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Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

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SEPTEMBER, 1921, to DECEMBER, 1921

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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The Census of 1921.

JUST twelve months ago (NATURE, August 26, 1920, p. 797) we directed attention to the effect of the Census Act of last year in facilitating the work of the Registrar General and his colleagues on the census, which was then appointed to be made in April of the present year, and to the value of the information that the census might be expected to afford. Effect was duly given to the provisions of the Act by an Order in Council made on December 21, 1920, fixing the date of the census for April 24; but when that day arrived the coal dispute and the strikes which were then threatened in the railway and transport industries gave rise to doubts whether the work could be successfully carried out as intended, and a further Order in Council was obtained fixing it for June 19, when the enumeration accordingly was made. It reflects great credit on the officers responsible for the work that they have been able so soon to publish a preliminary Report (Cd. 1485) containing in adequate detail the broad features that are presented by the figures. We must await the future Reports for much of the information that we referred to in our previous article as desirable, but in the meantime this preliminary Report may be consulted with interest and profit.

For obvious reasons this Report does not contain any particulars relating to Ireland. For Great Britain the total population is given as 42,767,530; an increase of 4·7 per cent. on that of the census of 1911. The total population of Great Britain at the census of 1821 was enumerated at 14,091,757, so that the population appears to have multiplied threefold in a hundred years. In the light of this fact it is not unsatisfactory to find that the increase shown by the present census is less in actual number and in percentage than that of any previous intercensal period during the centennium. A continuance of the previous rate of increase would have resulted in over-population.

The next step in the comparison, that of the relative numbers of the sexes, introduces a new element. In England and Wales, in 1921, the males are 18,082,220 and the females 19,803,022, 1095 females to 1000 males. In 1821 there were

5,850,319 males and 6,149,617 females, or 1036 to 1000 males. There has been during the hundred years an almost unvarying increase in the proportion of females to males, and at the present census it has nearly reached eleven to ten. It is interesting to observe, however, that in Scotland, on the contrary, there has been a diminution, the proportion in 1821 having been as high as 1127 to 1000, while that in 1921 is as low as 1079 to 1000, or less than that of England and Wales.

This superiority in number of the female sex does not alarm us. Too much has been made by the Press of what are somewhat discourteously called the "surplus women." The numerical preponderance of women over men was 1,322,502 in 1911, and 1,906,284 in 1921, showing an increase of 583,782; but that is not equal to the losses by death in the war, which are estimated at 627,870. Meantime the desire of women to acquire independence, to "live their own life" in industry, in the arts, and even in science, has been greatly developed, and with it has come a marked increase in the facilities for obtaining a training to fit them for it. When the results of the returns as to age and occupation have been co-ordinated and digested, much valuable information as to the social changes which have accompanied the events of the decennium under review may be expected to be derived.

We stated last year that an increase in the number of items of information demanded in a census was likely to lead to a diminution of the probability that the returns obtained would be accurate. It is satisfactory to find that the census authorities have to some extent adopted this view, and have left out of the schedule for 1921 the inquiry as to infirmities and the inquiry as to duration of existing marriages and the number of children born of such marriages, which were both included in the schedule for 1911. The first is scarcely a fair question, and the wealth of material obtained from the second has not been completely exhausted, so that it became unnecessary to add to it.

The Registrar General appears to cast a longing, lingering look behind on his two lost columns, for he directs attention to the fact that "this is the first time in the modern history of census-taking in this country that an inquiry once introduced into the schedule has been omitted therefrom on a subsequent occasion." However, he has supplied their place by two new columns, one as to the number and ages of children under sixteen, including an inquiry as to orphans, and another as to the place of work. He thinks, and we agree with him, that the limits of expansion have now been approximately reached, and we hope that in future the principle that information should be valued, not for its quantity, but for its trustworthiness, will be borne in mind.

This leads to the consideration of the important provision of section 5 of the Act of 1920 by which the Registrar General is authorised to enter into relations with other Government Departments so as to further the supply of statistical information and provide for its better co-ordination. Much appears to have been done by him already with that view, and now that the Act has established the work of taking the census upon a permanent footing, more may still be expected to be done. By this means the Census Office may face the problem presented to it of so presenting the information it acquires as to give the maximum of useful service to the nation at the minimum risk of annoyance to the individual.

In pursuance of the steps taken to procure concerted action in making the separate censuses of the Dominions and other Colonies, this preliminary Report contains a table of the population in 1921 of Great Britain, Australia, New Zealand, the Indian Empire, and the Union of South Africa, amounting in the aggregate to 370 millions.

In addition to the general results, of which we have briefly specified some of the more outstanding features, the details are given for each county, county borough, municipal borough, and urban and rural district of its population in 1911 and 1921, and of the acreage, affording material for ascertaining instructive facts relating to density of population and the changes that have taken place in the decade.

For Greater London an increase is shown during the ten years from 7,251,358 to 7,476,168, or 3 per cent., which is much less than the increase recorded at the five previous censuses. Indeed, in that portion of Greater London which comprises the Administrative County of London and the City of London, which showed a decrease of 0·3 per cent. in the census of 1911, there is a further decrease of 0·9 per cent. in that of 1921, falling from 4,521,685 to 4,483,249.

The perfection of the numerous mechanical contrivances used for the first time on the present occasion has no doubt been of much service in the preparation of the Report.

Indian Silviculture.

The Silviculture of Indian Trees. By Prof. R. S. Troup. Vol. 1, *Dilleniaceae to Leguminosae (Papilionaceae).* Pp. lviii + 336 + iii. Vol. 2, *Leguminosae (Caesalpinieae) to Verbenaceae.* Pp. xi + 337–783 + iv. Vol. 3, *Lauraceae to Coniferae.* Pp. xii + 785–1195. (Oxford: At the Clarendon Press, 1921.) 3 vols. 5*l.* 5*s.* net.

THE history of the East India Company is of interest to men of science from the evidence it affords of a sustained and enlightened desire to increase the natural knowledge of the economic vegetable resources of its territories. At times this took the form of approval of suggestions from India, as when the Board of Fort St. George was authorised in 1780 to employ a Government botanist in the Madras Presidency, or when the Council of Fort William received in 1787 "the most hearty approbation" of the Hon. Court of Directors in London for a proposal to establish a botanical garden in Bengal. At times the proposal emanated from the Hon. Court, as when in 1785 it was resolved to publish the sumptuous volumes of Roxburgh's "Plants of Coromandel," or when in 1807 the Council of Fort William was informed that the directors were of opinion that a statistical survey of the country under the immediate authority of their presidency "would be attended with much utility," and recommended "proper steps to be taken for carrying the same into execution."

In this particular instance the Hon. Court provided detailed instructions as to the nature of the survey, and nominated the surveyor to be employed. Its choice fell on Dr. F. Buchanan, who had been attached as naturalist to an embassy to Ava in 1795 and to a mission to Nepal in 1802, had been employed by the Fort William Council to make an economic survey of Chittagong in 1798, and had been deputed in 1800 by the Marquis Wellesley to carry out a statistical survey of Mysore.

So far as the forests of North-eastern India were concerned, Buchanan's orders were to assess their composition and the value of their products beyond as well as within the company's boundaries. Among the results of his work was the preparation in 1808 of a "Catalogue of Woods peculiar to Goalpara," in Assam. This, a list of ninety timber trees, was transmitted, with the corresponding timber specimens, to the Hon. Company's master-builder at Calcutta. The information as to these timbers was incorporated in 1831 in a "List of Indian Woods," based by A. Aikin upon specimens transferred for the purpose in 1828 by the Court of Directors to the Society of Arts. Such was the value of Buchanan's observations regarding the resources of this single forest district that in 1837 his catalogue was reconstructed by M'Cosh and incorporated in the "Topography of Assam" as being still "a fair statement of the timbers" of the whole of that important province.

The tradition established by the Hon. Court of Directors of the East India Company has been worthily sustained by the distinguished Secretaries of State for India in Council who since 1858 have fulfilled the duties formerly undertaken by that court. Confining our attention to the field of study first definitely opened up by Buchanan in 1808, we may note, among those works published under the authority or with the approbation of the India Office, the "Timber Trees" of Dr. E. G. Balfour, the three editions of which were issued in 1858, 1862, and 1870, and the "Manual of Indian Timbers" of Mr. J. S. Gamble, first published in 1881, and revised and re-edited in 1902.

By 1870 the economic knowledge of the products of Indian forests had attained a standard which emphasised the need for works calculated to assist the officers who controlled these forests in identifying the species which yield the timbers concerned. Between 1869 and 1874 Col. R. H. Beddome prepared a "Flora Sylvatica" for Madras; in 1874 appeared the admirable "Forest Flora of North-west and Central India," begun by Dr. J. L. Stewart and completed by Sir D. Brandis; in 1877 was issued a "Forest Flora of British Burma," written by Mr. S. Kurz; in 1878 Mr. J. S. Gamble published a "List of Trees, etc.," for the Sikkim region of the Eastern Himalaya; and in 1894 Mr. W. A. Talbot did the same service for the Presidency of Bombay. The sustained labour which work of this essential character entails was crowned by the publication in 1906 of "Indian Trees," a comprehensive treatise in which Sir D. Brandis has dealt with the woody constituents of all the Indian forests. This work, as essential an item in the equipment of every Indian forest officer as is the "Manual of Indian Timbers," belongs, like that of Mr. Gamble, to the class of books which, in addition to provoking admiration on account of their intrinsic merits, excite wonder as to how, before they appeared, it was possible to get along without them.

The Indian forester is able to handle with some confidence the timbers his forests provide. He may with some assurance rely on the identity of the species whence these timbers are derived. Thanks to the labours of Sir W. Schlich and Mr. W. R. Fisher, whose "Manual of Forestry" was published between 1889 and 1896, he is in a position to apply the principles of forest management with success under Indian conditions. But a gap was left in his equipment. He was without a systematic guide to the life-histories of those forest essences the products of which it is his business to dispose of to the best advantage. The importance of the factors that govern reproduction and condition the growth and survival of seedlings is now as fully realised in scientific forestry as it is in scientific agriculture.

Turning to account his own long and varied Indian experience, Prof. R. S. Troup has endeavoured to fill this gap by placing at the disposal of his former colleagues a comprehensive treatise on "The Silviculture of Indian Trees," now published under the authority of the Secretary of State for India by the Clarendon Press. Modestly regarding his work as an incentive to further study rather than an exhaustive presentation of his subject, Prof. Troup has fortunately taken a broad view with regard to the species dealt with. That a difficulty should have been felt may easily be appreciated. The area administered by the Indian Forest Department is of wide extent and is diversely conditioned as regards both soil and climate. It includes dry plains, where the rainfall may be negligible, and wooded escarpments with an annual precipitation that may exceed 400 in. It contains tropical uplands well under the normal cloud canopy of the rainy season, and temperate mountain valleys swathed in mist for weeks at a time. It extends from the mangrove forests at the outfalls of Indian rivers to the upper limits of Himalayan trees. The number of arboreal species met with is necessarily great. Not all of these, however, yield useful products; many of those that do are limited in distribution or occur but sparingly, so that their timbers, though often employed locally, are little known, if known at all, in commercial circles. The decision to deal in this work with most of the species the wood of which is known to be of value will meet with the approval of all who may use it, as will the further decision to deal with the life-histories of exotics like those Australian "gums" and American "mahoganies" the cultivation of which has become definitely established in India. But in dealing with the trees thus included the author has shown a due sense of proportion, for while the accounts of elements so important as sal and teak, chir and deodar constitute veritable monographs, trees of minor consequence are discussed with commendable brevity.

The illustrations with which the work has been provided deserve especial notice. The series of coloured plates in which seeds, germinating seedlings, and young plants are displayed are of great interest and value; the remaining drawings and the photographs are well chosen, carefully reproduced, and always instructive.

Prof. Troup will doubtless prove justified in his hope that this work may induce further research in what is a fascinating and important field. Meanwhile it is possible to say that, as a complement to those of his distinguished precursors, his work is worthy of the ægis under which it has been produced, and will prove as indispensable to the Indian forest officer as that of Gamble on "Indian Timbers" and that of Brandis on "Indian Trees."

The Works of Cavendish.

The Scientific Papers of the Honourable Henry Cavendish, F.R.S. Vol. 1: *The Electrical Researches.* Edited from the published papers and the Cavendish manuscripts in the possession of his Grace the Duke of Devonshire, K.G., F.R.S., by Prof. J. Clerk Maxwell. Revised by Sir Joseph Larmor. Pp. xxviii+452. Vol. 2: *Chemical and Dynamical.* Edited from the published papers and the Cavendish manuscripts in the possession of his Grace the Duke of Devonshire, K.G., F.R.S., by Sir Edward Thorpe, with contributions by Dr. Charles Chree and others. Pp. xii+496+6 plates. (Cambridge: At the University Press, 1921.) 6*l.* net 2 vols.

THE Cambridge edition of the scientific papers of Henry Cavendish is much more than a mere reprint. In 1879 an edition of the electrical researches was published, a work to which Clerk Maxwell, the first Cavendish professor of experimental physics, devoted the last five years of his life. This long period was required because Cavendish had left behind, in addition to his papers in the Philosophical Transactions, a manuscript record of many experiments which were not published, but were sufficiently precise to prove that he was familiar with the theory of divided currents; had made a most extensive series of experiments on the conductivity of saline solutions in tubes, compared with wires of different metals; and had found out the inductive capacity of glass, resin, and wax. These manuscripts occupy 255 pages of the present edition as compared with sixty-six pages which are covered by the two published papers on electricity. In addition, Clerk Maxwell's introduction and notes extend over more than 100 pages, and form a permanent record of his work on the manuscripts. The new edition of the electrical researches, which now forms vol. 1 of the "Scientific Papers," has been prepared by Sir Joseph Larmor, who has added a preface and a number of notes such as were needed to bring Clerk Maxwell's commentary up to date, and has made a number of improvements in the text as issued just before the death of the first editor.

The chemical and dynamical researches which form the second volume of the "Scientific Papers" are edited by Sir Edward Thorpe, and have not been issued previously. In this case the proportion of published papers is much larger, but the seventy-four pages of introduction form a masterly review of Cavendish's work as a chemist, and bring out in a remarkably clear way some of the main features of this work. Thus it appears, not only from the papers, but also from the manuscripts, to how large a degree Cavendish's experiments assumed an accurately quantitative character—even the alkalis that he used were standardised by neutralising with nitric acid and weighing the nitre which they yielded on evaporation. It was perhaps this passion for exact measurements that caused him to withhold from publication much of his experimental work, as, for instance, part 4 of his "Experiments on Factitious Air," in which he studied with much care, but without securing completely consistent measurements, the mixtures of gases (carbon monoxide and dioxide, marsh-gas, and hydrogen) produced by the destructive distillation of wood, tartar, and hartshorn.

A second feature to which the editor directs much attention is Cavendish's adhesion to the doctrine and language of the phlogiston theory. The doubt as to Cavendish's claim to the discovery of the composition of water, which is indisputable as a matter of experiment, rests mainly on the ambiguous expression of his results in the language of this theory. Those who have read his published papers are familiar with the necessity that exists for thinking of oxidation when Cavendish speaks of dephlogistication; but it is perhaps fortunate that the letter written by Cavendish to Blagden on the receipt of a copy of Lavoisier's "Nomenclature Chymique" was not published at the time, for it contains a strong protest against naming substances in terms of a theory, a protest which is scarcely justified from one whose writings, almost from beginning to end, require to be translated mentally, in order to disentangle them from the language of an obsolete theory in terms of which they are expressed.

The unpublished manuscripts on chemistry contain a considerable amount of valuable material. An unpublished paper describing Cavendish's "Experiments on Arsenic" (probably made in 1767) shows that he was familiar with the oxidation by nitric acid of white arsenic to arsenic acid, and that he had fully investigated the properties of the latter acid and its salts, probably ten years before Scheele. He considers, however, that "the only difference between plain arsenic and the arsenical acid is that the latter is more thoroughly deprived of its phlogiston than the former," and does not recognise the significance of the gain in weight which he had found to accompany the oxidation. His unpublished "Experiments on Tartar" also compete in interest with the paper in which Scheele, in 1769, first described the properties of the acid; but it is not clear whether Cavendish's two series of experiments preceded and followed the publication of this paper, or were all carried out independently of it. A note on the "Solution of Metals in Acids," which was withheld from the first paper on "Factitious Air," explains the action of nitric acid in dissolving metals as due to the "affinity of the phlogiston of the metals to the nitrous acid," giving rise to vapours "composed of the nitrous acid united to the phlogiston of the metal." The influence of phlogiston also appears in Cavendish's incredulity when he found that charcoal deflagrated with nitre showed a loss in weight which was smaller than the loss of weight when the carbonate of the ash was decomposed by acids—from his point of view the "fixed air" in the ash was wholly derived from the charcoal by a mere process of dephlogistication, and the oxygen contributed by the nitre was not allowed for; in the same way, it may be noted, Lavoisier at first tried to recover oxygen from mercuric oxide by heating it with charcoal—a phlogisticating agent the material character of which was realised only when at last the theory of phlogiston was obliged to release its strangle-hold on the growing science of chemistry.

One other service which the editor of the chemical and dynamical researches has rendered to the vindication of the merits of Cavendish as a pioneer worker in science is seen in his detailed study of the experiments on the freezing of aqueous acids, which Cavendish carried out with the co-operation of Mr. John McNab, of Albany Fort, Hudson Bay, as described in the Philosophical Transactions of 1788. Sir Edward Thorpe is able to show, by a comparison with modern measurements, that Cavendish and his colleague froze out and separated the hydrates $HNO_3,3H_2O$, $HNO_3,2H_2O$, and H_2SO_4,H_2O; determined accurately their compositions and melting points, as well as those of the eutectic mixtures in which these hydrates are concerned; and secured data which can be plotted with remarkable accuracy on a modern freezing-point diagram.

In addition to the chemical papers and manuscripts, the second volume of the "Scientific Papers" includes reprints of the remaining papers, of which the most important describes the well-known "Experiments to Determine the Density of the Earth." In dealing with this section of Cavendish's work the editor has obtained contributions from Dr. Chree, who writes a note on the determination of the height of the aurora, and gives an account of Cavendish's magnetic work; from the Astronomer Royal, who writes on Cavendish's astronomical manuscripts; from Sir Archibald Geikie, who writes on Cavendish as a geologist; and from Sir Joseph Larmor, who adds a note to a manuscript on "The Refraction on a Mountain Slope," and gives an account of Cavendish's mathematical and dynamical manuscripts.

It is a tribute to the work which has been expended on these two volumes that only sixty-six out of 452 pages of the first volume, and 220 out of 496 pages of the second, are occupied by reprints of the papers from the Philosophical Transactions. The Cambridge University Press has produced a worthy memorial of the work of one of the most distinguished of Cambridge men, and no student of the history of science in England can afford to ignore or to neglect these volumes.

T. M. L.

Paris Weather Statistics.

Atlas Météorologique de Paris. By Joseph Lévine. Pp. vi+83+9 plates. (Paris: Gauthier-Villars et Cie, 1921.) 20 francs.

MUCH more will be found in this atlas than is to be inferred from the title. The author promises to set out graphically the annual values of meteorological elements for Paris from 1700 to 1920, with monthly values from 1761. This is shown in a series of plates. He also gives complete monthly and annual tables for several elements from 1874 to 1920, with a column of annual departures from average, and of variations from year to year. The wind tables are not so full, as they date back only to 1890, and some of the other tables do not begin until 1876 or 1878. In addition, there is a table of extreme barometer readings from 1809 to 1919 for each month and for the year, and of highest and lowest mean monthly and annual readings from 1757 to 1919. The highest recorded barometer reading at an altitude of 67 m. was 781·2 mm. in February, 1821, and the lowest 713·5 mm. in December of the same year. During the period from 1878, of which fuller details are given, the highest readings were 782·4 mm. on January 16, 1905, and 782·3 mm. on January 17, 1882, at an altitude of 50·3 m. (corresponding to 780·7 mm. at an altitude of 67 m.), and the lowest 718·1 mm. on January 10, 1916. It is to be remarked that at Greenwich, in the same period, the highest readings—782 mm.—were recorded on January 17, 1882, and January 29, 1905. The latter was nearly a fortnight later than the Paris maximum, though the former was on the same day, indicating a very extensive anticyclone, with possibly an even higher reading at some intermediate point. Naturally, no such accordance can be expected in the minimum readings.

The highest shade temperature at Paris was 38·4° C. (101·1° F.) on July 20, 1881, five days after the Greenwich reading of 97·1° F., which has been exceeded only by that of 100·0° F. on August 9, 1911, on which day the Paris reading was 97·7°. The lowest shade minimum in the same period at Paris was −25·6° C. (−14·1° F.) on January 20, 1879, about 20° F. lower than anything at Greenwich since 1841; but in spite of the greater rigour of the Paris frosts, they occur neither so early nor so late as at Greenwich. The limiting dates at Paris are October 5 and May 13; at Greenwich, September 27 and May 24. The corresponding limits for ground frost at Paris are September 13 and June 9, but the period covered by the table is only from 1902 to 1920. There are no real limits at Greenwich for ground frost, for it has been recorded during the same period in both July and August.

The mean rainfall of Paris is about an inch less than that of Greenwich. In the forty-six years of the table 28 in. was exceeded at Paris twice, and at Greenwich eight times. On the other hand, in six years at Paris, and in only two at Greenwich, did the annual total fall below 19 in.

Unfortunately, there is scarcely any information about duration of sunshine. The author remarks that the record is not homogeneous, and gives only the figures for 1919.

W. W. B.

Soil and Soil Management.

(1) *Agricultural Geology*. By Dr. F. V. Emerson. Pp. xviii+319. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 16*s*. 6*d*. net.

(2) *The Soils and Agriculture of the Southern States*. By H. H. Bennett. Pp. xviii+399 +plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 18*s*. net.

(3) *Productive Soils: The Fundamentals of Successful Soil Management and Profitable Crop Production*. By W. W. Weir. (Lippincott's Farm Manuals.) Pp. xvi+398. (Philadelphia and London: J. B. Lippincott Co., 1920.) 10*s*. 6*d*. net.

(4) *Soil Alkali: Its Origin, Nature and Treatment*. By Prof. F. S. Harris. (Wiley Agricultural Series.) Pp. xvi+258. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 13*s*. 6*d*. net.

(5) *Text-book of Land Drainage*. By J. A. Jeffery. (The Rural Text-book Series.) Pp. xx +256. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 10*s*. 6*d*. net.

(6) *Agriculture and Irrigation in Continental and Tropical Climates*. By K. D. Doyle. Pp. xv +268. (London: Constable and Co., Ltd., 1921.) 19*s*. net.

THE output of books on the soil is now considerable, especially in the United States, and it is gratifying to find that the number of agricultural students is so large as to justify an array of volumes such as now exists.

(1) Prof. Emerson deals with the subject fundamental to a large part of the work—the geological processes by which the mineral particles of the soil came to have their present properties, composition, and position. It is no longer supposed that the study of soil is simply a branch of geology, because the vital part played by biological factors is fully recognised. Nevertheless the fact remains that geological factors determine the whole structure of the soil, on which its agricultural value largely depends.

The book deals exclusively with United States conditions, but it is of more than local interest. The method of handling the subject may be commended to teachers in this country who have no book on similar lines dealing with Great Britain. In particular the illustrations and the models are distinctly helpful in character.

Good use is made of the material collected by the U.S. Soil and Geological Surveys, and there are sketch maps to show the broad outlines of the soil regions and the main types of soil. One of the most important soil regions is the coastal plain, extending from New Jersey through Texas and on to the south, which consists mainly of sands or light loams. West and north of this region is the Piedmont Plateau, the soils of which are in the main rather heavy. A third highly important group contains the glacial and loessial soils, which include much of the wheat and corn belt.

In addition to the account of soils there is a useful survey of the phosphate deposits of the States. It is not generally realised that the United States is by far the leading producer of rock phosphate, and claims to be able to maintain this position in virtue of its enormous untouched reserves. Tennessee and Florida are the most important sources.

Altogether the book is one which cannot fail to interest the teacher in this country, while the serious agricultural student will welcome it as a concise statement of the origin of the soils of the United States and will wish he knew of as good an account of British soils.

(2) Dr. Bennett starts where Prof. Emerson leaves off, and, assuming the soils already formed, proceeds to describe them in detail and to show what agricultural systems have grown up on them. As an illustration: the coastal plains soil mentioned above is here subdivided into eighteen divisions, of which by far the largest is the Norfolk soil. General farming predominates over the whole area, the particular crops being determined by the climate, which varies from subtropical to moderate conditions not far removed from our own. The main crops, however, are cotton, maize, and tobacco; about 70 per cent. of the United States cotton is produced on these soils. There are also many specialised areas and instances of crops or products which, at first subsidiary, have gradually assumed more and more importance, until finally they dominate a district or formation. The data are well collected, and there are many tables of statistics, both in the main part of the book and in the appendix, which the reader will not easily find elsewhere. There are numerous illustrations of normal agricultural practices and novel features which possess sufficient interest to justify special description.

We know of no better account of the soil and agriculture of the Southern States, and, as in the case of Prof. Emerson's work, the British teacher will certainly wish he had as good an account of the uses to which British soils are put.

(3) Prof. Weir's book deals with the subject of

soil generally, not with the soils of a particular region. It is written for the practical agriculturist and for the student who wishes to farm rather than for the man who desires to become a soil expert, and the illustrations and the tables are of such a kind as will appeal at once to the man interested in the business aspects of the subject. Take, for instance, Table I., which summarises a long and complex series of experiments in Ohio, or the comparison between grain-farming with and without livestock respectively shown in Table II.

TABLE I.—*Effect of Liming an Acid Soil.*

Treatment (once in 5 years).	Average value of crops per acre per rotation.		Average cost of lime and fertiliser per acre per rotation.		Net gain per acre per rotation.	
	Un-limed. Dollars.	Limed. Dollars.	Un-limed. Dollars.	Limed. Dollars.	Un-limed. Dollars.	Limed. Dollars.
No manure, no fertiliser	49.40	61.40	—	5.00	—	7.00
Manure (8 tons per acre)	78.58	94.49	16.00	21.00	14.96	25.87
Acid phosphate (320 lb. per acre)	67.80	81.80	2.60	7.60	15.20	24 20
Complete fertiliser	87.76	104.49	17.60	22.60	23.46	35.09

TABLE II.—*Grain-farming* v. *Stock-farming in maintaining Soil Fertility.*

Crops.	Average yields per acre in grain-farming.		Average yields per acre in stock-farming.	
	Grain or seed.	Hay, stover, or straw.	Grain or seed.	Hay, stover, or straw.
	Bushels.	Tons.	Bushels.	Tons.
Corn ...	58·6	None harvested	64·6	1·55
Soybeans	19·0	0·87	21·9	1·00
Wheat ...	28·7	1·32	32·4	1·55
Clover ...	Not gathered			2·23

It would be difficult to find terser and clearer illustrations of the important part played by lime and livestock as adjuncts to good farming.

There is an excellent section on ploughs and other implements, and an interesting example of a fraudulent use of soil analysis of a kind we have not met with in this country. We should not agree with the author's unqualified statement of the Law of Diminishing Returns as applied to fertilisers; recent experiments in this country indicate that the return increases at first in a greater proportion than the amount of fertiliser used; not until a certain excess is reached does the return begin to diminish.

(4) Dr. Harris's book is entirely specialised, and deals with one aspect of soil only, viz. alkali, a sufficiently important subject, however, to occupy one man's whole time and attention. He speaks with great authority; as the Director of the Utah Agricultural Experiment Station he has had unrivalled opportunities for studying the problem at first hand. By alkali is meant any soluble salt that makes the soil solution sufficiently concentrated to injure the plant; the salts include the chlorides, sulphates, carbonates, and nitrates of sodium, potassium, and magnesium, and the chloride and nitrate of calcium. In the author's view these salts arise from desiccated inland seas. Most of them are actually neutral, but the word "alkali" has so long held the field that it is not likely to be displaced. Some idea of the magnitude of the problem is conveyed by the statement that more than 9,000,000 acres (or 13 per cent.) of the irrigated land of the United States suffer from this cause. While the author devotes his attention largely to practical problems he is quite alive to the scientific interest of the matter, and he gives numerous references which will allow the student to proceed further in the inquiry.

There are useful lists of indicator plants and descriptions of some of the most typical of them. Certain of the Atriplex species are the last to abandon an alkali flat. Various methods are described by which the ill effects can be mitigated, but the only permanent cure is flooding, which, however, must be accompanied by adequate drainage or it soon makes matters worse.

(5) Prof. Jeffery, who was for long in charge of the Soil Department of the Michigan Agricultural College, and has now become Land Commissioner for one of the important States railways, has published the book on drainage for which he was known to possess considerable material. It is intended for the student, and presents the subject in a very comprehensive form. Some of the experimental demonstrations are ingenious, and many of the data will prove of interest to the teacher. In the United States, as in England, the level of the wells is falling, though usually only slightly, the minimum lowering per decade for the entire country being 0.68 ft. for dug wells and 2.17 ft. for drilled wells; the maximum recorded is 4.66 ft. for the decade. The book contains some interesting illustrations of actual drainage problems which cannot fail to help the student.

(6) Mr. Doyle's book deals with the specialised subject of irrigation in its wider aspects and regarded as the basis of prosperous farming. "The most certain road to profitable production is by permanent irrigation with good drainage, in an equable climate, free from frost. Under these circumstances much of the uncertainty of farming is eliminated and the best conditions of

growth can be secured as if in a laboratory." This thesis is developed at length, and the author does not confine himself to any one country, but ranges over much of the British Empire. The book will be found to help the agricultural student who wishes to farm in the Empire, but is not certain where to go or what sort of problems will confront him when he begins.

E. J. RUSSELL.

History and Method of Science.

Studies in the History and Method of Science. Edited by Dr. Charles Singer. Vol. 2, Pp. xxii+559+55 plates. (Oxford: At the Clarendon Press, 1921.) 48*s.* net.

IN recent years there has been a great development in the study of history as applied to science, and apart from special journals and magazines dealing generally with the history of science, there is a constant accession to scientific literature of historical treatises, essays, and biographies. The present volume is the second of a series the aim of which is to help the student to a conception of the true place of scientific discovery in the history of human thought, and by a series of special papers to show the lines along which the accumulated mass of scientific knowledge has evolved.

The scope is wide, for the volume deals with such diverse subjects as hypothesis, science and metaphysics, Aristotle and the heart, medieval astronomy, the scientific works of Galileo, Leonardo as an anatomist, Greek biology and its relation to the rise of modern biology, etc. Whether it is expedient to collect in one volume subjects differing so widely in nature may be open to argument. At the same time, so far as we can judge, all the articles are of high merit, and many of them represent the work of years or even a lifetime. There must be few people whose minds are so constituted or whose knowledge and interests are so great that they can turn from reading "Four Armenian Tracts on the Structure of the Human Body" to read with relish or profit the learned article on "Archimedes' Principle of the Balance and some Criticisms upon it"; but the object of the editor was no doubt one of instruction and an attempt to keep open the wider channels of science which are daily liable to silt up through the contracting power of extreme specialism.

Mindful of these difficulties, it would therefore be invidious to criticise each article. As the bulk of the volume applies to history in the natural sciences, it will appeal most strongly to biologists, and in this connection we may direct attention to the interesting article by E. T. Withington, "The Asclepiadæ and the Priests of Asclepius"; that by the Norwegian, H. Hopstock, on "Leonardo as Anatomist"; and the very exact and accurate article by F. J. Cole on "The History of Anatomical Injections." The editor, Dr. Singer, contributes the longest article in the book, entitled "Greek Biology and its Relation to the Rise of Modern Biology," amply, and indeed expensively, illustrated.

Altogether, the book is a credit to all those who have co-operated in its production, and considering its get-up as well as the price of everything connected with printing at the present time, its cost must be regarded as very reasonable, if not actually cheap.

W. B.

Our Bookshelf.

The Chemists' Year Book, 1921. Edited by F. W. Atack, assisted by L. Whinyates. Vol. 1, pp. vi+422; vol. 2, pp. vii–viii+423–1142. (Manchester: Sherratt and Hughes, 1921.)

THE new edition of "The Chemists' Year Book" has been revised in the sections on fuels and illuminants, crystallography, and cellulose, while the section on coal-tar has been completely rewritten. There are some inaccuracies to be noticed in the section on "Notable Dates in the History of Chemistry," but the numerical data appear to have been edited carefully in accordance with recent work. The section on acid and alkali manufacture is too brief to be of much value, though in some cases in which the book has been tested it has shown itself superior to other more ambitious works. The exact meaning of "percentage" in density tables, for instance, is given in cases where other compilations are quite ambiguous.

Pure Thought and the Riddle of the Universe. By F. Sedlák. Vol. 1, *Creation of Heaven and Earth.* Pp. xv+375. (London: George Allen and Unwin, Ltd., n.d.) 18*s.* net.

THE aim of this book is praiseworthy in the highest degree. Unfortunately it cannot be said to achieve success. The author tells us that he has already published a translation of the first two volumes of Hegel's "Wissenschaft der Logik," but it had failed to arouse interest. He has therefore conceived the idea, not of paraphrasing it literally, but of presenting what he considers and accepts as its essential meaning in his own words. Where he seems to us to fail is in not understanding that Hegel, so far as he makes appeal to present students, does so in the spirit of his thought and not in the now antiquated form of its expression.

A Geological Excursion Handbook for the Bristol District. By Prof. Sidney H. Reynolds. Second edition. Pp. 224. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall, and Co., Ltd., 1921.) 5s. net.

THE second edition of this useful handbook reproduces the first in all essential features. The author is, however, well known for his untiring investigations into the geology of his district, and the recent researches of his pupils and himself have necessitated a number of minor alterations in the descriptive portion of the book.

The chief additions relate to the igneous rocks associated with the Carboniferous Limestone, and four out of five new text-figures illustrate the outcrops and exposures of these rocks at Goblin Combe and in the neighbourhood of Weston-super-Mare.

It is to be regretted that page-references are lacking, not only in the list of illustrations, but also in all the other references made to text-figures. T. F. S.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Ruling Test Plates for Microscopic Objectives: Sharpness of Artificial and Natural Points.

TEST plates for microscopic objectives should consist of alternate opaque and transparent lines approximately of the same width, and placed on a plane surface (not grooves engraved on transparent material). Considerable difficulty has been found in producing such lines when the distance between them is less than about 1/2000 in. They might be made by ruling on thin opaque films, and, so far as opacity is concerned, films of silver or other metals chemically deposited on glass would meet the case; but the intrinsic strength of these films is greater than their adherence to the glass, and the whole of the metal is torn away by the ruling point when the lines are close together. In many trials I have never succeeded in ruling on chemically deposited silver at even 2000 lines per inch. I have found, however, that films of certain aniline colours dried on glass are well adapted for the purpose, their opacity being so intense as to show a fair depth of colour even when the thickness of the film is a very small fraction of a wave-length of visible light. Their adherence also to the glass is greater than their intrinsic strength, and, so far as my experience goes, the limit to the fineness of the lines which may be ruled on them is not reached until the spacing of the lines is less than the thickness of the film.

In ruling lines on such films the load on the ruling point should be sufficient to remove the material of the film, but not to scratch the surface on which it is laid, and considering how soft the film is compared to glass or quartz, it seemed worth while to see whether a steel point might not be substituted for diamond in the ruling process.

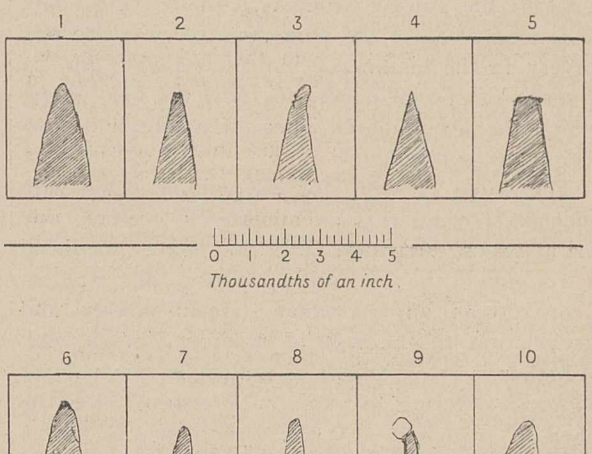
In looking into this question, one of the first things to be noticed was the extraordinarily small load which must be placed on the point. Suppose, for instance, that it is required to rule at the rate of 100,000 per inch, the area of the point in contact with the plate must not be greater than $(1/200{,}000)^2$ in., and since a grain is roughly about 1/15,700,000th of a ton, a load of 1 grain on the point will produce a pressure of more than 2500 tons per square inch. Even hard steel would not stand a hundredth of this pressure for long, and though I am not aware that any accurate measures have been made of the pressure required to scratch glass, I should expect it to be less than 10 tons per square inch.

For ruling lines at 100,000 per inch, therefore, the load on the point should be not greater than 1/200th of a grain, and the holder in which the point is carried by the ruling machine would have to be made with a very small mass, and counterbalanced.

To find out whether it was possible to grind steel points to the requisite fineness, I began by examining the points of needles in the state in which they are sold.

They varied in the degree of sharpness, but their extremities were all somewhat parabolic in section, with an average minimum radius of curvature of the order of 1/20,000 in. (Fig. 1).

On trying to secure a finer point by grinding, it was found that, using the lightest pressure which could be applied by hand to a needle mounted at the end of a light reed, the point continually broke away,



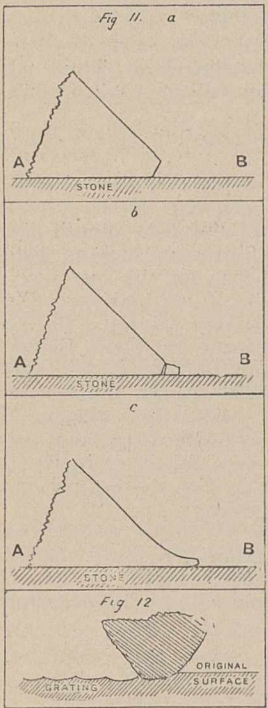
FIGS. 1 to 10.—(*Traced from photographs*) 1, needle: average point as sold. 2, needle: ground under a load of 15 grains; see broken point. 3, needle: softened to show bending under the same load. 4, needle: ground under a load of 1 grain (about). 5, needle: dropped, point downwards, on a glass plate; fall 1 in. 6, spine of cactus (Opuntia): barbs much sharper than the apex. 7, thistle spine. 8, gorse prickle. 9, stinging-hair of nettle: this is a thin-walled tube; a drop of poison is issuing from the end. 10, bramble: immature prickle; older prickles are not so sharp.

leaving a rough end somewhat less than 1/10,000 in. in diameter (Fig. 2). On repeating the process with a needle which had been slightly softened, the end tended to become cylindrical, and the cylindrical part broke off when its length was about two diameters (Fig. 3). (This cylindrical end is analogous to the "wire edge" left when sharpening a rather soft knife or chisel.)

Using an unsoftened needle so mounted that very light pressure might exist between it and the grinding stone, a point was produced which appeared perfectly sharp under a microscopic power of 300 (Fig. 4). How sharp this really is is quite uncertain, for probably the same appearance would be presented whether the radius of curvature were one-half or one-hundredth of a wave-length of the light used in its examination.

I believe, however, that, short of molecular dimensions, there is no limit to the sharpness attainable if sufficiently light pressures are used in grinding.

In order to get some idea of the chance which a fine steel point would have of surviving when in use, I dropped a needle weighing about 3 grains through a distance of 1 in. on a glass surface. The result is shown in Fig. 5.



FIGS. 11, *a*, *b*, *c*, and 12.

It would seem, therefore, that though it might be just possible to rule lines separated by 1/100,000 in. with a steel point, great care would be required, especially in bringing the point into contact with the film at the beginning of each line.

What happens in the process of grinding is indicated in Fig. 11, *a*, *b*, *c*. Suppose that a truncated cone (*a*) is being ground, and that the pressure between it and the stone is at first uniformly distributed along the line AB; as grinding proceeds it is evident that the pressure near the small end will diminish, owing to the necessary bending and shear set up at that part. Continued grinding either causes the tip to break off (*b*), or forms a quasi-cylindrical end (*c*), according to the brittleness or pliability of the material. (The wire-like end (*c*) is analogous to the "wire edge" formed when grinding a slightly soft knife or chisel.)

The harder the material and the more obtuse the cone, the nearer to the geometrical apex will the break occur.

In the ground diamond points which I have examined the end is rounded, and the lines of diffraction gratings ruled by them are merely very shallow grooves, as may be seen if thin sections are made of celluloid or gelatine casts. Casts taken from a Rowland grating of about 17,000 lines per inch gave spectra nearly as brilliant as the grating itself, but the depth of the grooves was not distinguishable even when viewed with an immersion twelfth objective. I have been told that in ruling these gratings the load on the point was 3 or 4 grains, and if this is the case the whole of the ruled surface must have been sunk below that of the original level. In casts from some of my own gratings of 5000 per inch, the grooves, though shallow, could be readily distinguished. Each groove was the full 1/5000 in. across, and I know now that the load on the point was excessive (see Fig. 12).

The natural edges of splinters of diamond offer sharper points than can be attained by grinding, and I believe that the finest ruling could be made with such splinters, properly mounted, if they could be applied with a sufficiently light load.

Many orders of plants form hard points, which, according to Bentham, should be called "thorns" when developed from the wood, and "spines" or "prickles" when products of the epidermis.

These points are often said to be "as sharp as needles," and at various times I have examined a great variety of them in order to determine their real dimensions. Figs. 6–10 are traced from photographs, but only in the barbs of the spines of some cacti have I found any natural points which approached the sharpness of a needle. As a rule "thorns" are much blunter than "spines" or "prickles." A. MALLOCK.

9 Baring Crescent, Exeter, August 16.

Biological Terminology.

I SUSPECT that there are many others of the rank and file like myself who have followed this correspondence and feel, like a man who is a bad guesser of riddles, that there is somewhere in the questions asked by Sir Archdall Reid a "catch," and cannot yet see it. Of course, he is too busy and earnest a worker in science to ask mere riddles, and many would be thankful for a concise statement of what has been gained so far. The leading biologists have held aloof lately, and the physiologists seem disinclined to answer the appeal made to them. Is this because Sir Archdall Reid has convinced both these groups, or because they are indifferent to the issues raised, or because they are waiting for them to be put explicitly and some proposals made?

Sir Archdall Reid is liberal enough to allow us to give up for the moment the familiar examples of a "head" and a "scar," and even the blacksmith's arm. The last of these is too imaginary a case to be of much use, for no one, so far as I know, has produced a series of, say, twenty generations of blacksmiths, male and female, and demonstrated the effect or non-effect of the special use of the blacksmith's muscles on those of his clerical descendant. I am sure he will allow me to bring forward a simpler and lowlier example which appears in a book written by me and reviewed in NATURE of June 2, p. 419. It is chosen from the mode of arrangement of the hair on the ventral surface of the domestic horse's neck, and I have contended that certain patterns found here are inherited and produced by the frequently repeated stimuli of friction in draught horses due to the collar. It may, I think, be granted:—

(1) That the domestic horse is descended from a wild form of the Equidæ, and it shares with the zebra, kiang, and onager a uniform slope of hair from the lower jaw to the chest.

(2) That numerous and varied patterns are found in place of this "normal" slope in a certain large number of horses to-day, and these are attributable to the friction of the moving collar through many generations. The inference here may be wrong or right, but this does not affect the bearing of the example on Sir Archdall Reid's questions to biologists as to what they mean when they speak of "acquired characters." It is legitimate, therefore, to speak of a horse in respect of this character as "normal" or "abnormal," the latter having patterns or reversed areas of hair, the former none. The normal horse

has thus inherited the uniform slope of hair which, I believe, is common to all mammals, but at some distant period of its evolution the abnormal horse began to assume the incipient variation because its ancestors were subject to friction from a collar *sufficient to produce it,* whereas the normal horse and its ancestors were not. We may surely to-day call these patterns "acquired characters," though their initial stages were too slight to be discovered. In such an inquiry as this, if we look away from the slight initial stages and concentrate attention only on fully formed "characters," we become bemused by this unfortunate term with all its implications. How does it help our view of the matter to call both the normal and abnormal slope "acquired" because the horse inherits the potentiality of responding thus to the stimuli of friction? If we must do so, we shall have to find some fresh term for the initial stages and changes of structure. Would Semon's conception embodied in the word "engram" not suit the case? On his hypothesis "engrams" are transmitted after the operation of a sufficient number of stimuli.

Will Sir Archdall Reid then tell us what he thinks of such initial variations as the one I have chosen, and what we should call them, if not "engrams"? These considerations are apart from the complications of inheritance introduced by bisexual reproduction and its shuffling effect on variations. WALTER KIDD.

2 Suffolk Square, Cheltenham, August 19.

The "Radiant" Spectrum.

THE title refers to an interesting optical effect observed and described many years ago by Sir David Brewster (*Phil. Mag.*, September, 1867), which appears, however, never to have been satisfactorily explained. When a small brilliant source of light is viewed through a prism held in front of the eye, a remarkable appearance is noticed, represented roughly in the accompanying diagram (Fig. 1). In the continuation of the spectrum of the source, but considerably beyond its violet end, is seen a patch of light consisting of

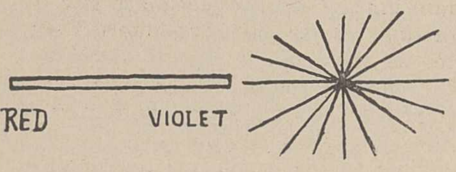


FIG. 1.

streamers radiating from a centre, as shown. A brief statement on the cause of this effect, as determined in an investigation made by me, may be of interest to readers of NATURE.

The phenomenon is due to the diffraction of light in its passage through the eye by the corneal corpuscles. Were there no prior dispersion of the light by the prism, the diffraction-halo would appear to consist of streamers surrounding the source and radiating from it directly. The effect of the dispersion on the diffraction-halo is to shift its achromatic centre towards the side of the shorter wave-lengths—in fact, to a point lying considerably beyond the violet of the spectrum of the source, exactly as observed. The streamers in the halo really consist of elongated diffraction-spectra, and the effect of the prism is to re-orient them, so that they now appear to diverge from the altered position of the achromatic centre. This explanation of Brewster's phenomenon is strikingly confirmed by the fact that very similar effects may be observed in the diffraction-halo due to a glass plate dusted with lycopodium, when held in front of the eye along with a 60° glass prism.

C. V. RAMAN.

22 Oxford Road, Putney, S.W.15.
August 12.

Remarkable July Rainfall at Blue Hill, Mass.

IN connection with the present abnormal season in North-Western Europe, it may be of interest to note that July, 1921, was not only the wettest July, but also the wettest month of any at Blue Hill since observations began thirty-six years ago. The co-ordinates of the observatory are $\phi=42° 12' 44''$ N., and $\lambda=71° 6' 53''$ W. Every effort has been made to preserve the integrity of the record. The total rainfall for July was 261 mm. (10·43 in.), the normal rainfall for that month being 99 mm. (3·92 in.). There were eleven rainy days, and one on which a trace of rain fell.

So far as frequency is concerned, it was a normal month.

It is difficult to characterise properly the rainfall of a summer month, owing to variability in the intensity of thunder showers. During the past month there were no remarkably heavy downpours such as distort monthly totals. Also there was on the last day of June a heavy rainfall which, if allowed for, easily makes the period one of maximum rainfall. By comparison with long-period records at New Bedford, 68 km. south (107 years), and Boston, 16 km. north (103 years), it is evident that the rainfall of July, 1921, is the heaviest in a century. With the exception of August, 1826, when at New Bedford 475 mm. was recorded, half of which, however, fell in 72 hours, the past month can be regarded as the wettest period in this section for more than a century.

Furthermore, this section of the North Atlantic coast is evidently in a period of maximum rainfall. At Blue Hill the data are as follows (in the upper row normal 35-year-period rainfalls; in lower rows the departures for 1920 and 1921):—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
35 years mm.	103	101	110	94	91	80	99
1920	−20	+88	+25	+69	+101	+139	−22
1921	−8	−1	−38	+36	+41	+30	+166

	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Year/12.
35 years mm.	100	104	99	96	98	1179	98
1920	+25	−28	−42	+76	+23	1621	135
1921	—	—	—	—	—	—	150 (?)

ALEXANDER MCADIE.

Harvard University, Blue Hill Observatory,
Readville, Mass., August 1.

The "Philosophical Magazine."

A LETTER which appears to have been widely circulated has reached me from the National Union of Scientific Workers virtually attacking the management of the *Philosophical Magazine*. Will you allow me, therefore, briefly to say that the referees mentioned on the title-page of that journal are frequently consulted, and that their services are not so nominal as the writers of the circular suppose?

I would add that, in my judgment, the *Philosophical Magazine* is well managed; that a conservative attitude towards old-established organs is wise; and that it is possible to over-organise things into lifelessness.

OLIVER LODGE.

The Present Position of the Wave Theory of Light.

By Dr. R. A. Houstoun.

I.

THE emission theory of light prevailed for a century after Newton's death. During this time his "Opticks" was regarded as of equal importance as his "Principia," and his emission theory as of equal value as his law of gravitation. Then, principally owing to the work of Fresnel, the emission theory was overthrown, and the wave theory established in its place. The latter in its turn has prevailed for a century, but now in certain quarters doubts are being expressed as to whether it is competent to explain the results of recent experimental work, and whether, after all, it may not be advisable to hark back to some form of emission theory, at least for certain fields of work.

There are two great differences between the situation now and as it existed a hundred years ago. Then the wave theory under Fresnel presented a clear and definite alternative to the emission theory of Newton, explaining certain decisive experiments in a simple and natural manner. The critics of the wave theory at present are not so much hostile as neutral towards it. They present no alternative to it; they admit its strong position and also admit the impossibility of Newton's emission theory in the light of the experimental work of to-day. But they direct attention to certain results which they have difficulty in reconciling with the wave theory, and hint at somehow combining the advantages of both theories.

Another difference between now and a hundred years ago is the manner in which we regard our theories. Then a theory was true or false; we were engaged in interpreting the processes of Nature which existed independently of us and outside of us, and it was necessary that the true solution should be true for all time. Nowadays we do not so much speak of the truth of a theory as of its utility, or rather the truth of a theory lies in its utility. Truth is what works. Consequently we require of a theory only that it should be true for our day and our generation. A theory works if it connects the facts together and enables us to predict new facts. We can never penetrate to the essential nature of things; we can only compare them with other things. Physical theories are metaphors. When we say that light is propagated in wave motion, we mean that it is propagated like wave motion. This change in the attitude of the physicist towards his theories had been pretty widely adopted before the results of the principle of relativity became known; the latter made the change of attitude known to the public.

The criticisms directed against the wave theory at present arise from two quarters, namely, the principle of relativity and the quantum phenomena.

The special theory of relativity requires that the mass of a system should vary with its internal energy, and that consequently radiation, including light waves, should have mass. In connection with this result a paper by Sir Joseph Thomson, entitled "Mass, Energy, and Radiation," which appeared in the *Philosophical Magazine* for June, 1920, is of the greatest interest and importance, not so much for its actual results as for the development it foreshadows. It is well known that the relativists operate with symbols and not with physical ideas; this paper is "an attempt to help those who like to supplement a purely analytical treatment of physical problems by one which enables them to visualise physical processes as the working of a model; who like, in short, to reason by means of images as well as by symbols."

The paper assumes that all mass, that of atoms as well as that of electrons, is distributed through space with a density determined by the electric field at the place where the mass is supposed to exist, and that energy of every kind, kinetic, potential, thermal, chemical, or radiant, is of one and the same type, being the kinetic energy possessed by the particles which are supposed to constitute mass. Transformation of energy is merely the flow of the mass particles from one place to another. Thus, for example, on this view, when a body gains kinetic energy, it is not because any of its mass particles are moving faster; it is because the mass of the body has been increased, and the increase in the mass implies a proportional increase in the energy.

We are not yet in a position to calculate the mass of any one of these mass particles, but at least 10^{11} are required to supply the mass of one electron. If energy is indivisible beyond a certain limit, the inverse square law of electrical attraction cannot hold over more than a certain finite distance.

The distribution of these particles and their movement from one place to another are determined by the distribution of the lines of electric force. In addition to mass particles it is assumed that there are in the universe lines of force spreading through space, the electron being at one end of a line of force and a unit of positive electricity at the other. The mass particles are concentrated in the places where the electric field is strongest. Thus, for example, if the radius of an electron is 10^{-13} cm., only one-thousandth part of its mass will be at a distance from the electron greater than 10^{-10} cm. The mass particles perform the functions of both æther and matter. Comparing the physical universe with a living organism, we may regard the mass particles as the flesh and the lines of force as the nervous system.

A light ray is consequently a jet of particles and lines of force moving sideways, the density of both varying periodically along the jet. Refraction is explained by the action of the secondary waves emitted by the electrons of the refracting medium under the stimulus of the incident wave.

The paper is noteworthy, because it points the way we shall have to travel if the new ideas are to be translated into everyday physics in all their original force. It also prompts the query whether it is worth while.

The special theory of relativity disturbed the generally accepted views about the æther by giving equal value to co-ordinate systems moving with uniform velocity with reference to one another. We had always thought of an æther at rest, through which the sun and the planets moved, and in which our ultimate system of co-ordinate axes was at rest. The most straightforward interpretation of the special theory of relativity is to give each planet, each moving electrical charge, its own æther, and at the same time to remove all substantiality from the very great number of æthers thus postulated. The plain man wants to know, if the light comes from the sun, in which æther it travels, the sun's æther or the earth's, and if there can be wave motion without a medium. This question of the æther has been discussed so fully, and there are so many different views, that it will be passed by here with the suggestion that possibly the special theory of relativity makes too great demands when it asserts that all moving systems have equal value. The system that the inhabitants of the earth are moving with possesses a special value for them and their physical theories, because they are moving with it. We only ask of Boyle's law, for example, that it should hold for the temperatures that we can produce in the laboratory, not for impossibly high temperatures that we can never attain. In the same way it is asking too much of the wave theory of light in the form we use it that it should be equally useful (and true) for us and the possible inhabitants of Mars. It is dangerous to attribute universal validity to theories which can be tested only in a limited class of cases. Consequently the æther moving with the earth is *the* æther. Again, with reference to the apparent unsubstantiality conferred on the æther by the principle of relativity, it is forgotten that it confers some unsubstantiality on everything else as well, even the water that water waves travel in.

The general theory of relativity required that light should be deflected on passing close to the sun's surface, and, as is well known, this deflection has been verified experimentally by the observations made by the 1919 solar eclipse expeditions. On the relativity theory the space in the sun's gravitational field is non-Euclidean, and the deflection is caused simply by the properties of space. The fact of the deflection is so much simpler than the explanation that it seems probable that the physicist will ignore the latter. One wonders if it is possible to treat the deflection geometrically in a simpler manner directly from the postulate of parallels. There has been an unsuccessful attempt to explain the deflection by an emanation of matter from the sun and a consequent increase of refractive index in its neighbourhood. Newton's emission theory gives a deflection of exactly half the required amount; so also does the electromagnetic theory, if we make the unusual assumption that ordinary mass is associated with the energy of the wave, and that this mass is acted on by gravity. At present there seems no satisfactory alternative to a non-Euclidean geometrical optics and wave theory, but it is probably better to wait and in the meantime to suspend judgment.

The existence of the quantum was discovered theoretically in Planck's celebrated theory of radiation. It will be advantageous to give an account of this theory here, because an important modification of it has strengthened the view that there is nothing in the quantum phenomena inconsistent with classical mechanics or electrodynamics. This modification came too late to be noticed in certain widely read descriptions of the theory published in this country, and it has consequently received little attention.

If a hollow vessel is maintained at a uniform temperature, and radiation allowed to issue from a small hole in its side, the intensity of the radiation and the spectral distribution of its energy are independent of the material of which the vessel is made. The rays are reflected forwards and backwards inside the vessel before they issue, and any initial difference in intensity is evened out by the successive reflection. In order to derive a theoretical value for the spectral distribution of the radiation issuing from such an enclosure at different temperatures—"black" radiation, as it is called—Planck assumed that there were in the enclosure a great number of oscillators or vibrators, small Hertzian doublets, all of the same frequency, and in a state of equilibrium, radiating and absorbing energy. The total energy of the system remained constant, but the energy of the different oscillators was not the same; there were always some gaining and some losing energy. Moreover, this exchange took place solely by scattered radiation; there was nothing in the nature of corpuscular radiation or characteristic radiation taking place. The distribution of the energy among the different oscillators occurs according to the laws of probability, and by using a general definition of temperature the temperature of the system can be derived from this distribution of energy. Then the density of the radiation in the enclosure can be calculated for the particular frequency in question. In order to obtain the correct value, namely:

$$E_\lambda = \frac{c_1}{\lambda^5} \frac{1}{e^{c_2/\lambda T} - 1},$$

it was necessary to assume that the emission of energy took place discontinuously in whole multiples of the quantum, the quantum being defined by $\epsilon = h\nu$, where ν is the frequency of the radiation and h a universal constant, Planck's constant. This emission of radiation in quanta was opposed to all previous ideas.

The criticism which the experimental physicist naturally passes on Planck's proof as outlined above, and as described in his "Vorlesungen über die Theorie der Wärmestrahlung" (second edition, 1913), is that in practice the energy changes do not take place by scattered radiation alone, but also by corpuscular radiation and characteristic or fluorescent radiation. It does not seem permissible to consider scattered radiation by itself. The genesis of radiation must involve the mutual play of both corpuscular radiation and waves. When X-rays fall on a body some of the incident energy reappears as scattered radiation, some as corpuscular radiation, and some as characteristic radiation. Consequently Planck's original oscillators formed an artificial body which has no counterpart in reality. He was, of course, aware of this, for on p. 133 he states that "it does not matter whether such a body exists anywhere in Nature, it is only necessary that its existence and properties should be compatible with the laws of electrodynamics and thermodynamics."

As a result of the difficulties associated with the form of the theory described in the book referred to above Planck made an important modification of his hypothesis ("Eine veränderte Formulierung der Quantenhypothese," *Preuss. Akad. Wiss. Berlin, Ber.* 34, pp. 918–23, 1914). This paper assumes that radiation and absorption take place continuously, and that the quantum action is not between the oscillators and the radiation, but takes place between the oscillators and the free particles (molecules, ions, and electrons), which exchange energy by impacts with the oscillators. The laws of classical electrodynamics then hold good for every interchange between the oscillators and free radiation. At the same time the radiating substance becomes more like its counterpart in Nature, and the feeling of artificiality which the former theory produced is removed. Also the difficulty connected with the use of Hertz's expression for calculating the density of the radiation disappears.

(*To be continued.*)

The Extent of the Recent Drought.

THE recent prolonged drought in the British Isles has directed attention to an interesting aspect of meteorological science. It is natural to inquire how far the drought has been confined to our immediate neighbourhood, or how far it has been general. With the exception of Hildebrandsson's pioneer work on action centres, no systematic research dealing with the extent to which drought has affected considerable areas of the earth's surface at one time has yet been carried out. A basis for detailed study of this character will be provided by the "Réseau Mondial," published by the Meteorological Office, five annual volumes of which have now been issued. This publication gives pressure, temperature, and rainfall for about 400 stations distributed over the globe, the month being taken as a unit. In the present article it is proposed to make a preliminary survey, so far as material is already available, of the world's weather this year, particularly during the months May, June, and July. As no system of telegraphic reporting from "Réseau Mondial" stations has yet been established, we have to rely in making such a survey on the most recent monthly, weekly, or daily weather reports obtainable from the various countries, and, largely, upon general newspaper reports.

Table I. shows the percentage of normal rainfall which has fallen in various parts of the British Isles since the beginning of the year:—

TABLE I.—*Percentage of Normal Rainfall.*

1921.	England and Wales.	Scotland.	Ireland.	British Isles.
January	146	168	119	145
February	15	39	51	34
March ...	101	170	129	133
April ...	59	61	46	56
May ...	79	108	90	91
June ...	17	40	24	26
July ...	Probably below 50	Rather above 100	Above 100	About 100

Table II. gives the percentage of normal rainfall for the various districts into which the British Isles are subdivided:—

TABLE II.—*Percentage of Normal Rainfall by Districts.*

	Scotland, North.	Scotland, East.	England, North-east.	England, East.	Midland Counties.	England, South-east.	Scotland, West.	England, North-west.	England, South-west.	Ireland, North.	Ireland, South.	English Channel.
January	164	162	144	107	128	118	165	174	123	132	99	95
February	64	26	16	26	15	21	37	14	9	38	60	15
March...	160	109	45	53	73	62	176	124	92	127	114	67
April ...	61	51	69	87	57	63	56	62	43	51	30	53
May ...	117	89	86	59	70	71	100	83	89	89	83	73
June ...	46	41	27	20	18	6	30	15	13	17	10	36
Average percentage February to June:—	90	63	49	49	47	45	80	60	49	64	59	49

It should be noted that Tables I. and II. are not based on identical stations.

Table I. shows that January was a month of excess rainfall in all regions. Previous to this we have to go back to July, 1920, to find another month with rainfall above normal for the whole British Isles, the percentages for August to December, 1920, varying between 68 and 96. It is evident from the table that the drought has been much more conspicuous in England and Wales than in Scotland and Ireland, where it has not been so remarkable. This is well shown in the map (Fig. 1), which has been prepared by the British Rainfall Organization. The area of greatest drought is the southern and eastern midlands, the amount of rainfall increasing outwards from this centre, particularly to the north and west. February, April, and June were the months of greatest deficiency. March, which appears to be normal (101 per cent.), was a month of drought in most places in the eastern and midland counties, but wet in the west and north-west.

The year 1887 was the driest one of the nineteenth century in the British Isles. The year 1893 was also very dry. A comparison of the mean values for twenty-five stations in England and Wales, during the months of drought, with the normal for 1881–1915 shows that the present year (February to July) has the least rainfall—49 per cent.—while 1887 (February to July) had 57 per cent., and 1893 (March to August) 65 per cent. If considered, however, from the point of view of frequency of absolute or partial drought periods at individual places, the present year was surpassed by both 1893 and 1911. Although we have had prolonged spells of hot weather, the maximum shade temperatures of 1911 have not been

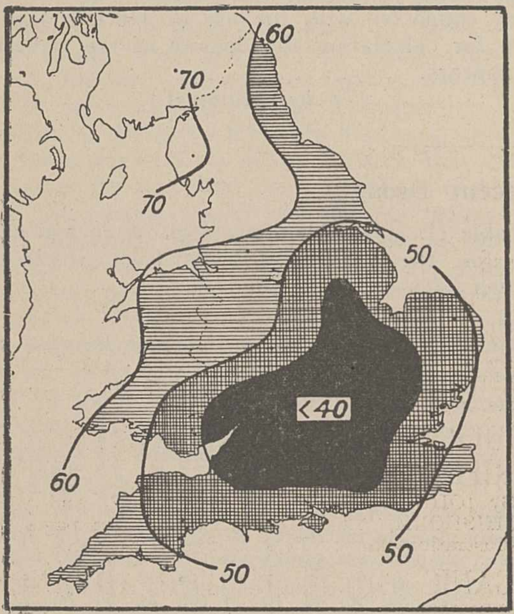


FIG. 1.—Rainfall, February-July, 1921. Per cent. of average, 1881–1915.

equalled. Woodland and moorland fires have been extensive and frequent, especially in Surrey.

In France the winter and spring were unusually mild and dry. Drought was severe in March and June, and persisted with only temporary breaks to the end of July. Paris rainfall, January 1 to July 15, was 104 mm., the normal being 236 mm. In Central and Southern France violent rainstorms occurred in July. Forest fires have been very numerous in Northern France and Belgium.

The winter was abnormally dry in Switzerland, with comparatively little snow. Early in January the Rhine and Rhone had shrunk to half their ordinary volume, and the general lack of water caused great restriction of electrical services. The winter is stated to be the driest for ninety years. Similar conditions were maintained throughout the spring, and June was so hot and dry that rivers were 6 ft. below normal, and the snow-line on the mountains receded more than 300 ft. On July 28 a shade temperature of more than 100° F., the highest since 1870, was recorded at Geneva.

In Norway, Denmark, and Germany forest and moorland fires were frequent in July after a spell of hot, dry weather. Central Europe generally does not, however, appear to have had the same degree of drought as North-western Europe. There was no rainfall deficiency in Germany in April to June, and temperatures, on the whole, were not unusually high, but drier conditions established themselves in July. In April Austrian temperatures were below normal, and rainfall, on the whole, above, in some cases two or three times the normal. In May, however, rainfall was deficient, and mean temperatures up to 7° F. above normal were experienced. Rainfall was also below normal at Budapest in April.

In Russia the drought has been very severe and prolonged, particularly in the south and south-east districts. Crops have consequently failed almost universally, so that a famine of unparalleled magnitude is threatened.

There is no information yet available from the bulk of the Asiatic continent. Winter snowfall in Baluchistan and the hills of the Punjab and North-west Frontier regions was the smallest for many years, but that in North-east Persia was normal. The monsoon broke rather late in India (June 22), but in spite of a lack of rainfall in the Bombay Presidency early in July, afterwards relieved by a week's rain, Indian rainfall has been quite satisfactory in general. Heavy rainfall, associated with a gale in the Mediterranean, caused a sudden rise of the Tigris in April; later on a period of intense heat set in in Irak and the Persian Gulf region. This is the hottest weather experienced since the British landing in 1914, and a shade temperature of 128·9° F. is stated to have been reached on July 16. If confirmed, this will constitute one of the highest shade temperatures ever recorded. Normal weather prevailed in Japan in April, but heavy rain and floods occurred in certain regions in June. Rainfall at Hong-Kong between January 1 and April 30 was 217 mm., the normal being 295 mm.; the temperature was not exceptional in April.

In Algeria, April and May were cloudy, with rainfall above the normal, and rather low temperature. The Nile was below its usual level up to June, and the Blue Nile was also low in May, owing to the lateness of the rainfall in the Abyssinian mountains. In June a rainfall unprecedented for the season occurred in Lower Egypt, a fall of 22 mm. being recorded at Ezbekia. During thirty-five years measurable rain has fallen only on one occasion in June, and it barely exceeded 1 mm. Apart from this, Egyptian temperature and rainfall were not remarkable during April to June, being somewhat above normal in some parts, and below it in others. At Dar-es-Salaam the total rainfall of April and May was 25 per cent. above normal.

There has been much hot weather in Canada, and rainfall, while by no means absent, has been deficient in many parts during the last three months. It is stated that there has been no such long period of intense hot weather in the history of the province of Ontario, and the same applies to the whole of Eastern Canada, where shade temperatures ranging from 95° F. to more than 100° F. have been reported. The heat has caused much interruption of work, and destructive forest fires have been numerous. The harvest will be an early one, but, on the whole, is nearly up to the average.

New York suffered from several hot spells in June and July, an unusual feature being the accompaniment of exceptionally high humidity, which intensified their effect. In the latter month the whole of the middle section of the country eastward of the Rockies experienced great heat. There does not seem to have been any general deficiency of rain. Further south the cotton-growing districts had an excess of rainfall in July, and the crop will be very poor unless fine, dry weather supervenes.

Little information is available from Central and South America, but British Honduras had rainfall and temperature below normal in April, rainfall above, and temperature below, normal in May, and drought at the beginning of June. Peru has been suffering from drought sufficient to reduce the maize crop to half its usual value.

In Southern and Western Australia temperature was above normal during last summer in that continent. A shade maximum of 108° F. was registered at Perth on January 21, the highest on record for that city, and at Adelaide on more than one occasion the thermometer was 2° higher. Sydney temperatures were, however, below the normal. There was a spell of dry weather in Victoria, South Australia, and New South Wales in April, but rain fell in May. Early in June there was heavy rain in many parts of Queensland and New South Wales, and in July heavy gales and rainstorms swept the country from Sydney northward to Queensland, and were followed by disastrous floods in the coastal rivers. Later the weather in New South Wales and Victoria was the coldest experienced for a quarter of a century, and snow fell in districts where it has never been seen before. South Australia, up to June at any rate, had experienced a dry and unusually mild winter.

The open winter in the Arctic regions has caused an abnormal number of icebergs to be scattered over a large area of the North Atlantic Ocean, and conditions are worse for ships than they have been for many years.

To summarise, so far as information goes at present, the drought has been mainly European, chiefly in North-west Europe and Russia. Canada has had extremely hot weather, but without a serious deficiency of rain. The season in Australia has been abnormal, and there are indications of abnormal conditions in other widely separated regions, notably Irak and Peru. The only region of special excess of rain in the northern hemisphere appears to have been the Southern United States.

The Disaster to the Airship R38.

THE suddenness of the catastrophe and the terrible death roll have directed the attention of the whole world to some aspects of airship construction. With the airship Britain and America have lost many valuable lives and a great amount of personal knowledge irreplaceable at short notice. A tribute to the bravery of the crew can be given with all sincerity, for some at least were aware of the fact that the airship was a great experiment, and on some important points designed without sufficiently exact knowledge of the conditions to be met. Not that anyone anticipated a collapse so complete and immediate as that which occurred, when the first warning was too late to enable experienced members of the crew to use the parachutes provided.

There have been less severe accidents to British airships in the past, but the cumulative effect had been to give some confidence in their ability to take appreciable damage without total failure. By taking the simple precaution of flying into the wind on the outward part of a trial flight, an airship when partly disabled has hitherto been able to return to its base quickly and safely. No parallel to the estimate of five seconds from first warning to fracture of the hull appears to exist.

It is too early to draw final deductions from the accident, for the evidence is incomplete, and the consequential failures are certain to mask, if not wholly to hide, the source of initial weakness. It may be gathered from the reported statements of eye-witnesses on the ground and survivors from the airship that the most probable element of failure was some weak member of the hull structure. The explosion, whether of petrol vapour and air or escaped hydrogen and air, followed the failure of girders amidships. It has been suggested that the breaking stress might have been imposed by a rapid application of the rudder in an endeavour to produce the equivalent of a gust of wind from the side. Whether this be true or not, it is probable that no one was able to estimate the forces which would result from the manœuvre. Airship design as known to us has been a matter of experience and guessing, and not of calculation founded on scientific knowledge. Policy, first dictated by the Admiralty and more recently by the Air Ministry, has never given any effective opportunity for the accumulation of the scientific knowledge on which alone rapid advance in construction could safely proceed.

In the early days of rigid airships the breaking of naval airship No. 1 at Barrow was followed by a cessation of activity by the Admiralty, and not until the early months of the war was airship construction entered upon with vigour. Having neither knowledge nor experience of our own, Britain was reduced to copying, as faithfully as possible, such German designs as we were able to capture. That lack of knowledge, and not a concession to essential utility, accounts for the present calamity may be inferred from the fact that the weight of the girders and gas fabric was much less than one-half of the gross weight of the ship, and that a modification of the proportions of total weight could have been made for the purpose of strengthening the girders had the necessity been foreseen.

The Air Ministry has assumed a great responsibility by its failure, during the last two years, to provide adequate facilities for fundamental research on airships. Now, for the second time, airship development is to be abandoned, and no further research is to be undertaken. This can be justified only if airships are always to be useless, a decision which may reasonably be questioned. Whatever may be the future of the airship, it appears to be true that the British authorities have never allowed it an opportunity of justifying itself, and the loss of R38 is not improbably due to lack of a fair field for the designer rather than to insuperable defects of the system of construction.

Fuel Problems and Prospects.

By PROF. JOHN W. COBB

THE "James Forrest" lecture which was delivered before the Institution of Gas Engineers by Sir George Beilby on June 28 was given the title "Fuel Problems of the Future," and is one of the most comprehensive and interesting surveys of that subject which the present writer has had the pleasure of reading. Commencing with the proposition that "civilisation on its physical side is based on fuel," the lecturer proceeded to show what he meant by some picturesque and relevant illustrations, beginning with "the kindling of the first fire of dried leaves and branches by our prehistoric ancestors," which established "a new dividing line between man and the lower animals by mitigating the horrors and dangers of the darkness of night, and arousing social instincts."

The more prosaic subject of the price of coal, however, soon found its inevitable place in the lecture, and it was indicated how every one of us is being penalised not only by the dearness of the coal supplied, but also by its inferior quality, arising from the unwarrantable and unnecessary introduction of useless stones and shale. This brought on a reference to the new Gas Act, with its new principle of paying for "therms," but not for inert material, and an extension of the principle involved to coal itself was suggested.

If the gas undertaking is in future to be paid only for the therms delivered to the consumer, it is entitled to throw at least a portion of the responsibility on the coalowners and miners by paying only for the potential therms received in the coal, and not for the inert and inferior materials, which are not only valueless and detrimental to economical working in the retort-house, but lower the value of the coke produced.

Coal is, of course, the dominating fuel in these islands, and Sir George Beilby's survey does not leave that in doubt; but the fuel position of the world as it is disclosed by the most recent figures of production for all kinds of fuel is subjected to comprehensive review. If an authoritative pronouncement were made that a new fuel was available in these islands which could compete effectively with coal, or was likely to be able to do so in the near future, it would arouse a natural enthusiasm, but, so far as this country is concerned, no comfort of that kind can be derived from dispassionate consideration of the facts of the case. The very interesting point is brought out, however, that Germany is facing, and indeed has already faced, the fuel problem of the immediate future, so far as she herself is concerned, by an extensive development of the lignite industry.

The glowing accounts of this development which have appeared in the technical Press during the past two years may have struck us as exaggerated, but the solid fact remains that the output of lignite in Germany last year was 111,000,000 tons.

This brown coal, though it contains from 40 to 50 per cent. of water, is to-day by far the cheapest source of thermal units. The deposits are often of great thickness, which can be worked open-cast and excavated by machinery with relatively little manual labour and light capital charges. Victoria (Australia) is also developing extensive deposits of brown coal, which are known to exist in Central Gippsland, and Canada is experimenting on the briquetting and carbonisation of the brown coals of Manitoba and Saskatchewan.

The other great source of fuel is oil, of which "the world's output for 1920 is estimated at about 97 million tons, of which

	Per cent.
The United States produced	64·8
Mexico produced	23·3
Russia produced	3·5
Dutch East Indies produced	2·5
India produced	1·2
Rumania produced	1·1
Persia produced	1·0
Countries producing less than 0·5 per cent. produced	2·6
Total	100·0

The amount seems large, but is only some 7 per cent. of the fuel output of the world reckoned in tons, or 10 per cent. in potential therms. Sir George Beilby discussed the possible exhaustion of these resources in view of the rapid development in the use of motor spirit for motor transport and of fuel oil for transport by sea. He pointed out that it is only the rapid development of production in Mexico and the extensive interests of the United States in this production which have prevented the actual danger of shortage in America from becoming acute, and gave a long extract from a statement by Mr. J. O. Lewis, chief petroleum technologist to the United States Bureau of Mines, defining the position in that country. The conclusion of this authority is that America is quite rightly concerned over the domestic supplies of petroleum from oil wells, but, on the other hand, there are known deposits of oil shales which, in three States alone, promise to yield many times more oil than will ever be recovered from the oil wells of the United States, and that there is no concern as to the ultimate supply. He also believes it probable that eventually alcohol could meet the American needs should gasoline fail.

This brought Sir George Beilby to the consideration of alcohol, and to the inquiries of Mr. Walter Long's Committee, and of the Fuel Research Board with Sir Frederick Nathan as Power Alcohol Investigation Officer. With alcohol one difficulty is that the most suitable raw materials for its manufacture are as a rule also important foodstuffs, but experiments in Burma appear to indicate that the joint production of alcohol and paper from waste rice straw should be commercially possible, and research work for developing the use of cellulosic materials in alcohol production is reported as in hand. Sir George Beilby appears to think that the commercial production of alcohol on these or similar lines for local consumption will soon be established in various parts of the Empire, but that there is no immediate prospect of alcohol counting for very much as an imported fuel for use in this country.

An interesting account was given of what has been done in the winning and utilisation of peat, but a fundamental difficulty was stated in the following sentence:—

> When it is realised that the peat deposit in a good bog 20 ft. deep is only the equivalent of a 12- or 14-in. seam of coal, it will be evident that even an output of 1000 tons a day of air-dried peat involves the laying-out and development of an enormous surface.

Prof. Pierce Purcell has been acting as Peat Investigation Officer of the Fuel Research Board, and 100 tons of air-dried Irish peat have been tried for boiler-firing and carbonisation, with quite encouraging results. But it will be understood that although the lecturer passed in review various fuels which had interest and value, he did not allow it to be forgotten that "coal is likely to remain the chief source of fuel, not only for Great Britain, but for the world at large, and that the problems of its winning, preparation, and use still occupy the foreground in all serious consideration of the subject." He declared that "the greatest of the fuel problems of the future was to decide what proportion of the total coal consumed it will pay to subject to a preliminary operation of carbonisation or gasification, with the object of sorting out the potential thermal units of the coal into groups of higher availability or greater convenience as fuels, *e.g.* gas, motor spirit, fuel-oils, and coke." He pointed out once more that "though the operations of carbonisation and gasification involve the expenditure of some heat, the loss may be more than compensated for by the increased value of the new fuels."

Sir George Beilby has been interested for many years in low-temperature carbonisation and its possibilities—in the production of a solid, smokeless fuel for domestic purposes by the carbonisation of selected coals at 550° to 600° C. The matter is being taken in hand by the Fuel Research Board at its experimental station, and data have been acquired as to the yields and quality of the gas, oils, and coke produced under definite conditions; but, as the lecturer clearly indicated, the problem has two distinct sides, the technical and the economic, and it is very difficult to determine with any certainty the resultant of the commercial forces at work, which change their value in such a disconcerting way. Hence this cautiously worded summary of the position:—"My own belief is that low-temperature carbonisation can only be established on a sound commercial basis with low operating costs and a very moderate margin of profit." It is, however, to be hoped that the technical results obtained by the Fuel Research Board in its experiments, which should have a permanent value, and can be connected up with other factors in considering the commercial position of any such process, will be published as soon as they are available. Information on this subject from an unbiassed and competent authority is wanted, and may serve to correct the extremes of laudation and condemnation to which we have become accustomed.

Considering how large are the quantities of coal used for steam-raising, Sir George Beilby rightly directed attention to the possibility of a large saving in fuel without any considerable capital expenditure which might be effected if steam plants were kept in order and their working properly supervised. Such supervision should begin, of course, with the coal itself, so soon as it becomes possible to exercise any reasonable degree of choice in that matter. The work of Mr. Brownlie, who has undertaken quite an extensive survey of steam-raising plants in some of our principal industries, has been very useful in this connection. As the lecturer pointed out, even if a moderate increase in efficiency of 10 per cent. were effected in the steam-raising plants of the country, it would result in a minimum saving of $7\frac{1}{2}$ million tons per annum. Mr. Brownlie's own experience leads him to take a much higher saving as a possibility.

The last part of the lecture was given up to a description of the new position of the gas industry since the passing of the Gas Regulation Act of 1920, which instituted the charging for gas by the therm and removed many useless restrictions. The new Act, which was based upon recommendations by the Fuel Research Board, will, in effect, not only make it possible to obtain and distribute as gas a portion of the volatile matter of the coal, but also permit much more extensive gasification of the fixed carbon. This should open out quite a new field of efficiency and economy. The lecturer referred in particular to one modern development in the gas industry on these lines which has been investigated with considerable thoroughness during the last three years. The process of increasing the yield of gas by passing a current of steam through continuous vertical gas retorts while carbonisation is being effected was investigated by a joint committee of the Institution of Gas Engineers and the University of Leeds, and the results were presented to the Institution of Gas Engineers at its annual meeting in 1920. These results, including chemical and thermal balances obtained with different quantities of steam, were obtained from one Scottish coal, but similar work extended to English coals and carried out later at the experimental station of the Fuel Research Board has added to our knowledge. "We can now say with confidence that there is not only a very substantial gain in therms in the form of gas, but also in the yields of tar and ammonia," when the steaming process is employed.

Sir George Beilby concluded his lecture by a brief summary and a reference to the present spirit of unrest, which complicates fuel and all other problems into which the human element enters :—

This spirit, as it is manifesting itself to-day, is fatal to the progress of reconstruction and development on any extensive scale, and we, whose chief interest in life lies in the control and use of the power and resources of Nature for the service of man, can only continue to do the work next our hand, while we cherish the hope that the better side of human nature, which we know is only temporarily overshadowed, will gradually reassert itself.

The "Proletarisation of Science" in Russia.

By DR. BORIS SOKOLOFF (formerly Lecturer, Petrograd University).

"Science? What is science? It is only a tool in the hands of clever politicians."—From report of a public discussion on science held in the Petrograd Palace of Labour, September, 1920.

SCIENCE in Russia is now passing through difficult times. The experiments being carried out by the Bolshevists in Russia are opposed to it—how could it be otherwise? Everything—art, education, poetry—have been "proletarised"; why not science? During the whole of the year 1920 a campaign was being carried on against "bourgeois science." In the Press and at special meetings complaints were made of the reactionary tendencies of professors, of their strange indifference to politics, of the necessity of turning scientific men into advocates of the Soviet system. By the phrase the "proletarisation of science" the Bolshevists seem to understand a reorganisation of the methods of scientific investigation, the broadening of its basis, and its practical application. But the real idea at the back of their minds is to make science serve the ends of Bolshevism. This view was expressed as follows by Communist speakers at the Petrograd Students' Conference :—

Comrade Lounatcharsky is quite right in saying that science is now in the hands of mandarins of bourgeois origin. We must appropriate science; we must make it proletarian. In the place of professors and scientific men imbued with political indifference and *bourgeois* ideals we must put real proletarians, learned men who will be able to create a science which will be obedient to us.

Such is the theory. The "proletarisation of science" in this sense is a matter of the independent reconstruction of scientific methods. But, in practice, the "proletarisation of science" is quite a different thing.

Science is the crown of the human intellect; it is the sun which man has created from his own flesh and blood. It is necessary to realise that the work of a man of science is the property of humanity as a whole. Science inhabits the domain of the highest altruism. Scientific workers must be considered as the most valuable of men, the most productive element of society. The premature death of a man of science means a great loss to the country; this must be fully understood by the workers' Government.

Look at the death-roll of scientific men within the last few months, and you will see how great is the loss of scientific energy in our country. If this process of extinction of learned men continues at the same rate, Russia will be deprived of her brains. Free science is indifferent to politics. (Petrograd journal, *Science and its Workers*, No. 1: article on "What is Science?")

So writes Maxim Gorky, a supporter and faithful adherent of the Soviet Government. He writes, he tries to convince—whom? Not, of course, the Russian *intelligentsia*, who know the state of affairs better than Gorky himself. Gorky's appeal is evidently addressed to Bolshevists, to the Soviet Government. However, they can neither understand nor appreciate the appeal. Being men of simplified views—doctrinaires and politicians—they cannot accept the fact that science must be independent of everybody and everything. They think it quite right and advisable to make scientific men "obedient" executors of the commands of the Soviet Government.

During the last three years the "Palace of Science" registered the names of 420 Russian professors and scientific men who died from starvation. These are not occasional sad events; they constitute something regular, systematic. Letters which I have received from my friends and colleagues—Russian scholars—give a vivid picture of life under Bolshevism. For obvious reasons I cannot give the names of my correspondents.

"These two and a half years," writes Prof. X, "have been a continuous nightmare. The Bolshevists declare us to be parasites and drones, and we have been deprived even of the scanty ration allowed to workmen and soldiers. Those of us—and not many were so lucky—who had any spare garments or possessions sold them in order to buy food. Those who had nothing sold their books, and that was the most terrible. . . ."

A professor of philosophy writes:—

It is easier for me than for others to understand Bolshevism. In it is something wild, something of the Russian recklessness. The experiments of the Bolshevists remind me of the Eastern mountain tribes; in the life of such tribes blood-revenge is closely connected with primitive communism. I am rather interested in the Bolshevists, impartially, as a philosopher should be. I do not mind the water freezing in my room, that instead of bread and meat I eat raw oats, or that one can write and create in Soviet Russia only during the summer months. But there is one thing which makes me despise the Soviet Government, and that is their endless lying.

"No, I and the Bolshevists cannot understand each other," writes the Moscow Prof. W. "I, an old man, who can scarcely walk, whose feet, on account of the cold winter, are sore and swollen, am kept in solitary confinement. May God forgive them; they have their own convictions; I am not angry with them, but why do they try to frighten me by stupid examinations? Yesterday I was again taken to be examined. . . . They cannot understand that one can be devoted to science without caring for politics; no, they cannot understand that."

Not until 1920, after many eminent Russian men of science had perished, did the Bolshevists establish a so-called "science-ration." But even this ration was repeatedly reduced and sometimes entirely stopped.

What is the attitude of scientific men towards the Bolshevists? This is a very complicated question. If we put aside the personal grievances which everyone now has owing to the grave economic situation, and consider the question from its logical side, we shall see how complicated it is. For example, there is Prof. Gredeskul, who urges the *intelligentsia* to join the Communist party; there is Prof. Behtereff, who declares that all Russian men of science now abroad should return to Russia; there is Prof. Pavloff, the declared anti-Bolshevist. As a general rule, learned men are not Communists; only a few of them have joined the party: Pokrovsky, the late Prof. Timiriazeff, Gredeskul. I am unable to find any other scientific men who would say "we Communists." A few Communists may be found amongst the young laboratory and lecture-room assistants, but all of them are quite unknown to the outside world; they have no scientific or public standing. The main body of Russian learned men is openly opposed to the Bolshevists—of course, among them are various shades of opinion, very interesting and characteristic.

Another group of savants, among them many prominent men, hold the view that they must defend the interests of pure science.

As Russian citizens, when we are outside our laboratories and universities, we say: "Down with the Bolshevists!" They have brought only damage and shame to Russia, and can bring nothing else. But as scientific workers we have another grievance. Russian science, that part of culture which belongs to the whole of humanity, must be saved from annihilation. We, the servants of science, must do all in our power to preserve her in Russia, to save the lives of Russian men of science, to reawaken her creative power in our country. We must, for the sake of science, make concessions to the Bolshevists; they appoint their commissaries to our laboratories and institutions—we must not object to this measure; they put us under a military *régime*—we must accept even this. We believe, we know, that Bolshevism will soon pass; meanwhile, we will do our best to preserve the eternal human culture. We believe that scientific work is quite possible under Bolshevism, in spite of the Bolshevists.

They did believe in this, but now their belief is waning, though they are still ready to accept any kind of compromise in order to preserve science and scientific institutions. To this group belong the academicians Oldenburg, Fiersman, Behtereff, Prof. Tarasevitch, Lasareff, Rojdestvensky, and many others.

Then there is the last group of Russian men of science, which embarrasses the other Russian scientific workers. These say:—

We are far removed from politics. We do not believe in the Bolshevists; we do not consider them to be either idealists or revolutionaries; we consider them as men who seized the State power by main force and now are willing to govern the country by force. They suppress every movement towards freedom; they cannot endure any independence apart from themselves, because they are afraid that the freedom and independence of the people will ruin Bolshevism. We do not believe in the Bolshevists. We were witnesses of the appeal of Lenin to the intellectuals when he asked them to collaborate with the Bolshevists. That was a year ago. But what did Lenin mean by "collaboration"? To be his lackeys? To carry out his orders? We were witnesses that this same Lenin, who in April asked the intellectuals to collaborate, in May shot many hundreds, and even thousands, of educated people. Why?

No, we do not believe in the Bolshevists.

Such is the theory and the practice of the "proletarisation of science": in theory—the peaceful reorganisation of science; in practice—its destruction, its exploitation for political purposes.

At this stage of Russian life two principles are struggling in the most fateful way: one, which unites synthesis and analysis, which seeks the truth of to-morrow, which has nothing to do with politics and political parties; the other, which is entirely subjective, full of personal ambitions and views, which is devoid of analytic conceptions, and is born of the evils of to-day.

Science is struggling with politics for its freedom; politics is struggling with science for its triumph. It is a struggle which, alas! human history has witnessed many times, but which has always ended in victory for science. It did seem that this useless struggle would not have to repeat itself again; yet now the fierce combat is going on in Russia; the old times of the Middle Ages have once more returned on the earth. The Bolshevists are repeating in many ways the long-forgotten past, though they themselves are convinced that for the first time they are propagating a new creed.

Physical Effects Possibly Produced by Vision observed by Dr. Russ.

By Dr. H. Hartridge.

THE rise and fall of scientific theories forms a topic for study almost as interesting as does the supersedence in history of one dynasty by another. Newton's corpuscular theory of light was displaced by the wave theory in much the same way as the teaching of Aristotle supplanted the older view of Plato—that in vision emanations proceed forth from the eye to strike the objects looked at. But just as modern physical research has revived certain aspects of the corpuscular theory, so the researches of Dr. C. Russ ("An Instrument which is Set in Motion by Vision or by Proximity of the Human Body," *Lancet*, July 30, p. 222) have recalled to memory the views of Plato. For these researches have shown that certain instruments react when the human eye is directed at them.

One instrument used by Dr. Russ consisted of a solenoid suspended by a single fibre of unspun silk within a case composed partly of glass and partly of metal, in such a way that the contents were shielded from air-currents. Above the solenoid was mounted a small permanent magnet, so that the suspended solenoid set itself in a constant meridian under the earth's magnetic field. In another instrument the solenoid was replaced by a condenser, oppositely charged metal plates being mounted outside the instrument-case. With both instruments it was shown that a rotation of the suspended system occurred when the gaze was suitably directed through a slot in the outside casing. As to the precise details of the rotation, the description is not very clear, but it seems that when the gaze was directed to the centre of the suspended system no rotation occurred; when, however, the gaze was directed on either side of the system, then that side rotated away from the eyes some 10 to 45 degrees, and then again came to rest. If the gaze continued to act, the deflection remained unaltered; but if the eyes were then closed, the index returned to zero.

In earlier experiments the rotation of the instrument was directly observed by the human eye; later, however, the instruments were fitted with concave mirrors similar to those applied to reflecting galvanometers, so that the rotation could be measured in the ordinary way by the movement of a spot of light on a scale. Besides demonstrating that rotation of the instruments occurred under the action of the gaze, Dr. Russ also found somewhat similar effects if the fingers were held near the instrument.

Nothing definite is known at present as to the explanation of these effects, but Dr. Russ made the following preliminary alternative suggestions:—

1. That the effects are due to changes of temperature.

2. That they are due to the electrical changes which accompany vision and muscular action.

3. That electrostatic forces are responsible for them.

4. That the eye may emit electromagnetic waves (*e.g.* visual, infra-red, ultra-violet, and X-rays).

With regard to the above suggestions, it may be said that temperature changes are not likely to be the cause, for hot objects placed in suitable positions near the instruments produced either no effects, or effects very much smaller than those producible by eye or hand. Electric changes produced in muscle or in eye can, I think, be safely ruled out, because of their smallness and because of the closed circuits which the connective tissues, skin, etc., form over them. To demonstrate or to measure these currents, the retinæ or muscles must themselves be connected to the leads of the galvanometer. Dr. Russ apparently ruled out the possibility of electrostatic changes being responsible, by finding that the directing of the gaze through a fine metal grid connected to earth (which would screen off electrostatic charges) did not prevent the instruments from reacting to the gaze as usual.

Lastly, in favour of the effect being an optical one (I intend X-rays to be included) are the following facts found by Dr. Russ:—

1. That interposing a column of water between the eye and the instrument reduced the effects.

2. That the effects are very much smaller, or

are quite absent, in the dark. (Dr. Russ's words are: "I did four tests which seemed to give a positive effect.")

3. That if a strong beam of light be allowed to fall on the suspended system of the instruments the gaze has no longer any effect.

There are no grounds on which a definite conclusion can be based, but I think the inference is that the effect is an optical one.

Measurements should therefore be made to see what electromagnetic rays are responsible for the effects. (1) Are they stopped by a thick slab of lead glass? If they are, they are probably X-rays. (2) Are they stopped by æsculin or by β naphthol disulphonic acid? If they are, they are probably ultra-violet rays. (3) Are they stopped by strong methyl-violet? If so, visual rays may be responsible. (4) Are they stopped by a saturated solution of ferrous sulphate in water? If so, then they may be infra-red rays.

In the next place tests should be applied to see if the rays obey the ordinary laws of (*a*) reflection, (*b*) refraction, (*c*) polarisation, (*d*) inverse squares. In fact, everything should be done to correlate Dr. Russ's observations with known physical laws, before metaphysical explanations are even thought of. Since writing the above I have seen a letter in the *Lancet* of August 6 in which Dr. J. D. Suttie points out that another conclusion can be drawn from Dr. Russ's experiments. For example, in the experiment in which he found that the side of the solenoid looked at rotated away from him, what Dr. Russ was really doing was to place the fixation point of his fovea co-ordinate with the side looked at. But Dr. Suttie observes that all other parts of the solenoid would be equally co-ordinate with some other part of the retina, and that if all parts of the retina were equally active there is no reason why any movement should take place, since the forces on the two sides would balance. Therefore he argues that the effects obtained by Dr. Russ drive us to the conclusion that the fovea is very superior to the rest of the retina in the degree of its activity [If it were very inferior, the same explanation would equally hold good.—H. H.], and holds further that the force ("if there be such") "is refracted by the optical media of the eye in a manner similar to light."

Dr. Suttie then goes on to suggest that "the deviation [refraction by optical media?] of the force would supply a valuable clue as to its nature, and that obvious controls would be to test persons whose retinas are inactive through disease, or who suffer from opacity of the eye media (*e.g.* cataracts)." With these points of Dr. Suttie's letter I entirely concur.

In his reply to Dr. Suttie's letter Dr. Russ (*Lancet*, August 13) writes: "His [Dr. Suttie's] reference to cataracts as controls is surely a feeble suggestion." To me, at all events, it seems clear that Dr. Russ has entirely missed the point of Dr. Suttie's suggestion, viz. that tests on an eye with a cataract would decide whether the effects found by Dr. Russ are due to forces originating from eye structures lying in front of or behind the crystalline lens. Surely not a "feeble" suggestion at all, but a very valuable one! It seems to me that it is not in regard to this suggestion alone that Dr. Russ has misunderstood Dr. Suttie.

Obituary.

Prof. G. T. Ladd.

Dr. George Trumbull Ladd, who died at New Haven, Connecticut, on August 8, was born at Painesville, Lake County, Ohio, in 1842. In 1879 he became professor of philosophy at Bowdoin College, and two years afterwards, in 1881, was appointed to the chair of philosophy at Yale. Later he was elected Clark professor of metaphysics and moral philosophy at the same university, a position which he occupied until 1905, when, on his retirement, he received the title of emeritus professor. As a lecturer Prof. Ladd was well known in other countries besides America. Three times—in 1892, 1899, and 1907—he gave courses of lectures in Japan, and in 1899 and 1900 he visited India, lecturing in philosophy at the University of Bombay, and in the philosophy of religion at Calcutta and elsewhere. He was in England in 1911, and was present at the first of M. Bergson's lectures on the nature of the soul at University College, London, in the October of that year. His writings are numerous, and many of them voluminous. Certain of his books have been widely used in the universities of the United States and of this country.

So far back as 1887 Prof. Ladd published his "Elements of Physiological Psychology," which was based, to a large extent, upon the second edition of Wundt's "Grundzüge," but had distinct merits of its own as an independent compendium and discussion of the psychophysical material then available. A revised edition appeared in 1911. A more important and original work of his is that which saw the light in 1894, "Psychology, Descriptive and Explanatory"—as was said of it at the time: "Literally a weighty production, it turns the scale at three pounds avoirdupois."

Prof. James Ward's Encyclopædia article had appeared nine years before, yet Prof. Ladd's volume, in certain respects, broke new ground, to which, however, Prof. Ward's article had obviously prepared the way. In particular, the divisions of the book involved the complete abandonment of the old and vicious doctrine of "faculties," and in it the conception was consistently adopted that the formation and development of a so-called faculty were themselves precisely the things which scientific psychology had to explain. Doubtless the author was inclined to lay too much stress on the view that the different "faculties" all resulted from the combination of the same elementary processes, and that each differed from the others by emphasising, so to speak, one principal kind of these processes, whereas the more fruitful procedure has been that of seeking to exhibit such "faculties" rather as differentiations of one common process. Nevertheless, his treatment of the growth and development of mental life, and especially of the higher forms of cognition, is illuminating and suggestive. In regard to feeling, he argues, but scarcely in a convincing way, against the view that pleasure and pain stand out as the only distinguishable qualitative differences characterising the primary experience we designate feeling.

In 1895 Prof. Ladd published a work entitled "Philosophy of Mind: An Essay in the Metaphysics of Psychology," in which were handled the problems which psychological science passes on to philosophy for a more thorough examination—problems started, for the most part, by that mode of human experience which is described as the consciousness of self. He maintained that a mind is a real being which is known as a self-active subject of states and as standing in manifold relations to other beings. The theory of psychophysical parallelism is vigorously criticised by him, and the theory of interaction defended.

In the volume of *Mind* for 1892 Prof. Ladd gave an interesting account of some researches of his concerning the influence of the *Eigenlicht* of the retina upon visual dreams—a subject that deserves more attention than it has hitherto received. He was one of the first to introduce the study of experimental psychology into America, and the Yale psychological laboratory was founded by him.

As a philosophical thinker Prof. Ladd was greatly influenced by Lotze, whose "Dictate" he translated into English. Perhaps his most distinctively metaphysical work is that entitled "A Theory of Reality," published in 1899. It presents a continuation of the line of thought he had pursued in an earlier book called "Philosophy of Knowledge," published in 1897, in which he had found that the categories of the understanding are forms of reality as well as of truth; that the knower has, in individual self-knowledge, an intuitive insight into reality; and that other real existents are known by analogy of the self. In the metaphysical treatise he tries to show that the universe consists of real beings of various grades, each grade being distinguished by the amount of self-hood possessed by its members. What we name "things" are, in truth, imperfect and inferior selves. Neither "things" nor self-conscious lives are mere manifestations of an absolute mind, for all have self-activity and relative independence, yet they exist together as a unitary system which is related to the absolute mind as object to subject. The activities of finite entities are, in fact, twofold; they are at once acts of the finite entity and acts of the absolute being which is their ground. In this last contention, it is true, he cuts rather than unties the Gordian knot; the conclusion is one which human thought throughout the ages has been striving to reach, but has never succeeded in rendering logically tenable.

Two other books of extensive scope followed—the "Philosophy of Conduct" in 1902 and the "Philosophy of Religion" (two volumes) in 1905. The latter is an exhaustive treatment of the subject from both the historical and the speculative points of view, and has scarcely received the consideration that is its due. Prof. Ladd's literary activity was maintained to the end. In the last few years there emanated from his pen a series of popular manuals bearing the titles "What can I know?", "What ought I to do?", "What should I believe?", "What may I hope?", and "The Secret of Personality," all of them thoughtful and replete with the wisdom of experience.

G. DAWES HICKS.

THE death is announced, in *Science* of August 12, of MR. LOUIS ALBERT FISCHER, physicist and chief of the Division of Weights and Measures of the United States Bureau of Standards. Mr. Fischer died on July 25 last at the early age of fifty-seven years, only a few weeks after his distinguished colleague, Dr. E. B. Rosa. Early in life he joined the old Weights and Measures Office of the U.S. Coast and Geodetic Survey, and during his eleven years' service with the survey he carried out numerous tests for the standardisation of weights and measures, particularly of the length standards. This work led to the formation in 1901 of the National Bureau of Standards, in which Mr. Fischer took an important part. He was immediately appointed chief of the Division of Weights and Measures, and continued to hold the post until his death. During this time he conducted numerous investigations of scientific and technical value, which covered such subjects as the standardisation of chemical glassware, screw-threads and gauges, the thermal properties of various metals and alloys, the densities of water-alcohol solutions, the testing of watches and clinical thermometers, model laws for State weights and measures services, etc.

In 1905 Mr. Fischer organised the annual Conference of Weights and Measures of the United States, and afterwards acted as secretary to the organisation, which consists of national, State, and other officials interested in the promotion of uniform legislation regarding weights and measures. Mr. Fischer was regarded as the leading spirit of the last decade in America in all matters concerning weights and measures, yet in spite of the immense amount of administrative and technical work he accomplished, he also contrived to find time to carry out researches which have earned for him a reputation as one of America's leading metrologists.

Notes.

Friends of the late Sir Norman Lockyer will be glad to know that 100*l.* has already been received for the portrait medallion which is to be placed at the observatory on Salcombe Regis Hill, but a further sum of 100*l.* is still required to complete the memorial. It is hoped that the medallion will be unveiled in the autumn, and donors will be notified of the date. Contributions should be sent to the hon. secretary of the Observatorv Corporation, Capt. W. N. McClean, 1 Onslow Gardens, London, S.W.7.

A preliminary meeting in connection with the visit of the British Association for the Advancement of Science to Hull in 1922 has been convened by the Lord Mayor of the city. There was a representative gathering and a strong committee was formed. The town clerk, Mr. H. A. Learoyd, and the museums curator, Mr. T. Sheppard, were nominated as local honorary secretaries for the meeting, and the city treasurer, Mr. T. G. Milner, as hon. treasurer.

In recent years an exhibition of botanical material has been a feature of the Section of Botany at meetings of the British Association. The recorder of the Section asks us to say that contributors who have material to exhibit during the forthcoming Edinburgh meeting should communicate their requirements at once to the local secretary, Mr. W. Wright Smith, the Botanic Gardens, Edinburgh.

A public meeting has been arranged by the National Union of Scientific Workers to take place at 5.30 on Tuesday, September 13, in the new buildings of the Medical School, Edinburgh University, for the delivery of an address by Prof. H. Levy on "The Function of the Man of Science in Organised Research." The address will be followed by a discussion to be opened by Prof. H. H. Turner. The meeting will be presided over by Sir Richard Gregory.

A meeting of the Royal Meteorological Society will be held in the Natural Philosophy Department of Edinburgh University on Wednesday, September 7, at 2.30, when the following papers will be read:—"The Functions of a Scientific Society, with Special Reference to Meteorology," R. H. Hooker; "Meteorology in Medicine," Dr. A. Macdonald; "Some Notes on Meteorology in War-time," C. J. P. Cave; "The Diurnal Variation of Pressure at Eskdalemuir, 1911–20," Dr. A. Crichton Mitchell; and "The Natural Tendency towards Symmetry of Motion and its Application as a Principle in Meteorology," Dr. S. Fujiwhara.

The annual general meeting of the Institution of Mining Engineers will be held at Stoke-on-Trent on Wednesday, September 14, when the following papers will be read or taken as read:—"The Adsorption or Solubility of Methane and other Gases in Coal, Charcoal, and other Substances," by J. I. Graham; "Suggestions for the Standardisation of Geological Sections of Strata proved in Boreholes, Shafts, etc.," by H. Roscoe; and "Coal-mining by Steam Shovel in Alberta, Canada," by G. Sheppard. The following papers, which have already appeared in the Transactions, will be open for discussion:—"Third Report of the Committee on 'The Control of Atmospheric Conditions in Hot and Deep Mines': Observations of Temperature and Moisture in Deep Coal-mines," by J. P. Rees; and "Characteristics of Outbursts of Gas in Mines," by Prof. H. Briggs.

Sir C. H. Bedford has been appointed honorary adviser to the Secretary of State for the Colonies on questions relating to power and industrial alcohol in the Colonies and Protectorates.

Mr. B. A. Keen, head of the Soil Physics Department, Rothamsted Experimental Station, has been awarded a travelling fellowship by the Ministry of Agriculture. He has left for America to inspect general agricultural conditions in that country, with special reference to problems on soil cultivation.

Messrs. S. A. Hodges and T. A. Davies, of H.M. Dockyard, Portsmouth, have respectively been awarded the scholarship for 1921 of the Institution of Naval Architects and the Earl of Durham prize of the same institution.

France is already preparing to celebrate on November 22, 1922, the centenarv of the birth of Pasteur. England probably, in her old insular way and her usual indifference toward men of genius not her own, will let the sacred day pass without much notice. But Pasteur's work lives and moves and has its being in every country of the world. If every Englishman and Englishwoman who has cause to be grateful to him and his followers would subscribe sixpence, we should obtain enough money for a life-size golden image of him, and more than enough. It is one of our national disgraces that there is no memorial to him in London. Why should we not next year wipe that disgrace off our national slate? Poor London, weighted with so many dull and grimy statues of lesser men whose life and work are not to be named in the same breath with his! There is a good bust of him at the Pasteur Institute: so let us have a replica of it, and let it stand between Miss Nightingale and Lord Herbert, in front of the Guards' Memorial. These three monuments bear witness to the days when our sick and wounded in war—and in peace likewise—died like flies for lack of protective treatments against disease and of antiseptic and aseptic surgery and nursing. Pasteur shall bear witness to our redemption out of our ignorance.

The Ministry of Agriculture and Fisheries and the Royal Horticultural Society have arranged to hold an International Potato Conference in London on November 16–18 next. During the conference, which will take place at the hall of the Royal Horticultural Society, Vincent Square, the National Potato Society will hold its annual show, at which it is expected that most British varieties of potatoes will be exhibited. An exhibit dealing with the scientific aspect of potato problems is also being arranged, and it is hoped that workers engaged on potato problems in all parts of the world will co-operate. The proceedings will open with Sir A. Daniel Hall's presidential address on the morning of November 16. Papers on the breeding and selection of potatoes in Great Britain and the United States, and on wart disease, potato blight, and other diseases which are botanically and economically important, will be read, and time has been allowed for their discussion. Invitations to attend the conference have been extended to the Dominions and Colonies and to foreign countries, and it is hoped that the meeting will be thoroughly representative from both the scientific and the commercial aspects. Arrangements for the meeting are in the hands of a committee representative of the Royal Horticultural Society, the Agricultural Departments of England, Scotland, and Ireland, the National Institute of Agricultural Botany, and the National Potato Society. The chairman of the committee is Lord Lambourne, and the joint secretaries are Mr. W. R. Dykes, of the Royal Horticultural Society, and Mr. H. V. Taylor, of the Ministry of Agriculture.

INFORMATION is to hand in a circular from the Brazilian Department of Agriculture that henceforth the meteorological and astronomical Government services united under the name "Directoria de Meteorologia e Astronomia" are to be separated, and will be known as the "Directoria de Meteorologia" and "Observatorio Nacional" respectively. The new Directoria de Meteorologia, of which Senhor Sampaio Ferraz has been made director, will, no doubt, lead to a desirable unification of official meteorology in a vast country like Brazil, and it is to be expected that the co-ordination of effort which should ensue will provide material for the study of a climate which is more or less unknown except in general outline. The publication before the end of the present year of climatological data of Brazil for the last nine years is anticipated, and among the activities promised under the new directorate are forecast, aviation, coastal navigation, agricultural, and rain and flood services. It is pointed out that Rio Grande do Sul, Minas Geraes, and San Paulo will continue their State services, but under the supervision of the Directoria, and that the Reclamation Service of semi-arid north-eastern Brazil will retain its rainfall organisation. Information on Brazilian climatology will be gladly given in answer to inquiries, and the Directorate hopes to exchange publications with foreign institutions. The official address is: Directoria de Meteorologia, Morro do Castello, Rio de Janeiro, Brazil.

AN interim report relating to alleged dangerous lights in kinema studios has been issued by the Departmental Committee on the Causes and Prevention of Blindness, acting on behalf of the Ministry of Health. Cases of inflammation of the eyes have been reported by Sir Anderson Critchett and others, but fortunately these injuries have been of a transient nature, and no instances of permanent serious injury are recorded. According to the evidence of experts, the trouble is due mainly to the use of very powerful arcs of the searchlight pattern in an unshaded condition. Such lamps are considered liable to cause injury owing to the unimpeded access of ultra-violet rays, and it is also possible that artists looking direct at the lights, even if properly screened, may suffer owing to the intense visible light. Moreover, irritating vapours may be given off by some forms of carbons and occasion trouble at close quarters. The Committee, however, considers that the possibilities of injury would be slight if all lamps were properly screened, and the evidence of photographic and other experts supports the view that these methods of diffusion are also preferable from the technical point of view. An assurance has been given by the Incorporated Association of Kinematograph Manufacturers that in future no open arc lights without glass filters will be used in their studios. Now that the source of the trouble is recognised, no further action is considered necessary for the present. The Committee, however, remarks that the industry is in a state of development, and that further research is desirable. It accordingly welcomes the information that the Illuminating Engineering Society is forming a joint committee to study these problems in detail.

A COMPLETE list of awards and grants from the Rumford Fund for Research in Light and Heat forms No. 10 of vol. 56 of the Proceedings of the American Academy of Arts and Sciences (July, 1921). In previous publications in 1905 and 1912 dealing with the Rumford Fund, outlines of the history of the funds of that name of both the American Academy and the Royal Society were given, together with lists to date of the awards. In the present publication the awards of the American Academy only, from the date of its foundation to the end of 1920, are given in chronological order. The first award of the Rumford Premium was made in 1839 to "Robert Hare, of Philadelphia, for his invention of the compound or oxyhydrogen blowpipe," and the last recorded, that of 1920, to "Irving Langmuir, of Schenectady, for his researches on thermionic and allied phenomena." The grants for research from the Rumford Fund extend from 1832 to 1920, and the names of many illustrious men of science appear in the list. The pamphlet concludes with an alphabetical list of recipients of the grant.

IN his Croonian lecture on "Release of Function in the Nervous System" (delivered at the Royal Society on May 5, and now published in the society's Proceedings) Dr. Henry Head has given an illuminating summary of his great work in neurology. Dr. Head is the successor of Hughlings Jackson, and the fundamental principle on which his investigations are based is the rule laid down by Jackson more than fifty years ago that "destructive lesions never cause positive effects, but induce a negative condition which permits positive symptoms to appear." In other words, in his interpretations of the clinical significance of the symptoms of injuries involving the central nervous system he has avoided the fashionable and misleading device of accepting all active manifestations of disease as the effects of irritation. "Removal of a dominant neural mechanism permits the activity of lower centres to appear. These unfettered manifestations are not fortuitous pathological states, but represent that part of a complex reaction which still remains active." It is impossible within the scope of a note such as this to give any adequate idea of a lecture that is itself the highly condensed summary of thirty years' research into problems of great inherent complexity which have become obscured by erroneous methods of interpretation. Dr. Head's work is a brilliant example of the successful application of the true scientific method in clinical medicine, and is complementary to Prof. Sherrington's investigation of the same sort of problems by the experimental method. Much as their researches are misunderstood and however inadequate the appreciation of their worth may be at the present time, there can be no doubt that in the future Head's and Sherrington's work will be known as the outstanding achievement of British science in neurology and the borderland between neurology and psychology. Dr. Head's contribution to this great advance in knowledge is well set forth in his Croonian lecture.

DR. J. RITCHIE contributes to the *Scottish Naturalist* (May–June, 1921) an interesting analysis of the status of the walrus as a member of the British fauna. He supposes that when the polar ice sheet extended much further south, and during its retreat in the late Ice age, the walrus was a regular inhabitant of British seas, and the evidence, though scanty, goes to show that even down to the sixteenth century it was regularly hunted by the islanders of Scotland for commercial purposes. In an analysis of the twenty-four records since 1800 Dr. Ritchie concludes that a change in its status has occurred, and that it is now only a straggler which chance conditions bring occasionally to our shores. Summer is predominantly the season for its visits, and its appearance in British waters is associated with the breaking-up of the winter ice of the Arctic and its gradual drift to sea under the influence of ocean currents and winds. The majority appear to have travelled from a westerly source towards Iceland, brought there by unusual developments of the Greenland-Iceland-Faroe oceanic circulation. A marked decrease in the numbers observed in British waters occurred after 1870, which Dr. Ritchie attributes to the activities of seal-hunters about that period in clearing the more southerly breeding-grounds off Greenland of their stocks.

IN an interesting article on "Snakes that Inflate" in *Natural History* (vol. 21, No. 2), Mr. G. K. Noble discusses the significance of an aggressive warning attitude assumed by certain snakes when disturbed. In *Spilotes pullatus mexicanus,* a harmless snake, he found that the animal, when uneasy or in a highly nervous state, inflated its neck and vibrated its tail, recalling the warning attitudes of cobras on one hand and of rattlesnakes on the other. The mechanism by which the snake is able to inflate itself is simple. The dorsal membrane of the trachea is an enormously expanded sheet capable of great distension, and the snake simply fills its lungs with air, closes the glottis, and, by means of its powerful body muscles, forces the air into the trachea, which then becomes distended. Mr. Noble finds this habit developed in many species of snakes, generally harmless, belonging to quite separate families, and the mechanism is in all cases the same. He regards the character as having arisen independently in a number of unrelated groups of snakes, and as an impressive example of parallelism in adaptation. Similar evidence is noted about the habit of vibrating the tail when disturbed. While admitting that both phenomena may be called warning attitudes, he suggests that both actions may be simply manifestations of an uncomfortable nervous state produced by the presence of some disturbing factor in the environment.

A RAIN map of Australia for the year 1920 has been issued by Mr. H. A. Hunt, Commonwealth Meteorologist. The distribution of rainfall in different parts of Australia is shown graphically for the year, and on the reverse side there is a rainfall map for each of the twelve months. For comparison a small map of Australia is given for each year from 1908 to 1920, which shows the percentage of the area with the rainfall above the average. In 1918 only 23 per cent., and in 1919 only 13 per cent., of the area received more than average rainfall; in 1920, however, on 54 per cent. of the area rainfall was above the average. The single sheet is admirably arranged, and the large amount of data in no way overcrowded. It affords a specimen for any rainfall organisation, and a similar sheet would be greatly appreciated by those interested in rainfall distribution in any country. A summary table and notes on the 1920 map are given. It is stated that the year will be memorable on account of the complete change from unpromising weather conditions during the early months to widespread rains in the latter half. The long drought which had prevailed over central and eastern Australia since the early part of 1918 was completely broken up. The splendid rains during the greater part of the agricultural season, April to October, are said to have resulted in one of the best harvests on record all through the wheat-belt. Brief summaries of the rainfall distribution in 1920 are given for each State. At many stations in South Australia 1920 was the wettest year on record.

MR. E. T. QUAYLE (Proc. R. Soc. Victoria, new ser., vol. 33, pp. 115–32, 1921) has issued an optimistic estimate of the beneficial effects on the climate and rainfall of Victoria and of the southern districts of New South Wales that may be expected from irrigation. He illustrates the fact that the leeward shores of wide arms of the sea have usually a higher rainfall than the windward shores by reference to the records from Spencer Gulf and Port Phillip. He considers that the extension of irrigation in the Murray valley may have the same effect as if the irrigated region were covered by an arm of the sea. He claims that higher evaporation will increase not only the local rainfall, but also that on the mountains in which the Murray River and its tributaries take their rise, so that the rivers will be magnified, and the benefits to the climate and the country will be so great and varied that "it would be hard to put any limits" on them. The evidence for these estimates is not convincing. That the influence of irrigation must be to increase the precipitation to some extent is not likely to be questioned; but the extent of the influence is uncertain. Mr. Quayle claims that irrigation has increased the rainfall during the past ten years. This period is, however, too short to give any trustworthy evidence of a permanent change, as are also the statistics quoted from 1885. Similar predictions have been made from other areas where extended irrigation happened to coincide with the wetter part of a climatic cycle. The absence of any increase of rainfall beside the irrigated areas of Egypt suggests caution in reliance on records for so short a period as are available in Victoria, especially as it is in a situation where irregular long-period variations in weather are so likely to occur.

MESSRS. LONGMANS AND CO. are to publish in the autumn vols. 1 and 2 of "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," by Dr. J. W. Mellor, which work will consist of six volumes in all. Vol. 1 will to a large extent be historical and introductory, and give a general survey of chemical research and discovery from the earliest times to the present day. This volume will also deal in detail with hydrogen and oxygen in their many forms and compounds. Vol. 2 will cover the whole range of the following elements and a systematic range of related compounds:—Fluorine, chlorine, bromine, iodine, lithium, sodium, potassium, rubidium, and cæsium. The same publishers also promise a new edition—the fourth—of Dr. E. J. Russell's "Soil Conditions and Plant Growth."

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press "Notes and Examples in the Theory of Heat Engines," by J. Case. The book is intended as a companion to lectures to enable the student to see at a glance the essential points of the subject and to help him with his revision for examinations. The engineer who has to deal with the elementary thermodynamics of steam and other heat engines should find the work of value, as all the important formulæ he may require are printed in heavy type and easily found.

A USEFUL catalogue (No. 89, August) of nearly two thousand second-hand books dealing with entomology, ornithology, general zoology, and botany has just been issued by Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1. It is obtainable upon application.

Our Astronomical Column.

LARGE METEORS.—Mr. W. F. Denning writes:—"A considerable number of unusually brilliant meteors were observed at about the period of the recent Perseid display. On August 11 at 9h. 28m. G.M.T. a very fine object was recorded at Bristol and at various places in South Wales. Near the end of its flight it illuminated the firmament so strongly that people at first mistook it for a flash of lightning. The meteor fell from a height of from 75 to 53 miles, and its path was over the region from Swansea to Barnstaple Bay. It was directed from the usual radiant point in Perseus.

"Another meteoric fireball appeared at 10h. 42m. G.M.T. on the same night. It passed over Berkshire at a height descending from 78 to 45 miles at a velocity of about 30 miles per second. This was also a Perseid, and it was observed from Bristol and Wimborne, Dorset.

"Another fireball was seen on August 15 at 9h. 46m. G.M.T. As viewed from Nuneaton, Warwickshire, by the Rev. Ivo Carr-Gregg, it crossed α Ursæ Majoris in a direction from Serpens and Scorpio. Only one observation has come to hand of the latter object, and a duplicate record of the path would supply the necessary data for computation of the fireball's real course in the air."

ANCIENT ECLIPSES.—Dr. J. K. Fotheringham was the Halley lecturer this year, and chose ancient eclipses as his subject. He noted the appropriateness of the choice, since Dr. Halley had been the first to announce the secular acceleration of the moon's motion from his study of the old eclipses.

Dr. Fotheringham expresses surprise that Dr. E. W. Brown in his new tables of the moon adopts the value 6″ per century which arises from the change in the eccentricity of the earth's orbit; the ancient eclipses, as discussed by Drs. Fotheringham and Cowell (misprinted "Cavell" on p. 25 of the lecture), make it tolerably certain that the actual value is 4″ or 5″ greater, and that the sun has also an acceleration of at least 1·5″, presumably arising from a retardation of the earth's rotation.

One of the most definite records of eclipses is that of Thucydides (August 3, 431 B.C.); it has hitherto been inferred that, since "some stars became visible," Athens must have been close to the central line, but Dr. Fotheringham shows that a magnitude of 10½ digits suffices. In the eclipse of last April Venus, Mercury, Capella, Vega, Arcturus, and Aldebaran were seen at places in the British Isles where the magnitude did not exceed 10·6.

In addition to their application to astronomy, the lecture shows the great value of several of these eclipses from the chronological point of view; in fact, their combination with Ptolemy's and the Assyrian eponym canons determines dates back to the tenth century B.C.

CALENDAR DATES IN METEOROLOGY.—M. Jean Mascart contributes a paper to *Comptes rendus* of July 11 in which he points out the desirability of dating meteorological phenomena by the sun's longitude in place of the calendar date. Owing to the odd fraction of a day that occurs in the length of the tropical year, the same calendar date corresponds with different solar longitudes. There is, of course, no question that M. Mascart's contention is sound in theory; but since it is almost inevitable that the observations should be taken at fixed hours of the solar day, it would involve considerably more labour to re-arrange them in accordance with the sun's longitude, and it is very doubtful whether there would be any adequate compensation for such extra work.

Agricultural Research at Rothamsted.

THE Lawes Agricultural Trust has recently issued a useful index to the activities of the Director of Rothamsted and his colleagues. The index is described as a "Report" for 1918–20; but within its 86 octavo pages it would be impossible to report adequately on the work now in progress. The pamphlet states the aims of Rothamsted, indicates the methods adopted in its scientific work, and mentions the sources to which those interested in the investigations may go for fuller information.

The aims of Rothamsted have not changed, but in recent years the soil and fertiliser problems investigated by Lawes and Gilbert have been studied in new aspects; the Rothamsted team now numbers nearly forty scientific workers, and includes chemists, physicists, biologists, pathologists, and statisticians. Whereas formerly the chief work might best have been described as the study of the soil, stress is now laid rather on crop production. No possible means of throwing light on the reasons for high or low yield is neglected. The physical condition of the soil; the factors which influence the supply of water to the plant or determine the mechanical effort required in tillage; the character of the soil population and the possibility of control; the gains and losses of fertilising substances; the precise quantities of fertilisers which different crops require; the effects on production of competition within the soil and between the individual plants of a crop, or between cultivated plants and weeds; the effects of overcrowding on the aerial development of crops; the extent to which attacks of insects and fungi reduce the yield; the influence of the year's weather and the cumulative effect of several favourable or unfavourable seasons—all these questions and many ancillary subjects are now engaging attention.

With so many subjects under investigation, the methods of work required the Rothamsted staff offer many contrasts. No contrast is sharper than that which the element of time introduces. A "time" distinction may not have much importance for those interested only in the results of scientific work; but in dealing with such problems as those which Rothamsted tackles, it raises considerations of very practical moment to the Director and his staff. The study of the organisms present in soils has recently engaged much attention. Changes in the soil population were so rapid that little light was thrown on their development by the examination of an occasional sample. For a year, therefore, on every day, counts were made of certain species, and now that the year's results have come in it is found that even more frequent sampling and counting will be necessary. In a building adjoining the laboratory, in which a team of workers has been handling samples and studying the ceaseless changes in these Rothamsted soils for 365 days in succession, without even Christmas Day for holiday, there are other samples, faithfully collected and stored by Lawes and Gilbert year after year for more than half a century, which are now awaiting the time when some chemist will turn to them for aid in unravelling the story of the changes in land in which wheat has been growing continuously since the autumn of 1843!

The fate of these old soil samples suggests that problems are not lacking at Rothamsted. There has been a large increase in the staff in recent years; but with agricultural science—as with its raw material, the soil—intensive cultivation increases output. The results, in a sense, are embarrassing. No sooner is a laboratory ready than its accommodation is exhausted, and the Trustees and Director must find more space or see the problems of their staff condemned to involuntary "pupation." It is understood that the entomological staff has, for some time, been awaiting a new laboratory, and that its construction must be put in hand without delay if a "resting stage" is to be avoided.

Not the least satisfactory feature of the work at Rothamsted is the care and trouble taken by the staff to explain the bearing of its studies. This readiness must have been remarked by many recent visitors, and it is reflected in the admirably clear abstracts which the report contains of the more important of the sixty-one papers published within the past two years. The abstracts are arranged in two groups—scientific and technical. A subject is not necessarily dealt with in each series; frequently publication in one or other form suffices. But nearly all the material embodied in the scientific papers is ultimately used in papers suitable for farmers' journals.

Scientific Research in the United States.[1]

By J. W. WILLIAMSON.

THE two papers referred to below, written by the Chief Physicist of the Bureau of Standards, whose recent death is widely deplored, though dealing only with the question of scientific research as it affects the United States of America, will well repay the careful study, not only of British scientific workers, but also of all British citizens who wish to form a just estimate of the part that scientific research should play in the national economy. In the first of the papers Prof. Rosa set himself to answer the inquiry: "Whether scientific research as carried on by the Federal Government is a luxury or a necessity; whether it is something to be enjoyed when taxes are light, and curtailed when taxes are heavy; or whether it is creative and wealth-producing, and therefore to be increased and developed when expenses are abnormally large and a heavy debt must be liquidated?" In an interesting and informative examination of the national Budget he shows that the appropriations for obligations arising from recent and previous wars and for the War and Navy Departments amount to 92·8 per cent. of the total, public works to 3 per cent., primary Governmental functions to 3·2 per cent., and research, education, and developmental work to 1 per cent.

Prof. Rosa pregnantly observes: "One is led to wonder whether the total burden of taxation would not be lighter if the expenditure for scientific and developmental work were increased; if, for example, it were one dollar per year *per capita* instead of fifty cents." He answers the question by a detailed account of how the fifty cents *per capita* is expended

[1] (1) "The Economic Importance of the Scientific Work of the Government." A lecture given before the Washington Academy of Sciences on May 20, 1920. Reprinted from the Journal of the Washington Academy of Sciences, vol. 10, No. 12. By Edward B. Rosa.
(2) "Scientific and Engineering Work of the Government." Reprinted from the February, 1921, issue of *Mechanical Engineering*. By Edward B. Rosa.

and what is accomplished thereby. We have not space to dwell on his review of the work of the various Government Departments included in the classification of "research, education, and developmental work." It embraces the activities of the Agricultural Department, the Geological Survey and the Bureau of Mines, the Bureaux of Standards and of Foreign and Domestic Commerce, the Coast Survey and the Bureau of Fisheries, the Bureau of Labour Statistics, the Woman in Industry Service and the Children's Bureau, Educational Work, the Public Health Service, and co-operation by the Government in Industrial Research and Standardisation. We may note, however, that nearly two-thirds of all the expenditures made under this group of services are for the work of the Agricultural Department.

To the scientific research designed to develop the industries of the country Prof. Rosa refers in more detail. He has no difficulty in showing the necessity and the value of an increased expenditure, wisely applied, in this field. In the course of a summary of his argument he well says: "It is stupid and blind to think that because taxes are heavy we cannot afford to do things intelligently. If a farmer's barn burns down, he would not sell half his supply of seed and fertiliser to buy lumber, and then plant only half a crop. He would, if necessary, borrow money to buy more seed and plant a larger crop than usual in order to increase his income and pay for the new barn more easily. Intelligent research by the Government, in co-operation with the industries, is like seed and fertiliser to a farmer. It stimulates production and increases wealth, and pays for itself many-fold. It is as productive and profitable in peace as in war."

If we put aside the temptation to ask why the barn was not insured against fire, the illustration is apt enough for a world painfully recovering from the ravages of war. But America is not the only country where the superficial economists, appalled by the weight of taxation, begin to economise by cutting down expenditure in the productive services of "research, education, and developmental work." It is a pity that Prof. Rosa's paper will not be read by the "anti-waste" apostles. It is easy to gain a reputation for economy by shouting loudly "We cannot afford it," and difficult to realise that there are some things we cannot afford not to afford.

In his second paper Prof. Rosa usefully supplements his general argument in the first paper by a careful inquiry into the actual expenses of the various departments of bureaux of the Government. He begins by admitting that there is in the mind of the general public a feeling that the scientific work of the Government is not carried on so successfully or so efficiently as it should be, and that it probably costs too much. In order to get an accurate knowledge of Government expenditures and to ascertain how they have increased in recent years, the receipts and expenditures of all departments for the last ten years were analysed. The analysis given by Prof. Rosa is full of interest, and is illustrated by several ingenious diagrams. We have not space to review this analysis, but we may note one conclusion: "The *per capita* cost of the civil side of the Federal Government in 1920 was only a little more than half of what it was in 1910 if measured in commodities or in money of equal purchasing power. During this ten-year period the wealth of the country had greatly expanded, the war had come and gone, the problems of Government had enormously increased, and yet the *per capita* cost of these civil activities measured in commodities had fallen to a little more than one-half. In face of these facts people are saying that the Government is extravagant, inefficient, and over-developed." That sort of criticism is not peculiar to the people of America.

Cotton Research in Egypt.

THERE has been for many years a great deal of talk about research work on cotton. The Empire Cotton Growing Committee put research in the forefront of its programme, and it was originally suggested that a research institute should be established in Egypt. About the same time the British Cotton Industry Research Association was established in Manchester, but so far it has not done anything in the way of cotton-growing except to discuss methods of co-operation with the Empire Cotton Growing Committee. The latter has, of course, not been able to do much yet, owing to the time necessarily involved in its reconstruction into the new Empire Cotton Growing Corporation.

In the meantime, the Egyptian Government took its own steps by setting up in May, 1919, a Cotton Research Board, consisting of representatives of all the Departments of the Government which are interested in cotton-growing. A very brief preliminary report was published by the Research Board in March, 1920, and the first annual report embodying a review of the work done up to this date is now before us.[1]

The report proper deals in about fifty pages with the experimental work which has been done on cotton during the year 1920. This work has covered a very wide field, including botanical work on cotton and cotton-breeding (in which selection has apparently played a very much larger part than hybridisation), the selection and propagation of seed by the State domains, and a number of variety tests. Experiments on spacing and on the effect of water on the crop are described, as well as the work done in connection with insect pests, especially the pink boll-worm, and some mycological research. The programme of experimental work for 1921 is also outlined. Much of the work is still unfinished, and certain parts of it will be published by the Departments concerned in other forms as soon as results are available.

The Research Board has, however, very wisely not confined this report to its own work, but has added about 75 pages of reports on special questions considered by the Board, many of these more of an economic than of a purely scientific character, and a number of useful summaries of various publications of the Ministry of Agriculture made within the last few years on subjects affecting cotton. There are also reviews of publications from other sources affecting cotton and some very useful appendices. This supplementary matter deals with such questions of direct economic importance as the development of Pillion cotton in Egypt and its threatened supersession of the superior variety known as Sakel. It also covers the development of Pima cotton in Arizona, U.S.A., which looked for a time as if it might prove a serious rival to Egyptian. On the latter point, however, Egypt has probably derived considerable reassurance from the very marked reduction of the Pima crop this year owing to the fall in prices.

1 First Annual Report (1920) of the Cotton Research Board, Ministry of Agriculture, Egypt. (Government Publications Office, Cairo.) 10 piastres (2*s.* 1*d.*).

Among the publications summarised are two of special importance by outside experts, who were called in by the Egyptian Government to report on their cotton problems within the last few years, namely, Mr. H. A. Ballou, a West Indian entomologist, and Mr. H. Martin Leake, a botanist in the service of the Indian Government. These independent reports have been of great value to those who are following the development of the cotton position in Egypt. The appendices contain some rather disconcerting statistics of the crop, an account of cotton legislation in Egypt during 1920, and a very useful summary of botanical research on cotton carried out in Egypt up to 1918, along with a bibliography of the chief cotton pests of Egypt.

There is always room for difference of opinion as to the scientific value of the results achieved by research work, and no one who knows the difficulties under which scientific workers in Egypt have laboured in the past would expect any very large results in the short time in which the Cotton Research Board has been in existence. These two years have, in fact, been largely spent in preliminary work, and indeed the new research laboratory at Giza was scarcely finished when the report was written. But no one can question the value of such a compendium of a great deal of the work that has been done in the past. The report will form a useful summary for those interested in all the various lines of activity regarding Egyptian cotton.

University and Educational Intelligence.

THE Merchant Venturers' Technical College, which provides and maintains the faculty of engineering in the University of Bristol, has issued a prospectus for the academic year 1921–22. A prominent feature is the "sandwich" scheme, which engineering students have the option of adopting. By this arrangement the course of five years is divided into three periods of ten months each, which are spent at the University, and three periods of fourteen, two, and fourteen months respectively, spent in engineering works. More than twenty well-known engineering firms in Great Britain co-operate with the University for this course, in many cases offering to receive students with reduced, or even without, premium. The scheme provides an opportunity for a thoroughly well-balanced training for the profession.

THE Edinburgh and East of Scotland College of Agriculture has issued a calendar for the year 1921–22, in which a full account of the courses available at the college will be found. The classes are arranged in conjunction with the science faculty of Edinburgh University, and two courses are open to students: (*a*) for the degree in agriculture conferred by Edinburgh University, and (*b*) for the college diploma in agriculture. Part of the course required for the University degree in forestry is also provided, and there are, in addition, a number of classes devoted to horticulture. A novel feature is the five weeks' course provided in January and February of each year for the benefit of farmers and others who cannot attend a full diploma course. The course extends over two years, the first being devoted chiefly to soils, manures, and farm crops, and the second to feeding-stuffs and the management of livestock; in the coming winter the second part of the course will be given. Local farmers co-operate with the staff of the college in investigating new conditions or special problems arising out of their farming operations, and a number of useful papers have already been published dealing with the results obtained.

Calendar of Scientific Pioneers.

September 1, 1648. Marin Mersenne died.—A schoolfellow and friend of Descartes, Mersenne occupied various ecclesiastical appointments, translated Galileo's "Mechanics," experimented on sound, and was one of the group of eminent men whose meetings led to the founding of the Paris Academy of Sciences.

September 2, 1832. Franz Xavier, Baron von Zach, died.—Retiring from the Austrian Army as a colonel, Zach became the first director of the observatory at Seeberg, Gotha. His *Monatliche Correspondenz*, founded in 1800, was the forerunner of Schumacher's *Astronomische Nachrichten*.

September 2, 1836. William Henry died.—Awarded the Copley medal in 1809 for his contributions to chemical literature, Henry experimented on gases and enunciated the law connecting the pressure with the solubility of a gas.

September 2, 1865. Sir William Rowan Hamilton died.—After a remarkable career as a student, during which he wrote mathematical papers of a high order, Hamilton in 1827, at the age of twenty-two, became Andrews professor of astronomy at Dublin. For many years a correspondent of De Morgan, he was, like him, of a speculative mind. He is best known for his "Theory of Systems of Rays," his prediction of conical refraction, his "General Method of Dynamics," and his discovery of quaternions.

September 2, 1883. Cromwell Fleetwood Varley died.—One of three brothers who were all concerned with the early telegraphs, Varley did valuable work in connection with the Atlantic cables. His brother, Samuel Varley, was a pioneer worker on the dynamo.

September 4, 1784. César François Cassini de Thury died.—The third of the five members of the Cassini family who became members of the Paris Academy of Sciences, César Cassini is best known for his trigonometrical survey of France.

September 4, 1852. William Macgillivray died.—Macgillivray in 1841 became professor of natural history at Aberdeen. His "History of Birds" was published in 1837–52.

September 5, 1902. Rudolf Virchow died.—Placed in the foremost rank of pathologists by the publication of his "Cellular Pathology" in 1856, Virchow for many years was director of the Pathological Institute at Berlin. In later life he rendered important services to ethnology, anthropology, and archæology, and as a public man he was instrumental in transforming Berlin from one of the most unwholesome of cities to one of the most healthy. The centenary of his birth occurs on October 13, 1921.

September 5, 1906. Ludwig Boltzmann died.—A distinguished worker in mathematical physics, Boltzmann studied the work of Clausius and Maxwell, and became an authority on the kinetic theory of gases and on thermodynamics. He held chairs at Gratz, Munich, Leipzig, and Vienna.

September 6, 1902. Sir Frederick Augustus Abel, Bart., died.—One of the first pupils of Hofmann at the Royal College of Chemistry, Abel in 1854 became chemist to the War Office, a post he held for thirty-four years. He made valuable researches on gun-cotton, with Dewar invented cordite, and was an authority on petroleum and coal-mine explosions. He served as president of various institutions, and in 1893 was made a baronet.

September 7, 1882. Joseph Liouville died.—An engineer in the Ponts et Chaussées, Liouville resigned his position, devoted himself to the study of mechanics and pure mathematics, and from 1836 to 1874 edited the *Journal de Mathématique*. To Liouville and Regnault Kelvin was much indebted as a student.

E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, August 16.—M. Léon Guignard in the chair.—L. **Maquenne** and E. **Demoussy**: The respiration of leaves in a vacuum or in atmospheres poor in oxygen. Intracellular respiration and normal respiration, which some authors have viewed as having a common origin, proceed in reality from different causes, and should be regarded as autonomous functions, as much by their internal working as by their influence on the life of the plant.—P. **Vuillemin**: A new parasitic fungus in man, *Glenospora gandavensis*.—C. **Nordmann**: Remark on a recent communication. Further details of the methods of observation in heterochrome stellar photometry.—R. **Ledoux-Lebard** and A. **Dauvillier**: The utilisation of constant electromotive forces in radio-diagnostics.—E. **van Aubel**: The influence of temperature on the viscosity of normal liquids. The formula proposed is

$$\phi = m + n \log (\Theta - t),$$

where ϕ is the fluidity or reciprocal of the viscosity, Θ is the critical temperature of the liquid, and m and n are two constants. As a consequence of this, the increase of fluidity for a given rise of temperature is inversely proportional to $(\Theta - t)$. The validity of the relation proposed is proved by comparing the fluidities calculated from the formula with the experimental data of Thorpe and Rodger, Heydweiller, and Meyer and Mylius.—P. **Woog**: The dimensions of the molecules of the fatty oils and some phenomena of molecular solutions.—H. **Gault** and R. **Weick**: The additive properties of the keto-enolic double linking.—E. **Chatton**: The reversion of scission in ciliated organisms.—E. **Grynfeltt**: The histological process of fatty osteoporosis of traumatic origin.—W. **Koskowski** and E. **Maigre**: The paralysing action of methylene-blue on the parasympathetic nerve-endings.

CAPE TOWN.

Royal Society of South Africa, July 20.—Dr. A. Ogg in the chair.—E. J. **Hamlin**: Some observed results of the effect of sunlight on lead storage cells. A cell exposed to sunlight is 3 per cent. less efficient than a similar cell shielded from the direct rays; the useful life of the cell is diminished by approximately 25 per cent. by the effect of the direct rays of the sun.—E. J. **Hamlin**: The effect of evaporation on the efficiency of lead storage batteries. By using a "topping" of ½ in. of paraffin the amp.-hour efficiency of a battery was increased by 1·7 per cent. This is more economical than "topping" the battery with distilled water to counterbalance the effect of evaporation.—Dr. J. D. F. **Gilchrist**: Note on the pectoral fin of the sole, *Achirus capensis*. The pectoral fin is represented by a small vertical fold of epidermis with rudimentary rays, situated on the body below and concealed by the opercular membrane. It functions as an accessory organ in respiration. Suggestions are made as to how it may have arisen and as to how the characters acquired have become hereditary.

Books Received.

Modern Motor Car Practice. Edited by W. H. Berry. (Oxford Technical Publications.) Pp. xii+582. (London: Henry Frowde and Hodder and Stoughton.) 31*s*. 6*d*. net.

Industrial and Power Alcohol: The Sources, Production, and Denaturing of Alcohol—its Manifold Chemical and Physical Applications in Industries and Manufactures, and its Use as a Fuel for Internal Combustion Engines—Technical, Commercial, and Excise Aspects of the Problem. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. x+110. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Historical Eclipses: being the Halley Lecture delivered May 17, 1921. By Dr. J. K. Fotheringham. Pp. 32. (Oxford: At the Clarendon Press.) 2*s*. 6*d*. net.

Die Phylogenese: Fragestellungen zu ihrer exakten Erforschung. By Prof. Bernhard Dürken and Prof. Hans Salfeld. Pp. 59. (Berlin: Gebrüder Borntraeger.) 15 marks.

Sulphur and Sulphur Derivatives. By Dr. H. A. Auden. (Common Commodities and Industries.) Pp. xviii+101. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Hygiene for Health Visitors, School Nurses and Social Workers. By Dr. C. W. Hutt. Second edition, revised. Pp. xiii+382. (London: Methuen and Co., Ltd.) 12*s*. 6*d*. net.

Etudes sur les Infusoires d'Eau Douce. By Dr. E. Penard. Pp. vi+331. (Genève: Georg et Cie.)

Nedbøriakttagelser i Norge utgitt av det Norske Meteorologiske Institutt. Årgang xxvi., 1920. Pp. xiii+78+45. (Kristiania.) 6 kroner.

The Free-living Unarmored Dinoflagellata. By C. A. Kofoid and Olive Swezy. (Memoirs of the University of California, Vol. 5.) Pp. viii+562+12 plates. (Berkeley, Cal.: University of California Press.)

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