BRITISH (TERRA NOVA) ANTARCTIC EXPEDITION
1910--1913

MISCELLANEOUS DATA

COMPILED BY

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The cost of the preparation and publication of this report has been defrayed from the Fund which was raised by public subscription in memory of Captain R. F. Scott and his companions.

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CHAPTER I.

The British Antarctic Expedition left England in June, 1910, under the leadership of Captain R. F. Scott, R.N., C.V.O., who has described his plans as they then were in the Journal of the Royal Geographical Society for that year.* The ship, the *Terra Nova*, reached Cape Town about the middle of August and remained there until September 2. Melbourne was reached on October 12, and Lyttelton, New Zealand, where Captain Scott joined her, on October 28. By November 26 all preparations had been completed and the ship left for the Antarctic. The account of all that happened on the voyage southwards to the Antarctic, and during the two years spent there, has been given in Captain Scott's diaries, and in the volumes which have been published by several members of the Expedition during the past ten years.

On the return of the Expedition to England in 1913 a fund was raised by public subscription to supplement the grant made by Government to the families of the deceased members of the Expedition, to discharge certain liabilities of the Expedition, to provide for the erection of a memorial, and to meet the cost of preparing the scientific results of the Expedition for publication, and for the printing and publication of the Reports. For this last a sum of £17,500 was allotted, of which £6,000 was to be employed in the preparation of the biological and geological reports which the Trustees of the British Museum undertook to print and publish. This Publication Fund of £17,500 was controlled by a Committee of three, Sir Archibald Geikie, O.M., K.C.B., F.R.S., then President of the Royal Society; Major Leonard Darwin, a Vice-President of the Royal Geographical Society; and Surgeon Commander E. L. Atkinson, D.S.O., R.N., as representing the Scientific Staff of the British Antarctic (*Terra Nova*) Expedition, who were appointed by the Mansion House Committee which had been formed to deal with the whole fund.† Colonel H. G. Lyons, F.R.S., was appointed Honorary Editor.

Work was commenced in the autumn of 1913 and by the following summer considerable progress had been made in the preparation of the scientific reports.

The outbreak of war in August, 1914, brought these preparations to an abrupt termination and though a certain amount of work was carried on during the four years of hostilities, it was not until 1919 that the preparation of the scientific results for publication could be fully resumed. In the meantime various members of the staff of the Expedition, and others concerned, had taken up other work and could no longer devote the whole of their time to their reports, with the result that these have appeared at rather long intervals.

* Geographical Society, July, 1910, pp. 11–20.

† *Geographical Journal*, Vol. XLI (1913), pp. 206–209.

The original intention of the Committee was to publish a complete History of the Expedition, but owing to the war the publication of these reports has been greatly delayed, and in the meantime several accounts of the Expedition have been published in which almost everything which the History would have contained has already appeared. These are "Scott's Last Expedition" (2 vols.), London, 1913; "With Scott: The Silver Lining," by Griffith Taylor, London, 1916; "With Scott in the Antarctic," by Captain E. R. G. R. Evans, R.N., 1913; "Antarctic Adventure," by R. E. Priestley, M.C., London; "The Worst Journey in the World" (2 vols.), by Apsley Cherry-Garrard, London, 1922.

The Committee decided therefore to abandon the idea of preparing the proposed narrative of the Expedition, and to include in a final volume of "Miscellaneous Data" such information as seemed to be worth placing on record for the use of geographers, naturalists, and explorers, and which had not been published elsewhere.

The scientific results of the Expedition have been published in a series of quarto reports dealing with the physical and physiographical material and observations by the Publication Committee, and in another series published by the Trustees of the British Museum in which the biological and geological results are set out by various authors.

The Reports containing discussions of the physical and physiographical observations made during the Expedition which have been published are :—

A. Reports published by the Publication Committee—

Meteorology. By Dr. G. C. Simpson, C.B.E., F.R.S.

Vol. I. Discussion. Pp. i—x, 1—326. 5 plates and 1 map. 1919.

,, II. Weather maps and pressure curves. 138 maps, 23 plates. 1919.*

,, III. Tables. Pp. i-xi, 1—835. 1924.

Terrestrial Magnetism. By Dr. C. Chree, M.A., Sc.D., LL.D., F.R.S. Pp. i—xii, 1—548. 60 plates, 5 text-figures. 1921.

Physiography of the McMurdo Sound and Granite Harbour Region. By Professor Griffith Taylor, D.Sc., B.E. (Syd.), B.A. (Camb.), F.R.G.S. Pp. i—xvi, 1—246. 143 plates, 10 stereoscopic plates, 173 text-figures, 4 maps in pocket. 1922.

Glaciology. By C. S. Wright, O.B.E., M.C., B.A. (Research, Cantab.), M.A. (Toronto), F.R.A.S., F.Inst.P., and R. E. Priestley, M.C., B.A. (Research Cantab.), Fellow of Clare College, Cambridge. [Pp. i—xx, 1—581, 291 plates, 179 text-figures, 15 maps in pocket. 1922.

Determinations of Gravity. By C. S. Wright, O.B.E., M.C., B.A. (Research, Cantab.), M.A. (Toronto), F.R.A.S., F.Inst.P. Pp. 1—106, 4 plates. 1921.

* Volumes I and II were printed in Calcutta during the war to avoid the risk of loss of the manuscript, which was prepared in India, by sending it to England.

Observations on the Aurora. By C. S. Wright, O.B.E., M.C., B.A. (Research, Cantab.), M.A. (Toronto), F.R.A.S., F.Inst.P. Pp. i—vii, 1—46. 2 plates. 1921.

Physiography (Robertson Bay and Terra Nova Bay Regions). By R. E. Priestley, M.C., M.A. (Cantab.), Fellow of Clare College, Cambridge. Pp. i—x, 1—87. 87 plates, 3 maps in pocket. 1923.

Physiography of the Beardmore Glacier Region. By C. S. Wright, O.B.E., M.C., B.A. (Research, Cantab.), M.A. (Toronto), F.R.A.S., F.Inst.P. Pp. i—vii, 1—25. 38 plates, 1 map in pocket. 1923.

Physiography of the Ross Archipelago. By F. Debenham, O.B.E., B.A., B.Sc. (Sydney), M.A. (Cantab.), Fellow of Gonville and Caius College, Geologist to the Expedition. Pp. i—xiii, 1—40. 15 plates, 12 text-figures. 5 maps in pocket. 1923.

Report on the Maps and Surveys. By F. Debenham, O.B.E., B.A., B.Sc. (Sydney), M.A. (Cantab.), Fellow of Gonville and Caius College, Geologist to the Expedition. Pp. i—viii, 1—94. 2 plates, 21 text-figures, 15 maps in pocket. 1923.

Miscellaneous Data. Compiled by Colonel H. G. Lyons, F.R.S. 4to. Pp. 84. 5 text-figures, 1 plate. 1924.

B. Reports published by the Trustees of the British Museum.

The biological and geological results which have been published by the Trustees of the British Museum, are as follows :—

British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report :—

Zoology. Vol. I. Vertebrata :—

Preface, Title-page and Table of Contents.

No. 1. Fishes. By C. Tate Regan, M.A. Pp. 54 : 8 text-figures and 13 plates. 1914, 4to.

No. 2. Natural History of the Adélie Penguin. By Staff-Surgeon G. Murray Levick, R.N. Pp. 55–84 : 21 plates. 1915, 4to.

No. 3. Cetacea. By D. G. Lillie, M.A. Pp. 85–124 : 14 text-figures and 8 plates. 1915, 4to.

No. 4. Larval and Post-larval fishes. By C. Tate Regan, M.A. Pp. 125-156 : 5 text-figures and 10 plates. 1916, 4to.

Zoology. Vol. II. Invertebrates :—

Title-page and Table of Contents.

No. 1. List of Collecting Stations—Mollusca, Brachiopoda and Worms. By S. F. Harmer, Sc.D., F.R.S., and D. G. Lillie, M.A. Pp. 12 : 4 maps. 1914, 4to.

Zoology. Vol. II.—*continued.*

No. 2. Oligochæta. By H. A. Baylis, B.A. Pp. 13–18: 1 plate. 1915, 4to.

No. 3. Parasitic Worms, with a note on a Free-living Nematode. By R. T. Leiper, D.Sc., and Surgeon E. L. Atkinson, R.N. Pp. 19–60: 11 text-figures and 5 plates. 1915, 4to.

No. 4. Mollusca. Part I.—Gastropoda Prosobranchia, Scaphopoda and Pelecypoda. By Edgar A. Smith, I.S.O. Pp. 61–112: 2 plates. 1915, 4to.

No. 5. Nemertinea. By H. A. Baylis, B.A. Pp. 113–134: 4 text-figures and 2 plates. 1915, 4to.

No. 6. Myzostomida. By C. L. Boulenger, M.A., D.Sc. Pp. 135–140: 1 plate. 1916, 4to.

No. 7. Mollusca. Part II.—Cephalopoda. By Anne L. Massy. Pp. 141–176: 43 text figures. 1916, 4to.

No. 8. Brachiopoda. By J. W. Jackson, F.G.S. Pp. 177–202: 1 plate. 1918, 4to.

No. 9. Mollusca. Part III.—Eupteropoda (Pteropoda Thecosomata) and Pterota (Pteropoda Gymnosomata). By Anne L. Massy. Pp. 203–232: 9 text-figures. 1920, 4to.

No. 10. Mollusca. Part IV.—Anatomy of Pelecypoda. By R. H. Burne, M.A. Pp. 233–256: 4 plates. 1920, 4to.

No. 11. Hirudinea. By W. A. Harding, M.A. Pp. 257–260: 1 plate. 1922, 4to.

Zoology. Vol. III. Arthropoda:—

Title-page and Table of Contents.

No. 1. Pycnogonida. By W. T. Calman, D.Sc. Pp. 74: 22 text-figures 1915, 4to.

No. 2. Crustacea. Part I. Decapoda. By L. A. Borradaile, M.A. Pp. 75–110: 16 text-figures. 1916, 4to.

No. 3. Crustacea. Part II. *Porcellanopagurus:* an instance of Carcinization. By L. A. Borradaile, M.A. Pp. 111–126: 13 text-figures. 1916, 4to.

No. 4. Crustacea. Part III.—Cirripedia. By L. A. Borradaile, M.A. Pp. 127–136: 7 text-figures. 1916, 4to.

No. 5. Crustacea. Part IV.—Stomatopoda, Cumacea, Phyllocarida, and Cladocera. By W. T. Calman, D.Sc. Pp. 137–162: 9 text-figures. 1917, 4to.

Zoology. Vol. III.—*continued.*

No. 6. Arachnida. Part I.—Araneæ (Spiders). By H. R. Hogg, M.A., F.Z.S. Pp. 163–174 : 3 text-figures. 1918, 4to.

No. 7. Crustacea. Part V.—Ostracoda. By R. W. Barney, B.A. Pp. 175–190 : 6 text-figures. 1921, 4to.

No. 8. Crustacea. Part VI.—Tanaidacea and Isopoda. By W. M. Tattersall, D.Sc. Pp. 191–258 : 2 text-figures and 11 plates. 1921, 4to.

No. 9. Insecta. Part I.—Collembola. By George H. Carpenter, D.Sc., M.R.I.A. 1 plate. Part II.—Mallophaga. By James Waterston, B.D., B.Sc. Pp. 259–272. 1921, 4to.

No. 10. Crustacea. Part VII.—Mysidacea. By W. M. Tattersall, D.Sc. Pp. 273–304 : 4 plates. 1923, 4to.

Zoology. Vol. IV.

No. 1. Echinoderma. Part I.—Actinogonidiata. By F. Jeffrey Bell, M.A. Pp. 10 : 2 plates. 1917, 4to.

No. 2. Cephalodiscus. By W. G. Ridewood, D.Sc. Pp. 11–82 : 12 text-figures, 5 plates and a map. 1918, 4to.

No. 3. Echinoderma (Part II.) and Enteropneusta, Larvæ of Echinoderma and Enteropneusta. By E. W. MacBride, D.Sc., LL.D., F.R.S. Pp. 83–94 : 2 plates (with Explanations). 1920, 4to.

No. 4. Rhabdopleura. By J. R. Norman. Pp. 95–102 : 6 text-figures. 1921, 4to.

Zoology. Vol. V.

No. 1. Cœlenterata. Part I.—Actiniaria. By T. A. Stephenson. Pp. 68 : 6 plates. 1918, 4to.

No. 2. Cœlenterata. Part II.—Madreporaria. (*a*) On *Favia conferta*, Verrill, with Notes on other Atlantic Species of *Favia*. By G. Matthai, M.A. Pp. 69–96 : 2 text-figures, 4 plates. 1919, 4to.

No. 3. Cœlenterata. Part III.—Antipatharia (and their Cirripede Commensals). By A. K. Totton. Pp. 97–120 : 18 text-figures and 2 plates. 1923, 4to.

Zoology. Vol. VI.

No. 1. Protozoa. Part I.—Parasitic Protozoa. By H. M. Woodcock, D.Sc., and Olive Lodge. Pp. 1–24 : 1 text-figure and 3 plates. 1921, 4to.

No. 2. Protozoa. Part II.—Foraminifera. By E. Heron-Allen, F.R.S. and A. Earland. Pp. 25–268 : 1 text-figure and 8 plates. 1922, 4to.

No. 3. Porifera. Part I.—Non-Antarctic Sponges. By A. Dendy, D.Sc., F.R.S. Pp. 269–392 : 15 plates. 1924, 4to.

Zoology. Vol. VII.

No. 1. Mollusca. Part V.—Anatomy of Gastropoda (except the Nudibranchia). By Nellie B. Eales, B.Sc., Ph.D. Pp. 1–46 : 42 text-figures. 1923, 4to.

Zoology. Vol. VIII.

No. 1. Crustacea. Part VIII.—Euphausiacea. By W. M. Tattersall, D.Sc. Pp. 1–36 : 2 plates. 1924, 4to.

Geology. Vol. I.

No. 1. Antarctic Fossil Plants. By A. C. Seward, F.R.S. Pp. 49 : 6 text-figures, 3 maps and 8 plates. [With a Bibliography.] 1914, 4to.

No. 2. Fish-remains from the Upper Old Red Sandstone of Granite Harbour, Antarctica. By A. Smith Woodward, LL.D., F.R.S. Pp. 51–62 : 1 plate. 1921, 4to.

No. 3. Recent and Local Deposits of the McMurdo Sound Region. By F. Debenham, O.B.E., B.A., B.Sc. Pp. 63–100 : 19 text-figures. 1921, 4to.

No. 4. The Sedimentary Rocks of South Victoria Land. (*a*)—The Sandstone, etc., of the McMurdo Sound, Terra Nova Bay, and Beardmore Glacier Regions. By F. Debenham, O.B.E., B.A., B.Sc. (*b*)—The Slate-greywacké Formation of Robertson Bay. By R. H. Rastall, Sc.D., and R. E. Priestley, M.C., B.A. Pp. 101–130 : 8 text-figures and 1 plate. 1921, 4to.

No. 5. The Metamorphic Rocks of South Victoria Land. (*a*)—The Metamorphic Rocks of the McMurdo Sound Region. By W. Campbell Smith, M.C., M.A., and F. Debenham, O.B.E., B.A., B.Sc. (*b*)—The Metamorphic Rocks of the Terra Nova Bay Region. By W. Campbell Smith, M.C., M.A., and R. E. Priestley, M.C., B.A. Pp. 131–166 : 2 text-figures and 2 plates. 1921, 4to.

No. 6. The Plutonic and Hypabyssal Rocks of South Victoria Land. By W. Campbell Smith, M.C., M.A. Pp. 167–227 : 14 text-figures, 1 plate and 2 maps. 1924, 4to.

Botany.

Part I. Freshwater Algæ. By F. E. Fritsch, D.Sc., Ph.D., F.L.S. Pp. 1–16 : 1 plate. 1917, 4to.

Part II.—Marine Algæ. By Antony Gepp, M.A., F.L.S., and Ethel S. Gepp. Melobesieæ. By Mme. Paul Lemoine. Pp. 17–28 : 4 text-figures. 1917, 4to.

Part III.—Lichens. By O. V. Darbishire, D.Sc. Pp. 29–76 : 10 text figures and 2 plates. 1923, 4to.

C. Reports in preparation :—

Zoology.

Birds, Systematic Account. By Percy R. Lowe, O.B.E., M.B.

Birds, Embryology of Penguins. By J. Cossar Ewart, M.D., F.R.S., and Augusta Lamont, B.Sc.

Tunicata. By W. Garstang, D.Sc.

Echinoderma. Part III.—Holothurioidea. By J. Pearson, D.Sc.

Mollusca—

Sessile Gastropoda. By J. H. Orton, D.Sc.
Opisthobranchiata. By G. C. Robson, M.A.
Amphineura, Heteropoda. By T. J. Evans, M.A.

Crustacea—

Larvæ of Decapoda. By Robert Gurney, M.A.
Amphipoda. By C. Chilton, D.Sc.
Parasitic Forms. By W. A. Cunnington, M.A., Ph.D.
Free-living Copepoda. By G. P. Farran, B.A.

Polychæta. By W. B. Benham, D.Sc., F.R.S.

Chætognatha. By S. T. Burfield, M.A.

Corals. By J. Stanley Gardiner, M.A., F.R.S.

Hydrozoa. By A. K. Totton, M.C.

Medusæ, Siphonophora, Ctenophora. By E. T. Browne, M.A.

Porifera, Antarctic. By R. Kirkpatrick.

No arrangements have as yet been made for working out the collections of Plankton, Polyzoa and Alcyonaria.

A few specimens of Arachnida and Myriopoda have not at present been described.

Geology.

The Volcanic Rocks of South Victoria Land. By W. Campbell Smith, M.C., M.A. Based on the collections and field notes of R. E. Priestley, M.C., M.A., and F. Debenham, O.B.E., M.A.

Notes on Limestones containing *Archæocyathus*. By W. T. Gordon, D.Sc. With notes on the limestones and some other sedimentary rocks by W. Campbell Smith, M.C., M.A.

Notes on Some Specimens Dredged in the Bay of Whales. By W. Campbell Smith, M.C., M.A.

D. Note-books, etc.

The scientific reports of the Expedition present the results which have been obtained from the study of the collections and from the discussion of the observations which were made by the members of the Expedition during their sojourn in the Antarctic. It may be that in the future other investigators may desire to refer to the original note-books, autographic records, etc., to determine points which they do not find specifically referred to in the reports. It seems, therefore, very desirable that the places where any of these original documents have been deposited should be placed on record.

The following list of this original material of the British Antarctic (*Terra Nova*) Expedition gives this information so far as it has been possible to obtain it:—

British Museum, Bloomsbury.

SCOTT, the late Captain R. F.

The Diaries of Captain R. F. Scott, R.N., C.V.O.

NOTE.—A copy of the Diary from January to October, 1911, is in the Library of the Royal Geographical Society, on loan from Lady Scott.

British Museum (Natural History), Cromwell Road, S.W. 7.

The following note-books are at present in the British Museum (Natural History), but it is possible that some of them may be claimed later by the writers or their representatives.

PENNELL, the late Comm. H. L. L.

Three Zoological Logs, January 28, 1911, to June 1, 1913.
Two other books of rough notes.

WILSON, the late Dr. E. A.

Cetacea.—Four sheets (7 figures) of coloured drawings of Dolphins, already made use of in the preparation of Vol. I, No. 3, of the Zoological Series of Reports.
Cetacea and Seals.—Note book, illustrated by sketches.
Ornithological Log.
Journal, South Trinidad.
Sketch-book.
Nineteen drawings.

ATKINSON, Surg.-Comm. E. L.

Parasitic Worms.—Two note-books.
Parasitic Protozoa.—One note-book.

PRIESTLEY, R. E.

Note-book, containing List of Geological Specimens collected by the Northern Party (dated March 16, 1911); also notes on the Biological Collection, Eastern Party, Cape Adare; and a few papers referring to Penguins at Cape Adare.

DEBENHAM, F.

Catalogue of Geological Specimens collected in South Victoria Land and Ross Archipelago, 1911 and 1912; with a few sketch maps.

NELSON, the late E. W.

Diary, June, 1910, to July, 1911 (2 vols.).

Plankton, Biological Log, June-July, 1910.

Winter Quarters (many unimportant).

- List of Biological Gear.
- Birds and Seals.
- Biological Log (I and II).
- Dredging and Shore.
- Lake Investigations.
- Lichens, Mosses, etc.
- Plankton (I and II).
- Cultures.
- Notes and Queries.
- Diary of Land Journey, December, 1911, to January, 1912.

MSS. of article on Hydrobiological Methods in Polar Regions.

A Note on some Biddulphoid Diatoms.

MATERIAL COLLECTED.

The entire Natural History Collections of the *Terra Nova* were received. Parts of them are still in the hands of the specialists who are studying them, but with the exception of these and of a very few duplicates which have been distributed, principally to the authors of Reports, all the specimens are in the Museum. It is intended to make a further distribution of duplicates when the preparation of the Reports has been completed or is nearing completion.

The collection in question is an extensive one, consisting of Zoological, Botanical and Geological specimens. Its general scope is sufficiently indicated by the lists of Reports published and in preparation.

Hydrographic Department, Admiralty.

Four tracings by Commander Pennell from Admiralty charts, showing the track of the *Terra Nova* and the soundings obtained; also a chart showing the tracks of the Polar parties. This information has been embodied in the current editions of Admiralty charts Nos. 3173, 3177 and 3206.

Meteorological Office, Air Ministry.

RECORDS FROM SELF-RECORDING INSTRUMENTS AT CAPE EVANS.

1.*—*Thermograph.*
Screen thermograph records.
Hut thermograph records.
Three notebooks of reductions.

2.—*Cup Anemometer.*
Records of cup anemometer.
Notebook of reductions.

3.—*Wind Direction.*
Records from instrument.
Notebook of reductions.

4.—*Pressure-tube Anemometer.*
Records.

5.—*Barograph.*
Records from two instruments.

6.—*Potential Gradient.*
Records.

METEOROLOGICAL REGISTERS KEPT AT CAPE EVANS, HUT POINT, AND ON SLEDGING JOURNEYS.

7.—*Meteorological Registers.*

Kept at Cape Evans.	I.—January 13th, 1911, to September 3rd, 1911.
,, ,,	II.—September 3rd, 1911, to March 2nd, 1912.
,, ,,	III.—March 2nd, 1912, to September 17th, 1912.
,, ,,	IV.—September 17th, 1912, to December 30th, 1912.

8.—*Sledging Diaries of Parties which left Cape Evans during the first year.*

Register of	One Ton Depot Party	Bowers.
,,	Western Party	Taylor.
,,	Cape Crozier Party..	Bowers.
,,	Corner Camp Party..	Evans.
,,	Western Mountain Party	Simpson.
,,	Motor Party..	Day.
,,	Dog Sledge Party	Meares.
,,	1st Return Party	Wright.
,,	2nd Return Party	Evans.
,,	Day's Depot Party..	Day.
,,	1st and 2nd Relief Party	Cherry-Garrard.
,,	Main Polar Party (Copy)	Bowers.

* The serial numbers correspond with the numbering of the packages in which the data are stored at the Meteorological Office.

9.—*Miscellaneous Registers.*

Register of Outlying Screens, 1911.
" " " 1912.
" Hut Point, I.
" " II.
" " III.
" Western Journey, 1912.
" Pony Party I, 1912.
" " II, 1912.
" Dog Party, 1912.
" Erebus Party, 1912.
" Assorted, 1912.

DIARY OF WORK AND NOTEBOOKS USED AT CAPE EVANS AND ON THE "TERRA NOVA."

10.—*Diary of Work kept at Cape Evans.*

January 11th, 1911, to December 31st, 1912.
January 1st, 1912, to February 22nd, 1912.

11.—*Notebooks.*

Atmospheric electricity observations made on the "*Terra Nova*" (results).
Radio-activity—on "*Terra Nova*" and at Cape Evans.
Potential Gradient Observations on the "*Terra Nova*," I.
" " II.
Weather Maps prepared by Griffith Taylor.

12.—*Notebooks.*

Balloons, I.
" II.
" III.
" IV.
Potential Gradient at Cape Evans.
Instrument Comparisons and Notes.
Notes on Meteorological Work.

REGISTERS, ETC., KEPT AT CAPE ADARE.

13.—*Cape Adare Papers.*

Rough notes—meteorological and aurora.
Barograph traces.
Thermograph traces.

14.—*Meteorological Registers kept at Cape Adare.*

I.—February 27th, 1911, to June 30th, 1911.

II.—July 1st, 1911, to November 15th, 1911.

III.—November 16th, 1911, to January 3rd, 1912.

Rough copy of I.

"Terra Nova" Logs.

15.—*Meteorological Logs of the "Terra Nova."*

Voyage from England to New Zealand, June 16th, 1910, to October 12th, 1910.

1st voyage between New Zealand and the Antarctic, November 30th, 1910, to March 17th, 1911.

Ditto, March 18th, 1911, to March 27th, 1911.

Sounding cruise to North of New Zealand, July 10th, 1911, to October 5th, 1911.

2nd voyage between New Zealand and the Antarctic, December 15th, 1911, to March 18th, 1912.

Ditto, March 19th, 1912, to April 3rd, 1912.

3rd voyage between New Zealand and the Antarctic, December 14th, 1912, to February 12th, 1913.

Australian and New Zealand Records.

16.—Hourly values of wind and pressure for Melbourne.

17 —Pressure and wind records for Wellington and Bluff, New Zealand.

Working Papers.

Working papers in files :—

18.—1. Pressure, Cape Evans.

2. Pressure, daily variation, Fourier's coefficients.

3. Pressure correlations.

19.—4. Pressure distribution, theoretical.

5. Pressure difference and change at Cape Evans, Framheim and Cape Adare.

6. Pressure surges.

20.—7. Temperature and Insolation.

8. Temperature on Barrier and Plateau.

21.—9. Cape Adare.

10. Framheim.

11. Gauss, Snow Hill and Kerguelen.

22.—12. Wind—general.

13. Wind—frequency of different velocities.

14. Wind—analysis of meteorological conditions with winds 0–5, 6–10, 11–30 and > 30 miles per hour.

23.—15. Cloud and Upper Air Movement.

16. Height above sea level, Pressure on Barrier and Plateau and Atmospheric Electricity.

17. Miscellaneous papers, including Balloon Ascents, Height of Antarctic Continent, Snow and Drift.

Papers used in Preparation of Diagrams.

24.—Curves supplied to draughtsman for preparing the diagrams for "Meteorology," Vol. I and Vol. II.

25.—Original drawings for the diagrams in "Meteorology," Vol. I and Vol. II.

Few blank pages of maps, similar to those used for the weather maps in "Meteorology," Vol. II.

N.P.L. Thermometer Certificates.

26.—Thermometer Certificates of the National Physical Laboratory, Teddington.

Notebooks, &c., referring to Observations in Terrestrial Magnetism deposited at Kew Observatory, Meteorological Office.

Sea Observations :—

Three Charts (Antarctic Sheets IV and VIII and a "Variation" Chart) on which results of observations at sea are shown :—

S.Y. *Terra Nova*, B.A.E., 1910–13. Fair Magnetic Log (Ship's), Vols. I, II (2 vols.).

S.Y. *Terra Nova*, B.A.E., 1910–13. Magnetic Work Books, A, B, C (3 vols.).

Terra Nova Magnetic Observations. Rough Books (I, II, III, IV, V, VI) (6 vols., variously bound).

Two large covers—one marked "Standard Compass Variation Curves," the other marked "Lloyd Creak Deviation Curves, C13."

Variation, Southern Journey, B.A.E. (In the originally unused end of this book are the calculations of base-line values for magnetograms.)

Observation books (bound in white) used at Cape Adare :—

Dip (1 vol.), Total Force (1 vol.).

The following refer mostly or entirely to Cape Evans :—

Book (dark cover) with printed title "Absolute Horizontal Force," containing stray observations (one or two from 1901–4 Expedition).

Observation books bound in white :—

Declination (2 vols.), Deflections (2 vols.), Vibration (3 vols.), Dip (4 vols., last with observations from other stations and lot of loose sheets), Total Force (1 vol., hardly used).

Two pocket-books dealing with scale-value observations of magnetograms.

Large book, " New Zealand Commercial Diary, No. 201912," containing information as to time observations.

Two magnetic note-books of a general kind (one in speckled, other in black covers).

All the magnetograph curves taken during 1911 and 1912 at Cape Evans, as well as the " quick runs " and corresponding eye-readings taken at other co-operating stations.

The Scott Polar Research Institute, Cambridge.

Log of the " *Terra Nova*." Fair copies. Three books. From June 1st, 1910, to June 14th, 1913 ; and the Engine Room log for the same period.

Navigation and Surveying notebooks :—

Complete series of originals, comprising—

(i) Observation notebooks,
(ii) Rough work books,
(iii) Field sketch books,
(iv) Chronometer books,
(v) Height books, etc.,

from the " *Terra Nova*," the headquarters at Cape Evans and Cape Adare, and from all sledge parties.

Original plane table sheets.

Special.—The navigation notebook of H. R. Bowers on the Polar Journey (original).

The meteorological Log-book of Polar Party kept by H. R. Bowers (original and copy).

List of stores landed and on ship (Bowers).

All negatives taken by F. Debenham.

The original diaries, journals and notebooks of R. E. Priestley and F. Debenham.

All the line and half-tone blocks used in the publication of the Physical and Physiographical Reports.

A small selection of sledging gear as used by the Expedition.

All notebooks, except diaries, by C. S. Wright relating chiefly to observations on Glaciology, Aurora Australis, Gravity and Natural Ionization will also be deposited at the Polar Research Institute.

CHAPTER II.

DESCRIPTION OF THE SHIP.

The *Terra Nova* was built at Dundee in 1884 for the whaling industry in the Arctic seas, and was strengthened specially on this account. Besides her whaling service, she had been in the Arctic with the Jackson-Harmsworth Expedition and in the Antarctic with the *Morning* on the relief expedition which was sent out to the *Discovery* in 1903. To prepare her for her second voyage to the Antarctic her bow and stern were reinforced with seven thicknesses of oaken beams, amounting to a total thickness of about 7 feet. Besides this there were sixteen oak beams about a foot square from the deck above the keel to the beams of the lower deck. These supporting beams and the strengthening of the bow took the strain of any impact against the ice-floes, so that the ship rose against them. The ribs, which were set close, were about a foot square in section and extended from the bow to near the stern, where six thicknesses of heavy oaken planking were used to provide additional strength. There was a 2-inch covering of steel on the lower part of the stern, but friction against the ice tended to tear this away from the woodwork.

The fitting-out of the *Terra Nova* was carried out by the Glengall Company in the East India Docks on the Thames, where they set up all the ship's rigging and renewed all the running gear. She was also sheathed with wooden skins from the bow to the break of the poop, to enable her to withstand pressure better in her passage through the ice. This sheathing extended to the upper deck and to about 4 feet below the water-line. The upper deck was in three portions: the forecastle forward, the upper deck as the middle portion, and the poop aft. At the break of the poop were the steps up to the poop deck from the main deck on either side. Both the forecastle and poop were railed. A simple swivel davit was fitted in the foremost part of the forecastle, and was useful in catting the anchors. Abaft this was a large skylight and ventilation having on either side flaps of thick glass in stout wood frames for supplying light and air to the compartment in the forecastle head; beneath this a covered iron grid provided

[NOTE.—The description of the *Terra Nova* and the discussion of the ship's journeys were undertaken by the late Commander H. L. L. Pennell, R.N., and at the outbreak of war, in 1914, he had received from Mr. F. E. Davies, Leading Shipwright R.N., the carpenter of the *Terra Nova*, the details of construction, which are printed below. Surgeon-Commander E. L. Atkinson has contributed a short general description, but as both of the officers of the ship's party lost their lives during the war it has seemed best to print this description as it stands, and to make no attempt to compile an account of the ship's journeys, which only they could have done satisfactorily.]

additional protection. Access to the forecastle from the upper deck was provided by a ladder on the starboard side. Two mooring bollards were on either side of the forecastle. Abaft the skylight was a ventilating cowl which supplied air to the sleeping quarters of the crew, which were on the lower deck below the forecastle head. Abaft the ventilating cowl was a capstan, which was used, when required, for raising the anchor and catting it.

Below the break of the forecastle on the port side were the men's W.C. and urinal, while those of the warrant officers were in a corresponding position on the starboard side, where there was also a compartment for the boatswain and his stores. Amidship on the main upper deck was a steam windlass, which was used for heaving in the anchor cable, and from here was a lead to the cable locker through a slotted hatch in the forward part of the winch.

Abaft the windlass was a hatch step leading to the crew's sleeping quarters on the lower deck. The foremast was stepped between this hatch and the galley. The galley was specially built and fitted with a naval range capable of cooking for 120 men, which was set up in the after part of the shelter.

In the forward part were shelves on which the various cooked supplies of meals for the days could be placed, to be removed by the watches as they were required. The galley was very strongly built, and was securely bolted through the upper deck ; it was provided with doors on either side so that the lee door could be left open for ventilation. Situated conveniently near the crew's mess, its distance from that of the officers was an inconvenience in rough weather.

On either side forward, below the break of the forecastle, were two skids of stout timber and on them two clinker-built double-ended lifeboats lay in their chocks. The position was a good one, and covered with canvas covers and secured by seizing ropes and grapplings, they withstood the worst weather. Abaft the galley was an accessory steam winch which was rarely used.

The ice-house which was erected abaft of it was tin-lined and had four thicknesses of wood besides thick felt. This was apparently insufficient to maintain a constant temperature for some of the meat stored in it went bad.

On the top of the ice-house were mounted the standard compass, a Lloyd-Creak instrument and a rangefinder for use when making running surveys. Abaft of the house was the main hatch, and next came the main mast and on either side of this a Stephens pump, while amidships at the break of the poop-deck was the small after hatch.

The forward part of the poop was occupied by the funnel, and forward of it was a steam winch, while between it and the funnel were two iron tanks for thawing ice when this could be obtained. On either side of the after portion of the funnel were gratings and the two cowls and ventilating shafts leading to the stokehole. The remainder of the mid-ship portion was occupied by a strong deck-house forming a protection for the enlarged wardroom, and an alleyway above this. The forward portion of this deck-house was used by the navigator as a chart-room.

On the starboard were two w.c.'s for officers and in-board from them were the steps leading to the bridge, the mid-ship portion of which was occupied by a wooden shelter in which was a large shelf for charts. A few steps ran from the mid-ship portion of the bridge to others which led to the top of the deck-house on which was a compass. Astern of the deck-house was the compass, and the wheel, which was double, and was fitted with a foot-brake. On either side two grills occupied the greater portion of the deck, and above the stern on the out-board side of these were two mooring bollards, port and starboard.

On the out-board side, port and starboard, there were two whaling boats slung from davits.

Up to the time of our departure from New Zealand for the Antarctic the forecastle head was used for messing accommodation by the crew, but then it was required for the ponies until they were landed at Ross Island in the Antarctic. It was sufficient for fifteen ponies and four stalls for the others were erected between the ice-house and the galley.

In the second year stalls were built on the upper deck for the mules, but this would have been impracticable in the first year. The accommodation for the officers and scientific staff consisted of a wardroom 24 feet long and 9 feet wide, down the centre of the ship, which was lighted by skylights in the top of the deck-house and by small ports at the sides of the cabins which opened off it. On the port side there was a large cabin with six bunks, and two smaller ones containing three and two bunks. On the starboard side there was a large cabin forward, and two smaller cabins each with two bunks, the remainder of the space being taken up by the alley-way and the steps leading to the upper deck. Over the stern there was a cabin on either side, each containing three bunks.

In the forward part of the wardroom was a stove, and forward on the port side was the entrance door to the pantry, which was fitted with cupboards, etc., for china, glass and cutlery.

Beneath the wardroom was the lazarette which was entered by a hatch in the alley-way forward of the wardroom entrance. In it was stored the bulk of the expendable stores, food, etc. Immediately below this was the tunnel for the propeller shaft. Forward of the lazarette was a small compartment which was used as a chronometer-room and for the storage of other delicate instruments. Forward of this from the keel to the upper deck was the engine-room and boiler-room.

The engines were vertical compound engines working at an initial pressure of 60 lbs. to the square inch, and with them the maximum number of revolutions per minute for going ahead was 60. After the first year alterations were proposed by Chief Engine-Room Artificer W. Williams to obtain increased efficiency, and these were carried out by M. Dickson of Lyttelton, New Zealand, with the result that they could then develop 89 revolutions per minute when going ahead and 60 when going astern.

The propeller shaft was exceptionally thick and of the best steel, and the worth of this was appreciated when, as not infrequently happened, the engines were brought to a dead stop by masses of ice jamming the propeller.

The necessity for the bedding of the boilers was questioned at one time, but they stood many trials, although the ship under some conditions rolled very heavily, as much as 50° each way, and was practically beam-ended on at least four occasions.

Forward of the engine-room bulkhead the lower deck space was divided between coal and general stores. Coal was stowed loose in the after third, and it could, by means of a hole in the bulkhead, be trimmed into two small bunkers on either side of the stokehold. A wooden bulkhead separated the coal from the general stores which were stowed in the forward two-thirds of the upper main hold.

Fresh water was stored in tanks holding 8·15 tons each, which were on the lower deck abaft the foremast. Two out of the four were used for this purpose, the other two being filled with compressed fodder for the animals. All the lower hold abaft these tanks was filled with coal.

The *Terra Nova* was three-masted, the fore and mainmasts being stepped above the keel, but the mizzenmast was stepped into a reinforced portion of the lower deck in the forward portion of the wardroom pantry.

The following details of the ship have been supplied by Mr. F. E. Davies, Leading Shipwright R.N., and those of the engine-room by Mr. W. Williams, Artificer Engineer R.N., while Messrs. David Bruce and Co., of Billiter Square Buildings, E.C., kindly sent prints of the plans of the ship.

S.Y. *Terra Nova.*

Built in 1884 at Dundee.

Tonnage register, 399·7 ; displacement, 858 tons (light).

Length	187 feet (over all).
Breadth..	31 feet (extreme).
Depth of hold	19 feet.

Barque rigged ; royal yards not carried this commission.

PARTICULARS OF CONSTRUCTION.

Keel.—Of American rock elm, 14¾ inches by 14¾ inches ; scarphed together after French style. Length of scarph, 6 feet 3 inches ; lip, 3½ inches.

Frames.—Of German oak sided to 13 inches or 14 inches. Maximum depth of frame, 12¾ inches, tapering to 6¾ inches at covering board ; breadth of frame, 12¾ inches.

Keelson.—Of pitch pine, 18 inches by 16 inches, running fore and aft from stemson to sternpost, tapering at fore and after ends. Scarphs of keelson, 7 feet 3 inches, with 4½-inch lip. Bolted through keel at every alternate timber by 1¾-inch bolts.

Sister keelson.—One each side of keelson, 2 feet 8 inches from it ; 14 inches in width and trimmed to shape of frames ; secured through each alternate timber by 1⅛-inch bolts.

Planking of bottom.—(Outer) of Canadian elm or American rock elm, from keel under bottom and on turn of bilge to a height of 7 feet 7 inches from base line. Sides of pitch pine. *Planks* are 1 foot by 4 inches in bottom, garboards being slightly thicker. From bottom of doubling to 7 feet 7 inches from base line they increase in thickness gradually from 4 inches to 5¼ inches. Secured by ⅞-inch bolts at butts and by hardwood trenails (1⅜-inch) at frames. Side planks 1 foot by 5¼ inches up to within five planks below covering board; from there they gradually taper in thickness until it is reduced to 4¼ inches at covering board.

Doubling.—Extends fore and aft from 3 feet above base line to 18 feet 6 inches above base line, of iron bark 2¼ inches thick, except two top strakes which are 2 inches and bottom strake 2½ inches thick. Fastened by 11-inch and 9-inch bolts.

Ceiling in bottom.—Pitch pine, 5½ inches thick in bottom and 4¼ inches at ship's side.

Main Deck.

Shelf.—13½ inches thick at top, tapering to 6½ inches and 18 inches deep.

Main Deck Beams.—Of pitch pine (12½ inches by 12½ inches); joggled 2 inches over shelf and secured by hanging and lodging knees with seven bolts in each. Beams about 5 feet 3 inches apart from centre to centre. Main deck stringer same size as shelf.

Upper Deck.

Upper Deck Shelf.—10½ inches thick on top, tapering to 5 inches and 15 inches deep.

Upper Deck Beams.—9½ inches by 10 inches and about 5 feet 3 inches apart centre to centre; stringer, 12 inches by 12 inches.

Covering Board.—4 inches thick.

Quarter Deck (Poop).

Upper Deck.—Stringer and shelf carried eight frame spaces under quarter deck.

Shelf.—Under quarter deck 5 inches at top, 3 inches at bottom, 12 inches deep.

Beams.—Of German oak (8½ inches by 9 inches), again 5 feet 3 inches apart.

Stringer.—9 inches by 9 inches.

Decks.—Upper Deck and Poop of pitch pine, 6 inches by 3 inches. Top gallant forecastle Deck of yellow pine, 6 inches by 3 inches.

Hatch Coamings.—Pitch pine. Main hatch, 14½ inches by 5 inches. Fore and after hatches, 8 inches by 6 inches. Top of coaming, 1 foot 5 inches above line of beam.

Hatches.—2½ inches thick.

Iron Beams under top gallant forecastle, 5 inches by 3 inches by $\frac{8}{15}$ inch, 4 feet 6 inches from centre to centre.

Bulwarks.—Stanchions, 7¼ inches by 6¾ inches at bottom; 7¼ inches by 6 icnhes at top. Bulwarks of pine 1¼ inches thick, top and bottom strako being 1½ inches.

The false stem, stem, stemson and deadwood of English oak, totalling to about 6 feet through at the water line.

Iron sheathing for protection against ice extended from the bows 6 feet aft and to 7 feet above and below the normal water line. She is also fitted with a heavy iron stem band.

On the inside of the bows below the main deck from the stem to 45 feet aft two extra tiers of beams were worked immediately below the main deck beams and well pilloried from the keelson. Also for this distance riders (12 inches by 12 inches) were worked inside the frames, diagonally across and 1 foot apart.

As originally built she had a screw well for lifting the screw but this had been filled in when the large propeller was fitted.

The rudder was plated with $\frac{5}{8}$ inch mild steel plates to about 6 feet below the normal water line. The weight of the wood in the rudder is nearly 1 ton and of the iron plating another $\frac{3}{4}$ ton. It is hung by 4 pintles and originally there was nothing to prevent the rudder unshipping except its weight. After the first season (1910–11) a wood lock was fitted for extra safety in case of a lifting force from pressure.

Masts and Yards.

Main Mast.

	feet	inches		feet
Lower Mast	70	6	Housing	18
Topmast	37	0	,, ...	9
T'gallant mast	36	6	,, ...	6

Height of Truck above U.D., 111 feet.

Fore Mast.

	feet	inches		feet
Lower Mast	68	0	Housing	18
Topmast	37	0	,, ...	9
T'gallant mast	36	6	,, ...	6

Height of Truck above U.D., 108 feet 6 inches.

Mizzen Mast.

	feet	inches		feet	inches
Lower Mast	58	0	Housing	7	0
Topmast	48	0	,, ...	7	0

Height of Truck above Poop, 92 feet.

Main and Fore.

	Length. feet	inches	Diameter. Bunt inches	Quarter inches
Lower Yard	64	0	14	13
Upper Topsail Yard ..	53	0	12¼	11
T'gallant Yard	41	0	0	9

Bowsprit.

	feet	inches		feet	inches
Length	49	3	Housing	16	6

Total length outboard, 32 feet 9 inches. Tapering from 16½ inches diameter heel to 8 inches.

General Remarks.

Coal Space.—By original design 130 tons could be carried on the main deck forward of the boiler room bulkhead. The tanks being removed from the hold this was used for coal, and then the hold from boiler room bulkhead to the fresh water tanks up to the main deck, and above the main deck from the boiler room bulkhead to the fore end of the main hatch, together with the 68 tons in the bunkers, brought her coal capacity up to 550 tons (New Zealand coal).

From the fore end of the main hatch to the foremast was then available for general cargo and extra living space.

Water Tanks.—In the hold, 10 feet abaft foremast and height to the main deck beams; four in number. Two rectangular ones, held 12½ tons each, and two wing tanks fitting the shape of the ship held 8 tons each.

Though in the design counted as ballast tanks they were all used, when required, for fresh water.

Crew Space.—The topgallant forecastle was used as a mess deck and the forecastle as a sleeping deck. The men slept in hammocks, all bunks being removed from both forecastles, and lockers were arranged along the ship's side for kits. On the port side of the lower forecastle abreast the foremast a warrant officers' mess was built with six bunks.

An instrument room of match boarding was built starboard side lower forecastle, opposite the warrant officers' mess to hold all instruments. It was, however, found to get very wet and no delicate instruments could be stowed there.

The wardroom was much enlarged and, including the pantry, extended from the engine-room bulkhead aft. Cabins were arranged all round, and the original engineers' mess now opened into the wardroom and was fitted up as a six-bunk cabin. Total number of bunks, 24.

The skylight and companion to the wardroom were removed, and a deck house built over the wardroom for light and air. The foremost end of this house round the mizzen mast was made into a chart-house, and it also allowed of a gangway about 2 feet 6 inches broad on the starboard side, between the after door and the companion down to the wardroom (the old hatch to lazarette). This house was constructed of two thicknesses of 1 inch spruce boards.

The gangway mentioned above was found almost indispensable in cold weather for the biologist, the baths into which the contents of a trawl were emptied, immediately it was got in-board, being at once put in here to prevent the catch freezing, and by keeping the wardroom fire up it was possible to keep the temperature here slightly above freezing point even with 20 to 30 degrees of frost outside.

On the port side of the poop four laboratories for scientific work were built of 1 inch spruce double thickness. The after one was fitted up as a photographer's dark room. The foremost one had two clome troughs with small tanks overhead (one salt water and one fresh water) for the use of the biologists, while all were fitted with shelves for bottles, etc. By exercising care in replacing bottles there was hardly a breakage in spite of the excessive motion which was sometimes experienced. These houses were found to be unsatisfactory as they soon leaked badly through the expansion and contraction of the wood, causing great annoyance to the scientists and damage to their gear. It would be advisable on any similar occasion to use teak in spite of the greater expense.

The compartment in the hold before the sail-lockers was used as a biological locker, it being about 8 feet fore and aft and the breadth of the ship.

As a contributory cause towards the freedom from loss due to breakage must be counted the fact that, as soon as possible after preserving, the bottles containing biological specimens were safely packed in wooden boxes and stowed in this locker. Water samples, however, which were stowed here froze and broke the bottles.

On the upper deck between the main and fore hatches an ice house was constructed of :—outside, two thicknesses of 1 inch spruce boarding grooved and tongued ; lagged top, bottom and sides, with a non-conducting material. Inside were another two thicknesses of 1 inch spruce boarding, and the bottom and 3 feet up the sides lined with lead. There were two drains to let the melted ice water run off. This house when filled with ice and meat was such a heavy weight (about 10 tons) that its position on the upper deck was a source of weakness. On top of the ice house were placed the Standard Compass, the Dip Circle gimbal stand and the Range Finder.

Below the wardroom over the shaft alley was a lazarette extending from the engine room bulkhead to the body post (22 feet), which was used for stowing " present use " stores in. Down here was also the chronometer room. The lazarette was the only really permanently dry place in the ship.

There were no watertight bulkheads throughout the ship.

Two leaks were a source of considerable trouble till they were finally located. One of the through bolts in the stem had become slack in the hole allowing free passage for water, but there were also other leaks about the bows beneath the sheathing ; the original caulking in the ship's planking beneath the sheathing having become perished from age, and the ship having had such frequent small repairs, it was difficult without a large refit to make the sheathing itself watertight.

In the stern, by careless workmanship at some time, a hole in the ship's planking beneath the sheathing had been left unplugged near the screw well. Water thus found its way easily inside the sheathing when it had a free passage inboard. This leak was very difficult to locate and was not found for nine months.

At her worst, when fully laden, she made about 1 foot 6 inches of water in a watch, and when these two leaks were stopped it was reduced to this amount per day, but after working in the pack there was always an increase of leak forward which could only be stopped properly by stripping down the sheathing in the bows and recaulking the hull.

Hand Pump.—Abaft the mainmast, four 6-inch plungers (two to each suction pipe) about 9 inch stroke.

The suction pipes as originally fitted were heavy cast-iron pipes in two lengths (*i.e.*, each length about 10 feet) running down between the frames and open at the bottom with no rose fitted.

A trunk gave access to the well from the after hatch, but the space in which the bottom of the suction pipe was, was so small that it was always difficult to clear it of coal even when it was practically dry, and almost impossible to do so at times when there was 3 feet of water in her.

After the first year's experience the lower end of the suction pipe was cut and flanged 3 feet 6 inches from the bottom, and a light iron pipe and rose fitted which could easily be removed if required.

In bad weather it was impossible to open the after hatch and so get down to the pump well, while from forward the way was blocked by coal and stores (when fully laden). It was necessary therefore in the gale of December 8, 1910, to cut a man-hole in the boiler-room bulkhead to allow access to the trunk.

After the first season the bilges were thoroughly cleaned and the ceiling, which was damaged, repaired. The bilges had become filled up with coal that had found its way through the damaged ceiling and mixed with the residue oil from the engine room bilge. This mixture formed into large balls that soon choked the pumps.

The original pump handles were short handles allowing of only three men aside, but these were replaced at Simonstown by long portable crank handles between the pump and ship's side on both sides of the ship.

Without these better handles it would often have been impossible to pump out in the Southern Ocean.

Skids.—Immediately abaft the foremast three skid beams were built the height of T'gallant forecastle. On these were stowed a whaler and cutter, and also the ship's spare timber for repairs. These skids were found of the greatest use.

Stables.

*First Year—*19 *Ponies.*

The top gallant forecastle was fitted up into fifteen stalls, the lamp room being removed.

Each stall was 2 feet 8 inches broad with portable partitions between. The front boards were fixed, but this was found to be a great disadvantage if an animal fell.

A trunk was built round the hatch leading from the top gallant to lower forecastle and carried up to the skylight so that the air the men got in the sleeping deck below should come direct and not through the stables.

Four stalls were built on the port aide of the fore hatch, between the ice house and the after skid beam, facing inboard. These were strongly constructed of 3 inch deals, bolted through the deck, receiving some support from the ice house and after skid beam, and also secured by chains to deck ringbolts. The partitions were of 2-inch red pine.

Second Year—Seven Mules.

The mules were all carried outside.

The stables were again built round the fore hatch, four stalls being on the port side and three on the starboard, all facing inboard. The deck between being brought up to the level of the hatch coaming.

The front boards were fitted to be easily removed to take out any one animal at a time. (See sketch below.)

At the bottom (in front) a wide board close down to the deck prevented the possibility of their feet slipping under.

The partitions were again removable but brought close down to the deck for the same reason.

On the floor of the stalls cocoanut matting was put down and 1 inch × 2 inch battens, to give the animals a hold. The matting choked the drain holes and was found to get very foul, and was therefore discarded after a few days.

Eye-bolts were fitted on the top of the stalls to assist in lifting the animals if they should fall.

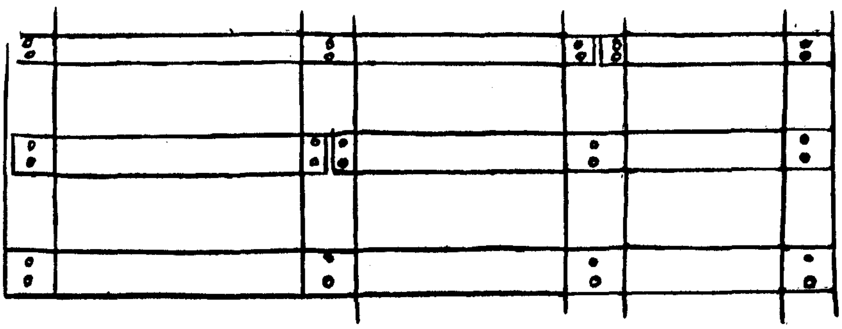

Fig. 1.

The stables were covered with painted canvas, and an awning that could be drawn across from stable to stable in bad weather was fitted.

Dogs.—Going south there was not room to place special fittings for the dogs, but for the passage home wooden trays were made for them to lie on. These trays were about 18 inches to 2 feet broad with a 2 inch batten running along the outer edge for the dogs to press their feet against when the ship was rolling.

They were raised 3 or 4 inches off the deck and had holes bored through to allow of free passage of air. In both hot and wet weather they were the greatest comfort to the dogs.

Engine-Room Particulars.

The propelling machinery consists of :—

One set of 2 cylinder (H.P. and L.P.) compound vertical inverted engines made by Messrs. Gourley, of Dundee, in 1885.

Nominal horse-power	140
Diameter of cylinders—H.P.	27 inches.
L.P.	54 ,,
Length of stroke	2 feet 9 inches.
Diameter of shafting	10½ inches.

The H.P. and L.P. slide valves were flat double ported.

One surface condenser was fitted, the circulating water passing through the tubes.

The air pump (1 double acting) was worked direct off the main engines.

The thrust block was of solid block type having six collars on the shaft, circulating water passing through the top cap.

The starting and reversing gear was of the "all round" description.

The main bearings, crankhead and eccentrics were lubricated by means of worsted syphons.

The propeller was four-bladed and of cast steel.

Engine Room Pumps.

Circulating Pump, worked direct off the main engines, for circulating water through the condenser, could if required be put on to engine-room bilge suction.

Capacity about 600 tons per hour.

Mail Bilge Pumps.—Two worked direct off the main engines. Diameter of plungers 4 inch, stroke 2 feet.

Feed Pumps.—Two worked direct off main engines. Diameter of plungers 4 inch, stroke 2 feet.

Evaporator.—Makers "Kirkaldy." Output 6 tons per day. The feed pump for evaporator was worked direct off the main engines taking its suction from main condenser discharge. Diameter 2 inch, stroke 10 inches.

Injector.—One ; for auxiliary feed and make-up feed. Makers, " Davies Metcalfe."

One auxiliary fire and bilge pump (independent of the main engines) made by " Gourley " with connections to fire main, engine room and stokehold bilges.

Boiler.—One marine return-tube boiler, having three furnaces. Working pressure, 80 lb. per square inch. Dimensions: diameter, 15 feet; length, 12 feet. Weight of water at working height, 26 tons.

Ventilation.—All natural draught. Two cowls at after end of engine room as uptakes. Two cowls over boiler room as down-takes, exhausting through the fire and up-funnel.

The space over the boiler was also ventilated by " ports " on top of the boiler room casing.

There was no bulkhead between the engine room and boiler. In the tropics the boiler-room was extremely hot.

The bunkers were ventilated by port-holes in the forward end and bunker lids on the poop.

The ship was fitted with two steam winches ; two cylinder, reversing type ; steam taken from boiler and exhausting to atmosphere.

The foremost winch, situated abaft the galley, had

Cylinder diameter, 8 inches.
Stroke, 12 inches.

It was used for trawling, and for working cable by means of a messenger chain and sprocket wheels on the cable holder. In cold weather the messenger chain became too brittle for this strain and snapped.

The after winch, situated at fore end of poop, had

Cylinder diameter, 6 inches.
Stroke, 12 inches.

It was used for trawling, and had a messenger connection to work the hand pump, but this was never used owing to the waste of steam.

Heaving in a trawl caused a loss of water varying from $\frac{1}{2}$ ton to 1 ton.

Remarks.

The boiler was examined and drill tested in 1910 and new plain tubes were fitted. The stay tubes were passed as good for the commission ; they were supposed to be the original stay tubes fitted.

The centre combustion chamber was found to be only 3/16ths of an inch instead of $\frac{5}{8}$ in one part. This had already been patched unsatisfactorily, but the thickness was increased to 5/16ths by the acetylene welding process, which proved quite satisfactory.

Only fresh and distilled water was used in the boiler the whole commission.

Corrosion was found taking place on the stern shaft near the propeller, so a zinc protector was made and secured to the shaft. The propeller was cement-washed and no more action occurred.

For melting ice two iron tanks were fitted one on each side of the boiler-room casing, with a steam jet entering near the bottom and discharges leading to the boiler and ship's tanks. A little ice being melted in them, and the water raised to boiling point, it was found that ice was melted in them almost as quickly as it could be put in. As first fitted the steam was kept enclosed in a spiral tube at the bottom, but after experience this tube was removed and the steam let direct into the tank.

While crossing the Atlantic in 1910, trouble was experienced owing to hot bearings. It was found that the main bearings had been lined up with tin liners under the different brasses and these liners had deteriorated. After brass liners had been fitted in New Zealand there was no more trouble from this cause.

Coal.—She took in 450 tons Crown Patent Fuel at Cardiff in June, 1910.

The bricks were two sizes, of 25 lbs. and 12 lbs. weight respectively. This fuel was very suitable for stowage (35 cubic feet per ton). It was easy to trim from the hold into the bunkers and was also convenient for use with a shore party owing to its compact stowage and easy handling. It was not found to deteriorate during two winters. For use in the ship it was found not so economical as coal proper, owing to the comparatively large percentage of ash and clinker.

From New Zealand both Westport and Blackball coal were found to give good results and to be economical. They were used mixed, and worked well, the percentage of ash being only about 3 per cent.

The Blackball coal requires good bunker ventilation, and great care had to be taken that it should be received on board perfectly dry.

To ventilate the coal in the hold six wooden trunks were fitted from the bottom of the hold to above the coal, and these were perforated with holes at frequent intervals. They also allowed the temperature of the coal to be taken daily. Whenever the weather permitted the hatches were uncovered during the daytime. On two occasions the coal heated sufficiently to cause some anxiety.

Oil.—The lubricating oil used was No. 1 mineral engine oil of the Vacuum Oil Company and was quite satisfactory.

CHAPTER III.

EQUIPMENT AND STORES.

NOTES ON EQUIPMENT.*

Primus Stove.—The Primus stoves used on the Expedition were manufactured by Hjorth, of Sweden, and were of two types—" silent burners " and " roarers."

After many tests the " silent burners " were considered to be the more efficient and economical, but since then experiments with British stoves under conditions prevailing in England have given better results with the " Roarer " type.

An abundant supply of prickers to clear the nipple and at least four spare nipples should be carried for a long journey, as well as a spare tool with universal joint for placing the nipple in position and screwing it home.

Under all ordinary conditions a gallon of paraffin suffices for cooking three meals a day for a four-man unit for seven days, and with economy and under summer conditions a gallon can be made to last for 10 days.

The methylated spirit necessary for lighting the Primus was carried in a cylinder holding four ounces, an amount sufficient to last a party of four men for a fortnight, being used three times daily. The cylinder delivered through a nozzle controlled by a spring, so as to avoid waste and evaporation.

Cooking Apparatus.—The cookers were of the same type as used in most recent expeditions and known as the " Nansen " cookers. They were made of aluminium and comprised an outer cooker, with inner and outer walls forming a hollow shell, surrounding an inner cooker or pot with a firmly fitting cover, which rested on studs projecting from the lower part of the outer cooker.

The cups were double, fitting accurately over each other, and all four pairs were carried in the inner cooker. Four aluminium spoons the size of a dessert spoon were also carried, and these were also placed in the inner cooker with the cups. When in use the inner and outer cooker rested on a circular tray with central hole, which was itself supported by extensions of the legs of the primus. Inverted over the whole was the large outer cover ; the lid of this formed a platform for the legs of the Primus.

* These notes have been prepared by Surgeon-Commander E. L. Atkinson, with additions by Messrs. F. Debenham, R. E. Priestley and C. S. Wright, other members of the Expedition.

With these cookers it took from 30 to 45 minutes, according to the degree of cold, to provide a meal for four men.

Fuel.—The oil used was a paraffin with a very low flash point. It withstood freezing in temperatures of – 77 deg. F.; below – 60 deg. F., however, it became slightly opalescent and thick.

The paraffin was carried in tins of rectangular section, each holding one gallon, the weight of tin and paraffin being 10 lbs. The tins were fitted with brass screw caps and leather washers. The caps had two raised lugs on top to facilitate opening the tins.

After exposure to excessive cold, the leather washers harden and are less effective in preventing evaporation, and this happened in the case of the tins placed at the foot of the flag-poles marking the depots. Returning parties found their supply at the depot short for this reason, and the Polar party also complained of shortage, as related in Captain Scott's diary.

Storage of Food.—The mode of storage of food at the depots is of the utmost importance, and the experiences of the sledge parties of this expedition should prove useful in future. The pemmican was carried in bags made of a light brown holland material, these were placed *on* the cairns and in most cases covered with slabs of snow.

On the return journeys, in every case where the sun's rays had been able to reach the bags, it was found that the heat had been sufficient to melt the fat, which then exuded through the canvas.

The heat had also led to partial decomposition in some cases, and the pemmican tasted rancid. The same remark applied to the butter ration when this formed part of the sledging diet. Butter, however, was stored in rough white calico bags, and the effect of the sun's rays was less marked. Amundsen also complains of ruined pemmican in his depots.

The experience of the Expedition suggests that care should also be taken with the tins of biscuit ration. Normally, the tins would be depoted unopened. If open when left at the depot, however, the very greatest care must be taken to cover them with sufficient snow.

The following case occurred. A party took its rations from an unopened box, but when they replaced the box they did not bury it efficiently, and the succeeding party found that drift snow had got into the box, the sun had acted on this, and a portion of the biscuits were embedded in ice.

It is thus necessary when storing food at the depots to place it in the centre of the cairn before this is completed. Care must even then be taken to see that the slabs of snow prevent access of the sun's rays and are of sufficient thickness to form a screen. The Northern Party depoted food sometimes in canvas tanks which were placed on the top of any opened biscuit tins, and so shielded them effectually from drift.

Spacing of Depots and Cairns.—On the southern journey the depots were placed at intervals of 60 miles on the Ross Barrier, and contained the estimated amount of food, sufficient to carry the party to the next depot on full rations when marching at the rate of 14 geographical miles per day.

Between the depots, rough cairns of lesser height were erected at varying distances when halts were made during the southward march. The distances between these by sledgemeter and the course between successive cairns were noted.

This was helpful on the Ross Barrier, as even a cairn lends interest to the return journey and most helpful in keeping the course when navigation is by dead reckoning.

The mid-barrier area, from experience gained in traversing it in November and (in the case of the second return party) in late January and February, seemed windless with almost continuous fall of light snow.

Glasses or Snow Goggles.—The goggles supplied for the Expedition were of leather, quadrilateral in shape with a central raised part. Two such pieces of leather, with glass between, formed each eyepiece. Apertures of suitable shape and size were then cut in the leather. These glasses were comfortable, did not compress the nose and were easily stored.

It would have been an improvement if this central raised portion of the leather had projected further from the face in order to secure some additional side ventilation.

This question of ventilation is one of the greatest importance, especially for man-hauling units, where the labour involved in dragging the sledge gives rise to profuse perspiration. The water vapour so formed condenses as dew on any surface, such as the glasses, which are at a low enough temperature, or in lower temperatures in the form of hoar-frost. With adequate ventilation, there is less tendency to form dew or hoar-frost except when there is no wind or a following wind. It is possible for dew to form on an inner glass surface at the same time as hoar-frost is deposited on an outer surface. Conditions are therefore particularly unfavourable for those individuals who normally wear glasses. With such persons it is most important that the coloured glasses should be ground with the correct curvature, so that two pairs of glasses need not be worn.

Photographically, as tested by actinometer, the light on these days was often brilliant, generally varying from two to twenty-four seconds by Watson's actinometer, even when the sun was not visible.

A depressing effect was often caused by the almost total diffusion of the light, the clouded sky and the snow surface appearing of equal colour and light intensity so that the two, and the horizon between, were indistinguishable from one another. The result was that there was often complete loss of contrast. No shadow was cast and the horizon blended with the dead white of the Barrier surface. One could stand almost alongside a cairn nine feet high and be unable to see it. No shadow being cast, one was quite unable to distinguish sastrugi or any snow projections on the surface before falling over them. Often on the better days, after sighting a cairn a quarter of a mile away, a stumble would cause it to be lost; after searching for long periods, one would realise that in the endeavour to pick up the cairn a false horizon was being searched.

These conditions are not confined to the mid-position, but are likely to occur on any section of the Ross Barrier, or indeed any snowfield of sufficient extent to possess an horizon.

The above conditions can be slightly remedied by the use of efficient coloured glasses, to give protection from snow blindness, and at the same time, by cutting out the blue and violet end of the spectrum, increase the contrast on such days. A sharp " cut " in the spectrum is essential, together with sufficient reduction in *total* intensity to give adequate protection on the brightest days.

None of the compositions for preventing deposition of dew or frost which were tried was found to be of any service.

Balaclava Helmets.—The Balaclava helmets supplied were of thin wool for summer use, and of a very much thicker wool for winter. The lower part could be tucked inside the sweater, and both kinds had a specially thick pad of wool attached over the ears, as this is an organ particularly liable to frost-bite. For ordinary use a piece of " wind-proof " material sewn to cover both ears and almost meeting behind, was found to give a very efficient additional protection. The wind-proof material should come well forward towards the face opening, but should not meet behind or on the top, so that perspiration can escape, to deposit as hoar-frost on the outer surface which can be easily brushed off. If the woollen helmet be completely covered in, the wind-proof becomes wet and freezes hard.

In very cold weather an addition in the form of an inverted T was used to protect nose and cheeks. For attaching this, beckets are sewn at appropriate places on the Balaclava helmet to take two large buttons sewn at either end of the horizontal portion, the third " arm " of the inverted T being sewn to the Balaclava helmet at a point directly above the nose.

Normally, the " nose-protector " is pushed under the forehead portion of the Balaclava, where it is thawed and dried when not in use.

When the " nose-protector " is required for use it can be pulled quickly from beneath the Balaclava and secured in place by means of the buttons and beckets. The " nose-protector " device is an old one, and it is doubtful whether it is ever really efficient.

Wind-proof Helmet.—The wind-proof helmets (of two qualities) comprised a hood fitting over the head, with a projecting funnel surrounding a narrow opening shaped to the face, and widening to the outer border which was attached to a soft copper wire. There was also a neck-piece which almost completely covered the shoulders, and could be tucked inside the wind-proof smock.

For added security on a long journey, it is better to sew the back portion of the wind-helmet to the wind-proof smock. It can then be carried as one garment, and when not in use dries in the air.

Experience showed that it was best to use the helmet formed of thinner wind-proof cloth on most occasions, for it dried more quickly, and in low temperatures, when covered with ice, did not become so hard as did the thicker winter helmet.

The function of the truncated cone was to form an enclosure which would retain a volume of air to act as a buffer against a head wind, the heat loss from the face being conditioned chiefly by the rate of renewal of this entrapped air. By suitable manipulation of the copper wire, the funnel could be shaped to give fairly effective protection against a side wind.

Wind-proof Smock.—The wind-proof smock was supplied by Messrs. Mandelberg in two thicknesses, one for summer and the other for winter use.

It was pulled on over the head and the neck opening was run round with 1 inch lamp-wick and the ends loosely tied. By tightening these ends the opening could be drawn close. The smock reached to the top of the thighs and was also run round with lamp-wick, so that it could be closed tightly around the top of the thighs, if desired.

Even in very cold weather, the thinner material was preferred by some, as it did not become so stiff when wet and frozen hard and was almost equally efficient. It was, however,. less durable than the thick material.

The trousers had no opening and were secured around the waist by 1-inch lamp-wick.

Puttees.—Two kinds were provided, one type being similar to the army pattern, while the other type was of thicker woven material for winter use.

Some members shortened them and wore them round the ankle, while others took the puttees up as far as the knee.

When wound around the top of the finneskoe they kept it in place on the foot and prevented it from sliding forward, as it has a tendency to do.

Socks.—Thick hand-knitted socks were supplied by the Wolsey Company, and were extremely well made, durable even after several months' wear. Two pairs of these socks were usually worn and this was sufficient in summer weather.

Goat-hair socks from Norway were also supplied and sometimes worn over the outer pair of woollen socks in cold weather, but they did not wear well, and after absorbing moisture they froze hard and were very difficult to thaw ; owing to their loose texture, they did, however, dry quickly in the open.

In the last year some long stockings similar to those worn by lumbermen in Canada were obtained by C. S. Wright for the Expedition. These were very warm and wear-resisting and may be recommended for future use. They came to the knee and were secured there.

Pants.—These were supplied by the Wolsey Company. They were of material almost twice as thick as that used for the thickest winter wear in England. One pair was sufficient for most people ; others preferred two pairs fitted with a front down-folding flap, with two buttons, for which eyelets were placed on either side of the upper part of the pants.

The vests were also made by this Company. They were approximately of the same thickness as the pants, with an extra thickness at the back to keep the heat in whilst lying in the sleeping bag at night. Over this vest an ordinary woollen sweater was worn, and a large piece of wind-proof was usually securely sewn to the front of this to form a pocket. In this was carried all personal gear that might be required in a hurry or was continually in use. For night wear and for cold weather, so-called pyjama jackets were supplied. They were made of merino material also supplied by the Wolsey Company and had two large pockets at either side, with large buttons down the front. Lastly, a thick woollen muffler was sometimes worn around the throat, and the efficiency of this was proved by its preventing frost-bite of the face on cold days.

Finneskoe.—The finneskoe used by the Expedition were obtained from Hagen of Kristiania and were secured of especially large size. (The Lapps who manufacture these fur boots have exceedingly small feet, so that those for Europeans have to be specially made.)

The best finneskoe are made from the hide covering the forehead and the shanks of the reindeer. The sole is sewn in so that the hair points from the toe to the heel for the foremost half, and in the reverse direction for the heel half, which minimises slipping. It would probably repay any future explorers to visit a Lapp village on the coast of Russia, a day's run from Vardöe, in Norway, and obtain from the Lapps the finneskoe and sleeping bags necessary for a projected expedition.

Good finneskoe will last for a year on snow surface with good treatment, but bad ones will last only a month or less.

Senna grass was also carried for the purpose of packing around the toes. On taking off the finneskoe the grass should be fluffed out in the hands to get rid of the frozen sweat.

The longer thigh or knee fur boots are not suitable for man-hauling. Their extra length only increases the difficulties due to freezing up in low temperatures. For driving dogs, however, they can be recommended, as there is comparatively small exertion with a dog team and proportionately less sweating.

Captain Oates brought a few lamb-skins with him and these he gave to some members of the party to make into sleeping boots. They were roughly sewn into the shape of the boot and secured below the knee by tapes. Sheep-skin has some advantages, as it is warm and wears well, while the wool in well-cured skins, after damping, does not tend to come out; its weight and the great stiffness due to the deposited ice and hoar frost that would ensue after it had been used for a sleeping bag in cold weather would be against it.

Mitts.—The description is of those supplied for the Expedition and of those evolved and found to be most useful in practice.

The half-mitt was a long woollen mitt, without thumb-piece or space for the other four fingers, worn next to the sweater and extending up the arms, the upper portion being pinned with a safety-pin to the arm of the sweater. The openings through which fingers and thumbs projected were sewn with tape to prevent fraying. As the joints of the fingers and thumbs were free and uncovered, it was commonly known as a half-mitt.

There were also short woollen mitts with a thumb-piece and single space for the other four fingers, but in cold weather these froze, and as it was no good trying to haul the mitt on with the wrist piece, the mitt was cut in two, so that the upper portion came only to the middle of the palm of the hand. They could then be placed in position immediately, even in cold weather when they were frozen hard, and were very useful when handling the cooker or any large metal instrument.

The outside fur mitts had a single compartment for the thumb and another single compartment for the fingers. A broad piece of lamp-wick was sewn to each, and secured by another shorter piece from side to side. By this they were slung over the head. They were fitted with thin inner fur mitts, but these crumpled and froze with use and were unhandy and unnecessary for sledging. These *thin* inner fur mittens had their use, however, as when dry it was possible to manipulate a theodolite without taking them off.

A small amount of senna-grass at the bottom of each fur mitt would aid in removing some of the frozen moisture.

The particular virtue of the large fur mittens was the fact that they were wind-proof. The combination of half-mitts and the truncated woollen mittens served our purposes excellently, except in high winds and cold weather, especially as the labour of man-hauling caused the deposition of so much ice and hoar frost in the woollen fabric that they, too, generally became wind-proof.

Sleeping Bags.—The sleeping bags were single, though in Captain Scott's previous expedition three-man bags had been used, and where very cold work is anticipated in the future they may be needed again.

The best fur is the close thick fur of the winter coat of the reindeer. The hairs of the summer coat after wetting tend to come out in clumps, and such skins should be rejected.

Clothing.—The allowance of spare clothing for the Southern Journey was calculated at 14 lbs. for each individual. This total included the allowance for tobacco, note-books and reading matter also. Personal experience and predilection alone can guide each one what to take.

A housewife, with thread and needles, should be carried in each personal kit. There are many small tears to mend and damage to socks and mitts to make good. In cold weather, tears in the wind-proof should be mended at once, otherwise local frost-bite beneath the tear occurs on each windy day. A small piece of beeswax for waxing thread is useful.

Crampons.—For working on the ice slopes of glaciers or on hard névé, crampons are necessary. A most useful type was evolved during the expedition and suited this purpose well. The lower sole was of an aluminium alloy studded with thick quadrate pointed nails and a piece of thick leather fixed the sole to a metal heel similarly studded. Around this leather a rough shoe of storm-canvas was sewn. The upper edge was fitted with beckets, and along the toe-piece ¼-inch lines were fixed, which crossed and recrossed through the beckets to the heel.

The feet, with finneskoe on, were fitted in and each cord from becket to becket gradually tightened. Finally, the two ends were secured around the ankle. In use the canvas became moist and on taking them off froze, so it was advisable to shape them after removing them from the foot.

Of the many types of crampon that were tried these proved to be by far the most comfortable and easy to adjust.

A Ski-shoe was also evolved, since the Finn bindings took some trouble to adjust and caused wear of the finneskoe. The sole of the shoe was made of seal-skin to which a portion of Venesta (triple-ply) board was sewn with copper wire. A toe-cap of sealskin was sewn to this sole. The heel was formed of thicker wood so as to ensure that the straps of the wheat-felt bindings were kept in place, and a portion of rolled sealskin was sewn to the upper part of the heel to prevent the binding riding up. A much more satisfactory result was achieved by the use of a *large* pair of ski-boots, with upper portion removed and suitably cut and opened up to permit entry of the finneskoe-clad foot.

Boots.—The boots provided were the Norwegian ski-boot and the Jaeger ski-boot. The latter was of a softer leather and excellent. A boot several sizes too large for the foot should be chosen.

These boots could not be used on the barrier, except as indicated above, but for coastal sledging in the summer, where moraine and rock has to be traversed they were essential. In cold weather, boots and even finneskoe should be thawed out before putting on in the morning. It is sufficient to hang them from the peak of the tent, as high up as possible, while breakfast is being cooked and consumed.

Perhaps a boot with a chrome leather sole and a canvas top, as devised by Shackleton for use in Russia, would be more comfortable, but it has no hold on ice, and would therefore have to be studded with nails. For use around the hut boots are essential, and the ice accumulated in them can be thawed and they can be dried on return to the hut ; for this we had the Russian felt boot. They wore out very easily and were only meant for use in deep, soft snow, but a plaited sennet sole was adapted to them and saved the felted sole from wear. They were warm and easily slipped on.

The Sledge and its Equipment for Man-hauling.—The most useful type of sledge in man-hauling for a four-man unit is the 12-foot sledge with hickory runners of Nansen type. Details are given in the reports of other Expeditions. Ten-foot sledges of similar make are useful for three-men units and should also be provided.

For work about the hut such as collecting ice for water, transferring stores, and rough work generally, a shorter and stouter sledge of 7-foot length is also useful. The trace is fastened to the two foremost pairs of uprights on either side and passed through a becket under the bow of the sledge ; it is seized to form an eye and a stout wooden toggle passed through this secures the man-hauling harness. The rope should be of 2-inch manilla, as tarred rope wears soon in cold weather and has a lower breaking strain. For the harness traces, too, the best manilla rope should be used. Three long straps are fitted at intervals along the bearer of the sledge with large buckles on the opposite side. They are best made of well-dried leather, free from grease, and they should be about 2½ inches wide to facilitate handling in cold weather.

At the rear of the sledge is lashed the instrument box, which is also secured to the sledge by means of a strap and buckle fixed to the bottom of the box. It is made of Venesta board and lined with canvas. A small compartment was occupied by the Primus stove and spirit tin, together with a thermometer and sometimes a hypsometer.

In the larger compartment the theodolite and other instruments and spares are carried. On the top are four wooden lugs to fit the base of the cooker.

It is as well to leave a space forward of the instrument box for the tins of buscuits and opposite to them must be a strap and buckle. A wooden tray for carrying the tins of fuel is also lashed to the sledge. A canvas tank of sufficient size to accommodate the provisions and with a narrow laced opening at the top was secured to the "fore and after." When not occupied with provisions it can be folded flat and is not in the way.

The attachment of the uprights to the runners is by raw-hide thongs and requires much skill. The upper ends of the uprights are cut so as to fit slots in the "bearer," and are seized to them with ¼-inch twine. The object of this construction is to ensure the flexibility of the sledge.

The sledges of the Expedition sat low, the uprights being about 9 inches in height, they proved very satisfactory, but for really deep snow a broader bearing surface would have been advantageous, and it should be tapered towards the rear of the sledge. A short note dealing with the question of bearing surface in relation to snow surfaces will be found in this volume on page 40.

Dog Sledge.—The type of dog sledge used by us differed little in its main features. The sledge was fitted with a long 2-inch rope trace fitted with beckets (in pairs), to which the dogs' harness was attached. The best beckets were made of a green chrome leather obtained in New Zealand, and their ends were plaited into the ply of the rope trace. The leader was on a light lead in advance of the other dogs. A vertical bow of strong cane material was secured to the first pair of uprights of the sledge by which it could be manœuvred over awkward places.

Opposite the first upright, a 2-inch grummet was seized slightly above the runner, through which the driving stick could be thrust into the snow. Added leverage for stopping the team was obtained by leaning forcibly back upon the upper end of the stick.

The driving stick was a stout oaken pole about 5 feet in length, 2 inches in diameter at the bottom and tapering upward to about 1 inch at the top. In the lower end a large spike was inserted and an iron ring beaten over the lower end served to secure this in place. A loop of leather was passed through the upper end for carrying the stick from the wrist.

The dog harness was made of a soft Willesden canvas, sewn double and consisted of a loop fitting over the dog's head, thus allowing him to pull from the shoulders, this harness loop was about 2½ inches broad. Another piece of canvas passing across the loop and sewn to both sides of the loop assisted in keeping the harness in place. The ends of the loop were finally sewn around the ring of a swivel, to which were attached two leathern thongs ; these were fastened to a wooden toggle, which was passed through the becket on the trace (thus attaching the dog to the sledge).

To secure the harness firmly in place a piece of lamp-wick 1 inch broad passed from one side of the harness under the dog's chest and was secured on the other side by toggle and becket.

At first the leathern portions of the harness were made from raw-hide, but this contained a certain amount of grease and became very hard in cold weather, then becoming difficult to get straight. The green chrome leather obtained in New Zealand is admirably adapted for use in cold weather. It was experimental in 1910, but is now coming into more general use and can be recommended in future for leathern fittings.

Tents.—Tents for the sledging parties were made by John Edgington, Old Kent Road, London, and were of green Willesden material, strengthened at the top where they rested on the pole-caps. The bottom ended in a valance about 30 inches broad, on which slabs of snow could be placed to hold the tent in position when it had been drawn over the poles.

The entrance was a circular opening fitted with a deep cylindrical funnel with lanyards for securing it inside and out. The poles were between 8 and 9 feet in length and made of male bamboo ; they were six in number and fitted into slots formed in the pole-cap of heavy canvas.

In windy weather, the poles were first put in position ; two men then took hold of the windward side of the valance, so that the wind filled the tent-cover, which could then be lifted over the poles. The other two men of the party had snow blocks ready, and these were placed on the valance as soon as the windward side of it was in position.

Sledgemeter.—For long journeys on the Ross Barrier a great part of the navigation had to be by dead reckoning, and to measure the distance traversed various forms of sledgemeter have been used. The instrument used on this Expedition was attached to the rear end of the bearer of the sledge and had a universal metal joint to allow free movement.

The wheel, the number of revolutions of which measured the distance, was made of aluminium alloy and was studded with spikes to obtain a better grip on the surface. It was, however, apt to get clogged in deep snow.

The Compass.—The compass in ordinary use was a small $2\frac{1}{2}$-inch card compass (boat compass) in a metal case closed by a glass top, the interior of the case being filled with alcohol and sealed. These were too heavily damped and, in cold weather, the vapour bubble above the card caused some difficulty. They were not wholly satisfactory, and an ordinary undamped compass with a very heavy needle was considered preferable. It was small, could be carried in the waist-coat pocket and settled down quickly. Also owing to the weight of the needle it was not seriously affected by vibration in strong winds.

NOTES ON SLEDGES.

By C. S. WRIGHT.

With particular reference to the relation between bearing surface and type of snow surface.

In view of the paramount importance of the sledge in all field work carried out in the Antarctic at a distance from Winter Quarters, a discussion on the efficiency of different types of sledge is not only justifiable, but even necessary. The note which follows has particular reference to the factors which seem chiefly to affect the friction between sledge runners and the surface beneath. Some of these factors are the type of surface, the area of sledge runner in relation to the weight carried, the flexibility of the sledge and the temperature of the surface.

It may be stated at the outset that no systematic measurements of friction were, or could be, made by us, and more attention should be paid in future to this important point.

Not only is the question of the general speed of travel bound up with these factors, but also the very important point of equality of speed when two or more man-hauling units are travelling together. No doubt the difficulties which may arise in such parties is largely a psychological one, but all who have sledged will bear witness to the reality of the effect. This difficulty is the danger that one unit may, if pulling an inefficient sledge, over-extend its powers in the attempt to keep up. Time and again, an exchange of sledges in such composite units has shown that the friction of sledges varies greatly ; if the party is pulling to the limit of its powers, the result upon the worst equipped unit may be quite serious. If equality of sledges cannot be attained, the personnel should if possible be shifted among the units until the normal rates of travel are equal. There are great difficulties in arranging this, especially as, though admitting the variation in friction from sledge to sledge, none of us was able to discover a sure criterion to distinguish between two new sledges—one good and one bad. Undoubtedly, however, the grain of the runner was of some importance.

If we consider the types of sledge which are used in different countries, we find at the one extreme the toboggan of Canada and at the other extreme the Esquimo sledge of Greenland.* Both are no doubt the products of generations of experience, the first in very soft snow, particularly in the wooded parts of the country and the second on sea ice which is generally snow-covered. The first type is flexible and is "all runner" to provide the maximum bearing surface ; the second type is rigid and has a small bearing surface. The Nansen type which was used by us lies between these extremes, being fairly flexible with moderate bearing surface. Though the writer has had no experience of conditions in the North Polar ice pack, it seems probable that what we may call the "Greenland" sledge is designed to withstand the roughest

* In the same way, we find the snowshoe of Canada, with its broad bearing surface for soft snow, becomes in Lapland the ski, admirably adapted to a treeless terrain wind-swept and, consequently, of harder surface. It is an open question whether snowshoes would not be the best to use in the Antarctic when pony transport is used.

usage on ice covered with only a moderate amount of snow, the runners often or generally sinking through the snow to rest upon the surface of the sea ice.

With this introduction one is probably prepared to admit that the question of the type of surface traversed by the sledge is of prime importance in the choice of a suitable sledge. One difficulty lies in the fact that all types of surface are liable to be traversed in a long journey—surfaces varying from sea ice through all gradations down to the softest snow. The conditions which obtain on sea ice and glacier ice are almost in a class by themselves; though snow does fall and is retained on the sea ice, the average wind velocity on the margin of the Antarctic Continent is generally high. Such snow is packed hard by the wind except in certain areas (as on the Western side of Robertson Bay) and the process of hardening is accelerated by recrystallization of the snow granules, a process which is specially promoted by the warm sea ice below. Conditions on a floating mass of ice such as the Ross Barrier are different. Here deposition is in the ascendant. The process of recrystallization which leads to a growth in average size of the snow grains and to an increase in density of the snow, proceeds more slowly by virtue of the lower temperature, and the process of forming the snow into a hard surface would be very slow were it not for the heavy winds which lead to a greatly increased coherence of the surface crystals—the process being partly one of "packing," but partly operating by blowing the loose surface snow away to seaward. Even here, however, there is room for much variation in the surface. Some areas, as in front of the outlets of large valley glaciers, are swept by fiercer winds than is the case elsewhere. The frequency of snowfall also varies from place to place, so that the chance that a strong wind has been blowing since the last snowfall is, if other things are equal, dependent on this factor also. Conditions are again different on the Plateau. The low temperature resulting from the great height here renders "packing" by recrystallization much less effective, this fact coupled with a comparative freedom from really high winds renders the surface generally soft, so that a sledge with narrow runners would sink right in.

It is this great variation in hardness of surface which renders the problem so difficult. We might at first sight assume that the sledge should be designed for average conditions, if these were completely known. We would be wrong for the reason that special weight should be given to those surfaces of very soft snow which can delay the party to an almost incredible extent. As an example we have the case of the Pole-ward bound party, which, after being delayed for five days by a blizzard at the foot of the Beardmore Glacier, had their progress further delayed by soft snow on the lower reaches of the glacier. Here the rate of travel on some days fell as low as ½ mile per hour or less, due to the sledges sinking in so far that the crosspieces rested on the snow. The conditions were admittedly unusual, men sinking into the snow below their knees when skis were removed. At the normal rate of progress, however, we would have been 30 or 40 miles further south if this soft snow had not delayed us.

Experience taught us, in fact, that the softer the snow the greater should be the bearing surface of the sledge runners, while, on the other hand, the harder the surface the less will the friction be under any normal circumstances. With very hard surfaces also the friction is less, the smaller the area of contact between snow and runners. Still another important factor enters here, namely, the roughness of the surface, especially when this is hard. In such a case, the actual bearing surface may be exceptionally small, especially if the surface is as hard as ice. This is especially true with a rigid sledge and the friction is then unusually low. Thus, a further factor which influences the friction is the flexibility of the sledge. The friction is actually a minimum on rough ice with a rigid sledge and a very narrow runner. The stiff narrow iron runners we took for use on ice surfaces (and especially sea ice) proved very useful. The use of such narrow rigid runners would, however, be impossible in soft snow, owing to the depth to which the sledge would sink into the snow and the consequent great increase in friction. Flexibility as well as large bearing surface is required for efficiency in soft snow and since soft snow forms one of the worst surfaces likely to be met, the sledges used for general work on an expedition such as ours should have, as ours did, a fair bearing surface and reasonable flexibility within the limits of strength imposed by the conditions of usage. As pointed out above, the bias should be towards a large bearing surface, in view of the labour and delay which result in very soft snow. With a broad runner the additional labour on the many occasions when the sledge is running well is offset by the labour saved in occasional soft snow. The loss of time in the latter case is, however, the really serious factor.

An attempt to analyse the results of our experience as regards the friction between various surfaces and the Nansen sledges we used would place the surfaces in the following order of merit—the best surface being that standing at the head of the list :—

(1) Bare ice free from salt, especially if rippled (slightly roughened) on the surface.

(2) Rough ice free from salt (bare glacier ice).

(3) Old sea ice, especially if slightly roughened on the surface.

(4) Névé.

(5) Hard wind-blown snow. This is, of course, never level.

(6) Softer snow of even surface, but somewhat compacted by wind and high temperatures.

(7) Still softer snow into which the runners sank two or three inches. Freshly fallen snow was the worst.

(8) Freshly formed sea-ice covered with a thin layer of snow, which remained wet (with brine) even at very low air temperatures.

(9) Very soft snow into which the runners sank until the body of the sledge rested on the snow surface. In these conditions a heap of snow was generally pushed in front of the sledge.

For conditions 1 to 5 a rigid runner of small bearing surface would have been more satisfactory. The same is true for condition 8, in which case it is desirable that the runner should cut through the wet snow and rest on the ice beneath. With a moderate bearing surface on this kind of ice, the friction seems to be a rolling friction *between* the snow grains, and the same is probably true of the " floury " surfaces (as 7) formed of snow freshly fallen at low temperatures—the individual crystals being very minute.

On the whole, however, it is considered that the sledges used had about the correct bearing surface. Whether better results might not have been obtained with an entirely different type of sledge is, however, open to question. Thus, a rigid sledge with runners of such shape that the bearing surface would automatically be increased as the snow surface became softer might well have proved more satisfactory for general work. An approach to such a sledge would be formed by adding a metal shield (*s*) to the under-body of the sledge, as indicated in Fig. 2, which represents a vertical section at right angles to the fore and aft line.

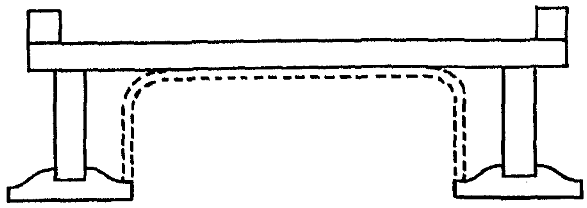

Fig. 2.

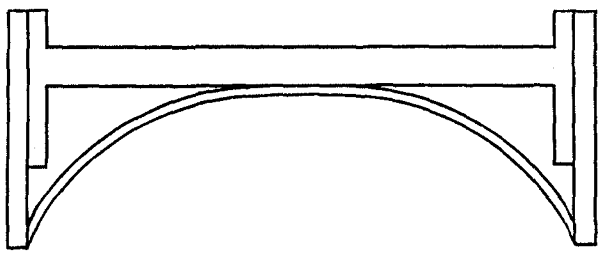

Fig. 3.

A nearer approach to what is visualised is indicated in Fig. 3, the sledge being rigid and completely built in some light alloy suited to withstand low temperatures. For snow surfaces and on smooth ice surfaces a sledge of this type seems to be feasible, and to present certain advantages ; it might be less satisfactory on rough ice. The friction between sledge runner and ice is, however, always comparatively slight except for case 8.*

It has been indicated that the friction increases as the snow surface becomes softer, some reduction being, however, attained if the bearing surface can be increased at the same time. Wind consolidates the surface and renders it harder, though a measure of consolidation is attained in course of time even in calm weather, the degree of hardening

* For general work on sea ice, at a station such as Cape Evans, the provision of an ice boat, with specially designed runners, has much to recommend it. The runners recommended would be similar to those used in Canada, but of heavier build and designed for use with 3 or 4 inches of hard snow above the ice.

being conditioned largely by the time and the temperature of the surface. Quite apart from any question of the hardness of the snow, however, the surface temperature has an important influence. Our opinion was that the friction decreased steadily as the temperature rose above zero Fahrenheit, the presence of brilliant sunlight having an effect, which was more than a psychological one, on the speed of advance. With air temperatures about freezing-point, however, there was some danger that snow would melt in contact with the runners, and subsequently freeze in lumps to increase the friction notably. Below zero Fahrenheit the friction seemed to increase progressively as the temperature fell, as if a greater and greater proportion of the friction were due to relative movement between the snow grains and less to sliding friction between runner and snow. The same phenomenon probably occurs at higher temperatures in the fresh-fallen snow surface, which we designated by the term "floury." The rate of wear of the runners also seemed to increase notably at low temperatures.

We have no definite information as to the friction which is actually experienced; the labour of man-hauling is, however, severe, and sledging even in moderately hard snow involves a daily exertion which is certainly not less than that corresponding to pulling a load of 250 lbs. per man up a glacier (bare ice) 3,000 feet high, the distance of travel being the same in each case.

A new sledge in which the runners tapered from front to rear of the sledge, being broader in front, was available in the second year. The general impression was that this form of runner was an improvement on the old runner, which was of equal width throughout; without accurate comparison in average conditions, however, such an impression can carry little weight.

It is recommended, therefore, that any future expedition should carry spring balances capable of making measurements of friction, under average sledging conditions especially in view of the importance of this measurement for the design of sledges and for a choice of the best distribution of weight per unit area in various conditions of surface hardness and of temperature.

BLUBBER STOVES.

Blubber stoves capable of cooking a sufficiency of food can be improvised under the very worst circumstances, and a description of the various blubber stoves used on the Expedition and their capabilities and utility may be of interest to further expeditions.

The experience of Captain Campbell's party at Evans' Coves has shown that any party marooned under similar conditions can, with ordinary luck, survive and cook their food if seals are obtainable.

Experiments to design a stove which would burn blubber efficiently were started in New Zealand, when the following requirements were laid down: to give a high heat production spread over an adequate surface; to have sufficient draught to allow of adequate combustion; to be economical in the consumption of blubber; and to have a fairly large area on top to allow space for sufficient cooking utensils.

Finally, with the assistance of Chief Engine-Room Artificer W. Williams, a stove of cast iron was designed in two parts. The lower portion, which was raised on cast-iron legs at the four corners, was fitted with a gutter into which the upper portion fitted. The whole was square, tapering towards the top. The top was square and had a removable cover, so as to allow inspection of the fire. The chimney started with an elbow-piece. Surrounding this, about 2 feet above the stove, was fixed a tank for melting the blubber.

Stores.

The following is a copy of the list made by Lieut. H. L. Bowers of the stores for the Shore Party when the ship left New Zealand for the Antarctic :—

Articles.	Total Quantity.
Meats—	
Brawn	100 2-lb. tins.
Bacon rations	200 lbs.
Potted Meats—	
Ham Loaf...	200 1-lb. tins.
Beef Loaf	200 1-lb. tins.
Assorted Potted Meats and Fish	1,200 4-oz. tins.
Fish—	
Sardines	15 cases 18-oz. tins.
Cod Roe	200 tins.
Salmon	230 tins.
Pilchards in Oil	500 lbs. (1s.).
Anchovies	12½ doz. 1-lb. bottles.
Anchovy Paste	12¼ doz. qts.
Bloater Paste, etc.	20 doz. qts.
Soups—	
Scotch Broth	200 2-lb. tins.
Cock-a-leekie	200 2-lb. tins.
Ox Tail	200 2-lb. tins.
Mock Turtle	200 2-lb. tins.
Giblet	100 2-lb. tins.
Hare	200 2 lb. tins.
Soup Squares	200 1-lb. tins.
Tomato Soup	23 cases, large.
Split Peas	500 lbs. in 7-lb. tins.
Pea Flour	100 1-lb. tins.
Lentils	500 lbs. in 4-lb. tins.
Pea Soup (Concentrated)	50 lbs. in 1-lb. tins.
Vegetables—	
Beetroot	300 1-lb. tins.
Brussels Sprouts	300 1-lb. tins.
Artichokes	300 1-lb. tins.
Broad Beans	300 1-lb. tins.
Spinach	300 1-lb. tins.

Articles.	Total Quantity.
Vegetables (contd.)—	
Haricots, Verts	200 1-lb. tins.
Petit Pois	250 2-lb. tins.
Asparagus...	400 1-lb. tins.
Cauliflower	200 1-lb. tins.
Celery	200 1-lb. tins.
Carrots (very young)	100 1-lb. tins.
Cabbage Lettuce	100 1-lb. tins.
Dried Vegetables—	
Potatoes	500 lbs.
Onions	200 lbs.
Brussels Sprouts	100 lbs.
Spinach	100 lbs.
Rhubarb	100 lbs.
Cabbage	100 lbs.
Cereals—	
Self-Raising Flour	12 tons, in 7-lb. tins.
Flour	5 tons, 6-lb. and 7-lb. tins.
Pearl Barley	200 lbs., in 4-lb. tins.
Semolina	150 lbs., in 4-lb. tins.
Cornflour	100 lbs., in 1-lb. tins.
Arrowroot	50 lbs., in 1-lb. tins.
Macaroni	150 lbs.
Sago	150 lbs., in 4-lb. tins.
Tapioca	200 lbs., in 4-lb. tins.
Patna Rice	500 lbs., in 7-lb. tins.
Oatmeal (Pinhead) (Mid.)	2,000 lbs., in 7-lb. tins.
Biscuits (assorted)	Sledging (?).
Biscuits (assorted)	
Plum Puddings	200 lbs.
Assorted Jellies	1 gr.
Jams—	
Golden Syrup	1,000 lbs., in 2-lb. tins.
Marmalade	700 lbs.
Red Currant Jelly	300 lbs.
Strawberry Jam	600 lbs.
Raspberry Jam	400 lbs.
Black Currant Jam	300 lbs.
Blackberry and Apple Jam	600 lbs.
Apricot Jam	400 lbs.
Bottled Fruits—	
Apricots in Syrup	300 lbs.
Peaches in Syrup	300 lbs.
Pears in Syrup	150 lbs.
Pineapple in Syrup	300 lbs.
French Plums	100 lbs.
Gooseberries	300 lbs.
Raspberries and Currants	200 lbs.

Articles.	Total Quantity.
Bottled Fruits (contd.)—	
Plums	100 lbs.
Cranberries	100 lbs.
Red Currants	100 lbs.
Cherries	300 lbs.
Rhubarb	300 lbs.
Dried Fruits—	
Prunes	100 lbs., in 7-lb. tins.
Figs	300 lbs., in 7-lb. tins.
Dates	200 lbs.
Valencias	200 lbs., in 7-lb. tins.
Currants	300 lbs., in 7-lb. tins.
Sultanas	200 lbs., in 7-lb. tins.
Almonds	50 lbs., in 1-lb. tins.
Crystalised Ginger	100 lbs., in 2-lb. tins.
Citron	50 lbs., in 4-lb. tins.
Orange Peel	50 lbs., in 4-lb. tins.
Lemon Peel	50 lbs., in 4-lb. tins.
Pickles and Sauces, etc.—	
Bever Chutney	20 doz.
Onions	13½ doz. pts.
Met. Mixed Pickles	24 doz. pts.
Large Baked Beans with Tomato Sauce	17 cases.
Red Kidney Beans	4 cases.
Tomato Chutney	2 cases.
Tomato Ketchup	2 cases.
Evaporated Horseradish	2 cases.
Queen Olives	1 case—10 oz.
Stuffed Olives	1 case—10 oz.
French Olives	9 doz.—pints.
Capucine Capers	3½ doz.—pints.
Savoy Sauce	45 doz.—½ pints.
Pâté au Diable	1 doz.
A.1 Sauce	100—½ pints.
Curry Sauce	100—½-lb. tins.
Sugar—	
Sugar	5,000 lbs.—Cube and Granulated.
Cocoa and Chocolate—	
Concentrated Cocoa	1,200 lbs.
Malted Cocoa	300 lbs.
Caracas Chocolate	700 lbs.
Milk Chocolate	300 lbs.
Fancy Chocolate	300 lbs.
Tea and Coffee—	
Tea	500 lbs. in 1-lb. tins.
Coffee (Red, White and Blue)	175 lbs.—1-lb. tins.

Articles.	Total Quantity.
Milk, Butter and Cheese—	
Unsweetened Milk	800 lbs.
Sweetened Milk	200 lbs.
Malted Milk	200—1-lb. tins.
Full Cream Milk Powder	1,000 lbs.
Skimmed Milk Powder	1,000 lbs.
Vezet Cheese	12 cases.
Edam Cheese	400 lbs.
Cooking Accessories—	
Salad Oil	1¼ doz.—quarts.
Essence of Anchovy	3⅓ doz.—pints.
Flavouring Essences	10 doz.—1 oz.
Browning for Soups	1 doz.—pints.
Salt (Cerebos)	600—1-lb. tins.
Mustard	100 lbs.—in ½-lb. tins.
Black Pepper	20 lbs.
White Pepper	20 lbs.
Cayenne Pepper	5 lbs.
Hops	100 lbs. (compressed).
Mixed Dried Herbs	8 doz. bottles.
Malt	100 lbs.
Mint	3 doz.
Beef Marrow	500 lbs.
Onion Powder	150 lbs.
Parsley	3 doz. bottles.
Yeast Cakes	100 lbs.
Celery Seed	25 lbs.—4-oz. bottles.
Sage	3 doz. bottles.
Cinnamon...	3 doz. bottles.
Chile Vinegar	10 pints.
Soda	200 lbs.
Carbonate of Soda	50 lbs.
Mixed Spice	5 lbs. (small bottles).
Whole Cloves	3 lbs. (small bottles).
Nutmegs	3 lbs. (small bottles).
Allspice	3 lbs. (small bottles).
Salt	200—2-lb. jars.
Yorkshire Relish...	56 lbs.—½ pints.
Tomato Conserve	about 100 tins.
Ground Ginger	
Vinegar	400 pint bottles.
Lard	40 cases.
Baking Powder	36 doz. ½-lb. tins.
Custard Powder	24 doz. pints.
Blanc Mange Powder	6 doz. pints.
Egg Powder	6 doz. 1-lb. tins.
Jelly Powder	12 doz. pints.
Truegg	500 lbs.—in ¼-lb. tins.
Suet	1,200 lbs.—in 2-lb. tins.
Candles (Belmont Sperm)	1,000 lbs. ss6.

Articles.	Total Quantity.
Cooking Accessories (contd.)—	
Zebra Grate Polish	½ gross—2*d*. packets.
Brasso	¼ gross—2*d*. tins.
Robin Starch	¼ gross—3 packets.
Sapolio	6 doz.
Soaps (assorted)	20 cases.
Special Travelling Foods—	
Pemmican...	3,500 lbs.
Biltong	
Oxo	1 doz. 4 oz.
	1 doz. 8 oz.
	1 doz. 16 oz.
Wines and Spirits, Limejuice, etc.—	
Concentrated Lemon Syrup	8 doz.
Limejuice	1,000 pints.
Wincarnis...	10 doz. bottles.
Courvoisiers Brandy, Y.Y.O.	10 cases (8 red, 2 green).
Wynand Fockink's	
Orange Curaçao	2 cases (1 red, 1 green).
Orange Fine Champagne	1 case (1 red).
Crême de Menthe	2 cases (1 red, 1 green).
Old Portugal	6 doz.
Sherry	4 doz.
Chas. Heidsieck	6 cases—pints.
Whisky	6 cases.
Sparklets (" C " Syphons)	2 (felt covered).
Bulbs	20 boxes of 12 " C."
Tobacco, Cigars, etc.—	
Plug Tobacco (Dark)	200 lbs.—¼ lb. plugs, sweet.
Capstan (Medium)	200—1 lb. tins.
Waverley Mixture	200 lbs.—1-lb. tins coarse cut.
Maspero Frères Cigarettes	10,000—50*s*. sealed.
Three Castles	5,000—50 patent tins.
Sundries—	
Tin Openers (assorted)	3 doz.
Horse Shoes	4 cases.
Desiccated Yeast	150 lbs.—1-lb. tins.
Dog Biscuits	3 tons—plain.
,, Cod Liver	3 tons.
Empty petrol tanks	70 cases.
,, ,, drums	123 cases.
Bamboo	3 doz.—18 feet (Female).
,, ...	6 doz.—14 feet (Female).
,, ...	4 doz.—9/11 feet (Male).
,, ...	5 doz.—9/11 feet (Female).
Barley, Groats and Oats	3 cases.
Pyrsos Lamps	5.
Harness	20 sets.

Shore Party—(*contd.*).

Articles.	Total Quantity.
Sundries (contd.)—	
Headstalls	10 spare.
Pony Body Sheets	20.
Puttees for Ponies	30 pairs.
Muzzles	10 spare.
Float Electric Lamps	5 cases.
Ice Cutting Saws...	2.
Knives	2 cases.
Calcium Carbide	2½ tons—No. 5.
Ski Boots	1 case.
Instruments (Berlin)	2 cases.
Primus Stoves	2 cases.
Square Shovels	3 doz.
Pointed Shovels	2 doz.
6-lb. Universal Picks (with handles)	4 doz.
Special Light Sledging Shovels	1½ doz.
Crossbars	6 each—4 feet 6 inches and 3 feet 6 inches.
Special Tempered Bars for ice breaking	9 each—7 feet 6 inches and 7 feet.
14 Sledge Hammers	2.
Spare Handles	6.
Mica Lamps	2 cases.

Surveying and Navigating Instruments.

(Divided up among ship, main and small landing parties.)

3 8-inch sextants.
2 6-inch sextants.
2 sextant stands.
2 artificial horizons.
6 4-inch sledging theodolites.
1 5-inch theodolite.
1 6-inch theodolite.
2 6-inch station pointers.
1 4-inch station pointer.
3 large boxes of drawing instruments.
2 small ,, ,, ,,
6 large magnifying glasses.
6 small ,, ,,
1 48-inch brass scale.
2 36-inch ,, ,,
1 24-inch ,, ,,
Straight edges—3 48-inch.
1 36-inch.
1 30-inch.
1 24-inch.

Cherry-Garrard's sextant was used on the ship; Campbell, Bowers and Oates also had their own instruments.

Survey and Navigating Instruments—(*contd.*).

Beam Compasses—2 48-inch.
1 36-inch.
1 24-inch.
1 12-inch.

1 Large Boxwood Protractor.
3 Custs Protractors.
2 Steel Tapes.
6 Assorted Parallel Rulers.
8 Chronometers.
14 Deck Watches.
8 Clocks.
3 Star Finders.
6 Sledging Compasses.
1 Large Lucas Sounding Machine.
1 Small ,, ,, ,,
1 Kelvin, Mark 4, Sounding Machine.
3 Admiralty Pattern Landing Compasses.
2 12,000 feet Surveying Aneroids.
4 8,000 feet ,, ,,
4 6,000 feet ,, ,,
6 Sledge Distance Meters.

Medical Stores.

The lists of medical stores were worked out by Dr. E. A. Wilson in concert with Mr. J. Dowdeswell, the Manager of Messrs. Burroughs and Wellcome, who supplied the medicines and surgical dressings for the Expedition.

These included :—

2 No. 251 Tabloid Chests fitted complete (*see* p. 52).
12 No. 117 Special cases designed by Dr. Wilson (*see* p. 54).
2 No. 254 fitted with an assortment of Tabloid photographic products.
3 No. 7 Hypodermic Case.
1 No. 10 Hypodermic Case.
3 No. 91 Ophthalmic Cases.

Each case was numbered and lists of the contents were supplied for ready reference, which greatly facilitated the allocation of stores to the different exploring parties of the Expedition.

For sledging operations Dr. Wilson designed a case for a unit of four men of which the contents were estimated to be sufficient for such needs as might arise. It was light and easy of transport, weighing 4 lbs. when full. It was constructed with square covers fitting into each other, and secured by a strap and buckle which passed round both compartments. A list of the contents is given below.

Ordinary requirements in the hut or in the ship could be met from the contents of the "Congo Case," and thus avoid much unstowing and restowing of the other boxes, an important consideration when space was very limited.

The following notes derived from experience gained by the Expedition may be of interest.

A large supply of Lanolin is most necessary, and " Borofax " and " Hazeline Cream " were always useful for chafes and in the treatment of frost-bite of serious degrees.

A small quantity of Adrenaline 1 : 2000, as well as some in tabloid form, " Hermiscine " to be diluted with water to 1 : 2000 was taken in order to try its effect upon the congestion caused by snow-blindness. It is very strongly to be recommended, for its effect is quick and painless, and was far more efficient than any other remedy that was tried. The zinc sulphate, 1/250 grains, and Cocaine Hydrochloride, 1/32 grain, for ophthalmic treatment were extremely painful and several applications were needed before they afforded any relief.

Anæsthetics should be taken in sealed glass phials to prevent evaporation if an expedition has to pass through the tropics, for no stopper of cork or glass is efficient to prevent this.

CONTENTS OF A NO. 251 " TABLOID " " CONGO " CHEST.

" Tabloid " Aloin Compound.
,, Ammoniated Quinine.
,, Ammonium Bromide, gr. 5.
,, Ammonium Carbonate, gr. 3.
,, Aromatic Chalk Powder and Opium.
,, Bismuth and Soda.
,, Blaud Pill and Arsenic.
,, Cascara Sagrada, gr. 2.
,, Chloral Hydrate, gr. 5.
,, Citric Acid, gr. 5.
,, Empirin, gr. 5.
,, Gentian and Soda Compound.
,, Ginger Essence, min. 10.
,, Ipecacuanha, gr. 5 sine Emetine.
,, Iron and Arsenic Compound.
,, Kola Compound.
,, Laxative Vegetable.
,, Lead and Opium, gr. 4.
,, Menthol Compound.
,, Opium gr. 1.
,, Paregoric, min. 15.
,, Pepana, gr. 3 s/c.
,, Pepsin Bismuth and Charcoal.
,, Phenacetin Compound.
,, Potassium Chlorate, gr. 5.
,, Potassium Iodide, gr. 5.
,, Potassium Permanganate, gr. 2.
,, Pulv. Kino Compound.
,, Pulv. Liquorice Compound, gr. 30.
,, Quinine Belladonna and Camphor.
,, Quinine Bisulphate, gr. 2.
,, Quinine Bisulphate, gr. 3.
,, Salol, gr. 5.

CONTENTS OF A No. 251 "TABLOID" "CONGO" CHEST—(*contd.*).

"Tabloid" Soda Mint.
,, Soda Salicylate, gr. 5.
,, Sulphonal, gr. 5.
,, Tannin, gr. 2½.
,, Thirst Quencher.
,, Tonic Compound.
"Soloid" Corrosive Sublimate, gr. 8·75.
"Tabloid" Hydrargyri Perchloride, gr. 1/100.
"Soloid" Alum, gr. 10.
,, Boric Acid, gr. 6.
,, Lead Subacetate, gr. 10.
,, Zinc Sulphate, gr. 1.
"Tabloid" Calomel, gr. 1.
,, Digitalis Tincture, min. 5.
,, Gelsemium Tincture, min. 5.
,, Grey Powder, gr. 2.
,, "Hemiscine," 0·0012.
,, Hyoscyamus Tincture, min. 10.
,, Morphine Sulphate, gr. ⅛.
,, Santonin, gr. ½.

SUNDRIES.

1 Instrument Tray containing :—
2 by ½-min. Clinical Thermometers.
2 Caustic Holders and points.
4 Caustic Points.
2 Throat Brushes.
1 Pair of Dressing Scissors.
1 Lancet.
4 Medicine Droppers.
1 Box of "Vaporole" Amyl Nitrite, min. 3.
1 by ½-in. Spool Adhesive Plaster.
1 by 1-in. ,, ,, ,,
1 by ½ yd. Court Plaster.
2 Boxes of Menthol Snuff.
1 Dredger of Iodoform.
1 Tube of Safety Pins.
1 by ½-yd. Oiled Gauze.
1 Arm Tourniquet.
1 Tin of Mustard Leaves.
3 Small Tubes of "Hazeline" Cream.
2 Reels of Suture Silk.
2-doz. Assorted Suture Needles.
4 Compressed Triangular Bandages.
12 by 2½-in. Compressed Bandages.
2 by 2-oz. Pkts. Compressed Boric Wool.
2 by 2-oz. ,, ,, ,, Lint.
2 by 3-yd. ,, ,, ,, Double Cyanide Gauze.
3 Menthol Cones in a pot.

CONTENTS OF A No. 117 SLEDGING CASE.

10 ½-oz. F.W. Tubes containing :—

"Tabloid" Aromatic Chalk Powder and Opium	No. 25
,, Aspirin, gr. 5	,, 22
,, Caffeine Compound	,, 38
,, Calcium Lactate, gr. 5	,, 21
,, Calcium Lactate, gr. 5	,, 22
,, Kola Compound	,, 22
,, Soda Salicylate, gr. 5	,, 28
,, Tonic Compound s/c	,, 20
,, Tonic Compound s/c	,, 20
,, Ophthalmic DD (21 regular Tubes).	

2 ½-oz. F.W. Tubes containing :—
Boric Acid Powder.
Sodium Bicarbonate Powder.

6 Large F.W. Tubes (Trit) containing :—

"Tabloid" Bismuth and Soda	No. 35
,, Digitalis Tincture, min. 5	,, 60
,, Laxative Vegetable	,, 32
,, Opium, gr. ½	,, 92
,, Soda Mint	,, 32
"Soloid" Corrosive Sublimate, gr. 1·75	,, 82

1 Medium F.W. Tube containing :—

"Tabloid" Calomel, gr. 1	No. 60

6 First Field Dressings.
1 by ½ yd. Court Plaster in envelopes.
1 by ½ yd. Adhesive Plaster in envelopes.

1 Instrument Tray containing :—
1 Medicine Dropper.
1 Pair of Take-apart Scissors.
1 Pair of Artery Forceps.
1 by 1 yd. Suture Silk.
1 Pair of small Tweezers.
1 Lancet.
1 Ophthalmic Dropper.
2 Camel Hair Brushes.
3 Suture Needles, 2 straight and 1 curved, in metal tube.

In Lid :—
1 Small Purse containing :—
12 Safety pins.
50 Ordinary Pins in pad.
1 by 4-dr. Vial of Chlorodyne B.P.
2 Eye Shades, 1 left and 1 right.
1 by 2-oz. Tube of "Borofax."
1 by 2-oz. Tube of "Hazeline" Cream.

CONTENTS OF A No. 7 HYPODERMIC "TABLOID" CASE.

1 Nickel-plated Syringe.
4 Platino-Iridium Needles.
1 Bundle of Wires.
1 Pestle and Mortar.
1 Tube each "Tabloid" Hypodermic Products :—

Apomorphine Hydrochloride gr., 1/10	No. 19
Atropine Sulphate, gr. 1/100	" 14
Cocaine Hydrochloride, gr. ½	" 40
Digitalin, gr. 1/100	" 30
Ergotinine Citrate, gr. 1/200	" 38
Hyoscine Hydrobromide, gr. 1/200	" 49
Morphine Sulphate, gr. ½	" 3
*Morphine Sulphate, gr. ⅙, and Atropine Sulphate, gr. 1/180	" 10
Pilocarpine Nitrate, gr. ⅙	" 64
*Strychnine Sulphate, gr. 1/100	" 17
Aconitine Nitrate, gr. 1/260	" 36
*Anæsthetic Compound, B	" 70
Caffeine Sodio-Salicylate, gr. ½	" 43
Digitalin, gr. 1/100, and Strychnine Sulphate, gr. 1/100	" 86
Eucaine Hydrochloride, gr. ⅓	" 79
Morphine Hydrochloride, gr. ¼	" 55

*2 Extra Exploring Needles.

* 12 more of each of these would have been desirable.

CONTENTS OF A No. 10 "TABLOID" BRAND HYPODERMIC CASE.

1 20-minim All-Metal Syringe (Quinine Injection case pattern).
2 Platino-Iridium Needles.
1 Steel Exploring Needle.
1 Tube each "Tabloid" Hypodermic Products :—

Morphine Sulphate, gr. ½	No. 3
Morphine Sulphate, gr. ¼	" 3
Strychnine Sulphate, gr. 1/60	" 16
Cocaine Hydrochloride, gr. ¼	" 54
Digitalin, gr. 1/100, and Strychnine Sulphate, gr. 1/100	" 86

Also : 1 by 2½ inches by 6 yards. Compressed Open-Wove Bandage.
1 by 1 inch by 6 yds. Compressed Open-Wove Bandage.
1 by 1-oz. Pkt. Compressed Cotton Wool.
1 by 1-oz. Pkt. Compressed Boric.
1 by 1-oz. Pkt. Compressed Lint.

CONTENTS OF A No. 91 OPHTHALMIC "TABLOID" CASE.

1 Pair of Metal Forceps.
1 Magnetic Spud.
1 Tube each "Tabloid" Ophthalmic Products :—

Atropine Sulphate, gr. 1/200	A.
Atropine Sulphate, gr. 1/200, and Cocaine Hydrochloride, gr. 1/20	B.

CONTENTS OF A NO. 91 OPHTHALMIC "TABLOID" CASE—(*contd.*).

*Cocaine Hydrochloride, gr. 1/20	C.
Hematropine Hydrochloride, gr. 1/400	H.
Physostigmine Salicylate, gr. 1/500, and Tropacocaine Hydrochloride, gr. 1/100	G.
Pilocarpine Nitrate, gr. 1/500	K.
Tropacocaine Hydrochloride, gr. 1/30	L.
Pilocarpine Nitrate, gr. 1/500, and Cocaine Hydrochloride, gr. 1/200	M.
Hematropine Hydrochloride, gr. 1/200, and Cocaine Hydrochloride, gr. 1/24	O.
*Zinc Sulphate, gr. 1/250	R.
Opium and Zinc Sulphate	(?)
Physostigmine Salicylate, gr. 1/600	F.
Fluorescin, gr. 1/2000	D.
*"Soloid" Boric Acid, gr. 6 (abundance)	P.
,, Corrosive Sublimate, gr. 1/1000	J.

* Extra supplies of these items would have been desirable.

MEDICAL STORES IN ADDITION TO THOSE IN SPECIAL CASES.

"Tabloid"	Potassium Chlorate, gr. 5	1,100
,,	Tannin, gr. 2½	500
,,	Citric Acid, gr. 5	1,100
,,	Potassium Iodide, gr. 5	6,000
,,	Hyoscyamus Tincture, min. 10	4,000
,,	Soda Mint	1,500
,,	Ginger Essence, min. 10	1,100
,,	Digitalis Tincture, min. 5	2,000
,,	Laxative Vegetable	2,200
,,	Ipecacuanha, gr. 5	1,000
,,	Ipecacuanha and Squill, gr. 4	1,100
,,	Aloin Compound	2,200
,,	Colocynth and Hyoscyamus	3,000
,,	Antipyrine, gr. 5	3,000
,,	Phenacetin Compound	3,000
,,	Quinine Bisulphate, gr. 2	2,200
,,	Quinine Bisulphate, gr. 5	300
,,	Sodium Salicylate, gr. 5	6,000
,,	Ammonium Bromide, gr. 10	1,500
,,	Bismuth Subnitrate, gr. 5	1,500
,,	Bismuth and Soda	4,000
,,	Pepsin, Bismuth and Charcoal	2,500
,,	Dover Powder, gr. 5	1,500
,,	Gelsemium Tincture, min. 5	1,500
,,	Iron and Arsenic Compound	3,000
,,	Tonic Compound	3,000
,,	Lead and Opium, gr. 4	1,100
,,	Cascara Sagrada, gr. 2	5,000
,,	Aromatic Chalk Powder and Opium	1,100
,,	Camphor Compound Tincture, min. 15	2,200
,,	Peptonic	1,100
,,	Voice	480

MEDICAL STORES IN ADDITION TO THOSE IN SPECIAL CASES—(*contd.*).

" Tabloid "	Potassium Bromide, gr. 5	3,000
,,	Sulphonal, gr. 5	4,000
,,	Chloralamide	3,000
,,	Salicin, gr. 5	1,100
,,	Calomel, gr. 1	2,200
,,	Phenacetin, gr. 5	1,200
,,	Selol, gr. 5...	1,200
,,	Ammonium Carbonate, gr. 3	1,500
,,	Belladonna Tincture, min. 5	500
,,	Grey Powder, gr. 1	3,000
,,	Blue Pill	500
,,	Cascara Compound	1,100
,,	Cascara and Gentian Compound	300
,,	Rhubarb Compound Pill	500
,,	Trinitrin, gr. 1/100	125
,,	Opium, gr. 1	1,100
,,	Opium Tincture, min. 10	1,100
,,	Santonin, gr. ½	150
,,	Nux Vomica Tincture, min. 5	2,200
,,	Potassium Permanganate, gr. 2...	2,200
,,	Tincture Capsicum, min. 1	500
,,	Compound Liquorice Powder, gr. 30	10,000
,,	Iron and Quinine Citrate	500
,,	Pepsin, gr. 3	500
,,	Grey Powder and Dover Powder	3,500

6 by 1–lb. Chlorodyne.
12 by 1–oz. Aspirin.
1,100 " Tabloid " Empirin.
3 by 1–oz. Toothache Tincture.
3 by 4–oz. Strong Iron Perchloride with Glycerine.
3 by 2–oz. Borax Powder.
6–oz. Menthol Cones in a tin.
1 Pair of Dispensing Scales and Weights.
1 Extra set of Weights for same.
3–lb. of Opium Tincture.
3 by 8–oz. Iron Perchloride Tincture.
3 by 8 oz. Nux Vomica Tincture.
3 by 1–oz. Crotonis Oil.
3 by 4–oz. of Blistering Fluid.
3 by 1–lb. Diluted Nitric-Hydrochloride Acid.
3 by 1–oz. Strong Nitric Acid.
3 by 1–lb. Strong Solution of Ammonia.
3 by 1–lb. Lead Solution.
4–lbs. Iodoform Gauze.
3 by 1–lb. Gall with Opium and Vaseline Ointment.
3 by 1–lb. Zinc Sulphocarbolate.
3 by 1–lb. Mercuric Ammonia Ointment.
12–lb. Boracic and Vaseline Ointment.
12–lbs. Zinc and Vaseline Carbolic Ointment.

MEDICAL STORES IN ADDITION TO THOSE IN SPECIAL CASES—(*contd.*).

3 by 1-gallon tins of Cod Liver Oil.
3 by 1-oz. Silver Nitrate Crystals.
3 by 1-lb. Spirits of Turpentine.
3 by 8-oz. Spirits of Camphor.
3-lb. Collodion in 6 bottles.
9 by 1-lb. Methylated Liniment of Belladonna.
9 by 1-lb. Soap Liniment.
3-lb. Acetate of Lead Ointment.
9 by 1-lb. Boracic Acid Powder.
9-lb. Sodium Bicarbonate.
3 by ½ lb. Iodine Liniment.
42-lb. Magnesium Sulphate.
9 by 1-lb. Carbolic Acid Crystals.
21 by 1-lb. Plaster of Paris.
3 by 1-lb. Chloroform Alcohol and Ether.
3 by 1-lb. Gentian Compound Tincture.
39 Jars, 20-lb. and 60-lb. Chloride of Lime (in two lots).
3 by 1-lb. Potassium Permanganate Crystals.
3 by 2-lb. Olive Oil.
120 by 100 Male Fern Capsules, min. 10.
3 by 1-lb. Confection of Senna.
15 dozen by 3-inch Calico Bandages.
15 dozen by 2½ inches Open Wove Bandages.
Phosphoric Acid and Cement (in addition to above).
4 Bent Throat Brushes.
4 by 2-oz. Conical Measures.
8 by 1-oz. Conical Measures.
8 by 2-dr. Graduated Measures.
8-lb. Plain Aseptic Gauze, packed in square small tins.
24-dozen by 3 inches Bleached Water Dressing Bandages.
4-dozen by 6 inches Flannel Bandages.
24 by 1-lb. Absorbent Wool.
6 Nests of Test Tubes.
2 dozen Books Blue Test Paper.
2 dozen Books Red Test Paper.
36 dozen Large Safety Pins.
4-lb. Marine Lint.
12 by 1-yard Belladonna Plasters.
2 Tins Brown's Sinapism.
12-lb. Tooth Powder.
18 by 1-lb. White Vaseline.
2 Large Spatulas.
2 Small Spatulas.
2 Ointment Slabs.
6-lb. Liquorice Powder Compound.
3 Pints Liquid Carbolic Deterg.
8 by 1-lb. Pure Chloroform.
8 by ½-lb. Pure Chloroform.
9 by 1-lb. Anæsthetic Ether.

MEDICAL STORES IN ADDITION TO THOSE IN SPECIAL CASES—(*contd.*).

9 by ½-lb. Anæsthetic Ether.
3-lbs. Lanoline Mercurial Ointment.
3 Medical Diaries.

5 Tubes	"Tabloid" Hypodermic	Morphine Sulphate, grain ¼	No. 3
1 Tube	,, ,,	Cocaine Hydroch., grain ½	,, 40
1 ,,	,, ,,	Morphine Sulph., grain ⅙, and Atropine Sulph., grain 1/180	,, 10
1 ,,	,, ,,	Pilocarpine Nitrate, grain 1/10	,, 34
1 ,,	,, ,,	Cocain Hydrochloride, grain ¼	,, 54
1 ,,	,, ,,	Eserine Salicylate, grain 1/100	,, 39
1 ,,	,, ,,	Hematropine Hydroch., grain 1/25 ...	,, 47
1 ,,	,, ,,	Morphine Hydrochloride, grain ¼ ...	,, 55

Adrenaline.
2-lb. Sodium Lactate.
½-dozen Packets of 24 inches by 18 inches Gooch's Splinting.
3 Chloroform Drop Bottles.
5-dozen by 10 B.W. & Co. Protective Skin.
Formalin for Disinfection (6 by 1-lb.).
1 by 1 pint Composition Pestle and Mortar for section No. 2.

"Soloid"	Zinc Sulphate, grain 1	1,500
,,	Zinc Sulphate, grain 10	1,100
,,	Corrosive Sublimate, grain 8·75	10,000
,,	Alum., grain 10	500
,,	Cocaine Hydrochloride, grain 1	600
,,	Cocaine Hydrochloride, grain 1	500
,,	Citric Acid	600
,,	Regular Tests	6.

8 Boxes of "Enule" Gall and Opium.
4 ,, ,, ,, Tannic Acid.
5 ,, ,, ,, Morphine Sulphate, grain ½.
12 ,, ,, ,, Glycerine.
3 1-lb. "Hazeline."
3 1-lb. ,, Cream.
50 Small tubes of "Hazeline" Cream.
2 lb. "Lanoline."
3 by 1-lb. Ichthyol Ointment.
1½-lb. Hydrochloric Acid.
1½-lb. Solution of Ammonia.
6 by ½-lb. Iodoform.
6 Tins of Mustard Leaves.
24 by ½ inch Spools Adhesive Plaster.
18 by 1 inch ,, ,, ,,
18 by 1½ inches ,, ,, ,,
18 by 2 inches ,, ,, ,,
5 Reels of Suture Silk.
36 Assorted Suture Needles.
12 Triangular Bandages.
3 by ½-minute Clinical Thermometers.

MEDICAL STORES IN ADDITION TO THOSE IN SPECIAL CASES—(*contd.*).

3 by 1-minute Clinical Thermometers.
3 Pairs of Scissors.
10 Caustic Points in bottles.
12 Medicine Droppers.
6 Medicine Tumblers.
9-yards Court Plaster (thin pink especially).
24-yards Flax Lint.
12-lb. White Cotton Wool.
48 Field Dressings, B. W. & Co.

CHAPTER IV.

THE DOGS.

The dogs used by the Expedition were of the domestic type of dog used on the banks of the Amur River for sledging during the winter, and were chosen largely by C. H. Meares, who had had experience of driving this class of dogs in Kamchatka previously.

Some of the dogs had been worked regularly with the postal sledge that crossed the sea of Okhotsk in the winter to the Island of Saghalien, and the Russian boy, Demetri Geroff, who had been driving them was engaged by Meares to accompany the Expedition and to look after the dogs.

Other dogs, and they were perhaps as a rule the best workers, were obtained from the Giliak Indians on the upper portion of the Amur River above Nikolaievs. Their lives had necessarily been harder, their food less. They worked harder and maintained their condition better on the whole than the others.

A full team consisted of 13 dogs, six pairs being harnessed to a trace opposite each other with the leader on a long line at the end of the trace.

Dogs who show intelligence and are to be trained as leaders are harnessed for some time as a foremost pair. Any selection is subsequently promoted to a shorter light trace behind the leader.

The average working dog with the Expedition weighed 60–70 lbs., but some of the bigger dogs weighed as much as 80–90 lbs.

The experiences accounted in the following description relate solely to Barrier sledging. There is very little opportunity in the Antarctic to use dogs in the summer on the sea-ice.

On the Barrier there is the great loneliness and for days no object to see. This reacts upon the dogs and they begin gradually to lose heart and will not respond sometimes to the harshest treatment.

An added difficulty was the large proportion of days when there was wind which raised drift from the loose snow crystals lying on the Barrier surface. Dogs when running always have their mouths open and it was with great difficulty that they could be persuaded to travel well against this drift.

We had two descendants of Eskimo dogs with us. They were pupped by dogs of Captain Peary's Expedition and were presented to Captain Scott by Captain Sverdrup. For hardihood and endurance they far surpassed the other dogs. One, on sledging journeys under the very worst conditions and with half the food, throve, whilst the other dogs were getting thin.

At first the dogs were fed on a special biscuit manufactured by Messrs. Spratts. The biscuits weighed two to the pound, and a dog's ration for the day was $1\frac{1}{2}$ lbs. The amount of fish oil incorporated in the manufacture of the biscuit seemed to have a purging effect on the dogs and, as a main article of diet, they were not entirely suitable.

For the Southern journey a rough kind of pemmican was made for them by melting down seal blubber and mixing in with it lumps of flesh from the seal. It was weighty and difficult to divide but it was an efficient food and the dogs throve upon it.

On the return journey from the South they were fed upon the carcasses of the ponies which had been killed and stored at different points on the route.

Their time of travelling is faster than that of ponies or men, and they will travel all the better if they are run by the side of a track which they can see and smell.

An ingenious method was employed by Amundsen's Expedition, their dogs were fed on stock-fish and on the outward journey at irregular intervals a fish was stuck up in the snow. Their time of travelling on the return journey will show how well this method justified itself. The speed of travel depends largely upon the amount of interest that is kept up amongst the dogs, as is well seen when any object left by the preceding party is sighted on the snow. As soon as this comes in sight the speed is increased and every dog pulls his weight.

The weights calculated for each dog on the Southern journey was 95 lbs. on the sledge per working dog, but running alone and on the surfaces found on the Barrier they would not do it over any considerable distance.

The average distance run with such loads varied, but the mean worked out at about 11 geographical miles per day for the first part of the journey, and an average of about 13 geographical miles a day for the latter part.

Ordinarily, with their interest stimulated and running light on good surface, 120 miles should be covered by dogs in three days, but then they should be rested for at least two days before proceeding on a similar journey.

On his return journey over the Barrier from the foot of the Beardmore Glacier, Meares had great difficulty in getting the dogs along. They became dispirited and straggled along, refusing to pull. If some such device as that of Amundsen had been adopted, the return journey might perhaps have been done in half the time.

When running with dogs on snow, a stop should be made after two miles for the snow tends to ball and ice in the webs of their pads, and, if not removed, the balling increases until the web is split.

In Russia, it is the practice to dock dogs' tails, but in the Antarctic this is a disadvantage, for when they are in the whole the tail seems to protect the testicles and to cover the face and nose, giving extra warmth. In cold weather, the dogs who had had their tails docked and were entire, suffered in nearly every case from frost-bite of the testicles.

The number of dogs in the first year was 33, and 14 others came at the end of the second year, but with a few exceptions these were of very little use. The best age for a working dog is about seven years old.

Judging from the experience of Scott's and Amundsen's Expeditions it would seem wise in future to secure dogs that have been bred by the Eskimo. The Russian domestic dogs are too temperamental for work on the Barrier, they need extra feeding and certainly cannot stand the hardships of autumn or spring sledging so well as the others. During these periods, too, they need extra food and the carrying capacity of a unit is correspondingly curtailed by the amount carried for them.

In the winter the dogs were chained to a long rope made fast at either end. Their length of chain is so arranged that they cannot reach each other. The best position is on hard snow to the leeward side of the drift, and when possible a bit of straw or hay put down for each dog. They were fed on the frozen flesh of seal.

One or two of the dogs had been infected with Dinofilaria immitis, probably on their journey down or in New Zealand, this caused their death. Beyond this their only infection was by tape-worms, probably from seal flesh; this was easily cured by extract of male fern, and did not affect their health.

PONIES AND MULES.

The use of ponies for travel on the ice Barrier had been discussed by Captain Scott in the light of the experience which he had gained on his first Expedition to the Antarctic (*Discovery*, 1901–1904), and they were employed in the Expedition (1907–1909) of Sir Ernest Shackleton, who laid much stress on the importance of white colouring. Those used in the Expedition were all white or dappled grey in colour and were selected at Vladivostock by C. M. Meares from the Manchurian ponies which are brought there in droves for sale. They stood about 14–15 hands. They were brought from Vladivostock to New Zealand in a cargo steamer with Anton Omelchenko, a Russian groom, in charge of them. Captain L. E. G. Oates, of the 4th Inniskilling Drgagoons, on his arrival in the *Terra Nova*, at the end of October, 1913, took over the entire control of the ponies, their training, exercise and feeding.

The quarters in which they were transported in the ship to the Antarctic ice and the various fittings that were built and devised for them are described in Chapter II, page 17.

The first loss of ponies occurred in a gale a few days out of New Zealand, when the ship was approaching Campbell Island. The ponies were unable to keep their feet and were cast in many cases repeatedly, owing to the rolling of the ship which continued for about 72 hours. Every expedient that was possible under the circumstances was tried; canvas breast and hind-quarter bands in broad strips were passed over and hauled taut with rope lashings to the sides of the stalls to try to prevent movement or rolling by the ship, and eventually a broad canvas band was placed under the belly and the sides tightened sufficiently to give support alone without actual lift.

Only two were lost in the gale, one died and the other went down badly and smashed his cannon bone, and so had to be destroyed. Several others, however, were in very bad case for days after and were only brought through by great care. Their recovery really depended upon the ship reaching the pack-ice and thereby getting into quiet water and steady motion.

During the many days spent in the pack-ice the ponies recuperated and eventually were landed in fairly good condition at Cape Evans.

The weight of the fodder taken for the ponies for this year was 2 tons of oats, 30 tons of compressed fodder, 5 tons of bran, 6 tons of oilcake and 2 tons of hay.

They were watered and fed three times daily and the ration was varied, being mainly hay, with, in cases of weak ponies, varying amounts of oats added. Once or twice a week a hot-bran mash was given. The compressed fodder was whole maize chopped and compressed into a bale which was clamped with stout steel wire and afterwards covered with loose sacking, roughly sewn on. Such a bale was oblong and the weights varied from 105–112 lbs. The shape of the bale was chosen so that it would be a handy package for placing upon a sledge whilst travelling. The nutritive value of either a ration of 11 lbs. or even of 13 lbs. was insufficient under sledging conditions, and the ponies became weak and lost flesh markedly on it.

On the Southern Journey, about 2 to 3 lbs. of oats and 1 to 2 lbs. of oilcake were mixed with the ration of compressed forage, the total weight of the daily ration being 11 lbs. per pony per day.

During the winter, the ponies were watered and fed three times daily, but when the break of the year came they were fattened with oilcake and oats. They were then given increased walking exercise and, later, draught work with laden sledges, to get them into condition.

On shore at first a stout hempen rope was secured between two rocks and the ponies were made fast to it by their halters at sufficient intervals for them not to reach each other. Eventually, on the leeward side of the hut at Cape Evans, a rough stable was built running the length of the northern side of the hut. This contained stalls and chut-board and was roofed with scantling and covered with rubberoid. A stove was installed at the end farthest from the entrance, and with this burning a combination of blubber and coal or wood sufficient ice was thawed out for the ponies' water daily.

The outer back wall of the stable was composed largely of the bales of compressed fodder which made an excellent firm wall for protection. When a bale was needed for use it was removed from the inside and replaced by boarding. Rough openings were left at two points by the omission of a bale, and when the light was returning these rendered artificial lighting.

The remainder of the stores of fodder consisting of oats, bran and oilcake was placed in one dump adjacent to the hut. The hay was also included in this dump; it was nearly snowed over and kept in excellent condition.

Attempts to make an efficient snow-shoe were tried, but the success or failure was largely dependent upon the temperament of the pony. Those supplied were made of a strong double outer circle of cane with stays of iron wire intersecting within the outer frame-work and being attached to it. These wire stays were centrally attached to an iron ring and the tread of the shoe.

On either side the outer tough fibre of cane was plaited into two semi-circular frames, and fixed to the stays.

The hoof of the pony fitted into these, and after inserting the hoof they were lashed with a leather thong.

In the second year a better shoe was made for the mules. This had a part toe-cap, the frame work was practically the same, but instead of the woven-fibre bechets, leather thongs secured the hoof in place.

The harness for sledging had necessarily to be light.

A head stall and bit fitted the head and to this a short lanyard was spliced.

The haulage was by a well-fitted collar with harness and two iron hooks from which the rope traces ran. At the sledge end of the trace there was a spliced eye and the other end was passed through this eye so as to form an easy-running noose.

Fitted to the front eye-splice of the trace of the sledge was a wooden toggle of Australian red wood with sharpened ends and a notch in the centre to take the rope.

A swingle-tree with a rope eyelet was also passed over this toggle. Either end of the swingle-tree was shaped into a knob over which the running noose of the pony's traces was passed drawn taut.

The swingle-tree allowed of free side to side play and did not hamper the snake-like movements of a loaded sledge.

The ponies' covers which were put on at camping time, were of stout green-canvas with cover cloth. They were secured over the fore-quarters, under the belly and flank, by short lamp wick ties attached to either edge. Latterly, experience taught the utility of a tail-piece in addition, made of light canvas and fitted to the end of the cover so as to fall well below the tail. When there is a blizzard or wind and drift the ponies naturally turn their hind quarters to the direction of the wind and the tail piece gives them protection.

The shackling lines for camping were of 1 inch pliable steel wire. At intervals a semicircular wire bechet of similar material was spliced in to the wire. This bechet was passed previously through the ring and swivel bolt attached to the green leather strap and buckle that was used for shackling the ponies by the fetlock. At either end of the wire an eye-splice was made and a short manilla lanyard spliced through this, so that the wire could be made fast at either end to the uprights of the sledges.

On camping the first two sledges lead outward to an appropriate distance. They then straightened and halted. The two succeeding sledges came alongside each of the others and the ponies were unharnessed. The swingle-trees were buried deep in the snow to prevent the sledges being drawn sideways, and heavy gear also was removed from the sledges and used for anchoring them. The lanyards of the wire were then secured to the foremost uprights of the sledges and the ponies were made fast.

Ponies suffer from snow-blindness and various forms of hat or shade were fashioned to prevent this. Perhaps the best and coolest was made of pliable copper wire for the frame with green canvas over it. Two stronger pieces of copper wire ran from the frame on either side and were secured in place by ties of lamp wick under the neck. This form could be turned as required and was cool.

On camping a wall of blocks of snow was built on the windward side of the ponies for shelter. The site for the easy construction of these walls is a matter of observation and practice. Whenever there is good crusted snow, the likelihood is that large blocks can be cut with the shovel and rapidity of construction is thereby increased, also the efficiency of the shelter, and if the patch from which the blocks are cut is beside the wall, added protection is afforded.

At the start of the Southern Journey, a mileage of 9 geographical miles a day was attained and after the day and night's rest at One Ton Depot, the mileage was increased to an average of 11 geographical miles, or approximately 13 statute miles a day.

The marching time was approximately 7 hours, and this included an hour to an hour and a-half for the mid-day rest and feed.

After the losses by the storm after the start of the Expedition and those incurred on the Depot Journey in the autumn, the number of ponies was reduced from 17 to 9. These all took part in the Southern Journey to the Pole.

The average weight pulled by the ponies varied from about 490 lbs. for the weakest to over 600 lbs. for the strongest.

The ponies in the units were attacked by lice, which caused great irritation to their bodies, and they were continuously gnawing at their coats, but light washing with a coal-tar mixture for several days removed these parasites.

MULES.

Before the ship departed from the Antarctic, Captain Oates had discussed with Captain Scott the advisability of providing Indian pack mules for the exploration work in the summer of 1912, and acting on his advice, Captain Scott wrote to Sir Douglas Haig, in India, asking him to use his interest in obtaining the grant of seven of these beasts from the Indian Government.

The seven mules selected for the work were sent to New Zealand and brought down by the *Terra Nova* on her return in January, 1912. They had been under the care of Lieut. Pullen, of the Indian Army Veterinary Service, and very great credit is due to him and to those concerned with him in their preparation and their provision of gear and equipment. These were designed for the snow under conditions existing about 7,000 feet up on the Himalaya Range, and many of the fittings were as effective in the Antarctic as those which we had found by our experience there.

A very useful snow-shoe had been made on which the mules, being better trained and more tractable than the ponies, pulled well over bad surfaces. Their clothing was of canvas material outside, and lined inside with thick felt.

For a considerable period before embarkation, they were exercised twice daily in a specially-constructed box, which reproduced the rolling and pitching of a ship, in order to strengthen their shoulder muscles.

On their arrival at Cape Evans, in May, 1912, W. Lashley was the only man left who had had any experience of animals. He undertook their care throughout the second following winter on the routine laid down by Captain Oates for the ponies, and it was due to Lashley's care that the mules with few exceptions performed so well with the search party in the early summer of 1912.

Unlike the ponies, the mules were always eager to get out during the winter and to get exercise. The ponies always knew when there was wind and drift, and wished to avoid it as much as possible, objecting strongly to being taken out.

A daily ration of 9 lbs. made up of about half oilcake and oats and the remainder of compressed fodder was allotted to the mules on sledging work with the Search Party. Some of the mules relished this ration and ate it well, and anything they could get besides, but two refused the ration and were only kept alive by eating their leaders' biscuits. Both had to be shot eventually early in the return march. The remainder returned to Cape Evans, after having done nearly 400 miles, in fair condition.

They were obviously stronger and better trained than the ponies, and, with the two exceptions above noted, could probably have done better than the ponies and have pulled longer distances.

A form of snow-goggle with leather fittings and tinted glasses had been sent by the Indian authorities to prevent snow-blindness in the mules; these were effective, but were not much needed.

CHAPTER V.

TIDAL OBSERVATIONS.

Reduction of Tide Gauge Records, Cape Evans.

By Dr. A. T. Doodson, Tidal Institute, University of Liverpool.

1. *Description of the Gauge and Records.*

The tidal observations taken at Cape Evans, together with some reductions made by Mr. Nelson, were found among his papers and were forwarded to the Tidal Institute in December, 1923, for examination. From these papers it has been found possible to give the following account of the gauge.

The tide gauge took the form of a lever AOB (Fig. 4), pivoted at O, carrying a pen at one end A and attached to a wire at the other end B. The wire passed from B upwards, but not quite vertically, to a pulley on a post, from which it descended to a sinker, and a

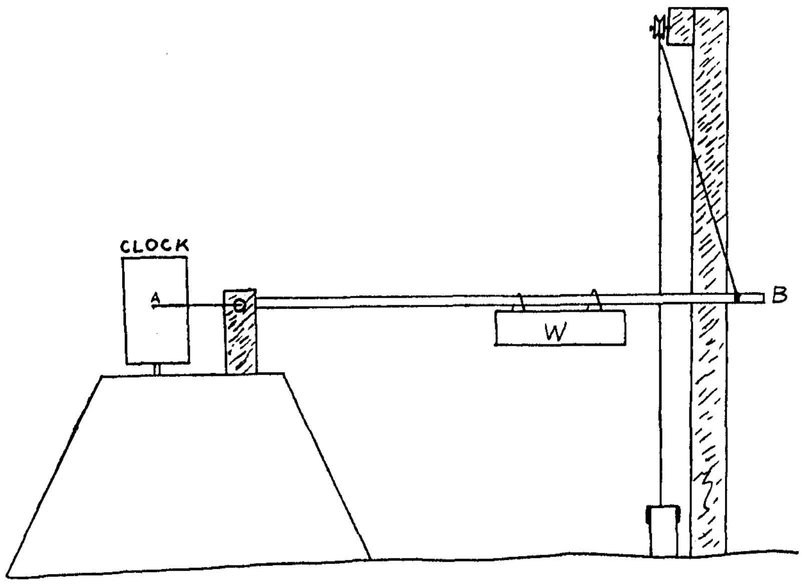

Fig. 4.

counterpoise weight W was adjustable on the lever. A scale in feet and inches was marked on the post, and at first direct readings of the position of the arm OB against this scale were taken at least daily. As the wire did not ascend vertically from B it was afterwards decided to read the position of an index on the vertical wire descending to the sinker, and a double series of readings were taken to determine the relation between the " arm " and " scale " readings.

The pen A operated on a piece of foolscap paper on a revolving drum, the rate of revolution being about 58 mm. per solar day, and about a week's record was given on each sheet. Neither time lines nor height lines were drawn on the sheets, but on each day, usually about 9 a.m. (time 180° E. long), the scale height and the time were marked on the sheets.

Mr. Nelson does not seem to have had any measurement *in situ* of the scale reduction ratio OA to OB, and the horizontal position of the arm in relation to the scale is only stated in a note which appears rather to be a deduction than a record of observation. The length of the arm OA is also not stated, but appears to have been deduced by Mr. Nelson from a trace made by the pen when the clock had stopped. The tide gauge records thus presented a rather difficult problem even to Mr. Nelson, but his papers indicated methods of reduction which had been used by him, chiefly in connection with the scale reduction ratio. These methods have been adopted and amplified at the Institute, but no use has been made of the readings and reductions by Mr. Nelson.

The observations available were summarised by Mr. Nelson as follows :—

June 12 to July 25	Disjointed series ; discarded	13 days.
July 25 to August 21	Wire attached to lever. Clock stopped	27 days.
August 24 to September 15	Clock stopped	21 days.
September 18 to October 1 ...	Wire lengthened. Wire broke	13 days.
October 10 to November 20	Restarted on different scale	40 days.
November 21 to January 29	Wire let out about 6 inches	2 months.

Obviously each set of readings had to be treated separately. The scale readings noted on the diagrams each day were plotted against the corresponding distances of the marked points from the bottom of the paper, and the factor for scale reduction determined graphically. The datum line for zero scale reading could have been deduced and drawn on all diagrams of a set at a uniform distance from the bottom of the paper, but Mr. Nelson's plan was followed. He multiplied the known scale readings on a diagram by the factor of reduction and obtained the distances of the points of zero scale readings. These should have been on a straight line, but the best fitting straight line was drawn as the datum line of that particular diagram.

As the pen traversed an arc of a circle it was first necessary to find the radius of the arc ; the trace made by the pen, as mentioned above, served sufficiently well for this purpose and also indicated the height of the centre of the pen. As some little doubt existed as to whether this height was the same for all records, owing to readjustments of the gauge, it was thought desirable to make various tests. Fortunately, the tidal motion at Cape Evans is of a simple diurnal character, with very little semi-diurnal inequality. By choosing days on which the tidal motion was most symmetrical in time and range it was possible to deduce the mean traverse of the pen as follows. The mean of the times at which the tide reached a particular height was marked on the diagram and a number of such points gave the mean traverse of the pen (Fig. 5). It was easily possible to find the height of the centre of

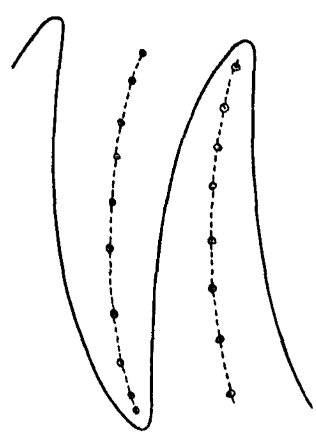

Fig. 5.

the arc, and a number of such tests having been made for the records obtained between alterations of the gauge (not merely changing of paper) the mean was taken.

Having found the " line of centres," the next procedure was to determine the clock rate. Constructing the time-arcs through marked points on the diagram for which time and height were stated, the points of intersections of these arcs with the datum line parallel to the line of centres were subjected to measurement and the number of millimetres per day thus obtained. An average of 58 mm. per day was found. Variations from this mean occurred and were allowed for each day, the point for zero hour of each day being marked on the horizontal datum line. These variations, however, were only allowed for in the zero hour of each day and a standard rate of 58 mm. was selected for interpolation for hourly heights. Thirteen time-arcs for intervals of 2 hours (58 mm. = 24 hours) were drawn on celluloid and appropriate datum lines and scale lines (as found above) were also drawn. The celluloid scale was placed over the tidal record and the lines of zero hour and hour 24 were placed so as to give the least possible error. The scale lines on the celluloid were amended from set to set as the reduction factor varied from set to set.

The tidal diagrams had a time-scale proceeding from left to right, and the scale readings increased upwards. The readings obtained were thus expressed in terms of the scale. Comparisons with Mr. Nelson's readings and analyses showed, however, that the scale was inverted, so that the scale readings increased with a falling tide. A note by Mr. Nelson also makes the " line of centres " below the zero of the scale, confirming this deduction. Allowance was made for the inversion in the analyses conducted at the Tidal Institute. Mr. Nelson explicitly states that the time of the records is Standard Time 180° E., twelve hours fast on Greenwich.

2. *Reductions made by Mr. Nelson.*

Mr. Nelson had made three analyses from a fortnight's record in each case, using Darwin's method (British Ass. Report, 1886). His results are as follow :—

Epoch	Values of H in Feet.					Values of κ in Degrees.			
	M_2	S_2	K_1	O_1	A_0	M_2	S_2	K_1	O_1
July 25	·21	·08	·87	·83	8·36	25°	300°	10°	359°
November 1 ...	·19	·16	·73	·49	7·87	47°	189	9°	353°
December 8 ...	·17	·05	·73	·60	7·78	55°	144°	15°	14°

Here κ is defined, as usual, to be the lag of the phase of the tidal constituent behind that of the corresponding constituent of the " equilibrium tide " at the place.

3. *Reductions made at the Tidal Institute.*

From the available data the records for four months of 29 days each were picked out for analysis, a little extrapolation being made to complete 29 days from set July 25 to August 21. The analytical method used is one that has been developed at the Institute ; " assignments " for constituent-time are not used and the elimination of the effects of constituents other than the one required is accurately effected. It has thus been possible to analyse for the constituents N_2 and Q_1, which have not usually been obtained by analysis of a month's record. In the analysis it has been necessary to assume that the constituents K_2, ν_2, P_1, ρ_1 are related to the constituents S_2, N_2, K_1, Q_1 respectively, according to the equilibrium constituents of the tide generating forces. The results of analysis are as follows :—

Station : Cape Evans, Latitude 77° 38′ 14″S.
Longitude 166° 32′ 45″E.

Middle day of month.	Values of H in Feet.						Values of κ in Degrees.					
	S_2	M_2	N_2	K_1	O_1	Q_1	S_2	M_2	N_2	K_1	O_1	Q_1
(1) August 8, 1911	·07	·16	·13	·70	·67	·10	298	356	248	5	358	315
(2) October 29, 1911	·12	·18	·13	·77	·77	·16	275	15	271	17	3	331
(3) December 6, 1911	·10	·18	·04	·75	·87	·19	234	38	253	8	8	0
(4) January 12, 1912	·08	·16	·08	·74	·69	·15	260	37	244	11	359	2
The mean values, deduced from means of H cos κ, H sin κ are	·09	·16	·09	·74	·75	·14	265	22	256	10	2	342

It may be remarked that the constants for K_2, ν_2, P_1, ρ_1 could have been deduced from the results of analysis for the separate months by using the method of least squares and the constants for K_2, P_1 have been sought by this method. The ratio of amplitudes of K_2/S_2, P_1/K_1 are respectively found to be 0·55, 0·28, where the equilibrium ratios are 0·255, 0·335. The values of κ for K_2, P_1 are apparently 303 deg. and 23 deg. respectively. In view of the small time scale of the records, and of the difficulties of reading the hourly heights, very little significance ought to be attached to these latter variations. Mr. Nelson made the remark that any error in the determination of the line of centres of the time arcs would chiefly affect the semidiurnal tidal constants.

It is very curious that all the amplitudes except those for N_2 vary in the same manner, being greater in the two middle months than in the extreme months. This variation may be due to errors of scale, but the possible errors of scale seem to be too small to account for the variation.

The diurnal constituents are related among themselves in a fairly normal manner ; the ratios of amplitudes of O_1, Q_1 with respect to K_1, are 1·01, 0·19, the equilibrium ratios being 0·75, 0·14 respectively, while the phase lags have the relationships

$$K_1^\circ - O_1^\circ = 8^\circ \qquad O_1^\circ - Q_1^\circ = 20^\circ$$

the corresponding differences in speed being

$$1^\circ{\cdot}098 \qquad 0^\circ{\cdot}544$$

The value of κ thus decreases with the speed of the constituent.

The semidiurnal constituents have somewhat abnormal relationships, since the ratios of amplitudes of S_2/M_2, N_2/M_2 are respectively 0·56, 0·56, the equilibrium ratios being 0·47, 0·19 respectively.

The phase lags for the semidiurnal constituents require comment, as the phase lag for M_2 is in excess of the phase lags for both S_2 and N_2, though its speed is intermediate with the speeds of these constituents.

4. *Variations of Mean Sea Level.*

The variations of mean sea level can only be considered separately for each set since the length of wire in the gauge varies from set to set. The mean level, Z, on each day has been obtained from twenty-five hourly heights centering on noon (time 180 deg. E.). The inversion of the scale has been allowed for, and the datum is taken as 10 feet below the zero of the scale. The results are given below.

VALUES OF Z.

Day.	July.	August.	September.	October.	November.	December.	January.
1	—	7·72	8·46	—	8·30	7·64	7·96
2	—	8·24	8·85	—	7·81	7·60	7·86
3	—	8·40	8·59	—	7·80	7·74	8·19
4	—	8·33	8·56	—	7·92	7·70	8·19
5	—	8·35	8·91	—	7·62	8·03	8·05
6	—	8·10	8·80	—	7·78	8·45	8·06
7	—	8·03	8·39	—	7·84	8·20	8·20
8	—	8·34	8·24	—	7·81	7·73	8·45
9	—	8·53	8·61	—	8·12	7·49	8·48
10	—	8·68	8·49	—	8·22	7·61	8·14
11	—	8·44	8·39	—	8·10	7·80	8·02
12	—	8·33	8·46	—	8·16	7·64	8·33
13	—	8·36	8·58	—	8·10	7·74	8·50
14	—	8·54	—	7·74	8·01	7·90	8·29
15	—	8·06	—	8·00	7·94	8·07	8·30
16	—	8·05	—	8·44	7·84	7·69	8·20
17	—	8·29	—	8·54	7·90	7·65	8·38
18	—	8·31	—	8·30	7·86	7·93	8·37
19	—	8·41	—	8·48	7·81	7·82	8·39
20	—	8·60	—	8·62	—	7·98	8·47
21	—	8·62	—	8·38	7·64	7·92	8·51
22	—	8·59	—	8·68	7·83	7·89	8·26
23	—	—	—	8·46	7·91	7·76	8·07
24	—	—	—	8·86	7·74	7·70	8·06
25	8·08	8·48	—	8·32	7·90	7·80	8·12
26	7·94	8·52	—	8·44	8·33	7·82	8·14
27	7·78	8·05	—	8·32	8·10	7·61	8·05
28	7·86	7·85	—	8·40	7·87	7·62	8·23
29	7·94	8·07	—	8·71	7·86	7·75	—
30	8·21	8·59	—	8·53	7·77	7·67	—
31	7·94	8·94	—	8·11	—	7·72	—

The mean values of Z for the months chosen for analysis are as follows :—

	Mid-day of month.	Z.
(1)	August 8	8·24 feet.
(2)	October 29	8·24 „
(3)	December 6	7·85 „
(4)	January 12	8·18 „

Inspection of the above table indicates that there are oscillations of mean sea level, with apparently a period of about three days. Such oscillations were noted by Darwin when analysing the *Nimrod* observations. He examined other records from Bombay, Karachi and Aden, and found no marked periodicity of this kind. The experience of the present author in connection with meteorological effects on sea level and tides has indicated that oscillations of sea level with periods of this magnitude are commonly found in British waters. They are not wholly due to the statical effect of atmospheric pressure, but seem to have relation to the average period with which cyclonic disturbances cross the region, both statical variations and wind variations contributing to the variation of sea level. The *Nimrod* observations were corrected only for barometric pressure, and Darwin remarks that " the zig-zags were sensibly reduced, but not annulled, and in one or two places a new maximum or minimum has been introduced. We may conjecture that distant barometric changes and distant gales may have annulled some maxima and minima which would otherwise have been visible." Consequently he made speculations as to the existence of a deep bay, extending beyond the Pole, and such that its seiches have a period of about three days. It is extremely doubtful whether any value can be attributed to these speculations, for it is undoubtedly premature to look for seiche effects before allowance has been made for all meteorological disturbances, wind as well as barometer.

5. *Comparison with Results of Previous Expeditions.*

This is the third expedition wintering on Ross Island, and a comparison is readily made with the observations made in connection with the *Discovery* and the *Nimrod.* Sir G. H. Darwin* has discussed the latter observations at considerable length. The *Nimrod* observations were taken at Cape Royds, which is a few miles north of Cape Evans, and Cape Evans is a few miles north of Hut Point, where the *Discovery* observations were made. The three sets of analyses are summarised in the following table :—

	Mean Values of H in Feet.				Mean Values of κ in Degrees.			
	S_2	M_2	K_1	O_1	S_2	M_2	K_1	O_1
" Nimrod," 1907	·08	·20	·69	·67	273	5	12	0
Cape Evans, 1921	·09	·16	·74	·75	265	22	10	2
" Discovery," 1902	·10	·16	·77	·77	272	10	14	0

Darwin examined the relation between the constituents K_2, S_2 and K_1, P_1. He found the amplitude ratio K_2/S_2, K_1/P_1 to be respectively 0·62, 0·22 for the *Nimrod* observations and respectively 0·27, 0·33 for the *Discovery* observations. The differences in phase lag K_2 deg. — S_2 deg. are of opposite sign at the two places. These results, compared with the results stated in §3, lead us to conclude that we are not justified in attaching significance to the variations from the equilibrium relations for these pairs of constituents.

The three sets of analyses are in very satisfactory agreement, and we may consider the tides in this small region as being adequately known.

No special significance can be attached to the variations in phase and amplitude as we go south ; these three stations are too near together to form a satisfactory basis for the discussion of the propagation of tidal motion in this region, but perhaps the tidal observations made by the Australasian expedition in Adelie Land, much further north, when compared with the observations near Ross Island may throw a great deal of light on the tidal regime in these waters.

* (1) " Collected Papers," Vol. 1, page 373. " On the Antarctic Tidal Observations of the Discovery."
(2) " Proc. Roy. Soc.," A, vol. 84, 1910, page 403. " The Tidal Observations of the British Antarctic Expedition, 1907."

APPENDIX.

A List of Publications relating to the British Antarctic (*Terra Nova*) Expedition. Compiled in the Library of the Royal Geographical Society.

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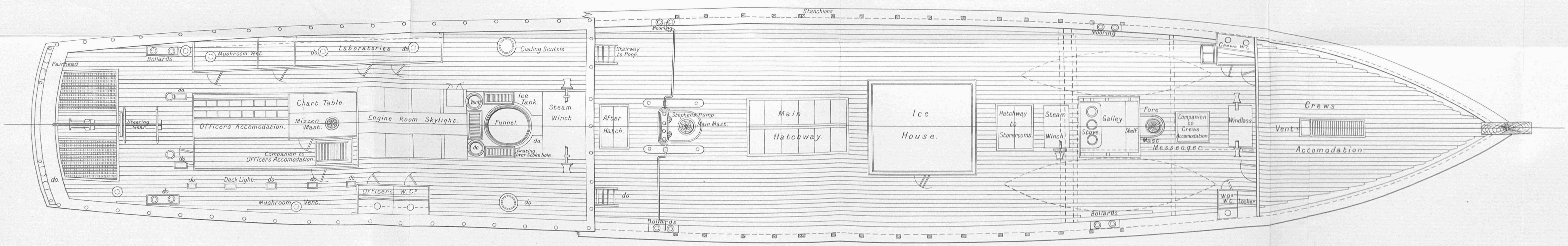
Hoffman

Fitzpatrick

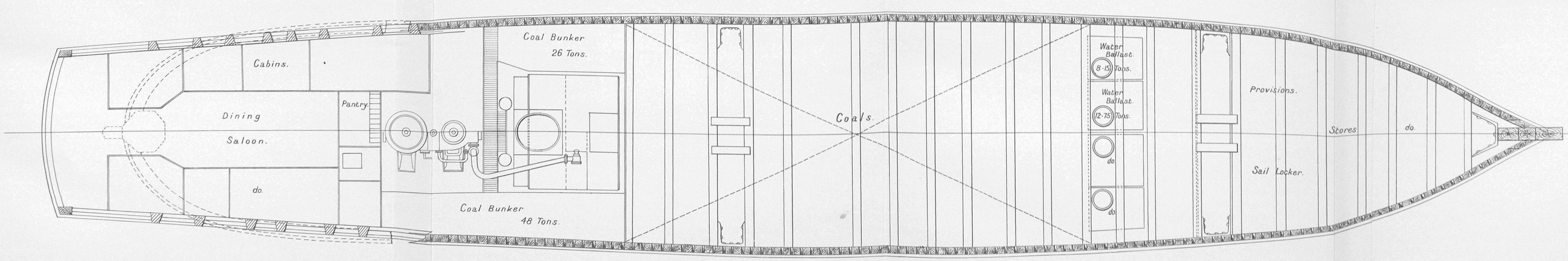
TERRA NOVA.

Scale, $\frac{1}{8}$" = 1'.

PLAN AT UPPER DECK.



PLAN AT LOWER DECK.



HARRISON & SONS, LTD LITH. ST MARTIN'S LANE, W.C.