more to be said than that science teaches us to think and literary education to express our thoughts, do we not require both?" Most reasonable people would probably be prepared to concede the soundness of Mill's opinion. Is not therefore the educational system of a country which concerns itself in no way as to the status of science altogether imperfect and lopsided? The educational value of science was excellently assessed nearly half a century ago by the distinguished author of the words above quoted, in the following terms (*vide* Rectorial Address, St. Andrews University, 1867):—

"But it is time to speak of the uses of Scientific Instruction: or rather its indispensable necessity, for it is recommended by every consideration which pleads for any high order of intellectual education at all.

"The most obvious part of the value of scientific instruction, the mere information that it gives, speaks for itself. We are born into a world which we have not made—a world whose phenomena take place according to fixed laws, of which we do not bring any knowledge into the world with us. In such a world we are appointed to live, and in it all our work is to be done. Our whole working power depends on knowing the laws of the world—in other words, the properties of the things we have to work with, and to work among, and to work upon. . . .

"It is surely no small part of education to put us in intelligent possession of the most important and most universally interesting facts of the universe, so that the world which surrounds us may not be a sealed book to us, uninteresting because unintelligible. This, however, is but the simplest and most obvious part of the utility of science, and the part which, if neglected in youth, may be the most easily made up for afterwards. It is more important to understand the value of scientific instruction as a training and disciplining process to fit the intellect for the proper work of a human being."

Since Mill's day there have been many realisations and warnings that those in charge of the country's affairs were not maintaining its position in the international scale of scientific efficiency, the probable contingent future effects being at the same time pointed out. The Government have no doubt always listened respectfully to the representations, emanating from conviction, that have from time to time been made to them, but, having no thoroughly intelligent apprehension, the central fact remains—they have done nothing. The country, in a matter vital to its welfare, has been allowed to fall back while parliamentary gentlemen have occupied themselves, and the minds of the majority of their fellow-countrymen, with domestic questions of only accessory, not essential, importance.

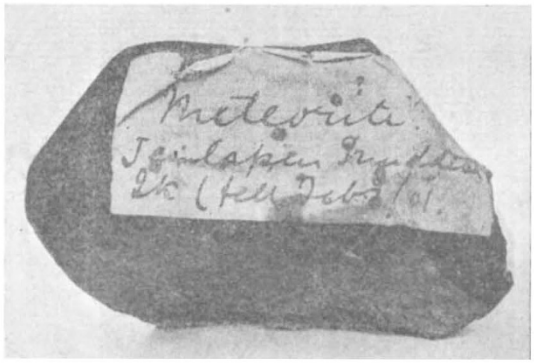
How can matters be remedied? In what possible way can progress in the future be ensured? Experience does not readily incline one to the belief that any number of memorials, deputations, or advisory boards will be able adequately to effect the greatly desired result. Would it not be an excellent thing and solve many difficulties were there a body of scientific opinion in the House of Commons? An old teaching of Bagehot's was that any notion, or creed, which could get a decent number of English members to stand up for it, might be a false, and, indeed, pernicious, opinion, but it was felt by nearly all Englishmen to be at all events possible—an opinion within the intellectual sphere, and to be reckoned with. And it was an immense achievement. This, of course, means that scientific men would require to stand as candidates for election to Parliament. The assertion that in general their very specialised scientific training would disqualify them from being useful participators in the ordinary business of the Legislature appears quite unfounded.

To the writer the foregoing suggests itself as one likely solution of our difficulty. The country, in an educational sense, appears to have got somewhat out of adjustment with external national requirement. Equilibrium with environment is, perhaps, not always easy of maintenance, but it is worth continually striving after, so far as is humanly possible; for, without this, insidiously begin the multifarious processes of destruction compassing an end which it is never possible precisely to define. D. BALSILLIE.

St. Andrews, April 30.

A Mysterious Meteorite.

THE photograph here reproduced is of a meteoritic stone which was recently obtained by Mr. A. S. Kennard from a curio-dealer in Beckenham, Kent. All that could be discovered of its history was that it had



been purchased at the sale of the effects of a local auctioneer named Harris. Hitherto also all efforts definitely to fix the locality given on the label have failed. Any help in the solution of the mystery will be welcomed by me. G. T. PRIOR.

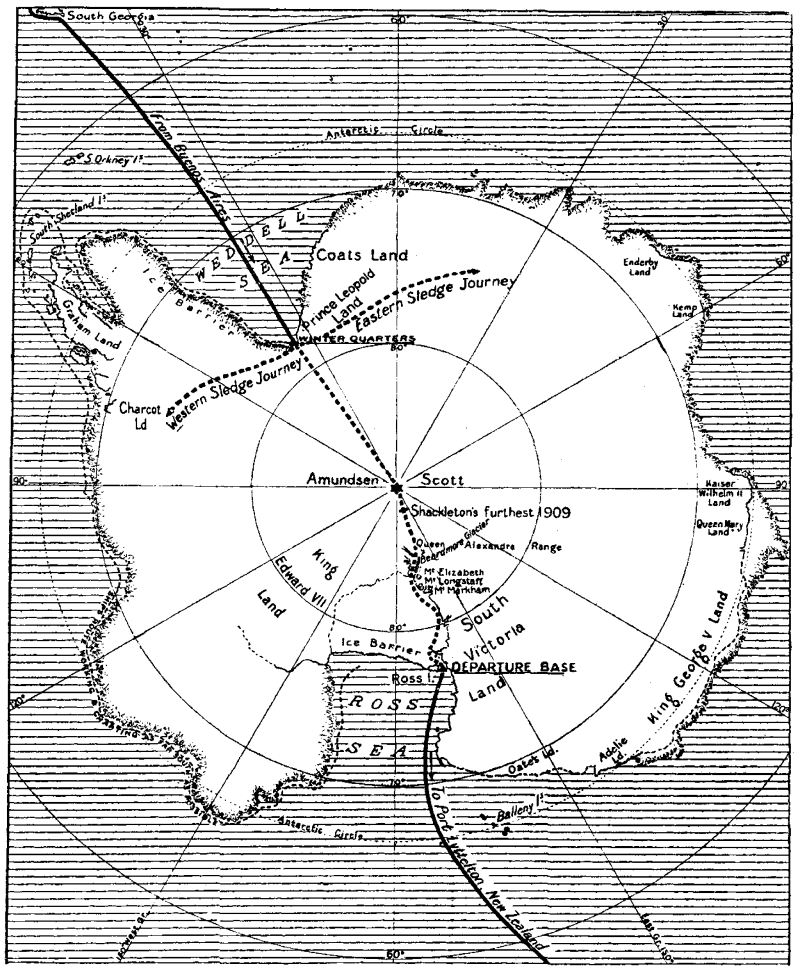
Natural History Museum, South Kensington.

THE RELIEF OF THE SHACKLETON ANTARCTIC EXPEDITION.

AS the middle of May has been reached without news of the *Endurance*, action for the relief of Sir Ernest Shackleton's expedition has to be taken on the expectation that there will be no further news this season. It is possible that the *Endurance*, damaged and short of coal, may still be slowly working her way northward, and that any day we may hear of her return to South Georgia with perhaps the whole of the expedition on board. But such a solution of the difficulty must be regarded as highly improbable, and the relief expedition must be prepared with the information already available.

The more detailed news received from the *Aurora* encourages the hope that she can be refitted in New Zealand and entrusted with the relief work necessary on the Australasian side of the Antarctic. If so, the problem there is comparatively simple. The main anxiety in regard to that section of the expedition is due to the fact that when the *Aurora* was blown out to sea there had been no news of the depôt-laying parties for two months. Three sledge parties had started at the end of January, 1915, from the *Discovery* Hut at the southern end of Macmurdo Sound. Some depôts were successfully laid on the Ice Barrier.

By March 11 these depôt parties had been reorganised by Captain Macintosh, who went south again to continue this work. The *Aurora*, after great difficulties, took up winter quarters opposite the 1910 hut at Cape Evans. After a stay there of nearly two months she was carried out to sea on May 6 and drifted, imprisoned in the ice, all through that winter and the succeeding summer. She was only released on March 10, 1916, when, even if she had been undamaged and had had adequate stores, it would have been too late to return to Macmurdo Sound that season. The *Aurora* had no news from Captain Macintosh between March 11 and May 6, but there seems no serious cause for anxiety. He would probably have spent the rest of March and the early part of April depôt-laying, and the bad weather at the end of April may explain his failure to communicate from Hut Point to Cape Evans. The men left ashore on Macmurdo Sound have the choice of three huts, and have ample stores for the two winters which they have had to spend there; and there would be plenty also for Sir Ernest Shackleton's party if it has succeeded in its journey across the Pole.



Proposed routes of the Shackleton expedition.

All that is necessary on the Ross Sea side is the dispatch of a ship from New Zealand in November or December to pick up the men left ashore at Macmurdo Sound and find what news there may be of the transcontinental party. As to the success of this relief expedition there need be no doubt, for no attempt to reach Macmurdo Sound has yet failed.

Regarding the opposite side of Antarctica, in the Weddell Sea area, there can be no such confidence, for the normal ice conditions there appear to be as unfavourable as those in the Ross Sea are favourable. The plans for search in the Weddell Sea must recognise at least three distinct possibilities.

(1) Sir Ernest Shackleton may have succeeded in establishing a land base where he hoped to winter, and thence started overland to the Ross Sea, while two sledge parties may have explored westward to the base of Graham Land peninsula and eastward to the south of Coats Land. The *Endurance* may have failed to return either in consequence of waiting for one of the two sledge parties, or by the packed condition of the ice in the Weddell Sea.

(2) The landing may have been effected so late, or so much further north than was intended, as to leave no chance of success for the transpolar sledge journey. Sir Ernest Shackleton, with his usual capacity for the quick realisation of facts, may have decided to devote all the resources of the expedition to research in the vast unknown area beside the Weddell Sea. In that case all the three sledge parties should have returned to the winter quarters, though any one of the three may have failed to get back, and thus have delayed the return of the *Endurance*.

(3) It would, however, appear quite possible, since the Weddell Sea has been so seldom found to be navigable, that the *Endurance*, in the effort to force her way to the land, may, like the *Belgica*, have been caught in the ice, and the whole expedition may be still on board drifting in the floes.

It is obvious that it is impossible to decide between these three possibilities with the information at present available, though from the news received as to the conditions of the ice in the Weddell Sea during the last two seasons it is highly probable that Sir Ernest Shackleton may not have been able to effect his desired landing. He may have been forced to land on north-eastern Coats Land. The *Endurance* may then have been car-

ried away from the winter quarters, and the relief expedition ought to be able to search independently for the ice-bound *Endurance* and for the party or parties left on shore. There would obviously be a much better chance of success if two vessels could be employed—one to search the coast-lands, and the other to scour the sea along the probable lines of drift of the Weddell Sea pack. From the observations of the *Scotia* in the Weddell Sea the prevalent wind direction there appears to be from the east, so that some belt of "land water" may be fairly persistent off Coats Land and the drift of the ice may be westward; but knowledge of meteorology in the Weddell Sea is so scanty that forecasts as to the usual drift of the ice would command but little confidence and may be falsified by an unusual season. The commander of the relief expedition should be at liberty to select his own route.

Sir Ernest Shackleton has met with very bad luck from the weather. His proposed transcontinental sledge journey was a daring and difficult undertaking. He had, however, considered all its possibilities, and it promised a fair chance of success; but his plans may have been deranged at the outset by the exceptionally unfavourable season. The ice conditions in the Weddell Sea may have prevented his starting forth on his great adventure. No time must be lost in organising the expedition to take him the help which he and his colleagues may sorely need. In addition to the return of the *Aurora* to Macmurdo Sound, two vessels, if possible, should be sent to the Weddell Sea, for the area that will have to be searched is vast, the clues are uncertain, and the season is short.

THE APPLICATION OF MATHEMATICS TO EPIDEMIOLOGY.

IT may seem remarkable that serious attempts to elucidate the mysteries of epidemic disease with the help of mathematical methods should only have been made within the last sixty years, and, even when made, should have been confined to the efforts of a very small number of students. In the seventeenth and early eighteenth centuries, the school of which Borelli was the most famous exponent endeavoured to bring much less promising medical fields under mathematical cultivation, while Sydenham's exposition of the principia of epidemiology would, one might have thought, have suggested to the founders of our modern calculus of probabilities that here was indeed an opportunity for them. No doubt, however, the explanation is to be found in the absence of statistical data, without which mathematical mills are forced to stand idle. It is of interest to recall the fact that the solution of a problem which took its rise in the failure to publish certain detailed statistics reveals a method which might have been generalised. We allude to Daniel Bernoulli's work on smallpox.[1]

His solution was as follows:—

If x denote the age in years, ξ the number who survive at that age out of a given number born, s the number of these survivors who have not had smallpox, and if in a year smallpox attacks 1 out of every n who have not had the disease, while 1 out of every m attacked dies, then the number attacked in element of time dx is sdx/n and we have:—

$$-ds = \frac{sdx}{n} - \frac{s}{\xi}\left(d\xi + \frac{sdx}{mn}\right) \text{ or } \frac{sd\xi - \xi ds}{s^2} = \frac{\xi dx}{ns} - \frac{dx}{mn}.$$

Substituting q for ξ/s, we have $dq = \frac{mq-1}{mn}dx$, so that $n \log (mq-1) = x + \text{constant}$, and ultimately, since when $x=0$, $s=\xi$,

$$s = \frac{m.\xi}{(m-1)e^{\frac{x}{n}} + 1}.$$

This investigation contains the germ of a method which, as Sir Ronald Ross has brilliantly demonstrated, might be applied to the study of the succession of cases in an epidemic. Nobody, however, took the hint, and the real history of mathematical epidemiology begins with Farr, whose work on these lines has been made familiar to the present generation by Dr. John Brownlee. Modern researches fall into one of two classes. On one hand, those directly or indirectly inspired by the epoch-making discoveries of Prof. Karl Pearson in the theory of mathematical statistics; on the other, the independent investigations of Sir Ronald Ross.

Prof. Pearson's development of a family of frequency curves, including the Gauss-Laplace or normal curve as a particular case and capable of describing effectively distributions very far indeed from normal, enabled statisticians to deal with a wide range of frequency systems, and it naturally occurred to some to use this method in the study of epidemics. Frequency curves have been fitted by Brownlee,[2] Greenwood,[3] and other medical statisticians to different epidemics, the most extensive work in this direction having been that of Brownlee. Much of this work was descriptive; that is to say, the object was in the first place to graduate the statistics, and, if possible, to classify epidemics on the basis of the type of curve found. So far as graduation is concerned, the results have been fairly satisfactory, but it proved to be impossible to effect any useful classification, the only result that emerged being that Pearson's Type IV curve was more commonly encountered than any other. The more fundamental problem of epidemiology, viz., that of discovering the law of which the epidemic, whether viewed in its temporal or spatial relations, is an expression, could scarcely be solved in this way. Brownlee, however, was by no means content with the mere graduation of statistics. Following Farr, he surmised, for reasons explained in his papers, that the theoretical curve of an epidemic in time or space should be normal, and that any practical departure from normality should be susceptible of an explanation capable of expression in terms of a function of the

[1] See Todhunter's "History of the Theory of Probability," p. 225.

[2] Proc. Roy. Soc. Edin., 1906, xxvi., 484; *ibid.*, 1911, xxxi., 262.

[3] *Journ. Hygiene*, 1911, xi., 96; Proc. 17th Inter. Congress Med., 1913, Sect. 18.