for 1901 [1] (published 1905) contains, in addition to the summary report (published in 1902), a report on the Klondike goldfields, by R. G. McConnell, 1905; a report on an exploration of Ekwan River, Sutton Mill Lakes, by D. B. Dowling, 1904; Dr. Barlow's elaborate report on the nickel and copper deposits of the Sudbury mining district, 1904; and other papers. Both volumes are illustrated and accompanied by separate portfolios of maps. The volume for 1902–3 contains the summary reports for 1902 (published in 1903) and for 1903 (published in 1904). There is also a report on the coalfield of the Souris River, East Assiniboia, by D. B. Dowling, and the "Section of Mines" annual report for 1902.

SCIENTIFIC FISHERY INVESTIGATIONS.

IN the unavoidable absence of the Chancellor of the Exchequer, Mr. R. M'Kenna received a deputation at the Treasury on December 18 in support of the application of the Marine Biological Association for a grant to continue the scientific fishery investigations which are at present being conducted in the North Sea and English Channel. The deputation was introduced by the Right Hon. Austen Chamberlain, M.P., ex-Chancellor of the Exchequer, and among those present were Prof. E. Ray Lankester (president of the Marine Biological Association), Sir Michael Foster, Sir William Ramsay, Mr. A. E. Shipley (chairman of the council), Sir Charles Eliot, Mr. Chas. Hellyer, Mr. J. A. Travers, Dr. Chalmers Mitchell, Prof. E. A. Minchin, and Dr. H. R. Mill.

In introducing the deputation, Mr. Austen Chamberlain stated that, as a former Chancellor of the Exchequer, it had been his duty to review the work which had been done by the Marine Biological Association, and he had come to the conclusion that it was most necessary, and that it had been efficiently performed. He considered that British Governments of both parties should do more to support both science and art. Prof. Lankester gave a brief account of the history of the Marine Biological Association, and explained the circumstances in which the association undertook, at the request of His Majesty's Government, to carry out the English portion of the international scheme of fishery investigations. He directed attention to the fact that the present application of the association for funds to continue their researches had received the special support of the Royal Society, which recorded in a strong minute its appreciation of the value and efficiency of the work being done.

Mr. A. E. Shipley said the Government has gained directly and in money by entrusting the North Sea work to the Marine Biological Association. He referred to the importance of extending over a sufficient period of years the kind of investigation which the association is making. Only so can the effects of secondary causes and exceptional fluctuations be eliminated from the essential, primary, normal factors. While time advances in an arithmetical progression so does the value of the results increase in a geometrical ratio. Mr. Shipley gave a short *résumé* of the work accomplished, and because it has furnished the problems of most pressing importance he confined his remarks chiefly to the plaice. During the last four years the association has devoted much hard work to tracing the life-history and the distribution of this species throughout the North Sea, with the result that many important facts concerning it have been established. Similar investigations have been carried on, but not yet so thoroughly, into the life-histories, the distribution, the migrations, and rate of growth of many of the other food fishes, the cod, the haddock, the sole, the turbot, and others. Special experiments have been made on the *Huxley* to determine the vitality and the extent of injury inflicted upon trawl-caught fish by the operations of trawling. The hydrographic observations and the investigations into the minute organisms which crowd the surface of the waters and form the ultimate food of fish have been efficiently carried on in accordance with the programme laid down by the international conferences. In this work especially, the Plymouth steamer, the *Oithona*, has supplemented and helped the *Huxley*. The association asked for a continuation of the grant which for the last five years the Government has made towards the expense of carrying on the English part of the North Sea international investigations. A grant of 6000*l*. a year is needed to continue the international work, and a grant of 2000*l*. for the work on the south coast, making a total grant asked for of 8000*l*. Next spring, for the first time, the International Congress has been invited to meet in England. There will be gathered together in London some thirty or forty of the leading men of science from Russia, Finland, Sweden, Norway, Denmark, Germany, Holland, and Belgium. It will be a pitiful thing, and also a deep humiliation, if we have to greet these gentlemen with the tidings that England, who takes from the North Sea far more than all the other eight countries together, more, in fact, than 90 per cent. of the total yield, is too impoverished to continue to do her share of this important work.

Sir Michael Foster, speaking on behalf of the British Science Guild, considered that the money asked for ought to be regarded as of the nature of an investment, and not as expenditure. He believed that scientific investigation was the only sound foundation upon which fishery legislation could be framed, and that experimental legislation, which was the only possible alternative to experimental research, would involve the country in far greater expenditure than the small sum required by the Marine Biological Association.

Mr. Charles Hellyer, chairman of committees of the National Sea Fisheries Protection Association, speaking as a practical man connected with the fishing industry, emphasised the importance to the industry of the knowledge being accumulated by the scientific investigations now in progress.

Mr. J. A. Travers, in the absence of the Prime-Warden, referred to the support which the Fishmongers' Company had always given to the work of the Marine Biological Association in the belief that an increase of scientific knowledge was bound to be advantageous to the best interests of the fishing industry.

Dr. H. R. Mill spoke of the very valuable results which had been obtained from the hydrographical work carried out in the North Sea and adjacent waters during recent years, and expressed the view that the time was not far distant when it would be possible to predict the movements of the migratory fishes from a knowledge of the hydrographical conditions of the sea.

Mr. M'Kenna, in reply to the deputation, stated that after what had been said there could be no question as to the value of the work upon which the Marine Biological Association was engaged. But the demands upon the national Exchequer were very heavy, and as a matter of experience they found that the satisfaction of one demand led to a number of others being brought forward. He promised to lay the views expressed by the deputation before the Chancellor of the Exchequer, who would, he had no doubt, give them his most careful consideration.

AGRICULTURAL RESEARCH.

IN concluding a course of Cantor lectures at the Society of Arts on Monday, on the subject of "Artificial Fertilisers," Mr. A. D. Hall, director of the Rothamsted Experiment Station, pointed out that only by continued investigation and experiment can a knowledge be obtained of the conditions necessary to make the maximum profit out of the land, crops, and stock. The teacher can only hand on what is already known; and much yet remains unknown about the growth of our commonest crops and the action of standard fertilisers. Adequate provision for scientific investigation of agricultural matters is of national importance, as the following remarks made by Mr. Hall show; but though a few counties and other local bodies are carrying out demonstrations, Rothamsted, with its comparatively small endowment, remains practically our only experiment station where problems in agricultural science are studied with the object of making new knowledge, and State aid for research amounts only to a few hundred pounds a year for the whole country.

The grants of our Board of Agriculture for agricultural

[1] "The Annual Report of the Geological Survey of Canada for 1901." (1905.) With separate folio of maps. The Annual Report of the Geological Survey of Canada, vol. xv., 1902–3. (1906.)

research during the past year amounted to 425*l.*, while the corresponding grant in the United States of America (salaries and administration expenses being excluded in each case) was more than 150,000*l.* It is true that in both countries the local authorities also spend some money on agricultural experiments, but the same disproportion would probably be found between the respective amounts if the figures could be arrived at.

Are we to take it, then, that these figures represent the relative importance of the agriculture of the two countries, or does the larger figure indicate the greater need of the American farmer for experiment and investigation? The exact contrary is the case; in the British Isles we have to farm with dear land, dear labour, and a number of charges due to the proximity of a high civilisation. Farming in consequence can only pay when there is a considerable monetary return per acre, and the bigger yield necessary involves intensive cultivation, the purchase of fertilisers, and the employment of skill, which are all needless to our competitors on a virgin soil. But each increase in the expenditure and skill necessary for the crop means a greater opening for knowledge and investigation; science can do little to save money for the man who merely stirs the surface of a virgin prairie, scattering in the seed meanwhile, and then leaves it to take its chance until harvest. Compare with such a farmer the highly technical routine of the hop-grower who spends 50*l.* per acre before he harvests his crop, his repeated cultivations, his manurings, his sprayings for various ends; it is with this kind of crops that science can find profitable employment.

Looking at the average yields of the various countries of the world, we find that Great Britain is the most intensively farmed country; it obtains the biggest crops per acre, it has to spend the most to obtain them. Furthermore, the biggest crop the greater are the risks of disease and blight, the greater are the difficulties in securing high quality. Here, then, in Great Britain exists the greatest need for knowledge and investigation; we cannot even always beg knowledge from wiser countries, for many of our problems are special, and brought about by the very conditions of high farming which prevail here. England was the first country to start an experimental station, yet Rothamsted still remains the only institution solely devoted to agricultural research in the British Isles, if we except the farm of the Royal Agricultural Society at Woburn. The income of the Rothamsted station, derived solely from private benefaction, is about 2600*l.* a year; in the United States each of the fifty-three States possesses a station receiving 3000*l.* a year from the Federal Government, besides what the State itself may contribute, in addition to the great central department of agriculture to which reference has already been made.

SOME NEW METHODS IN METEOROLOGY.[1]

PROF. BIGELOW has here collected six studies. The first four deal with diurnal periods:—(i.) of temperature; (ii.) of barometric pressure; (iii.) of vapour tension, electric potential, and coefficient of dissipation; (iv.) of terrestrial magnetism; (v.) treats of the variable action of the sun and its effects upon terrestrial weather conditions; whilst (vi.) is a general review of the status of cosmical meteorology.

The immediate occasion, the author tells us, for these studies was the necessity of deciding upon the best lines of work for the new "Mount Weather" Observatory, at Bluemont, Va., which is intended to serve as a centre for research in connection with the U.S. Weather Bureau. This observatory is to have on its staff experts in various departments, and there is to be an advisory committee, of which Prof. Bigelow is described elsewhere as chairman.

Several of Prof. Bigelow's views as to the prosecution of the higher meteorology have much to recommend them, as, for example, the following:—"If cosmical meteorology is to be established then all rough and ready methods must be abandoned, and the work of computing and discussing the data must be placed in the hands of physicists and astro-physicists who possess scientific instincts and training" (p. 48); or again:—"We must waste nothing by using bad methods of work and unskilled men" (p. 51).

But Prof. Bigelow possesses, apparently, a duality in his nature, and the following are examples of his second self:—"In the midst of this concatenation of forces the terrestrial magnetic field stands out as the best unifier or integrator. It is the most sensitive and delicate pulse which we possess, having one throb in the solar mass, and the other in its synchronism with the earth's meteorological elements" (p. 48). This seems not unworthy of Colonel Starbottle addressing a jury, but what exactly does it mean? Here, again, is what we are told of the sun:—"Recent computations indicate that at the centre . . . there is a nucleus which . . . is nearly as solid as the interior of the earth, with a temperature of about 10,000° C.; the average density . . . is 1·43 times that of water, and this is located at half the distance from the centre to the surface" (p. 39).

Feeling doubts of our capacity to follow with advantage Prof. Bigelow's highest flights, we have devoted more attention to his studies on the diurnal variations. The view to be taken of these must depend on whether they are intended as examples of the methods to be followed by the Mount Weather Observatory, or whether they are simply illustrations of the "rough-and-ready" methods the abandonment of which the author elsewhere recommends. Study i. deduces from continuous temperature records at Blue Hill Observatory, and from observations made during or in connection with kite ascents there, the diurnal variation of temperature at a series of heights for every month of the year. The final results are embodied in Figs. 14 to 25, the diurnal variation being assumed negligible at the height of 3400 metres the whole year round. The original data are not given, and the methods of manipulating them are only indicated generally. Of the probable value of the results no estimate seems possible. Study ii. gives some general, but not very lucid, information about the diurnal variation of barometric pressure. Of the amplitude of the 24-hour term it says, not incorrectly, "it is very different at neighbouring stations." Yet Prof. Bigelow obtains Fourier coefficients for a composite diurnal inequality based on data from Boston, New York, Washington, Buffalo, and Cleveland. Again, we are told in the general remarks that the amplitude of the 24-hour term is from one-fourth to one-half that of the 12-hour term. But in the composite case treated by Prof. Bigelow the 24-hour term is larger than the 12-hour term in the summer months, and the arithmetic means from the twelve monthly values of the amplitudes seem closely alike for the two waves.

In the calculations, the diurnal variation is assumed to be *completely* accounted for by three waves of periods 24, 12, and 8 hours. If $[n]$ denote the departure at hour n from the mean for the day, then the contributions to $[n]$ from the 12- and 8-hour waves are respectively

$$\tfrac{1}{2}\{[n]+[n+12]\} \text{ and } \tfrac{1}{3}\{[n]+[n+8]+[n+16]\},$$

and what remains after subtracting these two contributions from $[n]$ is *assumed* to represent the contribution of the 24-hour wave. This method cannot be recommended even for rough preliminary work, unless the 24-hour term is largely dominant and the Fourier series is known to converge very rapidly. In the present instance the amplitude of the 8-hour wave is, according to Prof. Bigelow's figures, about half that of the 24-hour wave from November to February. In these months the observational data would certainly give an appreciable 6-hour term. The same method is then applied to the diurnal variation of temperature (with sign reversed) as deduced in Study i. for heights of 195, 400, and 1000 metres at Blue Hill. The results for the 8-hour wave at 195 metres during the summer months at once arrest attention. In July, for instance, no hourly value assigned to this wave is positive. This seems to be due, not to misprints—though these are somewhat numerous in the tables—but to error in the figures for the diurnal inequality itself. If the *twenty-four* hourly differences from the mean are summed algebraically, there is in most months a substantial remainder, showing that the mean value for the day has not been correctly taken.

Limits of space allow only of brief reference to other

[1] "Studies on the Diurnal Periods in the Lower Strata of the Atmosphere." Reprints from the *Monthly Weather Review*, 1905. By Prof. Frank Hagar Bigelow. (Washington: Weather Bureau, 1905.)