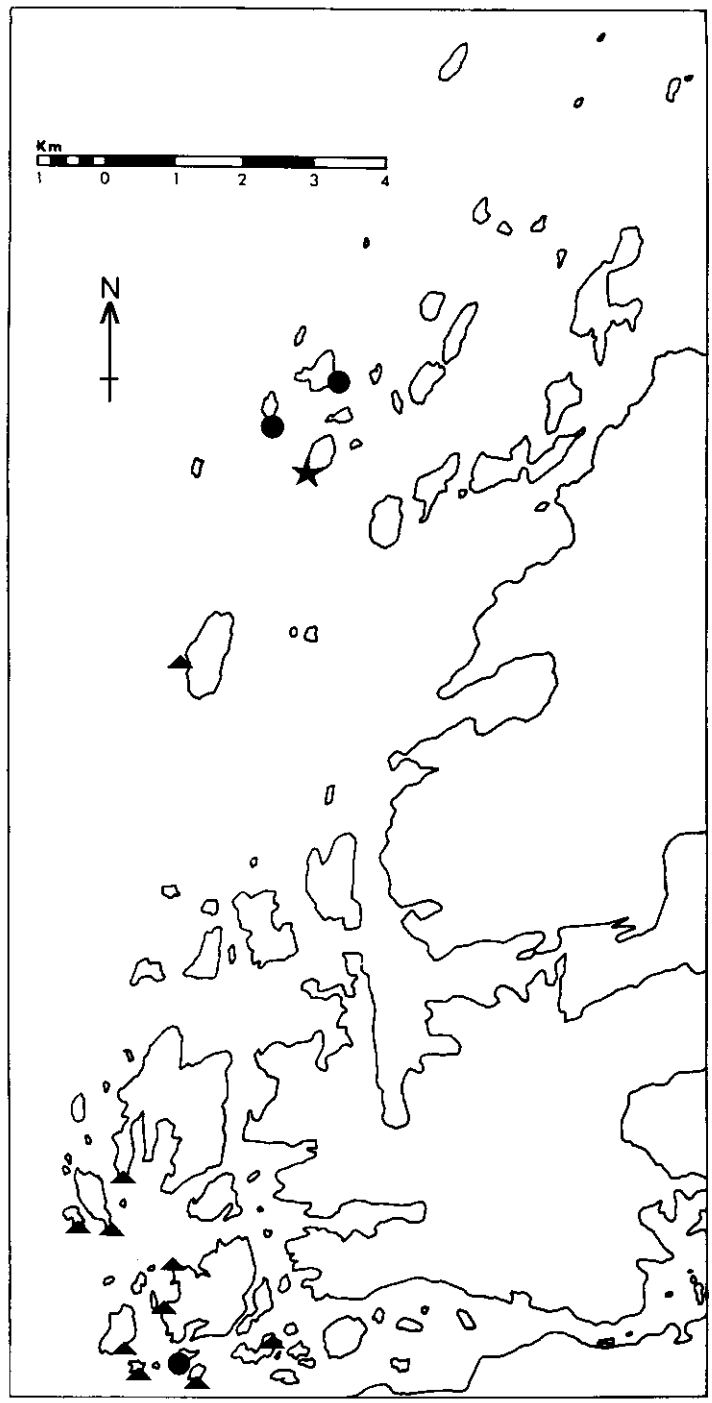


FIGURE 4. Locations of Cape Petrel colonies recorded up to 1973. Their approximate populations are indicated:

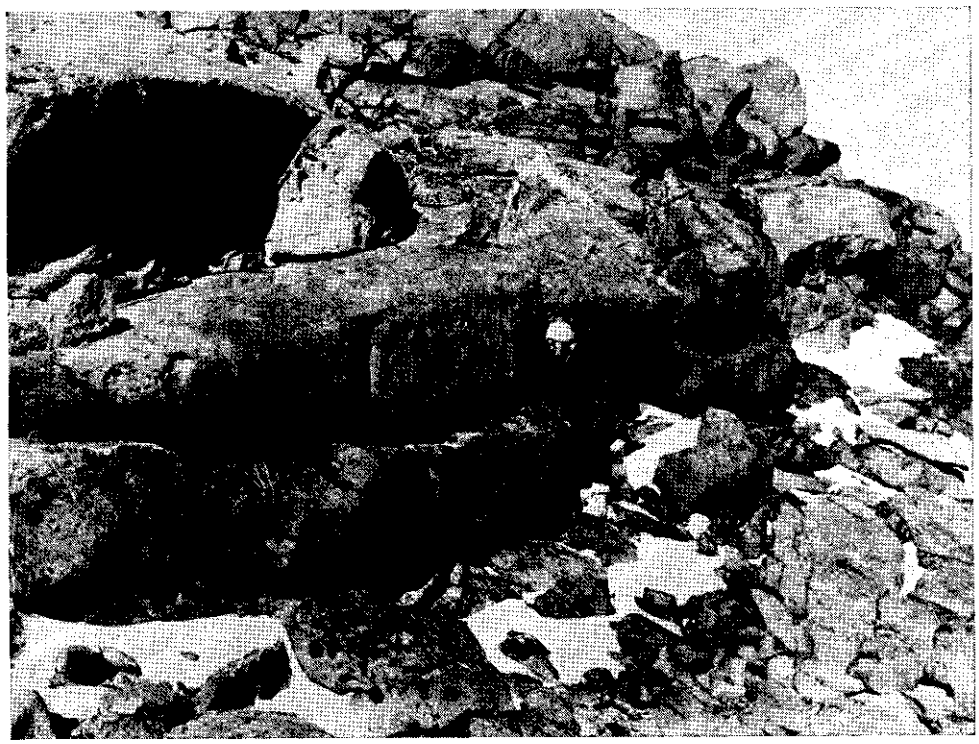
▲ small (1–30 pairs)
● medium (30–100 pairs)
★ large (*c.* 250 pairs)

TABLE 8
Annual calendar for Cape Petrels at the islands of the Vestfold Hills

Year	Earliest record	First egg	First chick	Fledging	Latest record
1957-58	17 October	2 December			4 April
1958-59	15 October				
1959-60	22 October	27 November			"Midwinter"
1960-61	17 October			28 February+	
1961-62	1 October	30 November (several)			18 April
1962-63	No records				
1963-64	14 October				
1969-70	10 September				9 May
	12 October				
1970-71	24 August				May (occasionally seen)
	4 October				
1971-72	17 October		16 January		
1972-73	22 October*		13 January		

\+ Young seen flying from nest
* Clearing out nest-sites

with birds seen cleaning out nest-sites on 22 October 1972. Egg-laying starts in late November. All eggs at Bluff Island were still intact on 15 January 1972 and at one of the southern islands a single chick had hatched on 16 January. The



Antarctic Division photograph D. A. Brown

PLATE 26
Snow Petrel nest-sites, marked by guano and frozen regurgitated oil, in massively jointed gneiss near Platcha.

incubation period for this species is about 45 days (Pinder, 1966) which means laying must start at the beginning of December. Chicks fledge in late February and early March. There are occasional records of adults until May.

2.3.5. *Antarctic Fulmar*

The Antarctic Fulmar does not breed at the Vestfold Hills and is seen there infrequently in summer (earliest record 15 October 1961). The largest numbers recorded at one time were groups of four and ten near Anchorage Island on the "night" of 16 November 1961. Most sightings have been at the outer islands near the Sørsdal Glacier, prompting the suggestion that the species may be breeding at the Rauer Group to the south of the glacier. This has since been confirmed (K. R. Kerry, personal communication).

2.3.6. *Snow Petrel*

The breeding biology of the Snow Petrel in the Vestfold Hills and at Mawson Station was studied by Brown (1966). The species breeds on most islands and at several localities on the mainland (Table 9). The nest is hidden under boulders

Antarctic Division photograph D. A. Brown

PLATE 27

Morainic material near Platcha, providing suitable nest-sites for Snow Petrels and Wilson's Storm-petrels.

TABLE 9
Breeding distribution of the Snow Petrel at the Vestfold Hills

Islands
- Plough
- Lugg
- Magnetic
- Turner
- Bluff
- Anchorage
- Trigwell
- Four islands between Lugg, Magnetic and Bluff
- Gardner
- Mule
- Four islands in Crooked Fjord abutting Sørsdal Glacier
- Topografov, Zvuchnyy, Partizan, Soldat — Only sparse nesting on these islands in Long Fjord

Mainland
- Long Peninsula—sparse throughout
- Southern side of Tryne Fjord to northern side of Long Fjord—fair numbers, nesting at moderate density
- Eastern reaches of Long Fjord—abundant
- Broad Peninsula—fair numbers in the area approximately south and east of Club Lake
- Mule Peninsula—probably nests throughout much of western part. Nest-sites recorded along western end of Crooked Fjord, at the head of Laternula Inlet, and around the northern side of McCallum Lake.

and in clefts (Plates 26 and 27). An important factor in determining breeding success is the blocking of nest-entrances by drift-snow, and most nests are either high on exposed ridges (up to 155 m above sea-level) or in sites lower down where snow does not accumulate. They have been found close to the water's edge beside Crooked Fjord and the eastern reaches of Long Fjord, and on offshore islands. On Bluff Island, Cape Petrels nesting on ledges in front of crevices sometimes hindered Snow Petrels in getting to their nests (Brown, 1966).

Snow Petrels are seen near Davis throughout the year, although only occasionally during June to September when they are presumably dispersed at sea beyond the zone of the fast sea-ice. First arrivals at the start of the breeding cycle are in late September, the main influx occurring about 20 October. Egg-laying is highly synchronized and in 1961 occupied the period 29 November to 6 December. After 42-44 days' incubation, eggs hatch about 10-15 January, and the young birds leave in late February to early March after a fledging period of about 51 days.

Predation by skuas is widespread, as evidenced by picked carcases near breeding areas; Brown (1966) considered it was largely confined to fledglings. After departure in early March, large numbers flock in the eastern reaches of Long Fjord in late April and May before the winter exodus is completed in late May.

2.3.7. *Antarctic Petrel*

There are few records of the Antarctic Petrel in the Davis area, perhaps at least partly due to the readiness with which it can be confused with the Cape Petrel; also its brown and white plumage renders it surprisingly inconspicuous at

nest-sites. During 1961 it was recorded frequently during the first half of May, up to 14 at a time, and again during October and November. During the "night" of 25-26 November "hundreds" were seen flying around Anchorage I., Bluff I., and Magnetic I. following a breakout of sea-ice the previous day which brought open water to the western shores of these islands; groups numbered up to 50 individuals. Although not observed breeding here, this species has recently been found nesting at the Rauer Group (K. R. Kerry, personal communication).

2.3.8. *Wilson's Storm-petrel*

Wilson's Storm-petrel, the smallest bird breeding at the Antarctic Continent, may also be the most numerous. The species is widely dispersed throughout the Vestfold Hills and the islands, nesting in usually inaccessible sites at the ends of tortuous passages dug in the sand and gravel under rocks and boulders (Plate 27). Birds were seen about 160 km to the south-west on the plateau by a sledging party in December 1963. Their nocturnal habits make them relatively inconspicuous, and the breeding population of the area can only be guessed at. On the basis of searches in a few areas, and the frequency with which individuals were encountered and heard calling from nests during nocturnal walks through the hills in late January and early February 1972, nests probably occur at a density of at least one per hectare (2½ acres). This gives a population of at least 40,000 pairs. However, their distribution may be quite clumped. While D. J. Lugg in 1964 found about 50 occupied nests in an area of 50 m x 150 m (0.75 ha) to the south of Davis Beach close to the station, he saw none at Warriner Island during many visits through the first half of summer. D. A. Brown found only three pairs nesting in a 6 ha area at Anchorage Island in 1961. It appears that there is considerable competition for nest-sites. On 22 December 1961, D. A. Brown collected an incubating adult with its egg from a nest on Anchorage Island. The nest was completely renovated over the 24 hours up to midnight on 5 January, and on 10 January a pair of storm-petrels was collected from the nest. On 13 January another bird was in occupation. This was in marked contrast to Snow Petrels; when mated Snow Petrel pairs were collected from nests at Anchorage Island, their nests were not used for breeding that season (Brown, 1966).

Wilson's Storm-petrel breeds relatively late in the Antarctic summer, an adaptation which exposes it to the least risk of snow blocking the entrances of its nest-sites (Beck, 1970). The first return to the mainland is usually noted in late October or early November and the earliest record of an egg is 19 December 1961. The breeding cycle is probably similar to that reported at Terre Adélie by Lacan (1971) with laying during December, an incubation period of about six weeks and a fledging period of seven weeks. Similar data were gathered by D. A. Brown and A. Bolza at Mawson Station in 1958-59. The first storm-petrel footprint was seen in the snow on 17 October, but the first bird was not seen until 19 November. The dates of laying at two nests were 15 December and between 15 and 18 December. The second of these eggs hatched between 20 and 22 January, giving an incubation period of 33-38 days. The young fledge in March and the last records of storm-petrels at Davis are in the first week of April.

2.3.9. *South Polar Skua*

South Polar Skuas breed throughout the area at widely dispersed nests, on most if not all islands and at several mainland locations. Their breeding distribution appears to be broadly correlated with the distribution of Adélie Penguin colonies from which they obtain much of their food in the form of eggs and young chicks during the first half of summer. They are also predators of Snow Petrels, as noted, and probably of storm-petrels too, as well as being general scavengers throughout the area and at the station. Like Giant Petrels they feed at seal-carcases (Plate 28), and in addition they attend the pupping Weddell Seals in late October to scavenge after-births. One was recorded eating a sea-urchin *Sterechinus* sp. stranded on a beach. As Young (1963) made clear, the most important food-source for these skuas is the open sea, especially after the penguin chicks have fledged and the skuas are still feeding young. It may be that South Polar Skuas nest in the same areas as Adélie Penguins, mainly because the habitat is suitable.

A pair nested on the northern shore of Ellis Fjord in 1969-70, beside the Ellis Rapids in 1971-72 (unsuccessfully), on bare ground north of Platcha in 1970-71, and in January 1972 and 1973 a pair raised at least one chick in the inlet just

Antarctic Division photograph D. J. Lugg

PLATE 28
A group of South Polar Skuas at a seal-carcase near Davis

south of Heidemann Bay. Skuas are encountered throughout the mainland area in summer, and careful exploration will probably reveal other pairs nesting away from the penguin colonies.

The breeding population for the area cannot be estimated with any certainty. Magnetic Island, with probably at least 9,000 pairs of Adélies, had at least 10 pairs of skuas attempting to breed in 1961. As already pointed out, the relationship between the skuas and the penguins is probably not a particularly close one despite Eklund's (1961) suggestion of a skua:Adélie ratio of between 1:360 and 1:70. However, taking the Magnetic Island figures of one pair of skuas for every 900 pairs of Adélies, and allowing for a few more pairs nesting not in association with the penguins, there are probably about 150-200 pairs of skuas breeding in the region. The non-breeding population may be considerable; studies in the McMurdo Sound region showed that skuas return to their natal areas at the age of two years but do not start to breed until they are five or six years old (Spellerberg, 1971). During summer 1961-62, when a dog-team was still maintained at Davis, more than 50 skuas regularly attended the dog-line. Smaller groups frequent the station garbage-cans and rubbish-tips. The largest number recorded at a seal-carcase was 60-70, on 1 February 1964. The composition of these groups is not known; presumably they may include breeding birds as well as pre-breeders and failed breeders.

Skuas return to Davis after their winter absence at sea at about the same time as the Adélies (Table 10, *cf.* Table 5). About a month later they start laying and the first chicks hatch during the second half of December. The breeding cycle is not highly synchronized and laying occurs over a period of about a month. A pair were still incubating eggs, probably addled, on 1 February 1972. The last skuas leave the area during the second half of April. Weights and dimensions of skua eggs collected near Davis are given in Appendix III.

A close relative of the South Polar Skua is the Brown Skua *C.s. lonnbergi* which breeds at lower latitudes on the subantarctic islands of the Indian Ocean and the New Zealand region. It is recognised by its slightly larger size and darker colour. The South Polar Skua occurs in two or three colour phases (Spellerberg, 1970b) of which the dark one is probably indistinguishable from the Brown Skua in the field. Hence field sightings of dark brown skuas in Antarctica have to be

TABLE 10
Annual calendar for South Polar Skuas in the vicinity of Davis

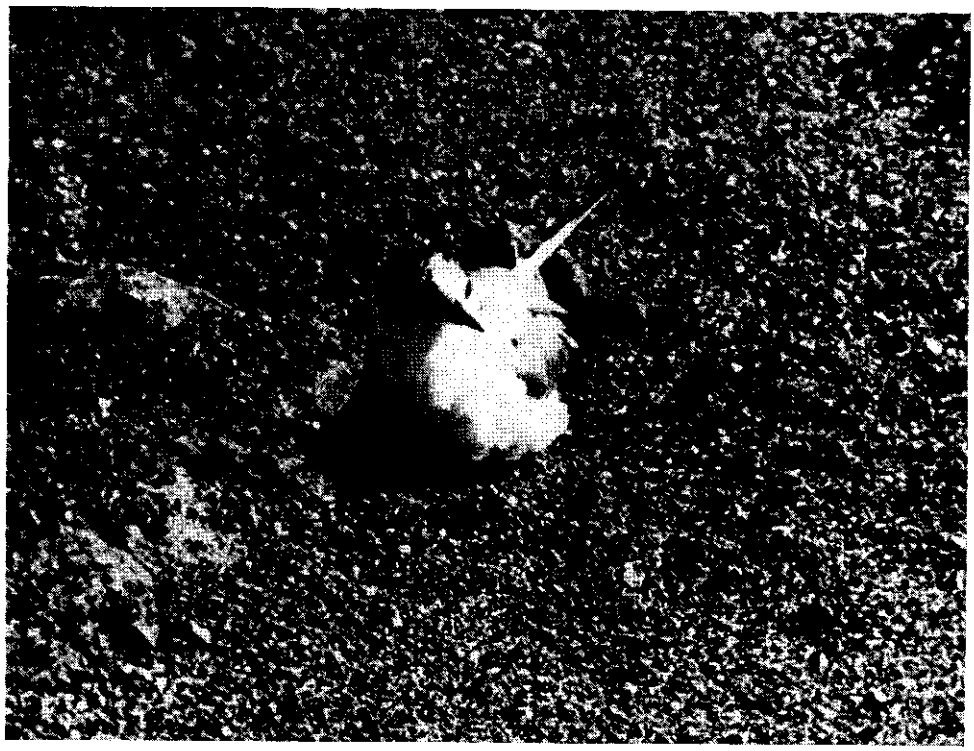
Year	First record October	First egg November	First chick December	Last record April
1956-57				28
1957-58	16	25	19	24
1958-59	13			
1959-60	14			mid-April
1960-61	25 September			23
1961-62	20 October	15		19
1962-63	15			28
1963-64	9			
1968-69				4
1969-70	19	19		22
1970-71	21			
1971-72	10			

treated with caution, and only one record in the Davis logs seems to be acceptable as *C.s. lonnbergi*. This was a bird seen at the station on 3 February 1970 and described as larger, taller, with more mottled and darker plumage than *C.s. maccormicki* and with a different beak and a different call and display.

2.3.10. *Other species*

When the sea-ice breaks right to the coast in summer, oceanic species normally frequenting the northern edge of the pack-ice zone may occasionally stray south and be seen close to the continent. On 21 and 22 January 1973 several birds thought to be White-chinned Petrels *Procellaria aequinoctialis** flew past the station after the sea-ice had drifted out on 20 January. Also at this time a group of six terns, probably Arctic Terns *Sterna macrura*, was found feeding at Heidemann Bay, and remained in the area at least until 1 February, coming ashore to roost (Plate 29). Terns are commonly seen amongst open pack-ice in summer between Mawson and Davis.

The only other species recorded in the area is the Dominican or Southern Black-backed Gull *Larus dominicanus*. A single individual was seen on 16 January 1972 at a small island between Kazak Island and the Sørsdal Glacier. It was standing on a crag about 30 m above the water and flew off as the observer



Antarctic Division photograph T. J. Tierney

PLATE 29
A probable Arctic Tern resting beside Heidemann Bay in late January 1973.

* This record is now considered doubtful.

approached by boat. It was immediately chased by a South Polar Skua and was not seen again. This was the seventh record of the species in Australian Antarctic Territory and there are only three other published records for Eastern Antarctica (Johnstone and Murray, 1972); another was recently sighted on 27 December 1972 at the edge of the fast sea-ice in about 66°40'S, 63°20'E (K. R. Kerry, personal communication). In Western Antarctica the only record outside the Peninsula is at Halley Bay Station (Watson and others, 1971). It breeds on the Antarctic Peninsula down to 68°S, on subantarctic islands, north up the western coast of South America as far as 6°S, in southern Africa, in New Zealand, and has recently started to colonise the south-eastern coast of Australia.

2.4. SEALS

The status of seals at all Australian Antarctic stations was summarised by Ingham (1960). When that paper was written, Davis had been in operation for only three years, and data gathered since then have filled in many details.

Table 11 shows the status of seals occurring at the Vestfold Hills. The Ross Seal *Ommatophoca rossi,* although not recorded ashore anywhere on the Antarctic Continent, occurs in dense pack-ice offshore from Davis in Prydz Bay where it has been recorded during ANARE voyages.

TABLE 11
Status of seals at the Vestfold Hills

Weddell Seal *Leptonychotes weddelli*	Breeds; about 150-200 pups born annually
Crabeater Seal *Lobodon carcinophagus*	Occasional on beaches and sea-ice in summer
Leopard Seal *Hydrurga leptonyx*	Occasional on sea-ice (once on beach) mainly in summer
Southern Elephant Seal *Mirounga leonina*	Non-breeding population present throughout year. Up to 700 on beaches in late summer

2.4.1. *Weddell Seal*

The Weddell Seal is the only species of Antarctic seal which breeds close inshore on fast sea-ice and not in the pack. The breeding cycle was studied in the Davis area by Lugg (1966). The seals are least commonly seen in winter when they are presumably concentrated around the outer edge of the sea-ice. They start to reappear close inshore in late September and early October, and pupping occurs from mid-October until late November. The earliest date for a pup was 12 October in 1971, and a post-partum cow was seen on 11 October 1970. The main pupping areas are in the north: in much of Long Fjord, especially in Weddell Arm and Shirokaya Bay, and in Tryne Fjord. There are few good counts of breeding numbers, but counts in Long Fjord suggest that up to 150 pups are born there each year (Table 12). Allowing another 50 for Tryne Fjord and any other parts not covered, the total output for the area is at least 200 pups. The behaviour of bulls in the breeding organisation is poorly documented, and few have been recorded in the pupping areas. Copulation apparently occurs in the water and has been seen only once (Cline and others, 1971); the cows mate after the pups are weaned at six to seven weeks old.

TABLE 12
Counts of Weddell Seals in Long Fjord in November

Year	Weddell Arm		Remainder of western half of Long Fjord		Total	
	Adults	Pups	Adults	Pups	Adults	Pups
1959	63	58				
1960					105	84
1962			100	70		
1963	59	54	96	71	155	125
1969	65	"many"				
1971					106	87
1972					*c.* 150	149

Through the summer, moulting Weddell Seals continue to frequent the sea-ice where it remains firm around the coast and in the fjords (Plate 30), some individuals hauling out onto sandy beaches where the sea-ice has broken right away (Plate 31). In January-February 1972 there were 120 on the ice at the entrance to Long Fjord, 28 in Weddell Arm, 49 in the north-eastern corner of Breid Basin at the head of Long Fjord, 11 in a small bay in Ellis Fjord, and about 10 noted here and there on beaches. Probably there were many more in other unvisited parts of the fjords, suggesting that most of the local population remains in the area throughout the summer.

Antarctic Division photograph G. W. Johnstone

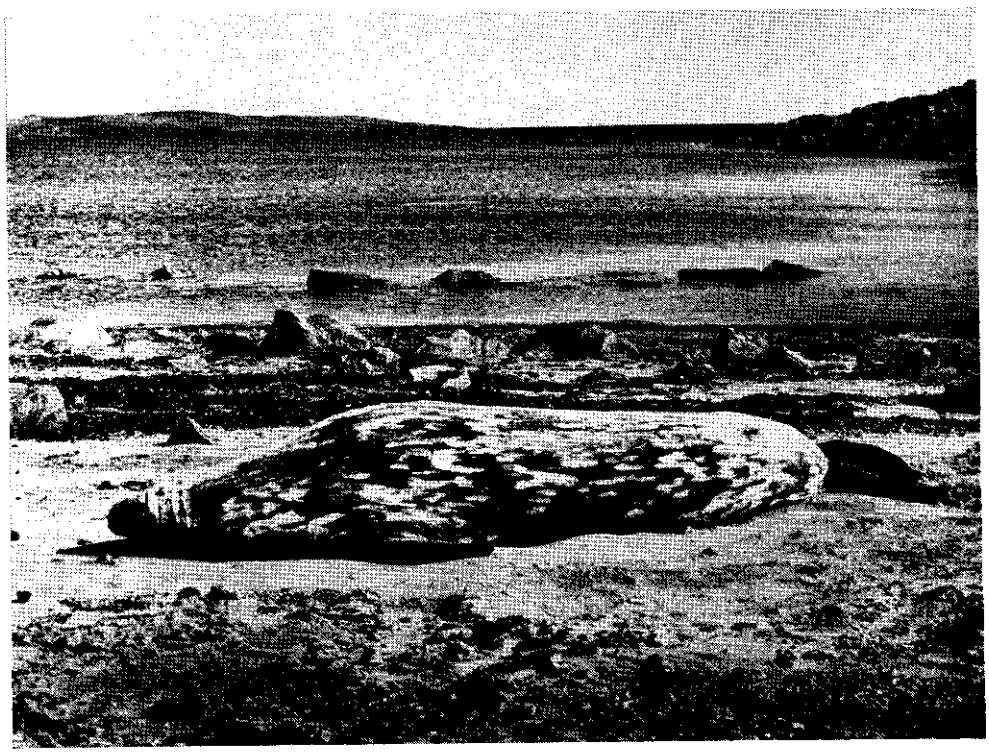
PLATE 30
Weddell Seals on rotten sea-ice at the entrance of Long Fjord in January 1972.

In the early years of occupation of Davis when a dog-team was maintained, Weddell Seals were killed for dog-meat. The greatest number killed in one year was 49 in 1957 (Appendix IV). Otherwise, visible mortality in the area is negligible. The dehydrated carcases of seals, some of which have been described as Weddells, have been found at various locations throughout the Vestfold Hills. A well-preserved and presumably fairly fresh Weddell carcase (Plate 32) was found 270 m above sea-level on the ice-plateau about six kilometres south-east of Platcha on 9 August 1963. It was only 164 cm long; as the newly born pup measures about 145 cm (King, 1964) this was probably the shrunken carcase of a weaned pup which had headed inland instead of seaward.

Parasitisation of this species by the louse *Antarctophthirus ogmorhini* has already been noted. Internal infestation with nematodes is common; a male was observed regurgitating a wriggling mass of these worms on a beach on 5 February 1972, a habit suggested by Feltz (1967).

2.4.2. *Crabeater Seal*

All records of Crabeater Seals near Davis are listed in Table 13. Stray individuals appear infrequently on the beaches and inshore ice, exclusively in summer. Their true home is in the pack-ice where they are seen in large numbers during



Antarctic Division photograph G. W. Johnstone

PLATE 31

A bull Weddell Seal on a beach on Mule Peninsula in February 1972.

TABLE 13
Occurrence of Crabeater Seals near Davis

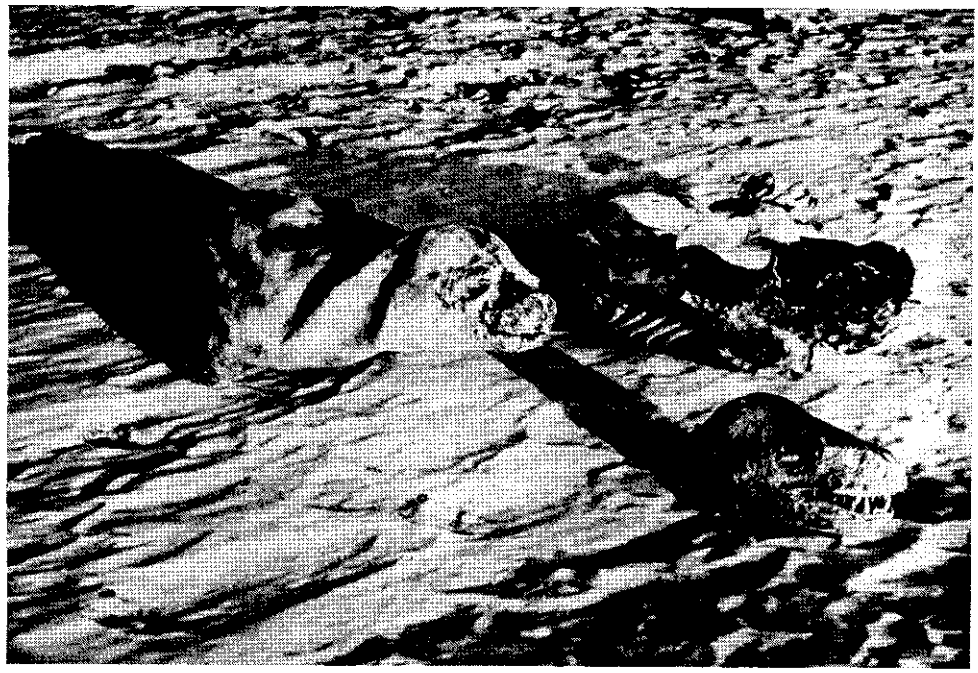
Year	January	February	March	December
1958	1	1, 2		
1960			1, 1	
1961		1		
1962		1	2, 1	
1963	1	1	(1)	
1964	(1)	1, 2, 1, 1		
1969			1	
1970			1	2

NOTE: Figures in brackets represent uncertain identifications

ANARE voyages. In earlier years, crabeaters tended to be taken for dog-meat whenever they appeared at Davis, but none has been killed since 1963 (Appendix IV). The carcases of at least two crabeaters were found about 15 m from the water's edge at the south-eastern corner of Deep Lake. Most seal-carcases found inland at other Antarctic oases have been identified as crabeaters (Péwé and others, 1959; Barwick and Balham, 1967), and probably many of those in the Vestfold Hills will prove to be of this species.

2.4.3. *Leopard Seal*

The occurrence of the Leopard Seal in the vicinity of Davis (Table 14) is similar to that of the Crabeater Seal, never being recorded in winter. Leopard



Antarctic Division photograph D. J. Lugg

PLATE 32

Carcases of a Weddell Seal and a Leopard Seal (head was attached to carcase when discovered) found on the ice-plateau six and three kilometres from Platcha respectively.

TABLE 14
Occurrence of Leopard Seals near Davis

Year	January	February	March	April	October	November	December
1955	1						
1960	(1)						(1)
1962	1						1
1963	1					1	1, 1
1964							
1965	1 or 2					1	2
1969							
1970			1	2	1		
1972	3						

NOTE: Figures in brackets represent uncertain identifications

Seals are notorious as predators of Adélie Penguins. At Davis they have been recorded chasing and catching Adélies on at least three occasions: near Magnetic Island on 30 January 1955 and 3 January 1965, and near Gardner Island on 27 December 1969. Several carcases found inland, including four at Club Lake, two at Lake Stinear and one at Deep Lake, have been identified as Leopard Seals. A partly eroded carcase of this species was found 210 m above sea-level on the ice-plateau about three kilometres south-east of Platcha on 9 August 1963 (Plates 32 and 33).

Antarctic Division photograph W. F. Young

PLATE 33
The head of the Leopard Seal shown in Plate 32.

2.4.4. *Southern Elephant Seal*

The Southern Elephant Seal is a predominantly subantarctic species, breeding at most subantarctic islands as far south as King George Island (62°S) in the South Shetland Islands, north-east of the tip of the Antarctic Peninsula. Outside the breeding season these seals disperse at sea; non-breeding groups occur at Ile St Paul and Ile Amsterdam and Tristan da Cunha to the north of their breeding range, and at the Vestfold Hills on the Antarctic Continent to the south (King, 1964). The discovery here of a regular hauling-out ground where several hundred Elephant Seals come ashore to moult and rest was recorded by Ingham (1957). Individuals have been recorded at other localities at and near the continent, and a non-breeding group of up to 32 seals has been reported at Peterson Island about 30 km from Casey (Ingham, 1960); but no other Antarctic locality is known to attract Elephant Seals in such large numbers as the Vestfold Hills.

The occurrence of Elephant Seals near Davis varies throughout the year. Although the species has been recorded in every month, there are few records during August to October. This is the period when most mature Elephant Seals are ashore at the breeding grounds. Their absence from the Vestfold Hills at this time emphasises the non-breeding status of this hauling-out ground; presumably most leave the area to visit subantarctic breeding stations.

The annual cycle of formation and breakout of sea-ice in the region has a major influence on the arrival of these seals on the mainland beaches. While the sea-ice remains firm between the islands and the mainland, any Elephant Seals that leave the water remain close to it at the edge of the sea-ice. During November and December numbers increase rapidly in the region of Kazak I. and Mule I., an area favoured probably because of the frequent presence of open water nearby, with a maximum of 358 recorded on 17 December 1957. As the sea-ice begins to break up east of the islands, it becomes unsafe for travel by observers; the Elephant Seals remain at the ice-edge, and consequently there are no counts available for this period. Once the sea-ice has broken out more or less completely, most of the Elephant Seals move in to the sandy beaches of the mainland. The most favoured beaches are those between two kilometres north of Davis and the entrance of Ellis Fjord. The maximum count for these beaches was 703 on 4-5 April 1969. When the sea-ice begins to freeze at the end of summer, the seals begin to move out to the islands again, but they cannot be visited by observers until the ice is firm enough for travel.

During March 1957 to May 1958 all Elephant Seals on beaches between Davis and Ellis Fjord, and at accessible islands south to Kazak Island, were counted at least once a month. The same was done 13 years later throughout 1970. The results are shown in Figure 5. The data for each year are similar—an increase in numbers through the summer to a maximum in March or April. Thereafter numbers declined steadily, but as late as July there were still 34 seals in the area in 1957 and 53 in 1970.

Despite annual variations in the maximum number of Elephant Seals recorded in the area (Table 15), there is no indication of a long-term change in population size. Davis Beach, the only beach actually in the station area (Plate 2), has been

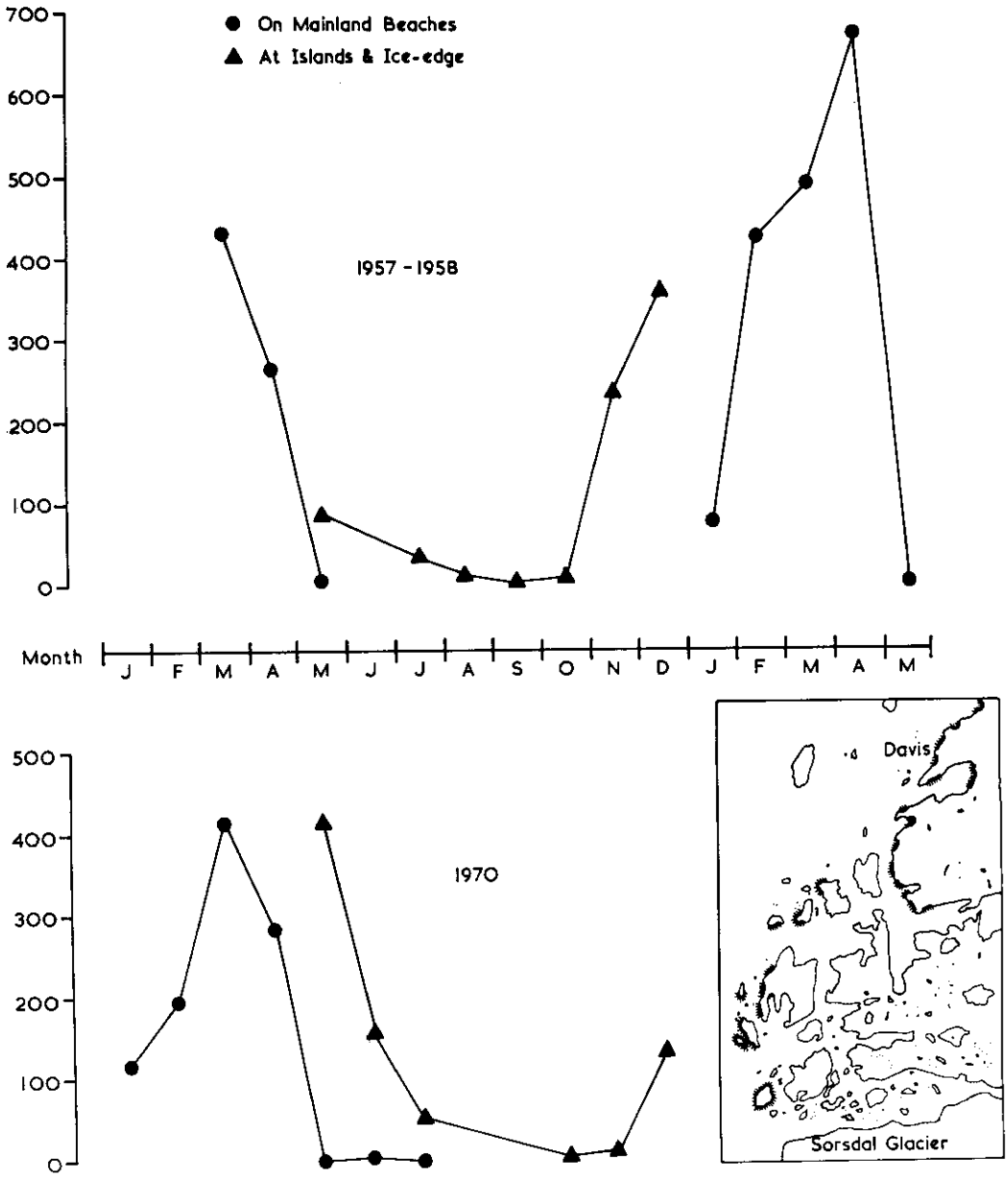


FIGURE 5. Maximum count each month of Elephant Seals at islands and mainland beaches in 1957-8 and 1970. Inset map indicates areas favoured by Elephant Seals.

particularly favoured by Elephant Seals in some years, especially in 1970. Numbers of seals at this beach vary considerably from year to year (Fig. 6). The reasons for this are not clear, but may be related in part to the amount of disturbance to which the seals are subjected. In 1957 23 were killed here for dog-meat (Appendix IV); at times they have been driven away from the vicinity of nearby installations.

The arrival and departure of seals at Davis Beach, as at other beaches, is related to the sea-ice regime as described above. In 1957 and 1970, the ice broke out in January and seal numbers rose steadily thereafter (Fig. 6). In 1958, by contrast, although there were many on the southern beaches (Fig. 5), very few came onto Davis Beach until the end of March when a blizzard blew the sea-ice out from in front of the station. Numbers increased rapidly but then declined as the sea froze again. However, many seals remain on the beaches until after the sea-ice has formed, and the last to depart may have to traverse some 10 km of ice before reaching open water.

The great majority of these seals are male, mostly of pre-breeding size (up to 3.5 m in length). A few are much larger, certainly large enough to be of breeding status. Cows occur in very small numbers; the largest proportion was three females out of a total of 108 seals counted in the area on 20 January 1972. Out of a total of 1,740 Elephant Seals (presumably including many repeats) sexed in 1961, only 13 were female, giving a sex ratio of 133:1. On average probably less than one per cent of the population are cows.

Two branded bulls have been reported, both branded as pups at Heard Island 1,750 km north. One found on 26 August 1957 was in its fifth year, the other on 28 November 1957 was in its sixth. The origins of this population are not known. There seem to be two obvious possibilities. These may be animals which have "dropped out" of the subantarctic breeding populations and have adopted a life in Antarctic waters, never returning to the established breeding grounds and so never breeding. Alternatively, and perhaps more probably, they may belong to the breeding populations but have adopted the habit of migrating south to feed in Antarctic waters, and consequently find it convenient to come ashore to moult in Antarctica rather than returning to the breeding island, as do most of the population.

The local movements of these seals have not been studied. The annual pattern of a slow build-up to a peak and subsequent decline in numbers is consistent with

TABLE 15
Maximum annual counts of Elephant Seals in the region from 2 km north of Davis south to the Sørsdal Glacier

Date	Total	Localities searched
6 March 1957	428	Beaches between Davis and Ellis Fjord
2 April 1958	676	
20 March 1961	*c.*560	
18 March 1962	*c.*600	
4-5 April 1969	703	All mainland beaches
25 March 1970	415	Some mainland beaches
22-24 May 1970	416	Mostly at outer islands
17 March 1971	380	Davis Beach
9-12 March 1972	450	All mainland beaches

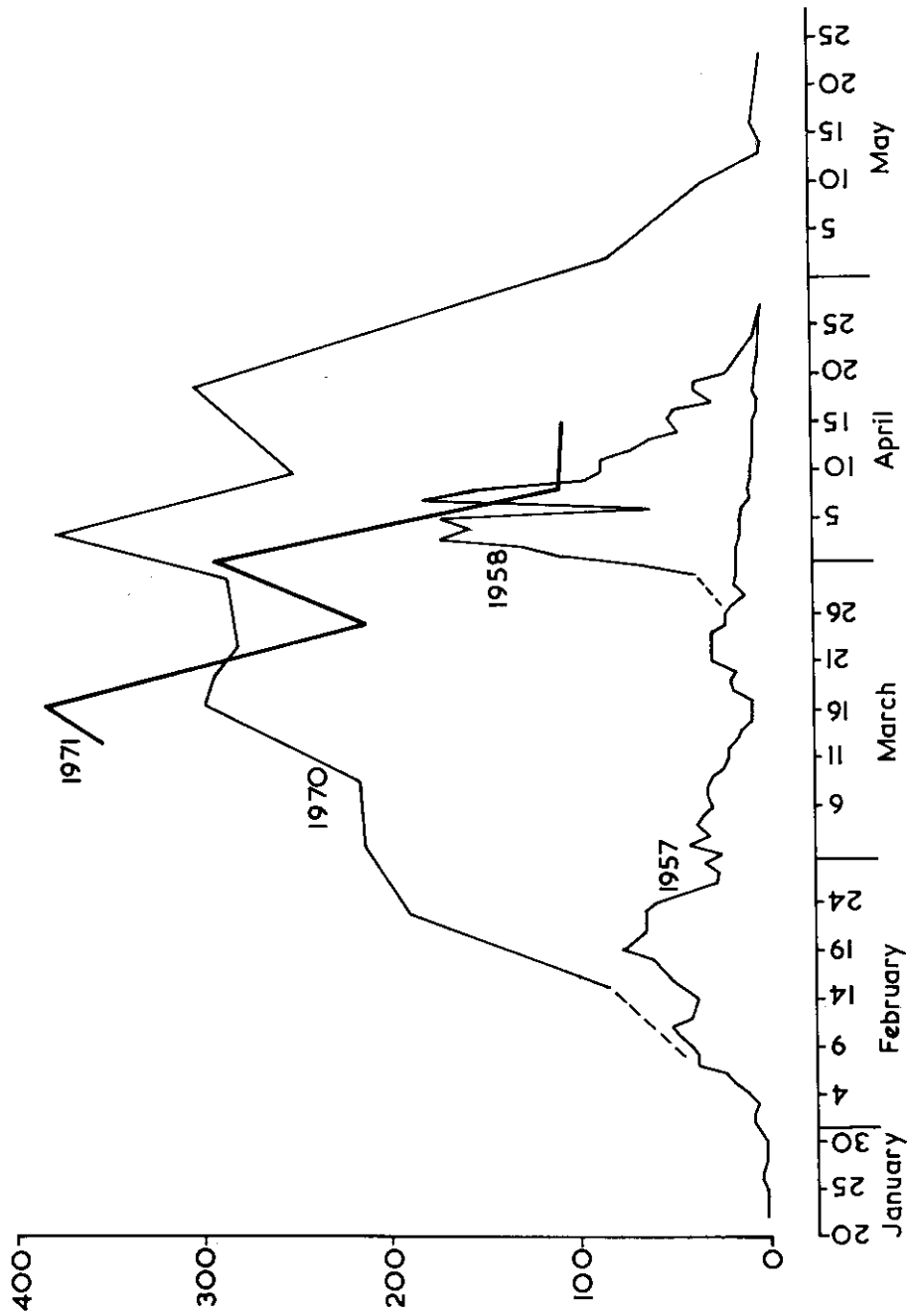


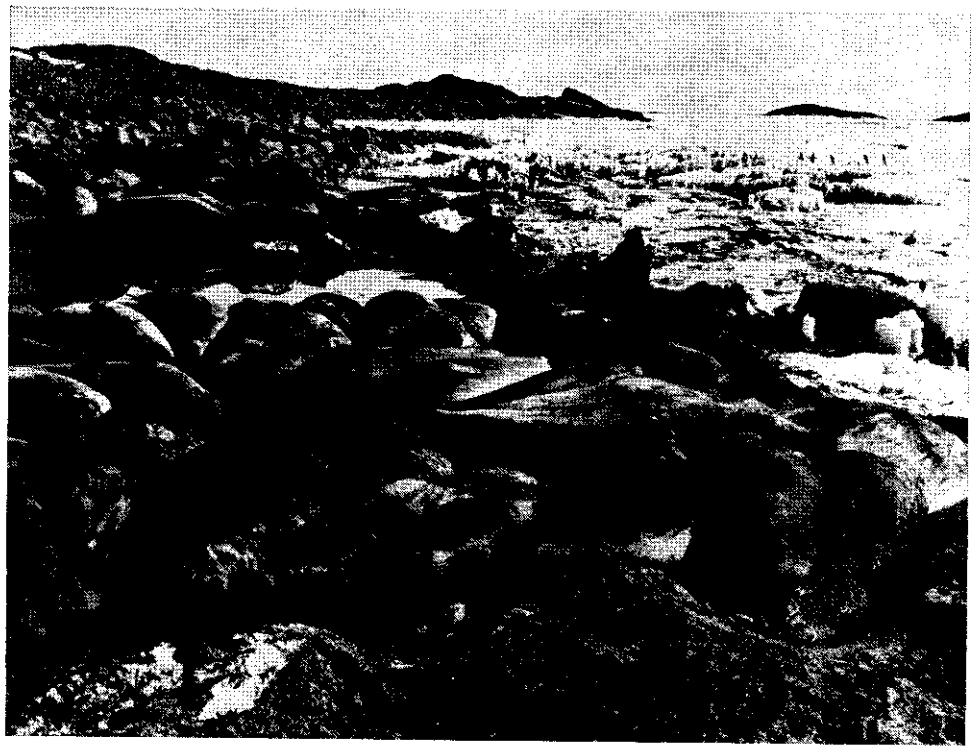
FIGURE 6. Numbers of Elephant Seals on Davis Beach in four years.

the view that individuals arrive and stay in the area for several months; in this case the maximum counted should be close to the actual numbers utilising the area. If there were a rapid turnover of individuals, each staying for only a few days or weeks, the total involved would be much greater than would ever be seen ashore at one time. A marking program currently in progress should provide information on this question.

The seals gather on the beaches in dense groups. Wallows are sometimes formed in meltwater pools (Plate 34), but usually the seals lie on dry sand. Probably these beaches are favoured because they are easily accessible from the sea, and offer greater security and freedom from disturbance than the pack-ice.

An unusually long period of submergence was recorded by D. A. Brown in 1961. He watched an Elephant Seal submerge in a tide-crack and remain underwater for 34 minutes before surfacing. King (1964) gives 20-30 minutes as about the limit for the length of seals' dives, but presumably when resting, as this one was, the period may be considerably longer. Weddell Seals can stay under for at least one hour (Elsner and others, 1970).

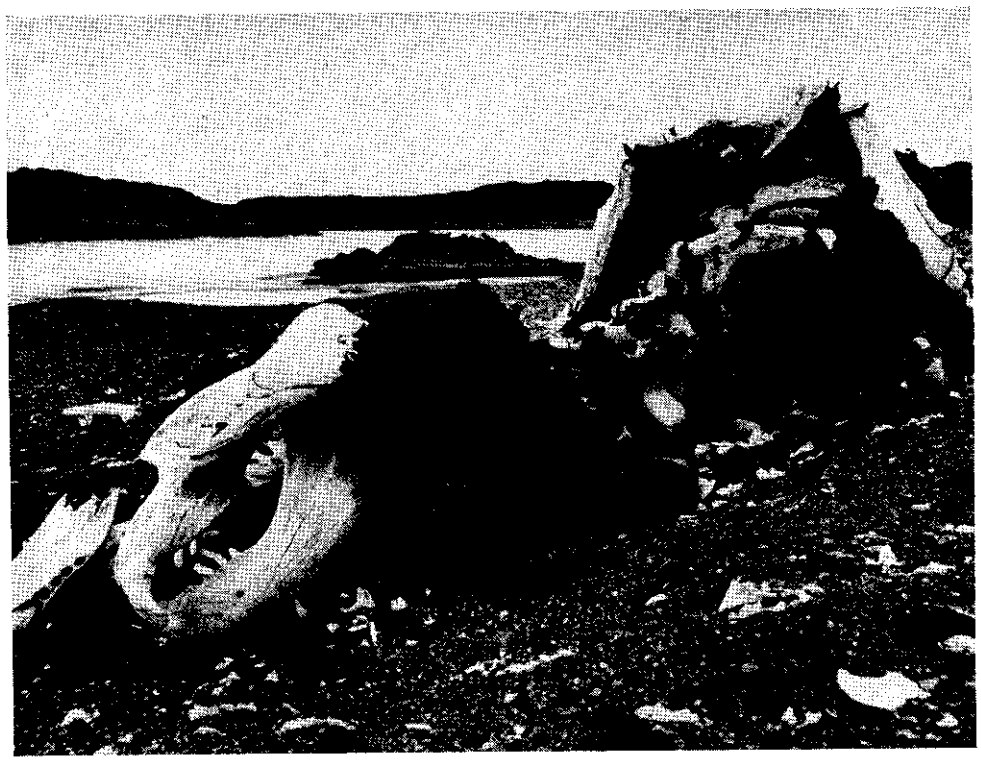
In February 1972 three carcases of Elephant Seals were found on the western beach of Cemetery Lake and one on the southern beach of Laternula Lake (Plate



Antarctic Division photograph W. Dingle

PLATE 34
Elephant Seals in a wallow near Davis

35). Others have been recorded at Lake Dingle and at Deep Lake. One was swimming in Cemetery Lake, which is separated from Ellis Fjord by a low saddle only about 150 m wide, on 6 February 1972.



Antarctic Division photograph G. W. Johnstone

PLATE 35

The eroded carcase of an Elephant Seal beside Laternula Lake.

3. ACKNOWLEDGEMENTS

This report is based on observations recorded by men stationed at Davis since it was established in 1957. We gratefully acknowledge their contributions, and trust that they feel that their efforts have been justified. We are indebted to Dr P. A. Arriens for his assistance in the Vestfold Hills in summer 1972 and his stimulating comments on the physical geography of the area. We also thank Mr D. E. Rounsevell for investigating some of the material in the early sections, Mr R. Williams for his comments on the lakes and their biology, Mr R. B. Filson for identifying lichens and commenting on earlier records, and Dr B. J. Smith for identifying invertebrates. Mr D. R. Grace and Mr D. E. Rounsevell kindly allowed us to quote their preliminary findings from research currently in progress.

The publication of this report was authorized by the Director, Antarctic Division, Department of Science.

4. REFERENCES

AKATOVA, N. A. (1964). The occurrence of *Daphniopsis studeri* Rühe (Cladocera) in Lake Posadochnoe of the Vestfold "oasis" (East Antarctica). *Rezul'taty Biolgicheskikh Issledovanii Sovetskoi Antarkticheskoi Eksspeditsii (1955-1958)*: 190-193.

BARWICK, R. E. *and* BALHAM, R. W. (1967). Mummified seal carcases in a deglaciated region of South Victoria Land, Antarctica. *Tuatara (Journal of the Biological Society of the Victorian University, Wellington, New Zealand)* **15**: 165-180.

BORUTSKII, E. V. (1962). New data on *Acanthocyclops mirnyi* Borutzky et M. Vinogradov from Antarctica. *Zoologicheskii zhurnal* **41**: 1106-1107.

BECK, J. R. (1970). Breeding seasons and moult in some smaller Antarctic petrels. *In* M. W. Holdgate (ed.), "Antarctic Ecology". Vol. 1. (Academic Press: London): 542-550.

BROWN, D. A. (1966). Breeding biology of the Snow Petrel *Pagodroma nivea* Forster. *ANARE Scientific Reports*, Series B, (I), Zoology. Publication No. 89.

BUDD, G. M. (1961). The biotopes of Emperor Penguin rookeries. *Emu* **61**: 171-189.

BUDD, G. M. (1962). Population studies in rookeries of the Emperor Penguin *Aptenodytes forsteri*. *Proceedings of the Zoological Society of London* **139**: 265-288.

CLINE, D. R., SINIFF, D. B. *and* ERICKSON, A. W. (1971). Underwater copulation of the Weddell Seal. *Journal of Mammalogy* **51**: 216-218.

CONROY, J. W. H. (1972). Ecological aspects of the biology of the Giant Petrel *Macronectes giganteus* (Gmelin) in the Maritime Antarctic. *British Antarctic Survey Scientific Reports*, No. 75.

CRESPIN, I. (1960). Some recent Foraminifera from Vestfold Hills, Antarctica. *Scientific Reports of Tohoku University*, Series 2, **4**: 19-31.

CROHN, P. W. (1959). A contribution to the geology and glaciology of the western part of Australian Antarctic Territory. *ANARE Reports*, Series A, (III), Geology. Publication No. 49.

DAYTON, P. K., ROBILLIARD, G. A. *and* DE VRIES, A. L. (1969). Anchor ice formation in McMurdo Sound, Antarctica, and its biological effects. *Science* **163**: 273-275.

EKLUND, C. R. (1961). Distribution and life history studies of the South Polar Skua. *Bird-Banding* **32**: 187-223.

ELSNER, R., KOOYMAN, G. L. *and* DRABEK, C. M. (1970). Diving duration in pregnant Weddell Seals. *In* Holdgate, M. W. (ed.), Antarctic Ecology, Vol. 1. (Academic Press: London): 477-482.

FELTZ, E. T. (1967). Evidence of regurgitation of nematodes by a Weddell Seal *Leptonychotes weddelli* (Lesson 1826), at McMurdo Sound, Antarctica. *Säugetierk Mitteil.* **13**: 55-57.

FILSON, R. B. (1966). The lichens and mosses of Mac.Robertson Land. *ANARE Scientific Reports*, Series B, (II), Botany. Publication No. 82.

FILSON, R. B. (in press). Studies in Antarctic Lichens I. *Muelleria* **3**.

GILL, E. D. (1955). Radiocarbon dates for Australian archeological and geological samples. *Australian Journal of Science* **18**: 49-52.

HEYWOOD, R. B. (1972). Antarctic limnology: a review. *British Antarctic Survey Bulletin*, No. 29: 35-65.

INGHAM, S. E. (1957). Elephant Seals on the Antarctic Continent. *Nature* **180**: 1215-1216.

INGHAM, S. E. (1959). Banding of giant petrels by the Australian National Antarctic Research Expeditions, 1955-1958. *Emu* **59**: 189-200.

INGHAM, S. E. (1960). The status of seals (Pinnipedia) at Australian Antarctic stations. *Mammalia* **24**: 422-430.

JOHNSTONE, G. W. *and* MURRAY, M. D. (1972). Dominican Gulls in Australian Antarctic Territory. *Australian Bird Bander* **10**: 59-60.

KING, J. E. (1964). "Seals of the World". (Trustees of the British Museum (Natural History): London).

KOROTKEVICH, V. S. (1964). Concerning the population of water bodies in the oases of East Antarctica. *Soviet Antarctic Expedition Information Bulletin* **1**: 154-161.

LACAN, F. (1971). Observations écologiques sur le Pétrel de Wilson (*Oceanites oceanicus*) en Terre Adélie. *Oiseau (Révue française d'Ornithologie)* **41**, special no.: 65-89.

LAW, P. G. (1958). Australian coastal exploration in Antarctica. *Geographical Journal* **124**: 151-162.

LAW, P. G. (1959). The Vestfold Hills. *ANARE Reports,* Series A, (I), Narrative. Publication No. 47.
LIED, N. T. (1963). Notes on sastrugi and snow dune observations, ANARE satellite station, Vestfold Hills, 1961. *Australian Meteorological Magazine* No. 40: 35-46.
LUGG, D. J. (1966). Annual cycle of the Weddell Seal in the Vestfold Hills, Antarctica. *Journal of Mammalogy* **47**: 317-322.
MCLEOD, I. R. (1963a). The saline lakes of the Vestfold Hills, Princess Elizabeth Land. *Antarctic Geology, SCAR Proceedings 1963.* II. Geomorphology: 65-72.
MCLEOD, I. R. (1963b). An outline of the geology of the sector from 45°E to 80°E, Antarctica. *SCAR Bulletin* No. 15: 262-275.
MCLEOD, I. R. (1967). Glaciological observations in Enderby, Kemp and Mac.Robertson Lands, Antarctica. *ANARE Interim Reports,* Series A, (IV), Glaciology. Publication No. 90.
MELLOR, M. (1960). Sea-ice measurements at Mawson and Davis, 1954-58. *ANARE Interim Reports* No. 19. Publication No. 55.
MURRAY, M. D., ORTON, M. N. *and* CAMERON, A. S. (1967). The Antarctic Flea *Glaciopsyllus antarcticus* Smit and Dunnet. *Antarctic Research Series* **10**: 393-395.
MURRAY, M. D., SMITH, M. S. R. *and* SOUCEK, Z. (1965). Studies on the ectoparasites of seals and penguins. II. The ecology of the louse *Antarctophthirus ogmorhini* Enderlein on the Weddell Seal *Leptonychotes weddelli* Lesson. *Australian Journal of Zoology* **13**: 761-771.
PENNEY, R. L. (1968). Territorial and social behaviour in the Adélie penguin. *Antarctic Research Series* **12**: 83-131.
PÉWÉ, T. L., RIVARD, N. R. *and* LLANO, G. A. (1959). Mummified seal carcasses in the McMurdo Sound region, Antarctica. *Science* **130**: 716.
PINDER, R. (1966). The cape pigeon *Daption capensis* Linnaeus, at Signy Island, South Orkney Islands. *British Antarctic Survey Bulletin* **8**: 19-47.
PRÉVOST, J. (1953). Notes sur l'écologie des pétrels de Terre Adélie. *Alauda* **21**: 205-222.
PRÉVOST, J. (1961). "Ecologie du Manchot empereur *Aptenodytes forsteri*". (Hermann: Paris).
PRYOR, M. E. (1968). The avifauna of Haswell Island, Antarctica. *Antarctic Research Series* **12**: 57-82.
SHAUGHNESSY, P. D. (1971). Frequency of the white phase of the southern giant petrel, *Macronectes giganteus* (Gmelin). *Australian Journal of Zoology* **19**: 77-83.
SPELLERBERG, I. F. (1970a). Abandoned penguin rookeries near Cape Royds, Ross Island, Antarctica and ^{14}C dating of penguin remains. *New Zealand Journal of Science* **13**: 380-385.
SPELLERBERG, I. F. (1970b). Body measurements and colour phases of the McCormick Skua *Catharacta maccormicki. Notornis* **17**: 280-285.
SPELLERBERG, I. F. (1971). Aspects of McCormick Skua breeding biology. *Ibis* **113**: 357-363.
STRANDTMANN, R. W. (1967). Terrestrial Prostigmata (Trombidiform mites). *Antarctic Research Series* **10**: 51-80.
STRETEN, N. A. (1969). Aspects of the frequency of calms in Antarctica. *Polar Record* **14**: 463-470.
TAYLOR, R. H. (1962). The Adélie Penguin *Pygoscelis adeliae* at Cape Royds. *Ibis* **104**: 176-204.
TOLSTIKOV, YE.I. *ed.* (1966). "Atlas Antarktiki (Atlas of the Antarctic)". (Glavnoye Upravleniye Geodezii i Kartografii: Moscow, Leningrad).
VORONOV, P. S. (1964). On the geomorphology of East Antarctica. *Soviet Antarctic Expedition Information Bulletin* **1**: 20-24.
WATSON, G. E., ANGLE, J. P., HARPER, P. C., BRIDGE, M. A., SCHLATTER, R. P., TICKELL, W. L. N., BOYD, J. C. *and* BOYD, M. M. (1971). Birds of the Antarctic and Subantarctic. *Antarctic Map Folio Series*—Folio 14. (American Geographical Society: New York).
WILLING, R. L. (1958). Australian discoveries of emperor penguin rookeries in Antarctica during 1954-57. *Nature* **182**: 1393-1394.
YOUNG, E. C. (1963). Feeding habits of the South Polar Skua, *Catharacta maccormicki. Ibis* **105**: 301-318.

APPENDICES

I. List of lichens recorded from Vestfold Hills.

II. Bird-banding and recoveries at Davis.

III. Weights and dimensions of freshly laid eggs of six two-egg clutches of South Polar Skuas *Catharacta skua maccormicki* collected by D. A. Brown near Davis.

IV. Numbers of seals killed at Davis since 1957.

APPENDIX I

List of lichens recorded from Vestfold Hills

Specimens have been deposited at the National Herbarium, Melbourne. The location of the most productive site, on the northern bank of Ellis Rapids, is approximately 68°36′S, 78°13′E.

Acarospora gwynnii Dodge & Rudolph
(1) Rock outcrop at edge of plateau, 68°28′S, 78°29′E, *c.* 70 m a.s.l., 9.ii.72
(2) Ellis Rapids, 4.i.73
(3) Valley south from Club Lake, 4.i.73

Alectoria minuscula Nyl.
(1) North-east of Lake Druzhby, 68°35′S, 78°25′E, 1961

Biatorella antarctica Murray
(1) Rock outcrop at edge of plateau, 68°28′S, 78°29′E, *c.* 70 m a.s.l., 9.ii.72
(2) North-east of Lake Druzhby, 68°35′S, 78°25′E, 1961
(3) A specimen collected at Magnetic Island, 68°33′S, 77°53′E, in 1955, was identified as *Sarcogyne angulosa* Dodge & Baker (Law, 1959). Filson (personal communication) suggests it may have been a weathered specimen of *B. antarctica*

Buellia frigida Darb.
(1) Ellis Rapids, on stones and rocks, usually in moderately sheltered situations with southern or south-western aspect, also sometimes northern or north-eastern aspect, seldom on vertical faces; very common, 27.i.72, 4.i.73
(2) Rock outcrop at edge of plateau, 68°28′S, 78°29′E, *c.* 70 m a.s.l., 9.ii.72
(3) Very common in sand and rock gullies on western side of Stalker Hill, 68°31′S, 78°27′E, 10.ii.72
(4) On dolerite (glacial pavement), southern aspect, and also on small stones, generally sheltered from northern and eastern directions, 68°35′S, 78°09′E, 22.i.72
(5) Northern side of Lake Bisernoye, 68°31′S, 78°29′E, 1961
(6) Two specimens collected at Magnetic Island, 68°33′S, 77°53′E, in 1955, were identified as *Rinodina sordida* Dodge & Baker and *R. frigida* (Law, 1959). The latter and probably the former are synonymous with *B. frigida* (Filson, personal communication)
(7) Valley south from Club Lake, 4.i.73

Buellia lignoides R. Filson
(1) Rock outcrop at edge of plateau, 68°28′S, 78°29′E, *c.* 70 m a.s.l., 9.ii.72
(2) Northern side of Lake Bisernoye, 68°31′S, 78°29′E, 1961

**Caloplaca citrina* (Hoffm.) Th. Fr.
(1) Valley south from Club Lake, 4.i.73

Caloplaca elegans var. *pulvinata* (Dodge & Baker) J. Murray
(1) Ellis Rapids, common on small stones, 27.i.72, 4.i.73. Same site, growing on bird-bone, 31.i.72
(2) A specimen collected at Magnetic Island, 68°33′S, 77°53′E, in 1955, was identified as *Gasparrinia harrissoni* Dodge (Law, 1959). This is synonymous with *C. elegans* var. *pulvinata* (Filson, personal communication)

Lecanora expectans Darb.
(1) A specimen collected at Magnetic Island, 68°33′S, 77°53′E, in 1955, was identified as *L. griseomarginata* Dodge & Baker (Law, 1959). This is synonymous with *L. expectans* (Filson, personal communication)
(2) Ellis Rapids, 4.i.73
(3) Valley south from Club Lake, 4.i.73

Lecanora rubina var. *melanophthalma* f. *exsulans* (Th. Fr.) Zahlbr.
(1) North-east of Lake Druzhby, 68°35′S, 78°25′E, 1961
(2) Northern side of Lake Bisernoye, 68°31′S, 78°29′E, 1961
(3) Ellis Rapids, 4.i.73

Lecidea sp. (Possibly new species, awaiting further collections)
(1) On small stones and gravel beside Ellis Rapids, 31.i.72

Lecidea phillipsiana R. Filson
(1) Ellis Rapids, 4.i.73

(2) Valley south from Club Lake, 4.i.73
Omphalodiscus antarcticus (Frey & Lamb) Llano
(1) Rock outcrop at edge of plateau, 68°28′S, 78°29′E, *c.* 70 m a.s.l., 9.ii.72
(2) Western end of Mule Peninsula, 68°39′S, 77°56′E, 5.ii.72
(3) On small stones in sandy gully, north-western aspect, *c.* 30 m a.s.l., 68°36′S, 78°12′E, about 500 m north of Ellis Fjord, 27.i.72
(4) Northern side of Lake Bisernoye, 68°31′S, 78°29′E, 1961
(5) Ellis Rapids, 4.i.73
Omphalodiscus decussatus (Vill.) Schol.
(1) North-east of Lake Druzhby, 68°35′S, 78°25′E, 1961
**Physcia caesia* (Hoffm.) Hampe
(1) Ellis Rapids, 4.i.73
Protoblastenia citrina (Dodge)
(1) Beside Ellis Rapids, growing on bird-bone, 31.i.72. Same site, growing on cushions of dead moss *Bryum antarcticum*, 27.i.72, 4.i.73
(2) Southern slope of snow-ridge north of Pauk Lake, 68°33′S, 78°29′E, 1961
Rhizocarpon flavum Dodge & Baker
(1) On small stones in sandy gully, north-western aspect, *c.* 30 m a.s.l., 68°36′S, 78°12′E, *c.* 500 m north of Ellis Fjord, 27.i.72
Xanthoria mawsonii Dodge
(1) Ellis Rapids, 4.i.73
* The names *Caloplaca citrina* (Hoffm.) Th. Fr. and *Physcia caesia* (Hoffm.) Hampe replace *Pyrenodesmia mawsonii* Dodge and *Parmelia coreyi* Dodge & Baker respectively (Filson, in press).

APPENDIX II

Bird-banding and recoveries of banded birds at Davis

Birds banded			
GIANT PETREL *Macronectes giganteus*			
17–18.ii.61	4 adults	Davis Station	130.25801–04
16.i.72	16 nestlings	Hawker Island	130.48904–12 48914–20
	1 adult	Hawker Island	48913
28.iii.73	25 nestlings	Hawker Island	130.73201–25
	1 adult	Hawker Island	73226
CAPE PETREL *Daption capensis*			
13.xi.59	26 adults	Bluff Island	080.14101–10 14121 14124–25 14128–40
29.xi.59	6 adults	Mule Island	090.07601–40
1.xii.59	34 adults	Bluff Island	
SNOW PETREL *Pagodroma nivea*			
13.xi.59	14 adults	Bluff Island	080.14111–20 14122–23 14126–27
1.xii.59	1 adult	Bluff Island	090.07702
28.ii.61	1 fledgling	Gardner Island	080.14141
SOUTH POLAR SKUA *Catharacta skua maccormicki*			
iii.58	21 adults	Davis Station	120.08313–14, 23, 27, 31, 35, 37, 40–42, 45–46, 53, 58–59, 62–63, 71, 86, 88, 98
4 & 12.xi.59	24 adults	Davis Station	120.08301–02, 04–12, 15–22, 25–26, 28–30
iii.61	78 adults	Davis Station	120.08333–34, 36, 38–39, 43–44, 47–52, 54–57, 60–61, 64–69, 72–87, 89–97, 08400, 23601–28

APPENDIX II (*continued*)

Birds recovered

GIANT PETREL

B. 71831 (Moscow) Banded at sea 56°58'S, 30°27'E, 6.xii.58.
Recovered Hawker Island 16.i.72, guarding small nestling

SOUTH POLAR SKUA

All banded as adults

120.08326	Banded Davis 4.xii.59	Recovered Davis 9.ii.61, 23.iii.61
120.08313	„ „ iii.58	„ „ 10.iii.61
120.08314	„ „ iii.58	„ „ 7.iii.61, 14.iii.61
617.00565	Banded Wilkes Station 66°15'S, 110°34'E, 26.iii.57	Recovered Davis 10.iii.61, 11.iii.61
C. 66915	(Moscow) Banding details unknown	Shot dead Davis 10.xii.59
C. 66942	(„) Banded Mirny 1956	Recovered Davis 12.xi.59
C. 66969	(„) Banding details unknown	Shot dead Davis 10.xii.59

APPENDIX III

Weights and dimensions of freshly laid eggs of six two-egg clutches of South Polar Skuas *Catharacta skua maccormicki* collected by D. A. Brown near Davis (now at the National Museum, Victoria)

Date	Weight (g)	Length (mm)	Width (mm)
21.xi.61	97.0	71.0	51.0
	93.5	68.0	50.5
21.xi.61	97.5	75.0	49.0
	94.5	73.0	48.5
22.xi.61	103.8	71.0	52.0
	98.6	67.5	52.0
22.xi.61	104.2	76.0	51.0
	104.0	74.0	51.5
22.xi.61	106.0	73.0	52.5
	104.7	73.0	51.5
26.xi.61	95.3	70.0	51.5
	96.5	73.0	51.0
Mean	*99.6*	*72.0*	*51.0*

APPENDIX IV

Numbers of seals killed at Davis

Most were for dog-food; a small number were taken for scientific purposes

Year	Elephant Seal	Weddell Seal	Crabeater Seal
1957-58	23	49	?
1958-59	?	?	?
1959-60	?	8	?
1960-61	?	?	?
1961-62	13	0	1
1962-63	?	38	4
1963-64	14	23	0
1964-65	9	0	0
1968-69	1	0	0
1969-70	1	0	0
1970-71	2	0	0
1971-72	0	0	0
1972-73	0	0	0

VESTFOLD HILLS

AUSTRALIAN ANTARCTIC TERRITORY

Scale 1 : 100,000

Miles 1 0 1 2 3 4 5 Miles

Kilometres 1 0 1 2 3 4 5 6 7 8 Kilometres

Contour Interval : 25 metres

CONTROL : Astronomical Determination by A.N.A.R.E. 1957
COMPILATION : from Vertical Air-photos using slotted template assembly
PHOTOGRAPHY : by A.N.A.R.E. 1957-1958
PROJECTION : Polyconic
ELEVATIONS : Barometer heighting and parallax measurement (in metres)

LEGEND

Ice Free Coast	Land Contour 200
Indefinite Coast	Ice Contour 200
Limit of Ice Free Land	Depression Contour 0
Cliff and Ice Cliff	Astronomical Station ⊕
Edge of Continental Ice	Spot Height in Metres · 50

Produced for Antarctic Division, Department of External Affairs, by
Division of National Mapping, Department of National Development,
Canberra, A.C.T. September, 1958
Reprinted September 1972

77°50′ 78°00′ 78°10′ 78°20′

68°25′ 68°30′ 68°35′ 68°40′

Tryne Islands
TRYNE BA
TRYNE SOUND
Barrier I
TRYNE FJORD
LONG PENINSULA
Pioneer Crossing
Tryne Crossing
Lucks Ridge
LONG FJORD
Lucas I
Lied Bluff
Plough Island
Magnetic Island
Turner I
Bluff I
Trigwell I
Flutter
Anchorage I
Lake I
WEDDELL ARM
Camp Lake
Cole
Deep Lake
Lake Stinear
Lake Dingle
Davis Station
Tarn
BROAD PENINSULA
Gardner I
HEIDEMANN BAY
The Lookout
Lookout Lake
ELLIS FJORD
CROOKED LAKE
Hawker I
MULE PENINSULA
Clear L
Mule I
CROOKED FJORD
SØRSDAL GLACIER

LOCALITY PLAN

SCALE OF MILES 0 100 200

Mawson

MAC. ROBERTSON LAND

VESTFOLD HILLS

AUSTRALIAN ANTARCTIC TERRITORY

Scale 1 : 100,000

les 1 0 1 2 3 4 5 Miles

lometres 1 0 1 2 3 4 5 6 7 8 Kilometres

Contour Interval : 25 metres

CONTROL : Astronomical Determination by A.N.A.R.E. 1957
COMPILATION : from Vertical Air-photos using slotted template assembly
PHOTOGRAPHY : by A.N.A.R.E. 1957-1958
PROJECTION : Polyconic
ELEVATIONS : Barometer heighting and parallax measurement (in metres)

LEGEND

Ice Free Coast	Land Contour 200
Indefinite Coast	Ice Contour 200
Limit of Ice Free Land	Depression Contour 0
Cliff and Ice Cliff	Astronomical Station ⊕
Edge of Continental Ice	Spot Height in Metres · 50

Produced for Antarctic Division, Department of External Affairs, by
Division of National Mapping, Department of National Development,
Canberra, A.C.T. September, 1958
Reprinted September 1972

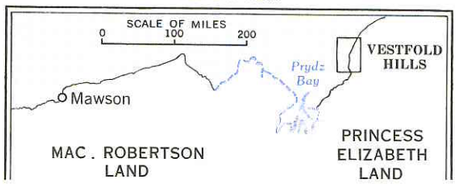
78°00′ 78°10′ 78°20′ 78°30′

−68°

−68°4

TRYNE BAY
TRYNE SOUND
TRYNE FJORD
LONG PENINSULA
LONG FJORD
Ridge
Pioneer crossing
Tryne crossing
Barrier I
Tryne Islands
Wyatt Earp Islands
Walkabout Rocks
Lucas I
Lied Bluff
Plough Island
Magnetic Island
Turner I
Bluff I
Trigwell I
Anchorage I
Flutter
Lake I
WEDDELL ARM
Camp Lake
Lake Stinear
Deep Lake
Lake Dingle
Davis Station
Tarn
BROAD PENINSULA
HEIDEMANN BAY
The Lookout
Lookout Lake
ELLIS FJORD
CROOKED LAKE
Hawker I
MULE PENINSULA
Clear L
CROOKED FJORD
SØRSDAL GLACIER

LOCALITY PLAN



ESTFOLD HILLS

RALIAN ANTARCTIC TERRITORY

Scale 1 : 100,000

0 1 2 3 4 5 Miles

0 1 2 3 4 5 6 7 8 Kilometres

Contour Interval : 25 metres

TROL : Astronomical Determination by A.N.A.R.E. 1957
PILATION : from Vertical Air-photos using slotted template assembly
TOGRAPHY : by A.N.A.R.E. 1957-1958
ECTION : Polyconic
ATIONS : Barometer heighting and parallax measurement (in metres)

LEGEND

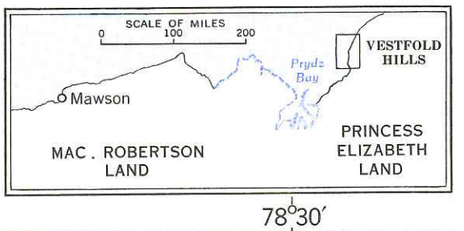
:	Land Contour 200
st	Ice Contour 200
ee Land	Depression Contour 0
Cliff	Astronomical Station ⊕
nental Ice	Spot Height in Metres · 50

Produced for Antarctic Division, Department of External Affairs, by
Division of National Mapping, Department of National Development,
Canberra, A.C.T. September, 1958
Reprinted September 1972

Wyatt Earp Islands
Walkabout Rocks
Tryne Islands
TRYNE BAY
TRYNE SOUND
TRYNE FJORD
Barrier I
LONG PENINSULA
Tryne Crossing
Pioneer Crossing
Luncke Ridge
LONG FJORD
Lucas I
Lied Bluff
WEDDELL ARM
Plough Island
Lake I
Trigwell I
Flutter I
Camp Lake
Lake Stinear
Deep Lake
Lake Dingle
Davis Station
Tarn
BROAD PENINSULA
HEIDEMANN BAY
The Lookout
Lookout Lake
ELLIS FJORD
CROOKED LAKE
MULE PENINSULA
Clear I
CROOKED FJORD
SØRSDAL GLACIER

−68°25′
−68°30′
68°35′
−68°40′
78°00′
78°10′
78°20′
78°30′

LOCALITY PLAN



78°00′ 78°10′ 78°20′ 78°30′

ESTFOLD HILLS

RALIAN ANTARCTIC TERRITORY

Scale 1 : 100,000

0 1 2 3 4 5 Miles

0 1 2 3 4 5 6 7 8 Kilometres

Contour Interval : 25 metres

TROL : Astronomical Determination by A.N.A.R.E. 1957
PILATION : from Vertical Air-photos using slotted template assembly
TOGRAPHY : by A.N.A.R.E. 1957-1958
JECTION : Polyconic
'ATIONS : Barometer heighting and parallax measurement (in metres)

LEGEND

Land Contour	200
Ice Contour	200
Depression Contour	0
Astronomical Station	⊕
Spot Height in Metres	•50

Produced for Antarctic Division, Department of External Affairs, by
Division of National Mapping, Department of National Development,
Canberra, A.C.T. September, 1958
Reprinted September 1972

Wyatt Earp Islands
Walkabout Rocks
Tryne Islands
TRYNE BAY
TRYNE SOUND
TRYNE FJORD
Barrier I
LONG PENINSULA
LONG FJORD
Tryne Crossing
Pioneer Crossing
Luncke Ridge
Lied Bluff
Lucas I
Plough Island
Lake I
Trigwell I
Flutter
WEDDELL ARM
Camp Lake
Lake Stowe
Deep Lake
Lake Dingle
Davis
Station Tarn
BROAD PENINSULA
HEIDEMANN BAY
The Lookout
Lookout Lake
ELLIS FJORD
CROOKED LAKE
MULE PENINSULA
Clear L
CROOKED FJORD
—68°25′—
—68°30′—
—68°35′—