extending perhaps beyond the orbits of the asteroids. In fact, the difference in the densities of the inner and outer planets and the sun, and the fact that practically all rotations and revolutions are in the same sense, suggest that our solar system once consisted of a sun and the outer planets, all having a very low density, and that on passing through a cloud of heavy meteoric matter, the density of the sun was slightly increased, and the inner heavy planets created; but it is impossible here to go into the details of these interesting questions.

As regards the nearer evidence of the earth's age to be sought for in the sedimentary rocks, no notice seems to have been taken either of the time required for the innumerable raisings and lowerings of level which certainly occurred during the coal periods or of the time which it must have taken to tilt horizontal strata through 90° and more. Thus Japan is being tilted at the rate of about 0·5″ per century, and if this tilting rate were steadily maintained in one locality, which is highly improbable, the Japanese strata would stand on end like our Cambrian strata in about forty million years' time. Yet a few such tiltings were completed before some of our oldest strata were formed and overthrusts suggest a still greater antiquity for the age of sedimentary rocks. C. E. STROMEYER.

"Lancefield," West Didsbury, April 26.

Man's True Thermal Environment.

IN connection with Prof. Leonard Hill's very interesting and instructive article on "Healthy Atmospheres" (NATURE, April 22), perhaps I may be allowed to direct attention to a paper which I contributed to the Journal of the Scottish Meteorological Society for 1912, entitled "On Atmospheric Cooling and its Measurement: An Experimental Investigation." In that paper will be found a description of an instrument termed a psuchrainometer ($\psi\nu\chi\rho\alpha\acute{\iota}\nu\omega$ = I become cold; and $\mu\acute{\epsilon}\tau\rho\sigma\nu$ = a measure) which traces on a moving paper strip, a continuous record of the amount of electrical heating needed to maintain at blood heat a body freely exposed to the atmosphere. This seems to serve much the same purpose as Prof. Hill's caleometer. In the same paper I also gave a table of preliminary numerical results obtained by its use in conjunction with an anemometer and self-recording thermometer, and from these data deduced an empirical formula giving the rate of cooling (ψ) as a function of temperature and wind velocity.

The question as to whether ψ could always be thus expressed as a function of already existing meteorological data can only be settled by a long continued series of observations with appropriate instruments, in the construction of which I have been engaged for some time. If ψ can be so expressed, then evidently there would be no need for a widespread installation of special apparatus for its measurements. If, however, this hope be disappointed, a new apparatus must be placed in the hands of meteorologists, and the simpler this is the better. I have now constructed a simple psuchrainometer, consisting essentially of a thermometer furnished with a small heater through which a constant current is always passing. This may be termed a "constant energy" psuchrainometer, and I propose to calibrate it against the necessarily more complicated form of "constant temperature" psuchrainometer, different patterns of which are described both in Prof. Hill's article and in my paper.

JAMES ROBERT MILNE.

Physical Laboratory Edinburgh University, April 30.

THE AUSTRALIAN ANTARCTIC EXPEDITION.[1]

THE most vexed question in antarctic geography has been the nature of the region west of South Victoria Land. D'Urville and Wilkes, who explored that region in 1838 and 1839, reported land in so many localities that it has been generally believed that their tracks skirted a continuous ice-covered and ice-barred land. Ross, however, sailed across the site of some of the land reported by Wilkes, and later explorers have had the same experience. The view has therefore often been held that this part of Antarctica consists of an archipelago. The first material step toward the solution of this problem was the sledge journey of David, Mawson, and Mackay during Shackleton's expedition. Their journey afforded strong evidence in favour of the continuity of the land; but this land might end far south of Wilkes's track and be separated from it by a fringe of islands. This question has been finally settled by the Australian expedition of 1911 to 1914 under Sir Douglas Mawson. The narrative of its experiences with some indications of its scientific results are given in two massive and superbly illustrated volumes.

The expedition sailed in the *Aurora* under the skilful command of Capt. Davis, whose soundings between Australia and the opposite coast of Antarctica are themselves of the highest geographical importance. Two bases were established in Antarctica, the main base in Adelie Land (about 142°40′ E.), and a western base under Wild in Queen Mary Land (95° E.); at each of these stations elaborate observations were taken, and the expedition established on Macquarrie Island a wireless station, which should be permanently maintained in the interests of Australian meteorology. From each of the bases extensive sledging expeditions were made to explore the surrounding areas. Wild sledged 4° eastward along the northern coast to Queen Mary Land in the hope of reaching Knox Land. A second party under Dr. S. E. Jones travelled westward to the Gaussberg, and thus reached the field of work of the German Antarctic Expedition under Drygalski. From the main base in Adelie Land one sledging party went eastward to Deakin Bay; a second under Bage nearly reached the Magnetic Pole; a western party sledged 4½° along the coast which had been seen by D'Urville. A sledge journey eastward over the ice-covered plateau led to one of the most tragic of Antarctic adventures, for Mertz and Ninnis perished on the journey, and only the lucky finding of a food depôt enabled Mawson to crawl back to his base.

The journey toward the South Magnetic Pole under Dr. Bage was one of the most arduous and successful of the sledging expeditions. The party reached lat. 70°36′5″ S. and 148°10′ E., where the magnet had a dip of 89°43½′ or only 16½

[1] "The Home of the Blizzard. Being the Story of the Australasian Antarctic Expedition, 1911–14." By Sir Douglas Mawson. Vol. i. Pp. xxx+349. Vol. ii. Pp. xiii+338. (London: W. Heinemann, 1915.) Price 36s. net two volumes.

min. from the vertical. This locality was 175 miles from the point reached by David's party in 1909, so the two journeys gave a nearly full section across Antarctica from South Victoria Land to Wilkes Land.

These great sledge journeys, combined with Capt. Davis's soundings along the coast, have proved the existence of land all along this part of Antarctica, though somewhat south of the positions where it was reported by Wilkes. Thus the *Aurora* sailed in clear weather over the site of the land marked by Wilkes to the east of his Cape Carr. Nevertheless, the result of the expedition is to confirm the general belief that from Cape Adare, for more than 80° westward, is one continuous ice-capped land, which forms the northern coast of Antarctica. Mawson attaches the name of the American explorer to a small part of this area, but the name of Wilkes Land appears too firmly established for the whole of it to be easily displaced. The discovery by the expedition of Queen Mary Land in the west, the long line of land to the west of Adelie Land, and of King George V. Land on the east has definitely established the northern coast of Antarctica in this district as approximately along the line of the antarctic circle. There are indications, however, from the charts that either shallow water or land extends in some places north of the circle.

The greatest trial of the expedition was the terrific violence of the wind. Gusts of wind are recorded with a velocity of two hundred miles per hour. The rate of 180 miles per hour is said (vol. i., p. 168) to have been common. The average velocities recorded for whole days are unprecedented. Thus on May 15 the mean for the whole twenty-four hours is given as ninety miles per hour. On May 18, a year later, it was 93·7 miles. The average for May was 60·7 miles per hour. The most appalling testimony to the wind strength is the record that the average speed for the whole year was fifty miles per hour (vol. ii., p. 157). Both volumes contain repeated references to hardships due to these hurricanes, and the prevalence of winds blowing at 100 miles per hour with a temperature of −28° F. (vol. i., p. 134) justifies Sir Douglas Mawson's lament that owing to "the rushing might of these eternal blizzards" Wilkes Land is "an accursed country" (p. 134). The wind records were apparently mainly made by a Robinson anemometer, which we are told was the greatest source of worry; and as meteorological authorities have issued frequent warnings of the untrustworthiness of anemometers, opinion as to the exact value of the

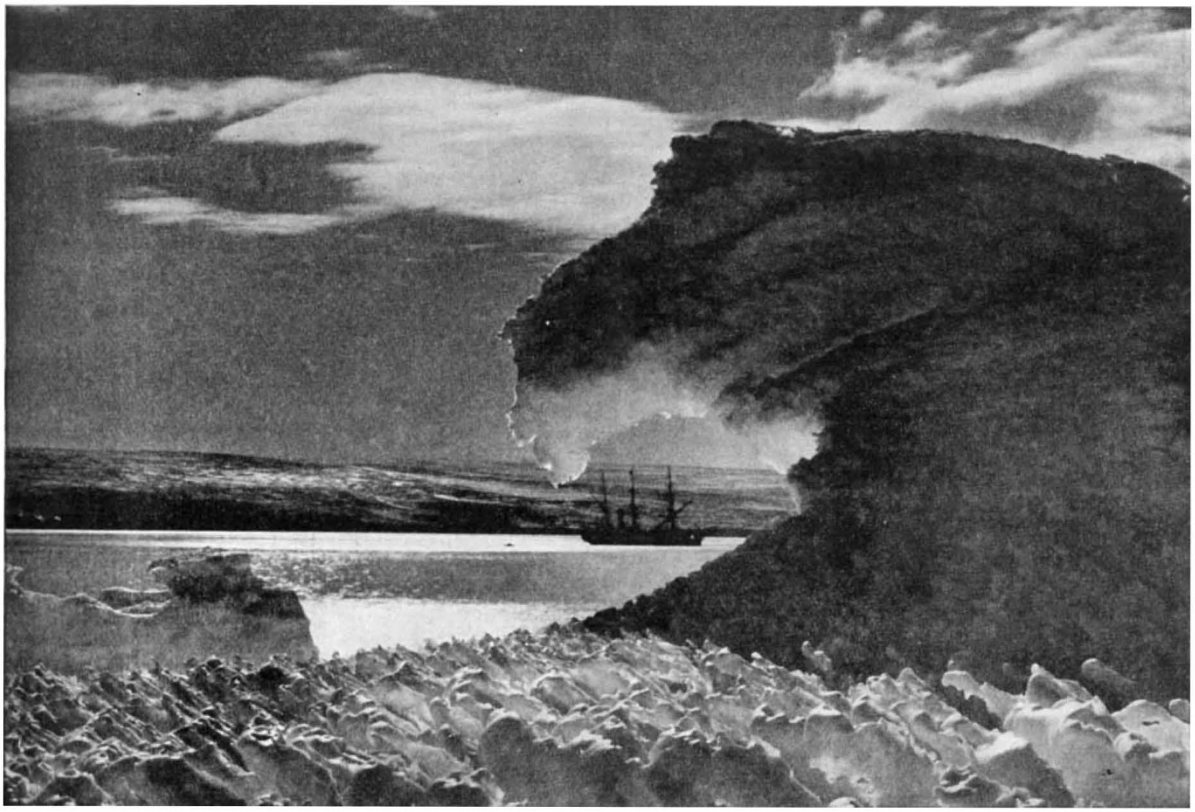

FIG. 1.—The *Aurora* lying at anchor, Commonwealth Bay. In the distance the ice slopes of the mainland are visible rising to a height of 2000 feet. In the foreground is a striking formation originating by the freezing of spray dashed up by the hurricane wind. From Sir Douglas Mawson's "The Home of the Blizzard." (W. Heinemann.)

records may be suspended until more detailed accounts of the observations are issued. There is, however, abundant evidence in the book to show that the main base is abnormally windy, and perhaps to justify the claim that it is the windiest place on earth. The "Roaring 'Forties" must give place to the "Shrieking 'Sixties." The author explains the power of the wind as due to the torrent of air rushing outward from a high pressure area around the south pole; but it is difficult to reconcile this theory, as now stated, with the experiences of Amundsen and Shackleton.

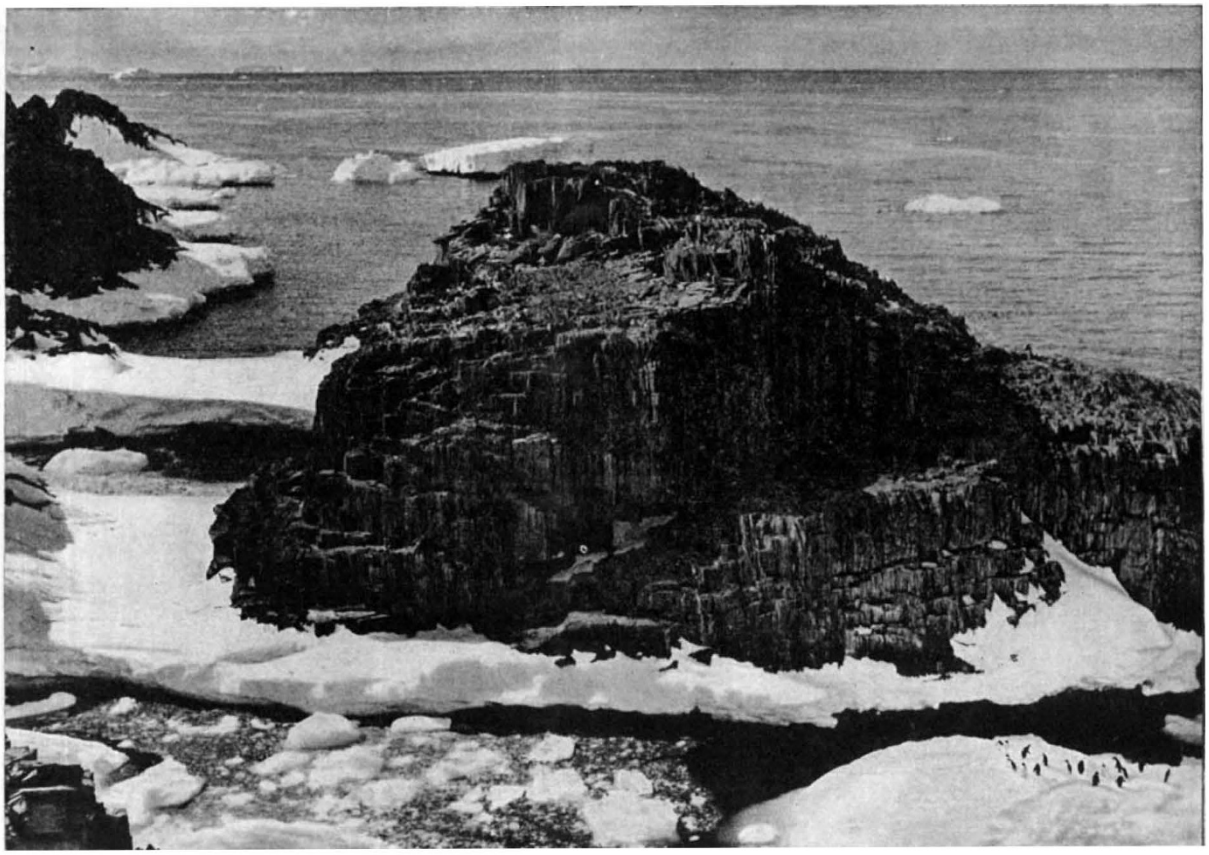

FIG. 2.—A view of a rocky stretch of the Adelie land coast west of Commonwealth Bay. From Sir Douglas Mawson's "The Home of the Blizzard." (W. Heinemann.)

The book, like much Antarctic literature, must have its usefulness restricted by its bulk; private students can scarcely afford the book space for such cumbrous volumes, a fact the more regrettable in this case owing to the exceptional beauty of the illustrations. Colour photography has been used with excellent results, and those of the starfish show the great value of this process in biology. The work includes only preliminary notices of the scientific results, but it shows that the Australian Expedition must rank as one of the most successful of modern antarctic expeditions.

J. W. G.

RECORDING RAIN GAUGES.

OF mechanical devices for the registration of rainfall there is no end, and from the early date of most of them it is scarcely too much to say that in this direction there is no new thing under the sun. Up to 1898 Mr. G. J. Symons had described and figured in "British Rainfall" no fewer than forty-five different patterns of self-recording rain gauges, and now there are at least a dozen more. Very few of these have proved fully satisfactory. The diversity between the various forms consists mainly in subordinate details. With the exception of Mr. W. J. E. Binnie's electrical drop-counter and Wild-Hasler's over-shot water wheel, I cannot find more than three principles which have been applied singly or in combination for the automatic recording of rainfall by a pen writing on a rotating drum. These are (1) the double tipping-bucket on a fixed pivot; (2) the descending counterpoised receiver, and (3) the ascending float.

Tipping-bucket rain gauges are amongst the oldest forms, and they have been constructed to record directly or through an electrical device, by an escapement wheel, a cam in the axle of