THE SCIENTIFIC WORK OF THE BRITISH ANTARCTIC EXPEDITION OF 1907–9.*

By JAMES MURRAY.

THE address dealt with the more important results obtained in geology, biology, and physics. In geology the greatest value attaches to the small collection of rocks brought by Sir Ernest Shackleton from a high latitude. Among these were coal and other organic vestiges. Should it prove possible to determine the horizon of any of these, an important step will be made in tracing the history of this part of the Antarctic continent. The study of a piece of coniferous wood from 85° S. lat. leads Prof. David to suggest that the Beacon Sandstone formation is of Lower Carboniferous or Upper Devonian age.

The problem of the Great Ice Barrier is now practically solved by the observations of this expedition, supplementing those made by Captain Scott. On the voyage south to Victoria Land it was noticed that the familiar tabular bergs showed no solid ice, except where the wash of the sea had made a crust. They appeared to consist entirely of compressed snow. Measurements of overturned bergs showed that they had floated very high, some showing as much as one-fifth, or even one-fourth, of the total height above the old water-mark. Subsequently the officers of the *Nimrod* made soundings round a grounded berg, and found that the portions above and below water were about equal. No ice was seen in the overturned bergs. The face of the barrier, like the bergs, showed only compressed snow in horizontal strata.

Joyce's depôt party were fortunate enough to locate an old depôt laid down by Captain Scott on known bearings, and were thus enabled to determine the rate of travel of the Barrier near its western edge, and the rate of accumulation of snow on the surface, over a period of more than six years. The movement seaward was at the rate of about 500 yards per annum, and the accumulation of drift about 1 foot per annum.

Although it appeared to be a level plain where these measurements were made, it must be supposed that the drift varies greatly at different places, and no doubt the rate of travel would be different in the central region remote from land. If these data are used as the basis of a rough estimate of the rates of travel and depression, it will appear that the layers of snow at the base of the Barrier face, where it is about 200 feet in height, must have fallen on the surface some 50 miles further south, 200 years ago. Yet under this great weight of overlying snow the lower layers are not changed into ice. Ordinary valley glaciers debouch on the Barrier at various points, one of them affording the highway towards the pole. From all these facts the history of the Great Barrier can be pieced out.

Originating in the glaciers which enter the contracted sea between Victoria Land and King Edward Land, the ice floats off and is driven northward, becoming gradually more and more depressed under the accumulating snow till it is beneath sea-level. Probably ere it reaches the Barrier edge the ice may be entirely thawed away by the action of the sea-water, leaving only the floating snow-sheet.

The surfaces of the lakes are often covered by a peculiar friable kind of ice, which we called "prismatic" ice, as it consisted of vertical prisms. This might be derived from snow, or from other forms of ice. Under the influence of changes of temperature, sun, and perhaps other factors, the surface of a snow drift, or of a heap of irregular chips of ice, has been observed gradually developing this

* Summary of Address at the Royal Society of Edinburgh, February, 1910.

secondary structure of vertical prisms, while the deeper layers retained the original structure.

The vertical prisms or fibres of the sea-ice are very evident in the newest stratum, which is exposed when trenches are opened for the purpose of dredging. Cracks which open in cold weather are quickly filled by new ice in the form of horizontal prisms, which grow out at right angles to the edges of the floe till they meet in the middle. Where a crack bends abruptly curved fibres are built up in adjustment to the contending influences of the two sides of the bend.

That the glaciation of the region is diminishing, or at least that it is less now than at a former period, is indicated by the extensive morainic deposits which are seen on the shores of Macmurdo sound. Erratics have been traced to a height of over 1000 feet on Mount Erebus, and the summit of Mount Hope, 2000 feet above the present level of the Barrier, is strewn with them. These facts need not, however, be taken to indicate that the ice ever stood as much as that above sea-level, as there are evidences of quite recent elevation of the land, to the extent of some hundreds of feet, and the elevation may have been much greater, though the traces of it be lost.

The receding of the Barrier since Ross visited it, the moderate snowfall, and the numerous dead glaciers point to diminishing glaciation at the present day. The elevation of the land is evidenced by many deposits consisting of recent marine organisms.

Near our camp there is a small deposit containing fragments of serpulæ, and another consisting chiefly of the spicules of siliceous sponges, making a soft felted mass 8 feet thick, in which are included many shells of molluscs and other organisms. At the mouth of the valley occupied by the Ferrar glacier, and far north near Mount Larsen, there are other deposits of recent marine organisms. At Hut Point little felted balls of sponge spicules were found lying loose on the ground, no doubt derived from some local deposit. Some of these beds occupy mounds, as though they were fragments of an extensive sheet now in great part denuded away. It is a curious fact that at some places these fossiliferous beds overlie strata of ice.

At the bottom of Coast lake there were found layers of a peat-like deposit interstratified with layers of ice. These may be accounted for by supposing that a number of recent summers have been successively colder, so that each year the summer thaw penetrated to a less depth. Only the very shallow lakes melted during the summers when we were there. The deeper ones did not melt at all, or merely had a little thaw-water on the surface in the neighbourhood of black rocks exposed to the sun.

The earth-shadow, or aërial shadow, is a familiar Antarctic phenomenon. The shadows of peaks, projected through the apparently clear atmosphere, can be seen, on account of the presence of minute particles of ice, as long tapering dark bars. Sometimes they appear curved. The shadow of Mount Erebus, projected over Macmurdo sound on to the foothills of Mount Lister, and easily recognized, when cast upon the snow, by the shape of the steam-cloud, could be traced all the way as a line making an arc of circle, which on one occasion rose apparently 30° above the horizon. The observer was looking in a direction transverse to that of the rays of light at the moment, and was within the shadow of the mountain. They also appeared curved when the observer was entirely outside the shadow. Thus when the sun got round so that Cape Royds was in sunshine in the mornings, the shadow of Erebus could still be seen, taking an apparently curved course over Castle rock and falling on the ice in the sound outside Hut Point.

Continuous tidal observations were got over a period of some months by means of an apparatus of which the recording part was an ordinary barograph drum, the scale being reduced by means of a long lever. Besides the tides the record indicated seiche oscillations. The scale of the recorded curve was so small that the seiche festooning was blurred, but by watching the apparatus for some time it was seen that in calm weather there were seiches having a period of several minutes and an amplitude of several inches.

In biology the greatest interest lies in the discovery of abundant fresh-water microscopic life in the frozen lakes, despite the fact that these only thaw for a short period in summer, and some of them only at long intervals. Even in a lake which never melted while we were there, there were many living animals on the bottom, under 15 feet of ice. The adult animals survive from season to season in a dormant condition, frozen in the ice.

Several are viviparous, and those are the most plentiful of all. Their abundance would be remarkable in any latitude. In the few weeks of summer one of them increases so rapidly that it makes blood-red stains on the beaches of the lakes, and these attain to inches in diameter. They can endure great vicissitudes of temperature, and some have lived after being made to pass in a short time through a range of 240° Fahr. The whole range endured by one species was over 300° Fahr., but the same individuals were not submitted to both heat and cold.

The composition of the fresh-water microfauna, which is not very abundant in species, is of great interest. Its negative as well as its positive characters raise many curious questions in geographical distribution.

In marine biology it is instructive to note that all the cold-blooded animals pass their entire lives at a temperature which is always several degrees below the freezing-point of fresh water, and that this temperature is therefore high enough for the performance of all their physiological functions.

REVIEWS.

EUROPE.

A Region of France.

'Le Var Supérieur. Étude de Géographie Physique.' Par Jules Sion, Ancien Élève de l'École normale supérieure, Docteur ès Lettres. Pp. 96. Paris: Colin. [1909.] *Price* 3 *fr.*

This is one of those detailed studies in physical geography which are now becoming so numerous and which illustrate the action of natural forces under varying conditions. The region chosen is the upper valley of the Var above the affluents descending from the massive of the Mercantour, an area of nearly 45 square miles. Further south the river meanders through a pebbly plain in a bed recently eroded in an immense Pliocene delta.

The author first describes the movements of the soil, the foldings which took place before the Permian age and at the conclusion of the Secondary period, the invasion of the Miocene sea and the elevation of the Miocene beds and also of the Pliocene, the latter to a height of about 1800 feet at Levens, while along the littoral of Nice Quaternary deposits occur at a height of about 190 feet above sea-level. A study of the structure shows that the hydrography in the upper basin of the Var often does not accord with the tectonique: the river often runs in a direction contrary to the dip of the strata, crosses anticlinal ridges, cuts into the flank of the Dôme de Barrot, which is traversed by one of its tributaries, the Cians, and even when it follows a synclinal basin, it remains at a distance from the axis of depression.