Observations on the Antarctic Sea-Ice

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and the shells of the amphipods that they eat better if they have stones in their stomachs than if they have not.

As to the distribution of the Emperor, the *Belgica* saw large numbers in the pack-ice to the west of Louis Philippe Land, but I believe the largest numbers of all were what we saw in what has been called King Edward VII. Land, a place we were unable to land on because the ship was getting frozen in. As to the breeding-place of the Brown-backed petrel, Lieut. Mulock mentioned there were thousands of birds on Scott island, and I think that is the place to go with the greatest probability of finding its eggs. We saw no place which was likely to produce Brown-backed petrels' eggs.

Captain SCOTT: I think the pack ice we saw contained a great deal of old ice mixed with one year ice.

The PRESIDENT: The meeting will wish to pass a vote of thanks to Dr. Wilson for his very interesting paper, and to Mr. Hodgson for his account of the invertebrate fauna; also to Captain Colbeck for his excellent description of the pack in various meridians and in various seasons. We also have to thank Lieut. Mulock for having read the paper so well and described to us the illustrations. I may add that he himself very carefully surveyed Scott island, and that we shall thereby be indebted to him for a most accurate and valuable map of the Antarctic discoveries. I now ask you to pass votes of thanks to these gentlemen for their papers.

OBSERVATIONS ON THE ANTARCTIC SEA-ICE.*

By Captain W. COLBECK, R.N.R.

FOR the following remarks on the southern ice-pack, I have drawn on my diaries for three seasons—1898–1900, when magnetic observer of the *Southern Cross*, and 1902–1904, when in command of the *Morning Relief Expedition*. The northern limit of the pack varies according to the meridian on which it is approached, and also according to the severity of the season, as will be seen from the following summary of the three voyages southward.

On December 30, 1898, the *Southern Cross* fell in with small drift-ice in lat. $61^{\circ} 56' S.$, and long. $158^{\circ} 53' E.$, and a few hours afterwards entered the main pack. For 70 or 80 miles we steamed through small floes without much difficulty, and were then faced by much heavier and more closely packed ice, varying from 4 to 10 feet thick, in immense floes. An attempt was made to force our way through between the 160th and 166th meridian which proved futile, the ice as we worked southward becoming heavier and the floes of greater area. From January 12 to February 10 we were within 80 miles of the Balleny islands, hemmed in on all sides by heavy ice; during this time, we took advantage of every opening to the south and east, changing our position a few miles daily, but making no material progress southward. The ice in this vicinity varied considerably; at one time we would be beset between floes 4 or 5 miles square and from 4 to 6 feet thick, with no open water visible in any direction. After a few hours light southerly or south-easterly wind and a day's steaming in the open leads, we would find smaller and heavier floes, such as our Norwegian whalers called "blue" ice, 10 to 20 feet thick, with numbers of much-worn bergs within a few miles of us, at another time the floes would be smaller and honeycombed, some of them half a mile to a mile in extent, upon which it was impossible to travel except upon ski, and even then it frequently happened that the upper surface would give way and we

* Read by Lieut. Mulock.

would find a footing on a honeycombed platform about 2 feet below. During January and the early days of February we experienced several heavy gales from west-south-west, north-east, and east-south-east; with the northerly gales a heavy swell was at times noticeable, but it had no effect on the floes around us; with the easterly and westerly gales there was no swell, nor was there any appreciable change in the ice-conditions afterwards. We experienced a strong westerly drift when to the eastward of the Balleny islands. The most favourable conditions for navigating were met with after light southerly winds or calm.

On February 7 we turned northwards, and after passing through heavy ice for forty-eight hours, fell in with loose sailing pack, in the same position where fourteen days earlier we had been faced by very extensive and closely packed floes from 4 to 6 feet thick. This was in lat. $65\frac{1}{2}^{\circ}$ S., and long. $165\frac{1}{2}^{\circ}$ E. Thence we steered an easterly course through loose ice, as far as 174° E. and $65^{\circ} 40'$ S., where open water was met with and a southerly course taken. Between lats. 68° and 69° S. we encountered a belt of pack about 30 miles broad, running east and west; but after passing through this only loose ice was seen, and we arrived at Cape Adare on February 17, 1899.

After the difficulties we had experienced to the westward in the *Southern Cross*, I had no hesitation in choosing a more easterly meridian on which to approach the pack, and decided to work southwards between longs. 175° E. and 180° E. in the relief ship *Morning*.

After leaving New Zealand on December 6, 1902, a course was set to cross the 60th parallel in long. 175° E., and thence due south to the pack; but in consequence of adverse winds being encountered, a more easterly course had to be taken. We saw our first iceberg in lat. $62^{\circ} 5'$ S., and fell in with loose pack and drift-ice in lat. $67^{\circ} 40'$, long. $179\frac{1}{2}^{\circ}$ E. We entered the main pack in this locality, and made about 100 miles to the south-west through loose hummocky ice before our difficulties really began. Up to this time we had been passing through belts of pack about 2 to 3 miles broad, running in a north-westerly and south-easterly direction with a mile or two of open water between them.

On reaching lat. 69° S., long. 175° E., the pack became closer, and we fell in with a number of ice islands, irregular in shape and quite distinct from the tabular berg common to these waters; they were visible so far as we could see to the eastward, and in the pack in their vicinity some very heavy old ice was observed with evidence of severe pressure during a previous season. We worked south from this position, averaging from 20 to 30 miles a day through loose but heavy pack; the smaller floes of 2 and 3 feet ice which were observed between the larger and heavier floes showed signs of recent screwing. We again met with close pack in lat. 70° S., through which we could make but little progress. When in lat. $70^{\circ} 26'$ S., and long. $175\frac{1}{4}^{\circ}$ E., we encountered a heavy east-south-east gale, which drove us into open water in long. $170\frac{1}{2}^{\circ}$ E., apparently extending to the coast north of Smith inlet. On the gale abating, a course was set for the coast; but the heavy floes and small bergs, closely packed along the coast and to the northward, prevented our approaching within 40 miles of it. We worked in a line of open water, between the coast pack and the loose ice to the eastward, until within a few miles of Cape Adare, where we fell in with loose ice; this, however, did not retard our passage, and we landed at Cape Adare on January 8. The ice in Robertson bay had only broken up in the vicinity of the cape, and there was every indication of its being a very late season.

On leaving Cape Adare we followed the coast-line, keeping well inshore to avoid the pack which showed up to the eastward. South of Possession island the ice was very heavy and closely packed. Coulman island was surrounded by

SCOTT ISLAND AND HAGGITT'S PILLAR.

BEACH-ON SOUTH-EAST SIDE OF SCOTT ISLAND.

immense fields of ice, and in the direction of Wood bay there was one solid field unbroken as far as the eye could see. A landing was effected at Franklin Island after great difficulty, the approach between unbroken floes of flat ice, 2 to 4 feet thick and several miles in length, being very tedious. From Franklin island we stood away to the north-eastward into open water, and then skirted the pack to Cape Crozier. The run from Crozier to McMurdo bay was through very heavy and close pack, and our success in making the passage as we did between Cape Bird and Beaufort island was mainly owing to the strong westerly drift on the northern shore of Ross island. After clearing Cape Bird we fell in with open water until faced by the field-ice extending to the *Discovery's* winter quarters.

The following year, we left Hobart on December 6 in company with the *Terra Nova*, we fell in with our first iceberg in lat. $62\frac{1}{2}^{\circ}$ S., long. 177° E., and entered the pack on December 26, in lat. $66\frac{1}{2}^{\circ}$ S., and long. $179\frac{1}{4}^{\circ}$ W. The ice on the outer edge was apparently old ice about 10 feet thick, and quantities of screw and hummocky ice were observed. After passing through about 60 miles of very heavy and closely packed ice, we were able to make a good course southward through loose and open pack until in lat. $69\frac{1}{2}^{\circ}$ S., when we encountered a fresh gale which closed up all the leads—we were compelled to lay to for thirty hours in lat. $69^{\circ} 22'$ S., and long. $178^{\circ} 37\frac{3}{4}'$ E. On the weather moderating, the ice opened up, and we had no further difficulty in making our course good, passing through the outer edge of the pack in lat. $70^{\circ} 20'$ S., and long. $176^{\circ} 53'$ E.

We found the Ross Sea quite open, and although we crossed our last year's track several times, no ice was met with, and we were able to traverse the same distance in four days which had taken us twenty-two days to do in the previous year. Off Beaufort island we passed through a belt of loose ice, about 30 miles broad, and arrived at the edge of the field of ice in McMurdo bay on January 5.

From the experiences, as related in the foregoing, I have no hesitation in saying that the pack should be entered between long. 178° and 180° E., as early in December as possible, and so take advantage of the whole of the open season. The ice between these meridians being lighter, more open, and easier to negotiate than to the westward, and moreover having no extent of land nearer than the Balleny islands, there is very little danger of the ship being damaged by pressure.

In the event of a ship going south for geographical work during the summer, I would strongly recommend that a due easterly course be taken after reaching the latitude of Cape Adare, with the view of examining the east side of the Ross Sea. The ice islands and the nature of the drift-ice we met with during our first cruise in the *Morning* gave every indication of having broken away from a glaciated coast-line in that locality.

The difficulty experienced by the *Southern Cross* when attempting to force our way through the pack in the vicinity of the Balleny islands was, no doubt, due to the prevalence of easterly gales in the Ross Sea, and the westerly drift north of Victoria Land, both of which tend to drive the pack in that direction, where it is held up by the islands until late in the season, and does not disperse until the sea to the westward is free from ice. We found no uniformity of thickness when in the pack, the nature of the ice varying from hour to hour.

I consider that the middle and the southern edge of the pack are the most difficult to navigate. At the northern edge loose drift and water-worn ice was met with for several miles before the pack was actually reached; and in the case of the *Southern Cross*, and the first voyage of the *Morning*, we sailed through from 80 to 100 miles of loose ice before meeting the close pack. On our second voyage in the *Morning*, however, when only a few miles from the northern edge, we were faced by as close and heavy pack as any we encountered during the voyage. In the

first year we had no southern limit, the pack extending practically to Cape Crozier. On the second voyage we were more fortunate, and, after passing through 30 miles of very loose sailing pack, we got into open water to the south, in lat. $70^{\circ} 22'$, leaving a clearly defined line of pack behind us.

Our first season, 1902-1903, I consider to have been exceptionally late and severe, and am of opinion that the conditions we met with in 1903 and 1904 were normal, and were such as might reasonably be expected by any one navigating in these regions. This conclusion is arrived at by comparing the ice conditions we met with during the *Morning's* two voyages with those observed around Cape Adare during my winter there in 1899.

A strong northerly current exists on the coast of Victoria Land, and is in a great measure responsible for the rapidity with which the ice clears away during the open season. It was an agreeable surprise to me to find so much open water on my return voyage in March, 1903; I did not think it possible that such a great change could take place in six weeks. Our only difficulty was when passing between Beaufort island and the Western mountains, where we were stopped by young ice from 4 to 8 inches thick, extending to the horizon on all sides. We were, however, favoured by a south-westerly gale, and managed to work through it under sail and steam, meeting with pancake ice as far as Coulman island. The coast-line was fringed with pack, but no ice was visible to the eastward.

On the return voyage in 1904 no new ice was observed, and with the exception of a small belt of pack south-west of Coulman island, the passage was made in open water. That there is a westerly drift on the north coast of Ross island was proved during our first voyage; we had further evidence of this when lying in McMurdo bay, and also that the current turned northwards along the coast of Victoria Land. I am of opinion that this current takes a north-westerly course after passing Cape Adare, and that it is the ice from further south, piled up on the coast, which has so far prevented an examination of that part north of Robertson bay.

On December 25 we sighted two small islands, bearing south-south-east, about 25 miles distant. We took a sounding when about 5 miles north-north-west of them, and got no bottom at 1000 fathoms. The larger island is about $\frac{1}{4}$ mile long and $\frac{1}{8}$ mile broad, lying in a N. by E. and S. by W. true direction, the northern end being about 126 feet high, and "steep to." The southern end was lower, and partially covered with an ice-cap sloping from the northern end, and appearing to get much thicker where it discharged into the sea. The northern extremity was almost bare of snow, much weathered and water-worn at the base of the cliffs. In each of the northern points there was an arched rock, the larger of which was about 80 feet high and 50 feet broad. The smaller island, which was almost circular, was about 200 feet in diameter, to a height of about 185 feet, with a conical top (the summit of which was about 209 feet above the sea-level), and was situated nearly a cable's length to the north-north-west of the larger island.

Whilst pulling round the larger island we noticed two beaches—one on the west-by-north, and the other on the north-north-east side. The first we estimated at 80 feet long, and the latter 50 feet, both shelving very rapidly, and making it impossible for us to land. The W. by N. beach sloped more gradually, but the approach was equally dangerous, owing to a number of rocks partially covered by the sea, lying about 100 feet from the beach. We managed to effect a landing on the southern part of the island by backing the boat in and jumping on a low rocky ledge as we rose to the swell. Having collected specimens of rock near our landing place, we returned to the boat, and pulled round to the smaller island. There was now no snow on the latter, which looked like basaltic rock as far as the cone, which had a reddish brown appearance. About a third of the way up

LOOSE PACK, NORTHERN EDGE SHOWING LINE OF OPEN WATER.

FLOES BREAKING AWAY FROM THE FIELD-ICE IN MCMURDO BAY.

the cone there was a thin stratum of grey-coloured stone, which appeared to separate the black basaltic rock from the reddish formation above.

Thousands of birds—Wilson's, brown-backed, and white petrels, prions, and cape pigeons—were seen near these islands, the northern end of the larger and the cone of the smaller one being covered with them.

On the following day we had fine clear weather. Good observations for latitude and longitude were obtained, and Lieut. Mulock made a sketch-survey, and took soundings all round the islands. The position of the centre of Scott island is lat. $67^{\circ} 24\frac{1}{2}'$ S., long. $179^{\circ} 55\frac{1}{2}'$ E.

THE GREAT ZIMBABWE AND OTHER ANCIENT RUINS IN RHODESIA.*

By RICHARD N. HALL.

Progress of Researches.—Before introducing a discussion as to the recent researches respecting Rhodesian antiquities, I would venture to express my high appreciation of the work of the late Mr. Theodore Bent at the Great Zimbabwe. Having devoted eight years to the study of the ancient monuments in various parts of Southern Rhodesia, and having resided for over two years at Great Zimbabwe, I have no hesitation in stating that I have found Mr. Bent's work to be both valuable and reliable. Mr. Bent experienced great obstacles in his examination of these ruins. He found the ruins to a great extent buried in soil and *débris*, and covered with dense and almost impenetrable jungle. He was also seriously handicapped by the shortness of his stay, by an insufficiency of labourers, and by adverse climatic conditions; yet he was able to sweep away many of the myths, romances, and theories which had always surrounded the Rhodesian remains. But to Mr. Bent belongs the credit of giving to this problem an entirely new orientation. This new orientation is now unreservedly recognized in the highest scientific circles of Europe as practically incontestable.

The recent researches have yielded additional internal evidences in support of Mr. Bent's conclusions, that the oldest portions of the Great Zimbabwe, and a certain number of the ruined structures elsewhere, testify to Southern Rhodesia having once been a colony of the ancient empire of Saba, in South Arabia.

The Royal Geographical Society was primarily responsible for the visit of Mr. Bent to Rhodesia. This Society, by its practical assistance and its consistent interest in our ruins, has always acted *in loco parentis* to researches in Rhodesia. In a sense, the Rhodesian monuments may well be considered as one of the specialities of the Royal Geographical Society. All South Africans will, with confidence, continue to look to the Royal Geographical Society for further manifestation of its support and interest in this direction.

* Read at the Royal Geographical Society, January 23, 1905.