NATURE

SATURDAY, MAY 14, 1927.

CONTENTS.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3002, Vol. 119]

British Settlement in the Dominions Overseas.

THE various schemes which were formulated just before the War to alleviate the hardships of the indigent workless and destitute and to provide for their old age had an immediate retarding effect upon emigration from the United Kingdom. The majority of emigrants are manual workers, and anything which makes for their greater security in Great Britain must increase their natural reluctance to become the sport of chance circumstance in other lands. But the empty spaces of our vast dominions must be peopled, and it is held that it is best they should be peopled by our own stock. With this object in view the Empire Settlement Act was placed on the Statute Book in 1922, to enable the Home Government, in association with the government of any part of His Majesty's Dominions, or with public authorities or public or private organisations, to formulate and co-operate in schemes for development or land settlement, and for facilitating settlement in or migration to our dominions by assistance with passages, initial allowances, training, or otherwise.

The Committee appointed to carry out these schemes has just presented to Parliament a report for 1926.[1] The total number of persons assisted under the Empire Settlement Act increased from 39,559 in 1925 to 66,103 in 1926, or rather more than two-thirds of the total number of emigrants to the Dominions and more than half the net movement of population from Great Britain. The numbers assisted to Australia and New Zealand show increases of 10,205 and 3698; while the numbers assisted to Canada have risen from 8809 in 1925 to 21,344 in 1926. The Committee states that out of a net movement from Great Britain in 1926 of 115,538 persons, 93,227 went to homes within the Empire, a gratifying proportion. If this number of emigrants is maintained for the next few years, the average will be considerably above that for the decade 1901 to 1911, when it averaged 76,000 persons a year. Yet, as the Committee points out, the net movement from Great Britain overseas represents only two-fifths of the natural increase in our home population. If it is a fact, therefore, that Great Britain is already overcrowded, and, as many think, that under our present system we cannot keep all our people who are willing to work employed, the need

[1] Report of the Oversea Settlement Committee for the Year ended 31st December 1926. (Cmd. 2847.) Pp. 30. (London: H.M. Stationery Office, 1927.) 6*d*. net.

for a greatly accelerated movement of our home population overseas is a matter of supreme urgency.

It is interesting to find that Australia absorbs more than half the migrants within the Empire. It seems reasonable that Australia should be preferred to Canada, but it is a little difficult to understand why New Zealand does not attract more settlers: it is a lovely and varied land, with a delightful climate and abundant natural resources. The Committee offers no explanation; neither are we informed in the report why so few British migrate to South Africa: only 126 went there in 1925 and 232 in 1926. The great increase in the number migrating to Canada is to be explained by the liberal arrangements made for their reception and settlement, including what appear to be generous terms for capital advances.

The subject of migration is important enough to warrant a much more comprehensive account of the work of the Oversea Settlement Committee than that which has been vouchsafed in this report. But the subject is dismissed in 16 pages, most of which are filled by rather vague generalisations, interspersed with quotations from other Government publications. Most of the vital statistics contained in the report are given above. A little information, it is true, is to be found in the four appendices which fill the last 11 pages of the report. Yet many aspects of the problem upon which it might be assumed members of Parliament would wish to be informed are not dealt with at all. No reference is made as to the proportion of British to other European immigrants to the Dominions, or to the assistance given by other nations to their emigrants. The tide of emigration from central and southern European States, in many of which the standard of living of the working classes is appallingly low, has an important bearing upon the overseas settlement of our own people. No attempt is made to deal with the economics of migration. If information is desired on this aspect of the subject, it must be culled from the biased and often unsubstantiated statements of overseas statesmen, or from the handbooks issued by the various shipping agencies, any of which, it must be confessed, are more informative than this official report. Yet there is much information to be gathered from an examination of our trade returns. Each family settled in Australia, for example, creates a demand for our home products the value of which is roughly equivalent to the amount required to maintain a family at home. If satisfactory arrangements could be made to transfer 20,000 families yearly to Australia, our own unemployment problem would be quickly solved.

There are other omissions. No information is given regarding the relative suitability of the various parts of the Dominions for settlement, or what are the principal crops raised or the markets they serve. Nothing is said regarding the terms on which land is granted: prospective emigrants will look in vain for information regarding the provision of the amenities of life to which they are accustomed at home, for example, education and health services, housing, transport, and communications. No indication is given of the return which can be expected from arable or mixed farming, or what are the prospects for pastoralists, based upon the purchase price of available land, the cost of domestic stock, and the cost of living.

The most serious omission, however, is in connexion with the movement of the rural populations of the Dominions towards the towns. It is well known that the urban populations of the Dominions are increasing far more rapidly than the rural populations. The percentage increase of the urban population of Australia in the decade 1911–1921 was approximately 36, whereas the increase of the rural population in the same period was less than 9 per cent. It is a striking fact that the ratio of 'primary producers' to other classes in Australia—an agricultural country—is appreciably smaller than the corresponding ratio for Great Britain—a highly industrialised community. It is sometimes urged that our education system in Great Britain is at fault for failing to make rural life more attractive than life in our large cities: and the criticism is just. With equal justice it could be urged that Australia has not yet come to grips with the same problem. The Australian town-dwellers realise their success mainly depends upon a growing number of agriculturists, and they are prepared to support any scheme which will attract agricultural settlers from Great Britain, just as ardently as they will oppose the indiscriminate transference of our urban population to their towns; but they fail to realise, apparently, that the flight from the land can be retarded or arrested only by complete re-orientation of their education system coupled with profound modifications of their economic policy.

It would be interesting to know from which classes of the home community overseas settlers are drawn, and it should not be difficult to include such an analysis in a report of this kind. In the summary of Lord Clarendon's report on his visit to Canada, it is stated: "Possibly somewhat too

strong a preference may have been shown for families with farm experience. Inexperienced families, if they have the right spirit, seem to succeed just as well as the experienced. . . . Families from the coal-mining districts of Great Britain appear to show as good an average of success as any other families settled under the scheme." An authoritative statement of this kind is of the utmost importance, but it would carry even greater weight if it were backed up by statistical evidence. Even such a qualitative statement, however, should do much to break down the prejudice of selection committees against offering inducements to urban workers to settle on the land in our Dominions. What the urban worker lacks in experience in comparison with the farm-worker is offset by his greater adaptability to new conditions, an adaptability born of a higher intellectual standard. Rural education in Great Britain is still in a backwater.

The Committee states that it is "conscious of the closeness of the relationship between research, development, and settlement." It would be interesting to know what kind of research the Committee has in view, what are the problems which face the Dominions for which no solution can be found on the basis of knowledge already available. Unquestionably there are vast fields of inquiry in which research workers may labour. But the Saul-like conversion of our imperial statesmen to the new faith in scientific research must not blind them, any more than the members of the Oversea Settlement Committee, to the fact that settlement and development schemes can be based upon existing knowledge. The immediate need is for a comprehensive survey of the accessible and potential resources of the Empire, an Empire stocktaking, in fact, upon which all sound schemes of overseas settlement and research should be based.

It is to be hoped that in its next report the Committee will make a real attempt to deal with the problem of re-distribution of population in a scientific spirit. There are a number of diverse contributory factors to be taken into account in an inquiry of this nature, most of which appear to have been completely ignored hitherto. The report, in fact, constitutes a slight on the members of Parliament to whom it is made. It implies either that they do not possess the intelligence to examine the problem of migration of peoples thoroughly, or that they have very little interest in a subject of vital importance to the whole of the advanced peoples of the world.

The Numerical Measurement of Genius.

Genetic Studies of Genius. Edited by Lewis M. Terman. Vol. 1: *Mental and Physical Traits of a Thousand Gifted Children.* By Lewis M. Terman and others. Second edition. Pp. xiii + 648. Vol. 2: *The Early Mental Traits of Three Hundred Geniuses.* By Catherine Morris Cox, assisted by Lela O. Gillan, Ruth Haines Livesay, and Lewis M. Terman. Pp. xxiii + 842. (Stanford University, Cal.: Stanford University Press; London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1926.) 21*s.* net each vol.

IT is only when one studies a vast American work like this—which in its first two volumes covers more than 1500 pages, with still more volumes to come—that one realises that America is not Europe, that American science, for good or bad, is obtaining an individuality of its own, and that there is some hope that a population, which anthropologically is probably the most mixed the world has ever experienced, will shake down and ultimately develop national mental, if not national physical, characteristics. America has had many difficulties to contend with; it is not usually the ablest races who emigrate, still less is it the ablest members of those races. For early emigrants also, good physique rather than strong mentality is the essential factor of success. Occasionally, as in the case of Dutch and Huguenot immigrants to England, some political or religious movement drives a better class of men to change their homeland. But the bulk of men who have colonised America, especially of recent years, are men who were not succeeding very well in Europe, and hoped to find in spacious America more room for a return for their hard labour. The very spaciousness of America has been one of its disadvantages. It was possible to *acquire* with relatively little effort; there was no need to preserve or to maintain past acquirements, whether mental or physical; property and tradition were of smaller value than in older and more crowded countries. There was no natural selection of physique or ability, because inferiority had merely to go farther westward, where ease of acquirement increased with every degree of longitude. The alternation from pauper to millionaire was as rapid as the reverse process, for to acquire was so simple that few learnt to conserve.

To most of us who think anthropologically, there is small wonder that America thus far has not been prolific in genius. In Vol. 2 of the work under

discussion we find sixteen American men of genius enumerated. Six were presidents (Grant, Jackson, the two Adamses, Lincoln, and Washington), two men of the sword (Farragut and Sherman), four statesmen (Franklin, Hamilton, Seward, and Webster), and four authors (Longfellow, Washington Irving, Emerson, and Prescott), all dying in the century 1790–1890, and all known to every educated European. But would a Frenchman or a German have included more than two or three of these in a list comprising Galilei, Newton, Laplace, Darwin, Shakespeare, Goethe, Molière, Voltaire, Rousseau, Heine, Byron, Spinoza, Descartes, Dürer, Raphael, Titian, Mozart, Bach, *et hoc genus*? These are men of creative imagination, world-shakers, who have set their seals upon human culture, and if only 282 men of genius are to be taken for the four centuries 1450–1850, a sense of proportion might have hindered a European scientific writer from allotting 16 to America in one century!

The Americans are a young people; it will not be possible to call them racially a nation until far more intermarriage has taken place among their component groups, and more intense selection has been called into play; then will come national individuality, and then no doubt also new and typical forms of genius. Were a genius to arise to-morrow in America, whatever his class, one to be reckoned respectively with the six greatest scientific workers, scholars, painters, or authors of the world, he would be an offspring of the Old World, a German, an Englishman, or a Jew, not only racially, but also in modes of thought. Yet the day will indeed come, if not yet, when the typical American genius will appear. Can it be hastened by such a work as we have now under notice?

The scheme attempted is undoubtedly a great one, one that could only be imagined by a youthful people without the heritage—or shall we say bondage?—of formed traditions. It proposes first to determine how much in the genius of the past is due to (*a*) heredity, (*b*) native endowment, and (*c*) training; then to discover the gifted children in the American population, and give them the training appropriate to genius. One of the striking points in this novel scheme is that the authors venture to preach in a great democracy the doctrine of caste, that ability runs in families, that not only are gifted children born from superior parents, but also that those parents have superior traditional culture and follow higher-class occupations.

Before we can determine, however, what the 'gifted child' signifies to American psychologists, we must appreciate how he is to be selected. One of the difficulties of examinational selection of mental characters lies in the differentiation of acquired knowledge from mental facility or general intelligence. The former is partly a matter of age and partly a matter of home environment. To surmount the age difficulty the Binet-Simon tests were devised; they provided a system of tests suited to the average child of each year of life, but even with these it is difficult to ensure that success in passing may not be correlated with home training. The year-tests which a child could just answer gave its mental age, and, on the suggestion of Wilhelm Stern, the ratio of mental age to chronological age provided a measure of intelligence which might be taken as independent of age. This so-called 'intelligence quotient' has been developed—especially in America—in an immense variety of ways. The original Binet-Simon mental age tests have been altered, adapted, varied until almost every American university, if not every psychological teacher therein, has an individual series of tests. At the present moment, from west to east, from north to south, the American population is being psychologically tested. Universities, schools of all classes, prisons, reformatories, homes for the mentally defective and for fallen women, orphanages and training camps are being examined for their intelligence quotients. The climax was reached in the War, when the whole American Army was psychologically tested. Its average mental age was, if we recollect rightly, just fifteen years! What is quite certain is that English public schoolboys and English undergraduates would only treat as a joke the questions put to their American confrères to test not only their intelligence but also their interests, their moral and their religious senses, their sociability and their personality traits. If we are to trust the mass of papers resulting from these tests, the schedule scatterer must have an easier time in new America than he would have in the Old World!

However, starting with a teacher's selection, followed by a Stanford-Binet psychological test, some 600 boys and girls have been selected out of some quarter of a million of the Californian school children. These are the 'gifted' children from whom we are to expect genius. They and their parents have then been examined in almost every conceivable manner after selection. Their parents have been requested to fill in 'blanks' not only with regard to their children but also with regard to themselves. Anthropometric examinations,

medical examinations, 'interests' examinations, character and personality traits examinations, etc., have been organised to an astonishing degree. We know now whether a Californian gifted boy likes to collect insects or tram tickets, whether he would like to be a statesman or a Christian Science healer, whether he always remembers to clean his teeth, whether he ever dreams of people being dead, whether he can keep still on being tickled; these are a few among some 85 similar questions!

But we feel some hesitation even yet. Is not real genius inert to all examinations, even to a psychological one? May not the one real genius that California may very likely produce in the next half-century have slipt through the meshes of this intelligence quotient net? Unfortunately, there is no adequate control series being followed up through life in the same way, and if another 600 not gifted, but mediocre, children were being pursued in like manner, would an isolated genius in one or other series prove anything at all? We should be able possibly to judge whether the gifted children had or had not done better in life, but the fact that one had taken a Ph.D. degree and become an academic instructor, that another had completed his work for an Sc.D. degree or gone to Europe for study, might only be the effect of the home environment selected by the sort of questions set in the intelligence test. Statistically also, when we divide into sexes, and allow for deaths before achievement, and for the probable disappearance otherwise of many individuals, the numbers, we fear, may ultimately be found quite inadequate.

As for the statistical treatment of the data, it can only be said to be moderately satisfactory. For example, Dr. Lenz's criticisms on the original Terman treatment of the size of family in the case of families with gifted children are taken as truth without apparently any further examination; but in the case of a family of eight or ten children whose births may be extended over a period of fourteen or sixteen years, it is not equally probable that all the children will be found at school at the same time, and Lenz's method of correcting fertility is fallacious, and therefore Terman's conclusions drawn by applying it appear to be incorrect. Again, in the fundamental table on p. 41 and in the "corrected" table, p. 44, no comment is made on the large correlation of intelligence quotient with age (correlation ratio of quotient on age is of the order 0·37), and yet this is certainly a matter which deserved ample treatment. The method of correction detailed in a footnote is, we venture to think, obscure, and the diagrams are not adequately elucidated. Many other points will occur to the mathematically trained statistician on reading the work.

Still, we would not appear ungrateful for the labour which the collection of such an immense amount of data—of varying grades of usefulness—must have involved. In the course of the next thirty or forty years we may know whether the grading of children by aid of their intelligence quotients is correlated with their success in after life. That may not be without value and scientific interest, but we may reasonably ask whether it could not have been better accomplished by following up an additional 600 children with low intelligence quotients rather than by piling up *questionnaires* on the first group. That we are, by the study of these high intelligence quotient children, on the path to determine anything about the genetics of or the suitable training for 'genius,' frankly, we do not believe.

We might think that the word 'genius' is understood in a different sense in Europe and in America, but when we turn to the second volume of these "Genetic Studies of Genius," we find that in the abstracts of the "Early Mental Traits of Geniuses" (which occupy some 600 out of the 800 pages of this volume), the bulk of the individuals included are those that a European would classify in the same way. Yet if 'genius' be one in a million—are there indeed 10 male geniuses in England at this moment?—what hope is there of those 352 'gifted' Californian children throwing light on the matter? However, Miss Catherine Cox accepts the European estimate, if with some patriotic bias. How, then, are these accounts of the early intelligence and early environment of genius to be brought into relation with the gifted children of California? Only if we can assign by the accounts we have of the childhood of genius —*i.e.* on the basis of biographies—the corresponding intelligence quotients!

Now the great merit of the Binet-Simon tests arises from the fact that they give a numerical value to the living child by aid of direct experiments. It appears to the present reviewer that when the psychologist turns the matter inside out and says that he has had such experience of these tests and of young children that he can measure the childish 'brilliancy' of genius as reported in dictionaries of biography by means of allotting intelligence quotients, he is standing as a scientific worker on a very dangerous slope indeed. Here again we have no control series, which would have to be from as many nations as the men of genius are

selected from. Yet without such a series, how can we judge the precocity, the 'brilliancy' as our author terms it, of these nationals? In the case of great men, every scrap of their handwriting has been sought for and often preserved; in the case of mediocre men, it goes into the waste-paper basket when their mothers die. Erasmus is given an intelligence quotient of only 135 before seventeen years age. What would it have been had his school scribblings been preserved? Benjamin Franklin is given one of 145, because we have his autobiography and know of his childhood. James Stuart Mill is given an intelligence quotient of 200, not because he was ever natively brilliant, but because his apt intelligence was reared in a forcing house by James Mill; and how old-fashioned would now be the economist who would even admit James Stuart Mill to a place among the 282 men of genius of four centuries in Europe! Galton as a child is given an intelligent quotient of 200, because his biographer included certain letters from his childhood in his Life; Darwin as a child is given an intelligence quotient of only 135, because his biographer had not, or did not think fit to print, any such letters. Newton as a child is measured by 130, but Leibnitz as a child by 185. Shakespeare cannot be rated at all, because nothing of his childhood has been preserved for us. What would such ratings be worth if they were not, as they actually are, guesses? They depend entirely on the amount and character of the material which has been preserved for forming an estimate; they depend on the nation to which the man of genius belonged. They can tell us nothing of the extent to which relative achievement in later life depends upon relative childish 'brilliancy.' With Defoe, Linnæus, Napier, Harvey, and John Locke as children at 125, and Klopstock, Wieland, and Longfellow at about 150, what can we learn from this modern psychological guessing based on biographical dictionaries?

Our author prefaces her work with much talk about the value and accuracy of 'historiometric' methods of investigation; she gives various mathematical investigations of the exactness of the process of guess-work involved and of her methods of 'correcting' her numerical estimates. Some of this is very open to question from the mathematical side. We do not base our main criticism on that, but on these two indubitable facts: first, that she has no control series of the mediocre men of the various nations through these centuries, and secondly, that the estimates of her colleagues and herself, even if accurate, depend entirely on the amount of data known, or at least cited in the biographical dictionaries. How would the intelligence quotient of Newton as a boy be modified by the discovery of his diary, or the knowledge that his mother sprung from an illustrious family? How would Nelson's 125 as a child be modified had the writer known that his mother was descended from the Walpoles, one of the English families most noteworthy for administrative ability?

Do we consider then that this volume is a waste product of several years' work? Not in the least. We know no book that so satisfactorily condenses the main facts with regard to the boyhood of great men. Its usefulness will survive long after the intelligence quotients which are scattered through its pages have ceased to be regarded. Is this the judgment of a European? Very possibly. The fact that it becomes more and more difficult for the European to grasp and judge modern American scientific work may be rather evidence of the European's conservatism than of the naïveté of that work itself. America is not, but is becoming, a nation, and, as we all know, nations with the very best intentions fail to understand each other. Youth too often fails to interpret itself to age.

Chinese Agriculture.

Die chinesische Landwirtschaft. Von Dr. Wilhelm Wagner. Pp. xv + 668. (Berlin: Paul Parey, 1926.) 42 gold marks.

THE agricultural methods of China have long excited the interest and curiosity of Western experts, partly because they are highly intensive and partly because of the element of mystery still surrounding all things Chinese. On western methods, 2-2¼ acres of land are required for the maintenance of each person; but there are great areas in China where two acres of land support no less than five people, to say nothing of a donkey and other animals. The comparison is striking, even allowing for the great difference between eastern and western ideas of maintenance.

Hitherto, and in spite of its inherent interest, Western experts have had little opportunity of learning anything about Chinese agriculture. There are a few articles in the Chinese Repository and in Millard's "Review of the Far East," not usually available in agricultural libraries, but no account by any English writers except the useful summary in the "Encyclopædia Britannica." The only accessible account hitherto has been that written by the late F. H. King, the well-known

soil physicist of Wisconsin, who visited the Far East in 1910 and recorded his impressions in his book, "Farmers of Forty Centuries."

Dr. Wagner had therefore almost a clear field when he undertook to describe Chinese agriculture. His qualifications for the task are considerable; he was appointed as agricultural lecturer in 1911 to the High School set up by the Germans in Tsingtau for the education of the Chinese, and he remained in China until 1920. When he began, the school was only two years old, and the agricultural equipment, he tells us, was a blackboard, a sponge, and a piece of chalk; by August 1914, laboratories had been erected and the institution possessed 16 hectares of experimental farm land and proper farm buildings, with more than 30 head of cows and 5 horses in addition to pigs and other animals. His students came from various parts of China, and he had many opportunities of learning about its agriculture.

The plan is to discuss first of all the natural conditions, particularly climate and soil, then the human factors, finally the methods of dealing with the soil and its chief crops.

The author adopts the usual divisions of China into a northern and a southern section separated by a folded range of the Tsing-ling-shan. The northern part is subdivided into the western highlands, often desert and sparsely populated; and the eastern plain of yellow loess soil, entirely agricultural and densely populated. The south is somewhat similarly divided, but the soil is not loess; it is largely sandy or calcareous. Again, however, the east is the agricultural land with the dense population. The river valleys are highly fertile, but even the hills are cultivated, being laid up in terraces.

The agricultural interest lies in the eastern portions of the country; it is there where the intensive methods are used. The basis of the crop production is a close regulation of the water supply to the crop necessities. China has a network of canals which serve to drain land that has too much water, to irrigate land that has too little, and also as a means of transport and communication, the roads being bad. The rainfall is high; so far as the slender records go, it varies from 25 inches in the Shantung peninsula to 100 inches or more in the warmer sub-tropical parts; it is more variable in the north than in the south. Much of the lower land is drained, but almost always by open drains, occasionally in the south by bamboo pipes, but never, so the author tells us, by clay pipes. Drainage is, however, less important than might appear, because the rainfall comes mainly in the summer, and swamp land is not the waste in China that it is in colder climates, for the paddy rice flourishes in it. The problem is rather the other way; land otherwise dry is watered so as to obtain maximum yields. This circumstance that the highest rainfall of the year comes in summer is an important factor in determining the intensiveness of Chinese agriculture. Crops have water during warm weather when they need it, and they are not hampered by high rainfall in winter when they do not need it. Where the winter is not too cold, two crops a year become possible; they are obtained on much of the land in the centre and south (though not usually in the north), especially on the tropical rice land which lies high enough to be dry in winter and yet can if necessary be flooded in summer. Even the low-lying wet land can be made to carry two crops.

The descriptions of the agricultural implements suggest affinities with Babylon and ancient Egypt rather than with Bronze Age north Europe, and it would be interesting to make a careful comparison between the agricultural system of ancient China and that of ancient Egypt so far as this is known or can be inferred from later Arabic writings. Some of the implements, however, notably the harrow and the roller, have a very western appearance.

Among the commonest manures are the mud from canal bottoms, green material cut from the large areas devoted to graves, and, above all, human excrements, all of which are carefully collected and applied to the land.

The chief food crops are rice and millet, and they form a good combination, since rice can tolerate any amount of water and millet does well in dry conditions, having great power of withstanding drought, and at the same time growing well when rain comes. The second crop, grown in winter, may be wheat, barley, beans, pease, or various vegetables. Land not well suited to rice, by reason of being too high above the water level of the canal, is devoted to bamboos, mulberries, fruit and vegetables.

This section of the book would have been more interesting had the author had more of his own photographs. As it is, he is driven to use illustrations from King's book of 1911. He devotes a great part of his book to descriptions of the crops, their varieties, and the conditions in which they are grown. The number of crops is amazing; including all the grain crops, many oil seeds, strange plants such as the lacquer tree (*Rhus vernicifera*)

and the tallow tree (*Sapium seliferum*), in addition to the better known tea, cotton—said to have been introduced into China from Khotan in the eleventh century—mulberry trees and other crops traditionally associated with the country. The animals are described at length, and finally the author collects some materials for a summary of the economic position of the Chinese farmer, an interesting attempt which one would like to see followed up.

As the only recent book on the subject, the volume would in any event be of interest to the agricultural expert. Added to this are its intrinsic merits; the mass of information, numerous illustrations by photographs and diagrams, and, where they can be obtained, figures of yields or analytical data. To those interested in eastern agriculture it will prove very valuable.

E. J. RUSSELL.

The Textile Industry.

Textile Bleaching, Dyeing, Printing and Finishing Machinery. By A. J. Hall. Pp. 320. (London: Ernest Benn, Ltd., 1926.) 50*s*. net.

THIS book is a very welcome addition to the literature of British textile industries. It brings together, in a complete form, a comprehensive summary of the best modern methods of carrying out the several important processes stated in the title of the book. Hitherto these processes have only received a cursory treatment and then simply as separate subjects. The author is to be congratulated on the able manner in which he has filled the gap in our technical literature and given an unusually complete survey of the mechanical methods used in carrying out the various processes.

The almost complete elimination of any idea of secret methods in spinning and weaving has been brought about by the publication of text-books, and the establishment of technical schools and research institutions. In the same manner progress can only be attained and maintained by clear statements of the best and most efficient methods of carrying out the processes of bleaching, dyeing, printing and finishing. The empirical methods of yesterday are totally inadequate to meet the world-wide competition of to-day, and they have always been a bar to development and progress. This book will place in the hands of the chemist, the engineer, the bleacher, dyer, and finisher a mass of information that will enable them to build up a solid business on sound constructive principles. Since each process is both important and extensive, the book is necessarily large, and although it has been compiled under only nine chapters, the illustrations number 365, excellently reproduced in half-tone and line blocks.

The arrangement of the matter has not been by any means an easy task owing to the close interdependence of many of the processes, but the author has solved the difficulty in a fairly satisfactory manner. He deals with the machinery of various types used in each process, and whilst avoiding the display of preference for any particular machine, has the happy knack of so expressing himself that the reader can readily understand what machine will be best for any particular purpose. The book therefore becomes an invaluable work of reference, and is very suggestive, to a progressive man, in conveying ideas of further improvements.

Whilst machinery forms the staple matter in the book, each set of machines has an introductory explanation as to the necessity of the machines, so that the non-technical reader can readily understand the various steps carried out in any given process. A very wide field of textiles is covered, and whilst the chief aim is intended to be of real practical utility to the trade, the work may prove of great value and interest to many people who do not share in the actual production of textile materials, but are vital factors in dealing with the fabrics and materials after they are finished, including merchants, drapers, etc., and, even in many of our bleaching and dyeing works, the directors who have seriously to consider the question of equipment. All interested in this great industry will find the book of immense value, and we congratulate the author on what must have been a severe task. The book is well bound, its type is clear, and it bears evidence of the utmost care having been taken in its preparation.

W. S.-T.

Our Bookshelf.

How Natives Think (*Les fonctions mentales dans les sociétés inférieures*). By Prof. Lucien Lévy-Bruhl. Authorised translation by Lilian S. Clare. Pp. 392. (London: George Allen and Unwin, Ltd., 1926.) 12*s*. 6*d*. net.

IN his preface to this book the author explains that "La Mentalité primitive," which appeared in English in 1923, and "Les Fonctions mentales dans les sociétés inférieures," of which this is a translation, are two volumes of one work. By an accident of circumstances, the second volume was translated into English before the first. This was unfortunate, as the essential principles of M. Lévy-

Bruhl's theories are contained in the latter, and although the two books can be read apart, some knowledge of these principles is necessary before the argument can be grasped as a whole.

M. Lévy-Bruhl's thesis is, in the main, a constructive criticism of the views of the English school of anthropologists at the head of which stand Tylor and Frazer. He holds that the work of this school is based upon an assumption that the working of the human mind is everywhere and in all cases identical. The vast body of facts relating to primitive peoples which have been gathered together in the employment of the comparative method, have been interpreted in the light of the animistic theory and explained by the law of association, whereas the author maintains they can only be understood as 'collective representations'—social phenomena having their own laws which no analysis of the individual *qua* individual, such as is implied in the method of the English school, can ever reveal. The 'difference in degree' in savage mentality which is recognised by the English school, therefore, becomes for M. Lévy-Bruhl a difference in kind.

Thanks in a great degree to the French school of sociologists and social anthropologists, and to the work of certain anthropologists in England, the tendency to consider facts entirely *in vacuo* is now by no means so marked as it has been. M. Lévy-Bruhl's stimulating book, in which the consequences of the difference of point of view are worked out in detail, is by no means so entirely destructive of English theory as he hopes, but it will serve as a caution and a corrective.

Light Treatment in Surgery. By Dr. O. Bernhard. Pp. xii + 317. (London: Edward Arnold and Co., 1926.) 21*s*. net.

IN a foreword to this book, Prof. Leonard Hill refers to it as a masterly production, and we are inclined to agree with this verdict. The translator has done his work exceedingly well, and we now have a book to which we can turn with some confidence on the question of the use of light treatment in surgery; we hope that some one will be found who can cope with light treatment in medicine in as broad a comprehensive way as the author of the work under notice. We shall then be spared a continuance of the present holocaust of books written on the subject of ultra-violet therapy by writers of very little experience.

The book is divided into two parts, the first being general in its scope, the second, special in the sense that it deals with the actual light treatment in surgical cases. The two parts of the book are of about equal length, and the first five chapters give one a very good idea of our present state of knowledge on the effect of light on the organism generally, right up through the vegetable and animal kingdoms.

The second part of the book is divided into a section dealing with the indications for the use of this therapy and two sections on the helio-therapy of surgical tuberculosis. Scattered throughout the book are photographs and radiographs illustrating the good effects which often accompany the treatment of patients with sunlight. That climatic conditions play an important part in the treatment of tuberculous patients is recognised by the author, and, in fact, twenty-five pages are devoted to this subject. In a book the object of which has been to set forth the beneficent action of sunlight in disease, a section of no less than twenty pages is devoted to the pathological action of sunlight. The dangers to specially sensitive subjects and those accompanying over-doses of radiation are dealt with very fully.

The book should be welcomed by those who have looked, so far in vain, for an authoritative account in English of this new, yet really very old, form of therapy. S. R.

An Outline of Plant Geography. By D. H. Campbell. Pp. x + 392 + 52 plates. (New York: The Macmillan Co., 1926.) 17*s*. net.

DR. D. H. CAMPBELL has written a simple and highly interesting outline of plant geography which can be read with pleasure and profit by the botanist, and also, which is of more importance, by all who are interested in the vegetation of the earth. He reviews in a light and pleasant manner the types of vegetation to be found in the north temperate zones of the old and new world, paying special attention to the interesting floral region of the western States of America and British Columbia. The south temperate zone is similarly discussed, and the central portion of the book is occupied with a description of the palæo- and neo-tropical regions, and their dense tropical forests. The descriptions of vegetation and scenery are enhanced throughout by numerous good and characteristic pictures, which add greatly to the interest of the book to the more general reader. Two prefatory chapters dealing with the succession of plants in geological times, the first land plants, man and the plant world, and the several climatic zones, give a useful summary of our knowledge of and the factors controlling the present distribution of plants.

It would have been useful for the more botanical reader had Dr. Campbell given the scientific names of some of the plants, to which he refers only by their popular names—names with which American botanists, no doubt, are quite familiar. It would also have been more convenient if data relating to rainfall, altitude, and temperature were given consistently either in the metric or English system. These, however, are only minor points in a very readable book, which is so readable because not only is it very well written, but also because the author writes with a personal knowledge of the vegetation of nearly every part of the world.

Civil Engineering Specifications and Quantities. By Dr. G. S. Coleman and G. M. Flood. Pp. xv + 282. (London: Longmans, Green and Co., Ltd., 1926.) 10*s*. 6*d*. net.

THE administration of contracts is one of the most arduous duties of the civil engineer, and this book should be of distinct value to those of limited

experience. An engineering contract may be divided into two parts, one legal and the other technical, and the book is roughly arranged to correspond. The legal sections, comprising ten chapters, are clearly written and illustrated by cases, but such legal expressions as "time is the essence of the contract, *prima facie*, *quantum meruit*," though commonplace to lawyers, are not always clearly understood by engineers, and a short explanation of them would enhance the value of the book. The technical chapters give suggested specification clauses for most of the general work carried out by civil engineers in excavation, embankment, concreting, masonry, brickwork, and steelwork.

The practice referred to is, as might be imagined, that common in the north of England, and in a few details would be modified in the south. The suggestion on p. 96 to paint reinforcing rods is rather unusual, and does not correspond with the advice given on p. 147. It would perhaps have been worthy of mention that wood street-paving blocks are laid with the grain vertical. The section on quantities is clear and straightforward. In essentials, building contracts and engineering contracts are similar, and a reference might have been made to the standard conditions of contract of the Royal Institute of British Architects, and to the standard method of measurement of building works of the Surveyors' Institution, which are often used as models for small engineering contracts.

E. E. MANN.

Types of Mind and Body. By E. Miller. (Psyche Miniatures, Medical Series, No. 4.) Pp. 132 + 5 plates. (London: Kegan Paul and Co., Ltd., 1926.) 2*s*. 6*d*. net.

THIS attractive little volume is an excellent introduction to the scientific study of the psycho-physics of temperament and character. It deals in a critical and independent manner with the best recent work on types of physique and mentality, and also contains many interesting suggestions towards new lines of thought and investigation. Dr. Miller lays special stress, as is natural, on the work of Kretschmer, but he by no means neglects the work of the French and other schools. Perhaps the most important section is that which deals with the 'physiological background,' which gives, among other matters, a useful account of the functions of the internal secretions in relation to character and behaviour. Especially suggestive is Dr. Miller's discussion of the endocrine system as a link between metabolic processes and neural and mental processes, which throws light not only on the relation between mental and physical forms, but also on the more general problem of the relation between mind and body.

There are some interesting remarks about the relation between the types distinguished by recent workers and the racial types of the anthropologists, which need fuller justification. So fas as is known, much the same types of temperament and character exist among all races of mankind, and this is scarcely compatible with anything like a simple correspondence between the two kinds of types. In the psychological section there are some points which raise doubts, as, for example, the alleged relation between the ego-instincts and introversion, and between the sex-instincts and extroversion, but on the whole the treatment is both balanced and stimulating. There is a very well-chosen bibliography.

MORRIS GINSBERG.

Exercises in General Chemistry and Qualitative Analysis. By Prof. H. G. Deming and Prof. S. B. Arenson. Second edition, revised. Pp. xii + 282. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 9*s*. net.

THE authors of this manual express the "opinion that quantitative work in an elementary course often consumes time that were better spent in the accumulation of useful and necessary qualitative information." Quantitative work is therefore reduced to a bare minimum and a scheme for the qualitative investigation of chemical phenomena, covering a fairly wide field, has been elaborated. A novel feature is the introduction of linear scales showing the relationship between the temperature and the vapour-pressure of water and between the density and the concentration of several common reagents. Working directions are minutely specified, and almost every page is liberally sprinkled with cross-references, which are likely to bewilder the student, whose natural desire to discover things for himself is stifled by the warning in heavy type that *all unauthorised experiments are strictly forbidden.* Yet the authors hope to "foster something of the research spirit at an early age"! About one-fourth of the book deals with ordinary qualitative analysis, this section being prefaced with the following instruction to the beginner: "The work is based on differences in solubility. Commit to memory the table of solubilities and get some class-drill in its applications." Such methods will not appeal strongly to teachers in English schools.

A Junior Inorganic Chemistry. By R. H. Spear. Second edition. Pp. viii + 392. (London: J. and A. Churchill, 1926.) 6*s*. 6*d*. net.

THIS little book, which is designed for junior forms, appears to possess no strikingly original features. It is, however, lucidly written and it contains a fair number of illustrations, though some of them are rather crude. There appears to be no direct reference to Fig. 13 in the text, nor is it clear to the reader that the rather wide tube dipping into the beaker in all probability represents a thermometer. Again, the muffle-furnace, depicted on p. 59, needs some explanation in the text. Some of the headlines are badly worded or even startling. Thus on p. 27 a paragraph of about five lines is headed "To show that Matter is not Created by the Rusting of Iron." The investigation of the rusting of iron in a later chapter is fairly good, but it might have been carried a stage further by considering the action of air-free water upon the metal. The weight of a litre of air is given incorrectly on p. 24 as 0·001293 gm.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Atomic Weight of Silver.

IN reply to Prof. Brauner's criticism (NATURE, Mar. 5, p. 348, and April 9, p. 526) of our determination of the atomic weight of silver (*J.C.S.*, 1926, 128, 2510), we have now investigated the volatility of silver and have most emphatically confirmed our original statement that no silver could possibly have escaped from the silica tube during the final melting in hydrogen.

Some finely divided silver, prepared by heating the oxide in air to 350°-400° C., was introduced into the silica tube shown in the diagram (Fig. 1). The tube was heated in the electric furnace for an hour at 700°-800° C., for a similar period at 800°-900° C., and finally for five hours at a temperature of 1000° C., whilst a slow stream of hydrogen passed through the

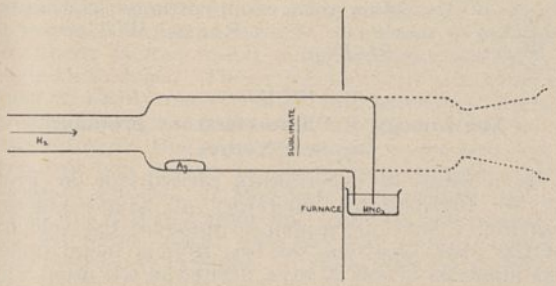

FIG. 1.

tube and bubbled through the dilute nitric acid ($1HNO_3 : 2H_2O$). The nitric acid was then poured into a nephelometer tube and a little dilute potassium bromide solution added. On examination of the nephelometer no turbidity could be detected, even after standing for several hours. On the addition of 0·2 c.c. of $N/1000$ silver nitrate (0·02 mgm. silver) an immediate and comparatively dense turbidity developed.

Taking into consideration the relative sizes and positions of the silica tube as used in the atomic weight determination (shown by dotted lines in Fig. 1), and the silica tube used in this experiment, also the time of heating, which was only twenty minutes in the determinations, then it is quite conclusive that no silver could possibly have escaped from the original silica tube.

On examination of the tube after the experiment, an extremely minute sublimate was observed 3 cm. from the silver bead, showing that the silver is slightly volatile, but not to anything like the extent suggested by Prof. Brauner.

Our preliminary investigations on the decomposition of silver oxide showed that it was essential to melt the silver in hydrogen after the initial decomposition. Silver, prepared from silver oxide by heating at 400° C., is a coherent mass full of voids. It could almost be called sintered. The loss in weight on melting in hydrogen was between 2 mgm. and 3 mgm.

In estimating the weight which ought to be attached to any determination of a constant such as an atomic weight, we would suggest that it is only the experimental facts which deserve consideration. Our determination of the atomic weight of silver has an advantage over others, in that it is the only one in which the direct ratio of silver to oxygen has been measured.

H. B. BAKER.
H. L. RILEY.
Imperial College of Science and Technology,
South Kensington, S.W.7.

Radioactivity and the Heat of the Earth.

IN a previous letter to NATURE (vol. 119, p. 277, 1926) I have discussed Dr. J. W. Evans's suggestion that the existence of pleochroic haloes in mica indicates that much of the energy of the rays from the radio-elements in rocks is used up in producing physical, chemical, or atomic rather than thermal changes in the surrounding minerals. I concluded that the close agreement between the calculated and measured heat productions of the radio-elements affords strong evidence for the view that "practically the whole of the energy associated with the radiations emitted by these elements is available for raising the temperature of the rocks in which they occur." In a later communication (NATURE, vol. 119, p. 424, 1926), Dr. Evans infers that if measurements of the heat production of radium were carried out in a mica container instead of in a glass tube, the results of experiment and theory might not show such good agreement, in spite of the fact that the fluorescence effects and colorations produced by the radiations and the thermo-luminescence resulting from subsequent heating of the coloured materials are quite analogous for the two substances. From the viewpoint of geothermal problems, the importance of an unequivocal decision on the question at issue is perhaps sufficient justification for my returning to the subject, for several independent lines of thought support the conclusion arrived at in my previous letter.

Since it can be obtained in very thin uniform sheets, mica has always been used extensively in absorption experiments with α-rays; its behaviour is perfectly normal. The calculated range of α-particles in mica, as in glass and aluminium, is in good agreement with that found by experiment. This we should not expect if the behaviour of mica as regards absorption were abnormal. In such a case, either each α-particle would lose an appreciable amount of its energy in promoting, say, *chemical* change and the observed range in mica would be smaller, or the α-particles would lose different amounts of energy in this way, when the range would be indefinite, in opposition to observations of pleochroic haloes where the range is sharply defined. Furthermore, the proportion of the energy of α-rays utilised in promoting *atomic* changes in mica must also be very small, for mica has been used extensively in absorption experiments on atomic disruption, and the number of H-rays observed, particularly when the mica has been outgassed, is insignificant for present purposes.

Dr. Evans mentions that Dr. Alfred Brammell found it necessary to keep biotite at a dull-red heat for about six hours to render the pleochroic haloes invisible; but here I think he has misunderstood my previous reference to the thermo-luminescent effects with minerals coloured by radioactive radiations. When coloured glass or minerals are heated appreciably, but below dull-red heat, the thermo-luminescent effect is of relatively short duration, and may often be designated a flash. My statement that the energy liberated during the process is "manifestly small"

was based primarily on visual impression, but it is supported by the fact that if an appreciable proportion of the radioactive energy from an inclusion were stored in the pleochroic sphere and liberated on heating, the energy so released would correspond to a flash of intensity about 10^{10} times greater than that necessary to excite the retina of the eye. Moreover, Duane has shown that when radium is mixed with a material which fluoresces strongly under the action of the rays emitted, the measured heat production is identical with that obtained with radium alone,—a result which surely admits of no other interpretation than that the energy of luminescence is negligibly small.

Quartz, and to a less extent glass, when subjected for a long time to intense radiation from radium, develops tiny fractures or cracks which can be removed by continued heating above the softening point of the material, just as devitrified glass can be restored to condition by suitable heat treatment. I am inclined to attribute Dr. Brammell's observation to an analogous mechanical effect in the mica, the original crystal lattice being restored by the later heating at dull-red heat. Markings in the outer shell or in the body of the pleochroic sphere might also arise from the escape of gases on the application of heat. Thus for a representative sphere (radius of sphere = 30 μ; radius of inclusion = 1 μ; age = 500 million years) the volume of helium available in the outer shell, neglecting diffusion, would be about thirty times the volume of the inclusion, and the oxygen contained in the mica of one-thousandth part of the pleochroic sphere would occupy a volume equal to that of the sphere.

The evidence of heats of formation also renders it probable that most of the radioactive energy is converted into heat in the mica, for the calculated amount of heat available from radioactive sources during the life of the pleochroic sphere of the above-mentioned dimensions has about twice the value of the heat of formation of a volume of water equal to that of the sphere. The heat of formation of mica is unknown, but on the assumption of an additive law for the constituent parts, I find that the radioactive energy liberated within the pleochroic sphere is of the same order of magnitude as the estimated heat of formation of an equal volume of mica.

It is observed that for each gram of radium some thirty or more cubic centimetres of electrolytic gas are produced daily in an acidified aqueous solution of radium, the requisite energy being derived primarily from the α-particles emitted. Knowing the heat of formation of water and the daily heat development of radium, we can readily deduce that only about two per cent. of the energy of the radioactive rays is used up in promoting chemical change in the solvent. When an identical amount of radiation acts on ice, the resulting amount of chemical change is much less than in the case of water, and for a stable mineral like mica it seems reasonable to conclude that the amount of chemical change produced will be exceedingly small.

The concordance of evidence advanced in this and in my previous letter is very strongly opposed to the views expressed by Dr. Evans, and I shall only briefly refer to the latter part of his letter. He points out that the presence of extensive granite and gneiss in and below the deep boring at Dubbelde Vlei, in the Cape Province of South Africa, seems to have had no appreciable effect on the temperature gradients. In the absence of actual measurements of the radioactivity of these rocks, however, it would be futile to attempt to discuss the above observations of temperature gradient, though it seems not unlikely that low radioactivity is the reason for the low gradients. The thickness of the granitic and basaltic layers, however, will also exert an influence. Prof. Holmes has referred to the gradient difficulty in two recent papers (*Geol. Mag.*, vol. 62, p. 533, 1925; vol. 63, p. 313, 1926) without coming to a decision as to the cause; but he is also convinced that anomalous absorption of the radioactive rays is insignificant in this connexion, and that practically the whole of the energy of the radiations from the radioactive substances in igneous rocks is available for raising or maintaining the temperature of those rocks.

It is to be hoped that before long additional evidence will be obtained on the question of the temperature gradients associated with, and the radioactivity of, the granitic layer in different parts of the world. Meanwhile it is interesting to recall that high gradients are associated with the highly radioactive granitic rocks of the Simplon tunnel, and that independently of the petrographic nature of the dominant rock type, some regions of the earth's surface are known to be characterised by more intense radioactivity (*e.g.* the Alps) than others (*e.g.* New Zealand). In future discussions it will be necessary to take account of the well-established radioactivity of potassium in this connexion, for in igneous rocks the thermal effect of potassium appears to be of the same relative importance as that of uranium or thorium.

ROBERT W. LAWSON.
University of Sheffield.

The Energy of Photo-electrons produced by Soft X-rays.

IN a series of experiments carried out in Prof. O. W. Richardson's laboratory at King's College, London, I have attempted to measure the velocity of the photo-electrons set free from a metal under the influence of soft X-rays, excited in the usual way by electrons from a hot filament falling on the radiator through an accelerating potential difference of 50-800 volts. The results obtained with the stopping-potential method—in which a varied retarding potential is applied to a surrounding electrode, thus preventing all electrons with a kinetic energy below the corresponding value to escape—are difficult to interpret because of the masking effect of scattered radiation on the measurements for higher voltages. Various forms of magnetic methods have also been tried, of which the last one has yielded definite results. In this apparatus the photo-electrons are emitted from a narrow rod forming the axis of a short cylindrical ring, connected to the electrometer and kept at the same potential as the rod. A variable magnetic field, applied in the direction of the axis, prevents electrons with velocity less than a certain value from reaching the cylinder.

In the measurements so far obtained, the potential on the tube was 700 volts. The anode-radiator was of carbon and the rod of copper—clean or covered with a thick coating of lamp-black. In both cases the curves show that the preponderance of low-speed electrons in the emission is very great indeed. More than 70 per cent. of all the electrons emitted have energies less than 10 volts. The following is a typical set of values showing the relative number of electrons within an equal interval in volts for different points on the distribution curve :

Energy (volts) . .	2	5	8	20	50	100	150	200 volts.
No. of electrons . .	100	41	14	2·5	1·6	0·7	0·5	0·3

It may be that this low average energy of the electrons results from the greater part of the incident

radiation being of comparatively great wave-length. On the other hand, recent experiments by Simons (*Proc. Phys. Soc. London*, 37, 58; 1925) with ordinary homogeneous X-rays have shown that in this case also a great part of the photo-electric emission consists of slow-moving δ-particles.

In both cases it is possible that the process by which the large quanta of energy carried by the exciting electrons are transformed to small quanta of the photo-electrons, involves some kind of a compound photo-electric mechanism. According to Auger (*Ann. de Phys.*, 6, 183; 1926) the compound photo-electric effect should play a very important part in the soft X-ray region.

The investigation is being continued with the object of gaining further knowledge on this point.

ERIK RUDBERG.

Stockholm, Odengatan 8,
April 19.

Correlation Coefficients and the Theory of Mental Abilities.

SINCE the discovery by Spearman of hierarchical order in correlations between mental tests, the theory of mental ability has been actively explored. Mathematical methods have been made possible by regarding mental abilities as variables composed of certain constituent factors which are distributed unequally among individuals. The extent to which such factors of mental ability may be called into activity will presumably depend on their use in any given situation.

According to this view, we may suppose that any given test will require for its solution a number of factors of ability. If two tests are applied, more factors will as a rule come into activity, but possibly some will assist in both tests and thus produce correlation between the results. If three tests are applied, three orders of factors may be expected according as they are common to all three, or to only two out of three, or are relatively specific, *i.e.* applying to one out of three. If four tests are used, four orders of factors might be expected; if five, then five orders, and so on. In any particular collection of tests, whether three or more, we regard the terms 'specific,' 'group,' and 'general' as referring to factors that are respectively (1) present only in one, (2) present in some, (3) present in all the mental processes required for the performance of those tests. In the furthest limit, when all possible variables have been considered, and provided their constituent parts could be known, the final and indivisible elements would stand out as the ultimate analysis of mental ability. However near to or remote from the actual truth this view may be, it forms an adequate method of constructing correlated variables, and is therefore of assistance in checking the interpretations that are placed upon correlation coefficients derived from experimental data.

The possibilities involved in the co-operation of constituent elements in either three or four tests have been examined by the writer, partly in conjunction with Prof. Godfrey H. Thomson of the University of Edinburgh ("The Essentials of Mental Measurement," Brown and Thomson, also *Brit. Jour. Psych.*, 1919). In the case of any three correlated variables constructed on lines described above, the expression $r^2_{12} + r^2_{13} + r^2_{23} + 2r_{12}\, r_{13}\, r_{23}$ (where r_{12} is the coefficient of correlation between the first and second variables, r_{23} between the second and third, and so on) has been shown to possess special significance. Disregarding negative correlation, the limiting values for the expression are zero and five. If, however, no general factor exists between any three variables, the maximum value for this expression is unity, and any value above unity definitely indicates the presence of a general factor, while any value below unity could be produced either with or without a general factor. When the value of the expression is exactly unity we have, in this sense, a boundary condition for three variables.

In proving this boundary condition, in the first place, the following restrictions on the nature of the elements were assumed: (1) That they were normally distributed with equal standard deviations, and (2) that, when present, they acted with full effect, never with a fraction or component, as it were, of their total strength. With this second restriction removed, however, it is still true that the expression could not be greater than unity without the aid of a general factor, and any other value, unity or less than unity, can be produced with or without the aid of a general factor.

So long as the 'all or none condition' is imposed, the expression is equal to unity (general factor absent), in every case when specific factors are absent, group factors alone remaining. In the wider conditions, however, the internal construction of the group factors must conform to certain laws before the maximum value is reached. The actual details of these laws, under which the 'all or none condition' is one particular case, will, I hope, be published at an early date.

A similar inquiry has been made in the domain of four variables. Here, two boundary conditions claim attention: (1) concerning the absence of a general factor and group factors common to three out of four variables, and (2) concerning the absence of the general factor alone. For the first boundary condition we have the expression $r^2_{12} + r^2_{13} + r^2_{14} + r^2_{23} + r^2_{24} r + r^2_{34} - r^2_{12}\, r^2_{34} - r^2_{13}\, r^2_{24} - r^2_{14}\, r^2_{23} + 2r_{12}\, r_{13}\, r_{23} + 2r_{23}\, r_{24}\, r_{34} + 2r_{13}\, r_{14}\, r_{34} + 2r_{12}\, r_{14}\, r_{24} + 2r_{12}\, r_{13}\, r_{24}\, r_{34} + 2r_{13}\, r_{14}\, r_{23}\, r_{24} + 2r_{12}\, r_{14}\, r_{23}\, r_{34}$. The maximum value for this expression, without the aid of general or group factors common to three variables, is unity, and at or below unity these factors are unnecessary.

The second boundary condition requires the same expression except that the first six terms, and also the tenth to the thirteenth, all take 4 as a numerical coefficient. Such an expression possesses 16 as a maximum value without a general factor, and at or below 16 a general factor is unnecessary. Both these boundary conditions are of course true without the 'all or none' restriction.

The above studies are intended to illustrate how far inferences may be safely drawn from experimental data in the form of correlation coefficients.

J. RIDLEY THOMPSON.

University of Sheffield.

Iron Crystals.

IT has been found possible to grow long crystals in iron wire by making use of the allotropic transformation which occurs at about 900° C. The method is to heat a portion of the wire between two mercury contacts by passing direct or alternating current through it and then to cause the heated portion to travel along the wire either by moving the support carrying the contacts or by moving the wire itself. The hottest part of the wire should be at 1400° C. or higher. Under these conditions a very steep temperature gradient exists at the point where face-centred cubic (γ) crystals, stable at high temperatures, are being replaced by body-centred cubic (α) crystals, stable at lower temperatures, and at a favourable

velocity of travel a single α-crystal will grow to a length of 20 cm. or more in wire 1 mm. in diameter.

Crystals have been grown in a vacuum and in an atmosphere of nitrogen, but the best results have been obtained in hydrogen at atmospheric pressure. The rate of travel principally used has been about 4 cm. an hour, but higher and lower rates have also given good results. The chemical purity and previous mechanical history of the iron seem relatively unimportant. Most of the experiments have been made on remelted electrolytic iron, but impurities usual in commercial iron do not inhibit growth. In a particular experiment, long crystals were grown in hard-drawn piano wire containing originally 0·8 per cent. carbon. In the final state the amount of carbon had been reduced, but, as judged by resistivity measurements, the carbon content was probably still greater than 0·3 per cent.

The large crystals occupy the whole cross-section of the wire, there being no surface layer of fine crystals as is usual in crystals grown by over-strain with subsequent annealing. Etching with nitric acid develops planes of the form {100}, so that an optical goniometer serves to locate the cubic axes normal to these reflecting surfaces. The orientations so found have been checked by X-rays, which permit more exact location than does the optical method. A considerable variety of orientations has been obtained, and it cannot yet be said whether there is any preferred orientation.

Irregularity in tension on the wire and torsional stresses in it result in twinning. Twins may either appear as small inclusions or as complete changes in orientation with the twinning plane traversing the entire cross-section of the wire. The twinning plane is of the form {211}.

The magnetic and magnetostrictive properties of long crystals free from twins are being investigated. These properties appear in some respects to differ from those of crystals prepared by others [1] by the method of over-strain and annealing. The initial permeability of nearly carbon-free crystals grown in hydrogen lies between 2000 and 2500, the maximum permeability is around 20,000, and the coercive force about 0·2 gauss. After treatment which should remove hydrogen (its actual removal has not been proved) the initial permeability drops to a few hundred, the maximum permeability rises to nearly 40,000, and the coercive force diminishes slightly. A crystal grown from piano wire in hydrogen and not further treated had an initial permeability of about 1000, but was otherwise much like the purer crystals in magnetic behaviour, though stronger mechanically. The dependence of properties upon crystal orientation in the wire, and the behaviour in fields of more than 50 gauss, have not yet been determined.

Plastic deformation of the crystals, even to the slightest extent, causes considerable changes in their magnetic behaviour, and restoration of the original condition by annealing seems only to be possible when the amount of deformation has been minute.

The method is being extended to iron alloys possessing in the cold the body-centred structure characteristic of pure iron and having an allotropic change at nearly the same temperature.

L. W. McKEEHAN.

Bell Telephone Laboratories,
New York, N.Y.,
Mar. 2.

[1] Webster, W. L., NATURE, **117**, 859 (1926); *Proc. Roy. Soc.*, **107a**, 496-509 (1925); **109a**, 570-584 (1925); **113a**, 196-207 (1926). Gerlach, W., *Phys. Zeit.*, **26**, 914-915 (1925); *Zeit. f. Phys.*, **38**, 828-840; **39**, 327-331 (1926). Honda, K., Kaya, S., Masuyama, Y., NATURE, **117**, 753-754 (1926). Honda, K., Kaya, S., *Sci. Rep. Tohoku Univ.*, **15**, 721-753 (1926). Honda, K., Masuyama, Y., *Sci. Rep. Tohoku Univ.*, **15**, 755-776 (1926).

The Transmutation of Hydrogen into Helium.

A FEW months ago, K. Peters and I published an account of experiments we had made in an attempt to transmute hydrogen into helium (*Ber. d. Deutschen Chem. Ges.*, 59, 2039; 1926). A more or less detailed account of this publication appeared in the columns of NATURE (vol. 118, p. 526, 1926), and perhaps I may be permitted to refer to a more recent publication on the same topic by K. Peters, P. Günther, and myself (*Ber. d. Deutschen Chem. Ges.*, 60, 808; 1927). In this communication, as a result of further experiments, we feel that we are in a position to give an explanation of the occurrence of the observed very small quantities of helium in our experiments, without having recourse to the assumption of a synthesis of helium.

In the first-mentioned communication we considered the penetration of helium from the atmosphere through the glass walls of the apparatus to be the most likely source of trouble in such experiments, and we excluded this possibility by the use of vacuum jackets, immersion in water, and similar devices. In addition, we also discussed the possibility of regarding the helium dissolved in the glass as an explanation of the observed effects, but blank experiments led us to the conclusion that the quantity of helium capable of being liberated in this way was beyond the limits of sensitivity of our method of detection. In the interval we have carried out experiments both in the Baker Laboratory of Cornell University and in the Chemical Laboratory of the University of Berlin, and these have shown that the liberation of helium from glass (and from asbestos) is dependent on the presence of hydrogen. Thus glass tubes which gave off no detectable quantities of helium when they were heated in a vacuum or in oxygen were found to yield helium in quantities of the order of 10^{-9} c.c. when they were heated in an atmosphere of hydrogen. Now in the earlier experiments the glass tubes containing palladium yielded helium, whereas the empty glass tubes used in control experiments did not; and since the former tubes would fill with hydrogen on the application of heat, we see that the source of the helium lay not in the palladium but in the glass, in spite of appearances to the contrary.

Our method of detecting helium is sufficiently sensitive to show that a glass tube which has been completely freed from its content of helium by heating in hydrogen takes up a detectable amount of neon-free helium from the atmosphere even after only one day's contact with the air.

Since asbestos behaves similarly to glass, we now see why one particular palladium preparation, bought as palladium-asbestos, yielded larger quantities (10^{-7} c.c.) of helium after being charged with hydrogen. Here, obviously, in contrast to the preparations we made ourselves, the asbestos had not been ignited until it was free from helium, and a fraction of the residual helium was always liberated by heating when the palladium was charged with hydrogen, whereas in oxygen no development of helium could be observed.

As a result of our more recent experiments we have thus established that, in using an apparatus made of glass, one cannot make any trustworthy statement as to the origin of 10^{-9} c.c. of helium if air comes in contact with the apparatus, parts of which are later heated in hydrogen. By avoiding all heating of the apparatus, we shall endeavour to decide whether a transmutation of hydrogen into helium of the order of 10^{-9} c.c. or less takes place. In any case, the amount of helium formed in experiments on electric discharges, as tested by various workers

and by ourselves, and in experiments on the action of palladium, does not reach the order of magnitude of 10^{-8} c.c.

It is scarcely necessary to emphasise the fact that the sensitiveness of our method, though limited to 10^{-8} c.c., is sufficient to decide with certainty the other questions dealt with in our first communication, such as the helium content of meteorites, the helium development of radioactive deposits, and so on.

FRITZ PANETH.

Berlin, Mar. 2.

Measurement of Radiation Intensity by Photographic Methods.

IN a letter to NATURE of Jan. 16, 1926, p. 83, Dr. F. C. Toy criticised the use of calibration curves in photographic spectro-photometry: but the grounds for his objections were rather the difficulties in the way of adequate calibration than any quarrel with the main assumption involved, namely, the essential uniformity of the plates of a single batch. Recently, however, Miss C. H. Payne and Mr. F. S. Hogg have concluded that each of their plates requires separate calibration, a conclusion fully borne out by the sample curves given by them in Harvard Circular 301.

The work at this Observatory in connexion with Prof. Sampson's method of stellar spectro-photometry has been free from trouble due to the variations of individual plates: indeed, the curves for different batches of plates, on the similarity of which no reliance is placed, are far more consistent than those for individual plates at Harvard. Fig. 1 shows

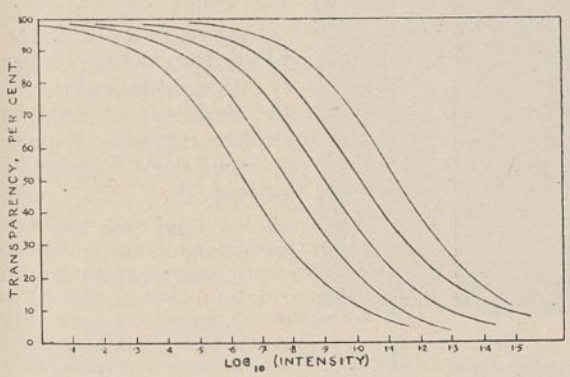

FIG. 1.

the calibration curves for wave-length 6100 Å.U. of the five batches of plates of the same make used during the last three years. It will be noticed that the differences are confined to the transparencies smaller than 20 per cent., that is to say, to the region which is strongly affected by the duration and temperature of development. A much closer agreement would have resulted had the first and fourth batches received somewhat longer development. The differences found at Harvard are of a totally different character, affecting the whole curve. In this respect they strongly resemble those found by Messrs. L. A. Jones and E. Huse (Eastman Kodak Research Laboratory Communication No. 193), which were eventually traced to different batches of chemicals used in making up the developer.

This suggests that these variations of individual plates may be due to the sensitiveness of the emulsion to slight changes in the composition of the developer, in which case a change of developing agent might lead to consistent results.

E. A. BAKER.

Royal Observatory, Edinburgh,
April 16.

Ionisation Potential of Hydrogen Fluoride.

THE ionisation potential of hydrogen fluoride has not yet been worked out experimentally. Several attempts have been made to calculate it on thermochemical data, on the assumption that hydrogen fluoride is ionised into H^+ and F^-. Such a calculated value, notably by Glocker (*Phil. Mag.*, 1924), appears to be $15{\cdot}67 \pm 0{\cdot}7$ volts.

Such a process of ionisation with molecular dissociation at the lowest ionisation voltage has been doubted by Mackay (*Phys. Rev.*, 1924), who has stated that even in the cases of those hydrogen halides where thermochemical data have yielded results in accord with experiment, the coincidence may be fortuitous. It has also been shown by Duffendack (*Phys. Rev.*, 1925) that "even with an intense arc in HCl vapour up to 70 volts, no trace of hydrogen spectrum could be obtained."

I have calculated the ionisation potential of fluorine, F = 16·7 volts (*Phys. Rev.*, awaiting publication). This calculated value seems to be justified by Prof. H. Dingle's recent observation of the ionisation potential of the neutral fluorine atom (approx. 17·0 volts) (*Proc. Roy. Soc.*, A, 113, 323). Ionisation values of hydrogen chloride, bromide, and iodide are all found to be greater than the corresponding values of chlorine, bromine, and iodine; and hence one is led to believe that the ionisation potential of hydrogen fluoride may also be greater than 16·7 volts or that the thermochemically determined value is too low.

On the other hand, there is reason to believe that the ionisation products of hydrogen fluoride may be $(HF)^+ + e$. This is the same kind of ionisation as that of the neon atom into $(Ne)^+ + e$. Hydrogen fluoride and neon are known to have a similar structure and an exactly similar disposition of outer electrons. In the case of hydrogen fluoride, the nuclear distance between the atoms is known to be greater than the atomic radius of neon (Bragg and Bell, NATURE, Mar. 24, 1921, p. 107), and thus the ionisation potential of hydrogen fluoride may be expected to be nearly equal, though somewhat smaller than that of neon (21·5 volts).

On the present view of ionisation in hydrogen fluoride, it can be shown on the Bohr-Sommerfeld theory that

$$I_{HF} \cdot (r^2_{HF}) = I_H \cdot (r^2_H) \cdot n.k.$$

where I_H and r_H stand for ionisation potential and radius of the normal (1, 1) orbit of hydrogen respectively, and I_{HF} is the ionisation potential of hydrogen fluoride and r^2_{HF} is the mean square radius of the outer n, k electron orbit of HF.

By this method of calculation $I_{HF} = 18{\cdot}04$ volts, $I_{HCl} = 13{\cdot}8$ volts.

S. C. BISWAS.

Physics Laboratory,
D.A.V. College, Lahore,
Mar. 31.

The Nuptial Pad of Kammerer's Water-bred Alytes.

I WAS delighted to read in NATURE of April 30, p. 635, a letter from Dr. Przibram vindicating the validity of Kammerer's results.

May I direct attention to one feature in the much-discussed Alytes which renders the assumption of fraud absurd?

This specimen when I saw it in 1923 showed a nuptial pad only *on one side*. Who, if he had wished to 'fake' an Alytes so as to deceive the public, would treat *one* palm only with Indian ink?

E. W. MACBRIDE.

Imperial College of Science and Technology,
South Kensington, London, S.W.7.

The Fields of Force in the Atmosphere of the Sun.

By Dr. GEORGE E. HALE, For. Mem. R.S.

THE structure of the solar atmosphere above and surrounding sunspots has been illustrated in a previous article in NATURE.[1] Single spots often lie at the centre of an apparent vortex resembling a terrestrial tornado or cyclone, sometimes nearly radial in form, more commonly showing marked clockwise or counter-clockwise curvature. Bipolar spots (Fig. 1) are often surrounded by a field of force similar to that of a bar magnet, though in many cases the structure is very different. I have recently discussed the nature of these fields of force,[2] but the evidence, which favoured a hydrodynamical rather than an electromagnetic explanation, was inconclusive, especially in view of the prevalence of the bar magnet type so frequently associated with bipolar spots. This seemed to point to an electromagnetic origin, and the impossibility of analysing adequately the structure of the hydrogen flocculi in these bipolar fields has greatly impeded progress.

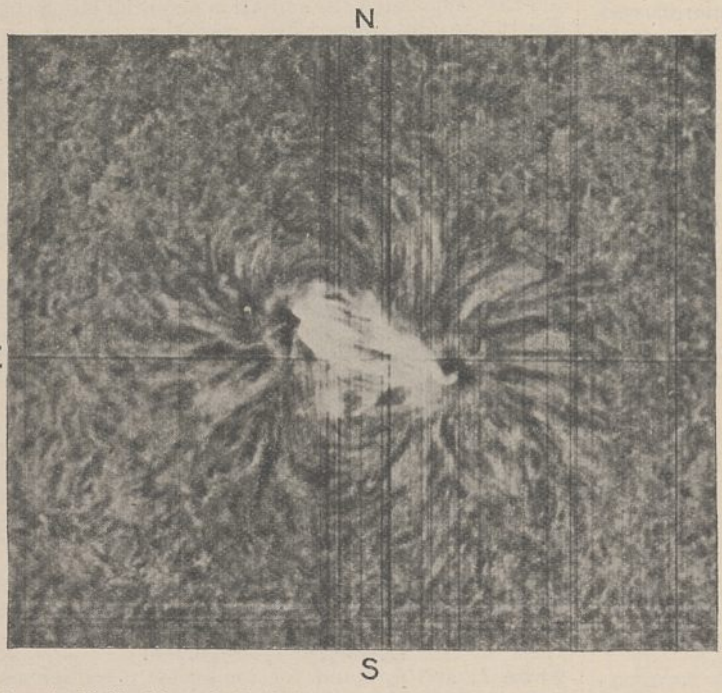

FIG. 1.—Field of force in the hydrogen atmosphere surrounding the bipolar spot of Aug. 29, 1924. The structure of the hydrogen flocculi resembles the field of force surrounding opposite magnetic poles.

In the study of this problem the spectrohelioscope, described in its preliminary form in my earlier article in this journal,[1] has proved to be indispensable. The spectroheliograph remains our best means of photographing the fields of force in the solar atmosphere; but as a device for detecting certain hitherto unrecognised phenomena, and of interpreting many puzzling questions, it is greatly surpassed by the spectrohelioscope. For example, during the last few months the spectrohelioscope has permitted me to observe repeatedly the rapid flow of large hydrogen flocculi toward sunspots, a phenomenon clearly recorded on a large scale but once in many years of work with the spectroheliograph. Moreover, it has also enabled me to measure the radial velocity of this inflowing gas, yielding results much higher than the Evershed effect would lead one to expect, but in good general agreement with the velocity of inflow of prominences photographed in elevation at the sun's limb by Slocum and Pettit with the Rumford spectroheliograph. It has also enabled me for the first time to distinguish quickly and clearly between these inflowing streams and the outflowing jets which often result in arched prominences. By rendering possible a study of these arches, seen in projection against the disc, it has shown that the 'bar magnet structure' surrounding bipolar spots is not necessarily an electromagnetic effect.

THE ELECTROMAGNETIC THEORY.

In 1912, at my request, Prof. Carl Störmer visited the Mount Wilson Observatory to investigate the theory of the fields of force shown by the hydrogen flocculi. I quote from his paper entitled "Researches on Solar Vortices"[3]:

"The detailed study of the collection of spectroheliograms made at the Observatory suggested to me an application of the classical researches on terrestrial cyclones made in 1876 by my countrymen Guldberg and Mohn. The hydrogen flocculi seemed to be arranged around a single spot in curved paths that were very similar to logarithmic spirals; and just the same curves were found by Guldberg and Mohn as trajectories of the air particles in the outer part of cyclones. It therefore seemed advisable to start with the hypothesis that the motion of charged electric gas molecules takes place along such spirals around the sunspot centre, and compute the resulting magnetic field.

"This investigation which I made in Pasadena showed that the lines of magnetic force due to a plane whirl of the kind mentioned above are space-curves whose projections on the plane of the whirl are also logarithmic spirals intersecting the first at right angles.

"This result led me to the idea first advanced by Brester in 1909, that the hydrogen flocculi resemble terrestrial auroras, thus implying that the visible whirls are not real current-lines, but lines of magnetic force due to a magnetic field at a lower level—a view expressed by Deslandres in 1910. Professor Hale had previously stated in his papers that the Zeeman effect

[1] "Some New Possibilities in Solar Research," NATURE, July 3, 1926, Supp. p. 1.

[2] "A Test of the Electromagnetic Theory of the Hydrogen Vortices surrounding Sunspots," *Communications from the Mount Wilson Observatory*, No. 95; *Proc. National Academy of Sciences*, **11**, 691; 1925.

[3] *Contributions from the Mount Wilson Observatory*, No. 109; *Astrophysical Journal*, **43**, 347; 1916.

was probably due to a low-level vortex. In accordance with the mathematical result mentioned above, the current-lines of this hypothetical whirl at a low level would be logarithmic spirals tending more and more to become circles according as the structure of the hydrogen whirl tended to be radial. This would much better explain the strength of the Zeeman effect of sunspots of radial structure."

Störmer's theory was developed merely as a working hypothesis and not as an expression of his opinion regarding the nature of these phenomena. According to the theory, the direction of the apparent whirl shown by the hydrogen flocculi (curvature of the projected lines of force), clockwise or counter-clockwise, should depend upon the sign, motion, and direction of the invisible low-level electric current surrounding the spot. As I have shown elsewhere,[2] a considerable modification of Störmer's theory, which was tentative in character and unavoidably based upon inadequate observational data, would be necessary in order to adapt it to the conditions as now known. If such modification be possible, the direction of curvature of the lines of force (and hence of the hydrogen flocculi supposed to follow them), clockwise or counter-clockwise, must conform with the magnetic polarity of the spots in question, if two reasonable assumptions are permissible. These assumptions are that the sign of the charge of the particles producing the field, as well as the direction of any radial component of motion, inward or outward, are invariable in all single spots and in the preceding spots of bipolar groups. While the evidence is insufficient, there seems to be no reason to doubt the validity of these assumptions. We may thus have a simple criterion which should enable us to determine whether the apparent vortices in the solar atmosphere surrounding single spots represent the lines of force of their magnetic fields. If so, the direction of curvature, clockwise or counter-clockwise, should be determined by the polarity of the field in question.

In the paper just cited, I have given the results of a preliminary test, based upon an examination of 51 hydrogen whirls photographed at Mount Wilson on various dates scattered over the period 1908–1924. Summarising the polarities and directions of whirl without regard to date, spot-type, hemisphere, or latitude, we find :

No. of spots.	Polarity.	Direction of whirl.
9	N	Clockwise.
16	N	Counter-clockwise.
13	S	Clockwise.
13	S	Counter-clockwise.

These results thus offer no support to the electromagnetic hypothesis. The same results, however, when grouped for the northern and southern hemispheres, show that 81 per cent. of the northern whirls are counter-clockwise and 84 per cent. of the southern whirls are clockwise, irrespective of the magnetic polarity of the accompanying spot, thus agreeing in direction with terrestrial cyclones.

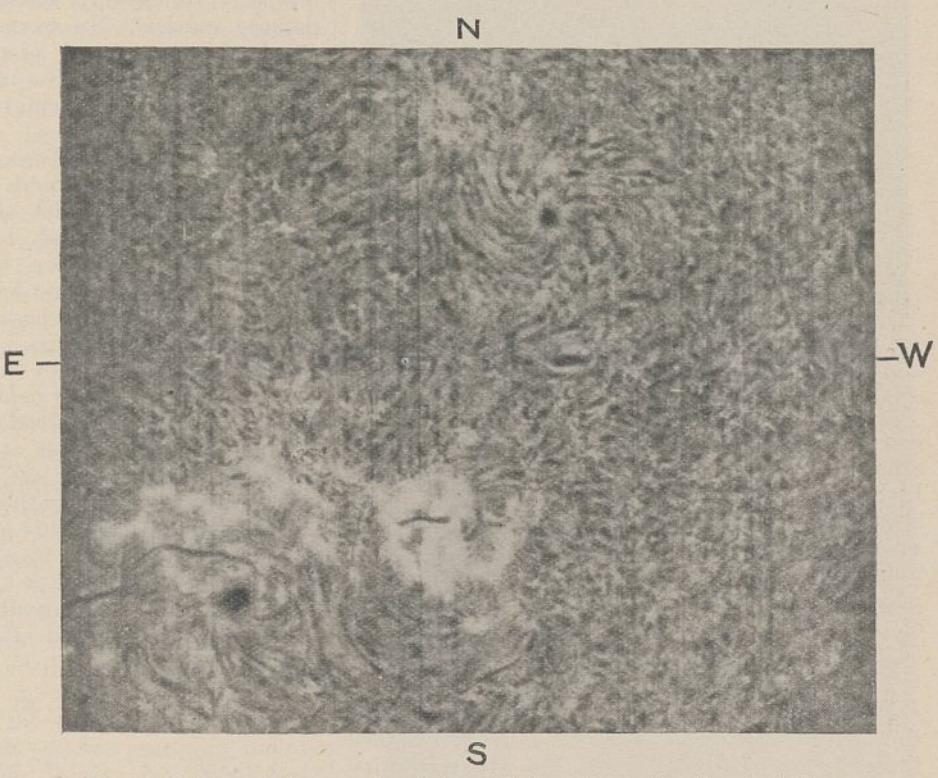

FIG. 2.—Hydrogen whirls surrounding single spots in the northern and southern hemispheres, July 21, 1919.

The directions of whirl in the northern and southern hemispheres are counter-clockwise and clockwise respectively. The northern spot is of north polarity and the southern spot is of south polarity.

I have since made a more critical examination of this question, excluding members of bipolar spots and other cases of low weight included in the above summary, and adding a number of other cases of high weight. Limiting the results to single spots, which are usually more trustworthy than the preceding members of bipolar groups, we have :

No. of spots.	Polarity.	Direction of whirl.
11	N	Clockwise.
14	N	Counter-clockwise.
12	S	Clockwise.
6	S	Counter-clockwise.

These results seem to prove beyond doubt that the direction of whirl at the level of the hydrogen flocculi is not determined by the magnetic polarity of the underlying spots. Apparently, however, it is determined by the hemisphere, as 83 per cent. of all these whirls are counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The significance of this correspondence with the terrestrial law of cyclonic storms seems to be greatly enhanced by the fact that hydrogen whirls, which are distributed over two successive 11½ year cycles, show no indications of reversal in direction following the sunspot minimum, corresponding to the reversal of the magnetic polarity of the spots that occurs in each hemisphere at this epoch (Figs. 2 and 7).

FIG. 3.—Spectroheliogram showing hydrogen whirls surrounding the spots of the southern bipolar group of Aug. 15, 1926. Both are clockwise and both showed inflow, as illustrated for the preceding spot in Fig. 4.

TESTS WITH THE SPECTROHELIOSCOPE.

Mount Wilson spectroheliograms taken during the present spot cycle, so far as I have examined them, are in harmony with the above results. Before reaching a final conclusion, however, it seemed advisable to make an independent test of the whole question with the spectrohelioscope, especially in view of the apparently serious difficulty presented by the fields of force of the bar-magnet type which so often characterise bipolar spots.

On account of my inability to make daily observations, and the necessity of devoting much of my attention to the various new phenomena revealed by the spectrohelioscope, the number of whirls included in this visual test is not large. Counting all cases, we find 14 (78 per cent.) in harmony with the terrestrial law and 4 opposed. All of the exceptions were associated with members of bipolar spots. Retaining only the single spots and the members of bipolar spots of highest weight, there remain 6 whirls (75 per cent.) agreeing in direction with terrestrial cyclones and 2 of the opposite sign.

In making these tests the spectrohelioscope offers some great advantages. On spectroheliograms the direction of whirl is generally inferred from the form of the hydrogen flocculi, on the assumption that the flow is spirally inward. As a rule, a series of photographs taken in quick succession does not help materially, because the critical moments at which large flocculi are drawn into the whirl are infrequent, and thus are usually missed if visual observations cannot be made for guidance. At long intervals, however, a series of photographs thus taken blindly may chance to record a great inflow of hydrogen, like that illustrated in my first article on "Solar Vortices" in 1908.[4] No case at all comparable with this in scale occurs among our thousands of photographs taken since that time. Similarly, we have few satisfactory records showing definite outflow. In examining a single photograph, or a series of photographs taken under customary conditions, we may therefore be left in doubt whether the flocculi really indicate inflow or outflow.

With the spectrohelioscope, however, there is much less room for doubt. In the course of my visual observations with this instrument I have repeatedly seen intensely black hydrogen flocculi, sometimes of great size, suddenly develop near active spots. When first formed, these are usually found to be rising at high velocity from regions marked by bright hydrogen flocculi, and if near the centre of the sun they may completely escape detection by the spectroheliograph unless they give an Hα line sufficiently wide to overlap the second slit (supposed to be set at the centre of the undisplaced line). They are easily picked up with the spectrohelioscope by the aid of the line-shifter—a plane parallel glass plate in front of the oscillating second slit, which can be rotated so as to displace the Hα line toward red or violet while observations are in progress. The divided circle on which this glass plate is mounted affords a quick and easy means of measuring the radial velocity of any portion of a hydrogen flocculus. At the beginning of a set of observations the second slit is adjusted so as to coincide with the centre of Hα when the glass plate is parallel to the plane of the slit and thus produces no displacement. This gives the zero of the circle. To measure the radial velocity

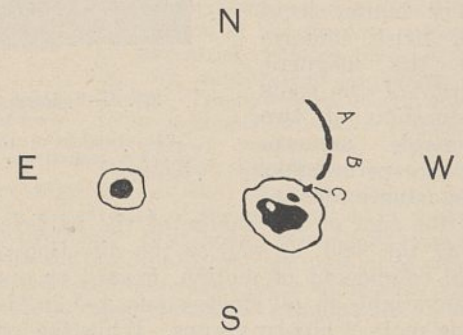

FIG. 4.—A new effect of inflow. Rapid acceleration in the radia velocity of the inflowing hydrogen is shown by the change in appearance of the flocculus from A through B to C when observed with light of increasing wave-length.

[4] *Contributions from the Mount Wilson Observatory*, No. 26; *Astrophysical Journal*, **28**, 100; 1908.

the glass plate is turned so as to move Hα toward the red, and several readings of the circle are made at the point where a bright or dark flocculus just begins to become visible against the background due to the continuous spectrum. This gives the wave-length (after calibration of the circle) of the violet edge of the bright or dark Hα line in this part of the flocculus. A similar series of settings on the other side of the zero gives the wave-length of the red edge of the line, and half their sum (if the intensity curve is symmetrical) gives the centre of the displaced line, which may differ by an Ångström or more from the centre of Hα. A quicker but somewhat less accurate method is to take several readings of the circle corresponding to the position of estimated maximum intensity of the flocculus (centre of the displaced line).

In exploring the hydrogen atmosphere around a sunspot the observer keeps this line-shifter in constant use, turning well to the red and violet in order to detect rapidly moving objects. When such are found, he may observe and record the quick changes in form and radial velocity which make these observations so fascinating. Evidently we have in this simple device a certain means of determining not only the direction of whirl but also the varying radial velocity of a flocculus as it is swept toward a spot.

A New Effect of Inflow.

The spectrohelioscope thus offers two distinct methods of distinguishing between inflow and outflow: (1) By watching the approach of a flocculus toward a spot, as in the photographic record of 1908 just cited; and (2), when no such phenomenon is in progress, by utilising a beautiful effect first clearly recognised on Aug. 15, 1926—the progressive advance toward a spot of the maximum of intensity of a curved flocculus when the wave-length of the light entering the second slit is increased by rotating the line-shifter.

The spot in question was the preceding member of a bipolar group (Mt. Wilson, No. 2656) at 18° south latitude, then about 4° east of the central meridian. This spot was of north magnetic polarity, strength of field 2800 gausses; the following spot was of south polarity, with a field-strength of 2500 gausses. The beautiful details of the Hα field of force surrounding the group (Fig. 3) were clearly seen, and one of them, the curved flocculus shown in the sketch (Fig. 4), which was more intense than the others in the same region, was selected for observation. When the circle of the line-shifter indicated a radial velocity of +22 km. per second, only the outer part of the flocculus (A in Fig. 4) was visible. As the line was displaced farther to the violet, the flocculus seemed to move from A to B, the portion B corresponding to a velocity of +45 km. per second. When the second slit was about 1·1 Ångströms to the red of the centre of Hα, corresponding to a velocity of about +50 km. per second, nothing remained visible of the flocculus except the black dot C on the edge of the penumbra. At still greater displacements the dot faded away and finally disappeared. The apparent advance of the flocculus toward the spot and the disappearance of all but the head were observed as often as the Hα line was moved across the second slit from violet toward red.

It is interesting to note the accelerating radial velocities indicated by the successive slit positions, increasing from 22 km. per second at a distance of 56,000 km. from the centre of the spot (A) to 45 km. per second at a distance of 36,000 km. (B) to about 50 km. per second for a distance of 20,000 km., corresponding to the dot marking

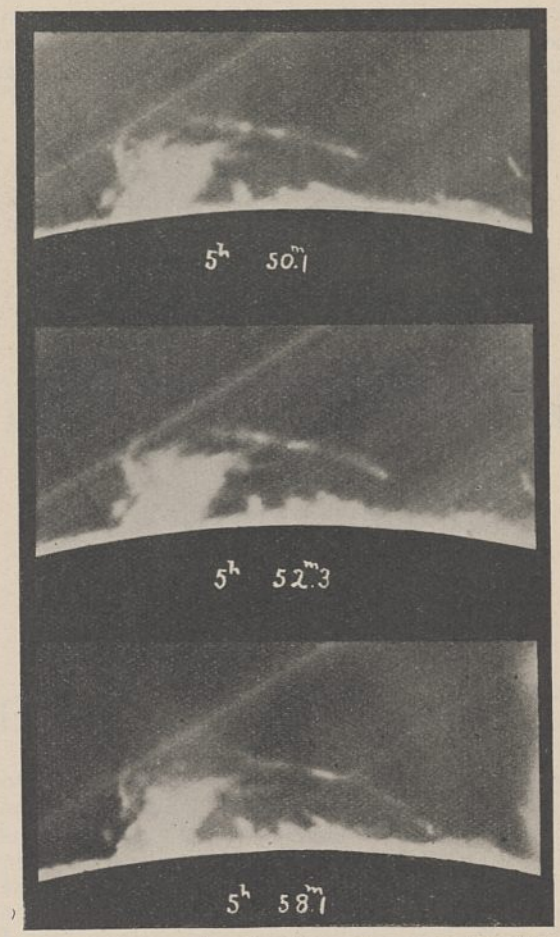

FIG. 5.—Slocum's photographs of the prominence of Oct. 22, 1910, showing inflow toward the spot at accelerating velocities.

the inner extremity of the flocculus on the outer edge of the penumbra (C). These values are not of the highest precision, but they cannot be far from the truth.

We at once recall the flow of prominences into sunspots,[5] as photographed in elevation at the sun's limb by Slocum with the Rumford spectroheliograph (Fig. 5). Another series of calcium spectroheliograms of the prominences surrounding a large spot at the sun's limb on Oct. 8, 1910, is also

[5] It should be clearly understood, however, that Fig. 5 represents three successive stages in the inflow of the tip of a prominence, whereas in the case illustrated in Fig. 4 the tip had already reached a point above the edge of the penumbra before the observations were begun. With a rather wide second slit, nearly the whole length of this curved flocculus (*A* to *C*) could be recorded in a single photograph, as shown in Fig. 3.

reproduced in his article on "The Attraction of Sunspots for Prominences."[6] Slocum directs attention to three bright knots on a long streamer, which gave velocities along the apparent trajectory of 16 km., 20 km., and 60 km. per second, at distances of 170,000 km., 130,000 km., and 75,000 km. from the centre of attraction. Pettit, who re-measured these plates, got velocities of 5 km., 8 km., and 44 km. per second respectively. From these and other measures Pettit concludes: "Normally the matter about the spot is moving into it with accelerated velocities averaging about 35 km. per second, sometimes reaching 100 km. per second." Both Slocum and Pettit found that jets may be projected away from a spot at similar

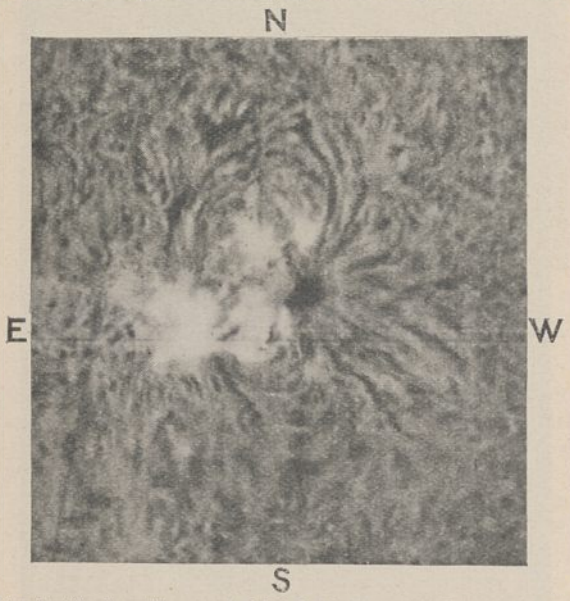

FIG. 6.—Single northern spot of July 9, 1919, connected with following eruptive centre by hydrogen flocculi resembling field of force shown by magnetic poles of opposite polarity. (Compare also Fig. 1.)

velocities, but Pettit[7] does not consider them to represent the normal condition. Evershed, on the contrary, in discussing his Kodaikanal observations of prominences, says: "No case has been found in which prominences were falling into sunspots, but the reverse has several times been observed."[8] The difficulties involved are sufficiently indicated by these differences in opinion among experienced observers, but fortunately most of these are removed by the spectrohelioscope, in so far as the determination of the direction of flow and the radial velocity are concerned.

It is evident, however, that the observed radial velocity must depend upon the velocity along the true trajectory and the angle between this trajectory and the line of sight. If the trajectory is parallel to the solar surface, and the spot, as in the present case, is near the centre of the sun, there will be no displacement of Hα, and the entire flocculus will be visible when the second slit of the spectrohelioscope is set on the centre of the line. Judging from the characteristic forms of prominences at the sun's limb, this is usually the condition of affairs at a considerable distance from a spot, though it often happens that at such a point the hydrogen is rising rapidly from below, thus producing a marked displacement of Hα toward the violet when observed near the centre of the sun. Nearer the spot, as the prominences at the limb discussed by Slocum and Pettit indicate, the trajectory makes an angle with the sun's surface ranging from small values up to 45° or even more. At the limb, the projection of the trajectory is usually nearly a straight line over a great part of its length, and the increase in the radial component of the velocity observed on the disc as the spot is approached is doubtless due chiefly to the acceleration found by Slocum and Pettit. Sometimes, however, their limb photographs show that the tip of the inflowing prominence turns down close to the spot, and in spectrohelioscope observations made near the centre of the disc, this might account in such cases for an increase in the radial component of the velocity at this point, without a corresponding increase in the acceleration along the trajectory.

The curved flocculus shown in Fig. 4 probably represents a prominence of moderate height. If we assume the trajectory to make an angle of 30° with the sun's surface, the corresponding velocities along the trajectory would be 44 km. per second for the outer part of the flocculus (A), 90 km. for the central part (B), and about 100 km. for the tip (C).

The observation of Aug. 15 proved to be typical, and it has been repeated in scores of cases, many of which will be described in detail in the *Astrophysical Journal*, where the bearing of these results on the work of St. John, Evershed, Fényi, Slocum, Pettit, and others will be discussed. In the present article I wish merely to point out this method of observation, in which the visibility of an object emitting approximately monochromatic light depends upon its radial velocity. The method evidently affords a valuable means of analysis, not merely of the hydrogen whirls but also of other important phenomena of the solar atmosphere. Among these are the fields of force of the bar-magnet type so often found in association with bipolar sunspots.

FIELDS OF FORCE SURROUNDING BIPOLAR SPOTS.

In the typical bipolar group the component spots, single or multiple, which form the preceding and following members are of opposite magnetic polarity.[9] If the group consists of two nearly equal spots, of opposite polarity, the magnetic field of force surrounding the group should resemble the field surrounding two opposite magnetic poles. The question before us is whether the observed structure of the hydrogen flocculi, at a considerable height above the sunspot level, actually represents such an electromagnetic field as Störmer's theory would indicate.

[6] *Astrophysical Journal*, **36**, 265; 1912.
[7] "The Forms and Motions of the Solar Prominences," *Pub. Yerkes Observatory*, **3**, part 4; 1925.
[8] *Memoirs Kodaikanal Observatory*, **1**, part 2; 106.
[9] See Hale and Nicholson, "The Law of Sunspot Polarity," *Contributions from the Mount Wilson Observatory*, No. 300; *Astrophysical Journal*, **62**, 270; 1925.

We have seen that the evidence offered by the fields of force associated with single (unipolar) spots does not support the theory, and a glance at the bipolar group of Aug. 15, 1926 (Fig. 3), shows a similar lack of agreement. The hydrogen whirls surrounding the preceding and following spots were examined visually by the method just described, and a definite inflow was repeatedly seen. This agreed with the spectroheliograms in showing the direction of whirl to be clockwise about both spots, in spite of their opposite polarity. Moreover, on Aug. 16 a long, slender, dark flocculus, which had apparently risen from a bright flocculus south of the group, was found to indicate inflow toward the eastern extremity of the preceding spot along a trajectory lying nearly at right angles to the lines of force. Many similar cases in apparent contradiction with the theory might be cited.

On the other hand, structure like that shown in Fig. 1 is so common that it may almost be called typical. In such cases the Hα flocculi surrounding a bipolar group strongly suggest the lines of force about two opposite magnetic poles. What evidence bearing on the nature of this structure is afforded by the spectrohelioscope?

On May 31, 1926, while observing spot No. 2571 (8° S., 20° E.) with the spectrohelioscope, I noticed a curious dark arch following the spot. The preceding end of this arch, which was seen when the second slit was on the violet side of Hα, seemed to rise from a small bright flocculus a short distance east of the spot. The central part of the arch, farther to the east, appeared when the slit was near the centre of Hα, but its eastern extremity, where it seemed to curve back toward the surface of the sun, did not become visible until the slit was well beyond the boundary of Hα toward the red. Obviously we have here a dark arched prominence, rising with high velocity from a bright source near the sunspot, pursuing a curved trajectory, the central part of which was nearly normal to the line of sight, and falling with high velocity at a point well to the east of its origin.

Since that date I have observed many of these arches. In a bipolar spot group three or four may often be seen at once, rising from a region of bright flocculi and falling at a distance, sometimes on the penumbra of one of the spots, sometimes elsewhere. When the velocities are high and the oscillating slits narrow, only a short section of an arch may be visible at a given position of the second slit on Hα. To show the whole arch, the line-shifter must be employed. As the line moves across the slit from violet to red, the maximum of intensity may be seen rising from the source of the ascending branch, passing along the trajectory, and running down the descending branch, which often seems to terminate in a rather definite dark head. The effect is of course different in different parts of the sun, because it depends upon the angle between the true trajectory and the line of sight. In general, it is best observed in the central part of the disc, but I have frequently used the method with good success near the limb.

These applications of the spectrohelioscope will serve to illustrate its advantages over the spectroheliograph when rapidly moving objects are under examination. Although I long ago recognised certain arches among the Hα flocculi on spectroheliograms, and made a study of them by stereoscopic and other means in 1925, I could only suppose, but not prove, that the bar magnet structure might be due in part to them. In this study I made use of a series of spectroheliograms taken with the second slit set on the red and violet sides of Hα, and inferred that their differences might be caused by motion of the gas along the arch. More can be learned in a few minutes, however, from such visual observations as I have just cited than from the comparison of many spectroheliograms, unless these are made with the spectrohelioscope as a guide.

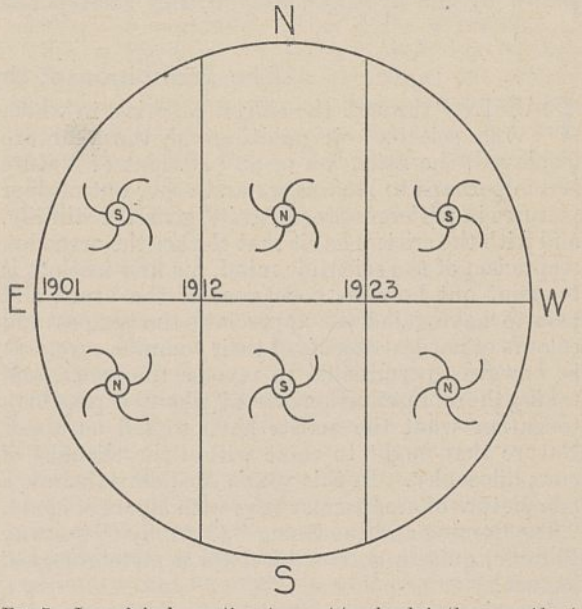

FIG. 7.—Law of single gyrating storms at two levels in the sun. About 80 per cent. of the high-level hydrogen whirls, in all sunspot cycles, are counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The underlying sunspot vortices, as inferred from the polarities of their magnetic fields, indicate opposite directions of whirl in the northern and southern hemispheres, and periodic reversal in direction of whirl at successive sunspot minima.

My spectrohelioscope and spectroheliograph are now being arranged for simultaneous use, so that I hope soon to have photographic records of the various types of phenomena described in this paper.

If groups of arched prominences originating in eruptive centres near the spots of a bipolar group are competent to account for the structure resembling the lines of force of a bar magnet, we might expect to encounter occasional indications of this structure between spots of the same polarity and also near single spots, *i.e.* where only one of the magnetic poles is present. I have found cases of both kinds on our spectroheliograms, one of which is illustrated in Fig. 6. The new evidence therefore seems to be strongly against the electromagnetic explanation, because of the phenomena exhibited by the inflowing gas and the apparent failure of the flocculi to coincide with the lines of force surrounding single spots, between pairs of spots of the same polarity, or between the members

of bipolar groups, where they often diverge, not from the magnetic poles (*i.e.* the spots themselves) but from bright eruptive centres at some distance from them. Nevertheless, as I shall show later, there still exist several difficulties in the way of accepting a purely hydrodynamical explanation of the structure accompanying single and double spots, and I am therefore reserving judgment until further studies can be made.

Whatever the results of these studies may be, I have already shown that many single spots are surrounded by hydrogen whirls, about 80 per cent. of which correspond in direction with terrestrial cyclones. We may therefore formulate an empirical law defining the direction of whirl of single gyrating solar storms (Fig. 7). For the high-level whirls shown by the hydrogen flocculi, this corresponds in all sunspot cycles to the terrestrial law, counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. For the underlying vortices which constitute sunspots the actual direction of whirl is not known, but we may safely infer from the resultant magnetic polarity of the spots that it is opposite in the northern and southern hemispheres and that it reverses at each sunspot minimum. In Fig. 7 the whirls represent the hydrogen flocculi and the letters N and S the magnetic polarities of the underlying spots in three successive cycles. A general law probably cannot be formulated for the hydrogen whirls above bipolar spots, but for the bipolar spots themselves the law has been given in a previous article.[10]

[10] "Sunspots as Magnets and the Periodic Reversal of their Polarity," NATURE, Jan. 19, 1924.

The Exhibition of the Royal Academy, 1927.

PASSING through the eleven galleries, in which 738 selected oil paintings of the year are displayed, the attention of any student of Nature is due perhaps to landscapes and other out-of-door pictures in preference to portraits, genre, or still-life, and with the critical habit that clothes the orthodox scepticism of the scientific mind, his first instinct is to point out how his colleagues of the brush and palette have failed to appreciate the shapes and colours of natural objects of their common care. It is, however, permissible to reverse the order, and taking the representations as real (wherever possible), to gather what the artists have to tell us about Nature that ought to come within the thought of our philosophy. In this year's Academy there is a fine picture of crepuscular rays with layers of cloud, "The Coming and the Going" (319), by C. Conway Plumbe, quite a good subject for a meteorological lecture.

Prominent in any exhibition of paintings are the colour of the sky and its gradation from a real blue up above, almost the cerulean blue of the poets, through a paler and still paler blue or green to a filmy, hazy white, or even dull grey, along the horizon, with or perhaps without any definite cloud in the visible sky. There are generally plenty of examples in any exhibition, and this one is no exception. In "Looking on to Antibes from Cagne, France" (162), Sir H. Hughes-Stanton gives a very good example; the same artist's picture of "Cagnes, Alpes Maritime, France" (241), is also typical, and in "Blackberries" (396), Harold Harvey has the gradation even too well marked. "The River Mill" (14), by Arnesby Brown, is also good. With less definite colour, "Shadow and Shine, Lake-end, Ullswater" (268), and "Loch Morar" (140), Sir David Murray, show beautiful gradation, and "November" (274), Hughes, is good enough. If we can believe what the artists tell us, there are days and places where the nebulous whiteness covers the whole sky and the gradation is of cloudiness, from the whitening of the blue above to the leaden skies which are characteristic of the British Isles. We can find examples of that kind of nebulosity in "Grey Morning" (35), by Arthur E. Law, and "Sand Dunes on the Kentish Coast" (36), by Oliver Hall. W. L. Wyllie has the same touch in his picture "Waterloo: The Doomed Bridge" (128) and his "A Suggestion for the New Charing Cross Bridge" (139). W. W. Russell, in "Rochester: Evening" (53), also gives us an example of pervading and graduated greyness.

Artists, indeed, clearly differentiate themselves by their appreciation of detail and of colour; some see the blue and its gradation, and some apparently are more apt to see the greyness, or only paint a landscape when it is suffused with grey. The difference of habit is perhaps not all temperament. The photographic eye, which in these days ranges beyond the visible on either side, shows the same kind of discrimination. A photograph in the light of the extreme red is conspicuous for its clear definition, whereas the same landscape in ultra-violet light is hazy. An exhibition of paintings moves us to wonder whether different eyes are in some way sensitive beyond the visible range and whether some artists specialise in the infra-red, while others range themselves with the ultra-violet.

This carries us from the landscapes to the portraits, for in them we find an echo of the same kind of difference. Some portraits are meticulously detailed and not infrequently also ruddy, while others are suffused with a sort of mistiness and have a paler cast. The portraits by Orpen are conspicuous for their definition and their colour. In (723) Prof. J. A. Fleming forces a hard smile while floating in a sea of scarlet and yellow. Lavery, in like manner, has marked definition and bold colour; but Solomon J. Solomon paints The Right Rev. the Lord Bishop of Worcester (44) in the more hazy part of the spectrum and with less violent definition.

Talking about culture and civilisation, philosophers have classed art, music, literature, and the mathematics as corresponding expressions of human genius and, like the rest of them, the artist expresses by his treatment not merely his subject but also himself. His true aim is not a perfect autochrome but something that through the material displays the

divinity that shapes his ends and ours. His claim that he can paint only what he sees must be set aside. Through the pictures we can obtain a sort of line spectrum of the artist. There is a good deal of interest in carrying that idea with one through the Academy exhibition. Of course the artist is not everything; the sitter as the medium of expression counts for something. It is clear from the exhibition that men are mostly clothes, sometimes little else, and women, with here and there an exception, are jewel stands. Clerics have a strong vein of pessimism, with the exception of the Bishop of Worcester; 'dons' are complacently resigned; politics, commerce, and industry are built up round an artificial smile; and marquesses are sly—very sly. But in spite of these intrusions into the natural spectrum we have to ask ourselves what are the lines belonging to the artist. For Orpen there is a strong line of realism and humanity towards the infra-red; he even goes so far as pinning down the unavoidable humanity of Miss Penelope Lawrence, M.D. (143), though he excuses women more easily than men. So does Sir John Lavery. Outside humanity there are not many lines in Orpen's spectrum. We can find more in Jack's picture of H.M. The Queen (133), and still more in his "The Blue Drawing-Room, Buckingham Palace" (103). There is something, too, in La Thangue's "Tying Watercress" (255) and Mrs. Dod Procter's "Morning" (735). W. W. Russell's spectrum is so nearly continuous that he seems to be waiting for a reincarnation either of himself or his sitters to suggest a relation of life's enigmas.

If a crowd round a picture at the private view is any clue to its greatness, "Paolo and Francesca" (179), by F. Cadogan Cowper, seemed to be the favourite, and certainly it is an impressive scheme of colour; but still more on the side of the mystery of divinity is "The Enchanted Road" (350), by F. O. Salisbury, or "Svilata, Avati and Augali Sen, Daughters of Mr. and Mrs. Rimsod Sen" (652), by the same artist, and Clausen's "The Nut-brown Maid" (566). The mystery is not confined to portraits; it is quite impressive in "Theatre Marcellus" (75), by Sydney Lee, though the picture belongs to the red end of the artistic spectrum. But spectrum analysis of character is a perplexing study. Those who visit the Academy may take with them their own instruments. "Quai des Grands Augustins, Paris" (86), by Charles Cundall, is good for demonstration.

Obituary.

PROF. E. H. STARLING, C.M.G., F.R.S.

A FEW days ago news was telegraphed from Jamaica that Prof. Ernest Starling died on board the *Ariguaing* shortly before reaching Kingston. Of late years he had had indifferent health and had suffered from disabilities under which one of less heroic spirit could not have continued to work strenuously. His enthusiasm for the discovery of new truths was unimpaired, and his mind was so sympathetic and alert that it was difficult to believe he was not a sound man. Nevertheless, evidences of diminishing capacity for work without undue fatigue were obvious to his friends and a source of anxiety to them.

At the close of the winter session, during which he had been daily occupied with arduous experiments, he was very tired. The weather was cold and dull, and he longed for sunshine and warmth. He therefore decided to take a voyage to the West Indies, in full hope that this would restore his energies and enable him to continue with enjoyment the experimental work with which he was occupied. However, that was not to be, but he had the satisfaction of going down with his flag flying, as he would surely have desired.

Ernest Henry Starling was born in 1866. His father, H. H. Starling, was Clerk of the Crown at Bombay. The family of seven children had perforce to be educated in England. They therefore saw but little of their father and were brought up by their mother, an extraordinary woman, and it is to her influence by heredity and nurture that Starling owed his determination, mental alertness, and much of his charm. As the eldest boy, in the absence of a father he early acquired a sense of responsibility and capacity for managing his affairs, and was, in some respects, unusually mature for his years. He was educated at King's College School. He left at 16½ years of age, having matriculated at the University of London with honours, and proceeded to the study of medicine. He chose Guy's Hospital because his uncle was a Guy's man.

At this time Starling's ambition was to be a physician and live in Harley Street, and it was not until a few years later that he began to doubt the all-sufficiency of this ideal and to contemplate the possibility that he might be able to devote himself to an academic career and perhaps become a discoverer himself. As soon as he touched the study of natural science it was clear that Starling had found his *métier*. The causal relation of facts enthralled him. He was intensely curious, and had a naturally scientific mind. He was gifted with fine intellectual machinery, a good memory, industry, and possessed great powers for work, and it was soon clear to his teachers that they had a very exceptional pupil. The teachers of natural science at Guy's in those days were men of distinction, but they only called for a few hours weekly to deliver their lectures. The one who made a great impression upon Starling was Dr. Debus, of the Royal Military Academy, Woolwich, who gave part of the lectures on chemistry. He was a fine teacher, and the enthusiasm with which he expounded the elements of chemistry was infectious.

At the examination in preliminary scientific subjects at the University, Starling obtained the first place in chemistry and botany and second place in physics. He obtained so many medals and prizes as he proceeded through his medical course that an account of these academic victories at university and hospital would be wearisome. About two-thirds of the academic honours available

were secured by him, including a free studentship at Guy's Hospital. These various college and university scholarships sufficed to maintain him, and if he had liquidated the many gold medals awarded to him he would have been able to enjoy comparative affluence.

Physics and chemistry attracted him and the generalisation of biology, but it was when Starling came to study physiology that he met his fate. It cannot be said that his affection for physiology was due to his teaching at the Hospital. It was largely his own discovery, but Foster's text-book made a great impression upon him. After two years' study of physiology, during which he read many original papers, including all the back numbers of the *Journal of Physiology*, he had determined, I think, to become a physiologist, if such a career was economically possible. He had felt the deprivation due to his inadequate knowledge of German, so, after disposing of his second technical examination in 1886, he went, largely with the idea of improving his German, for a few months to Heidelberg, and worked in Kuhne's laboratory. He returned at the end of the year with his hair *en brosse*, much teutonised, and more than ever determined to become a physiologist, However, he had to put these aspirations aside for a while and devote himself to the study of practical medicine. This he did with his usual enthusiasm. Starling found great satisfaction and enjoyment in clinical work. The human side appealed to his sympathetic nature and the immediate value of the application of knowledge to his practical mind. If it had been possible to devote himself whole-heartedly to the study of medicine, as is now possible by the institution of full-time professorships, Starling would have been as happy investigating disease as in a physiological laboratory. Indeed, not many years ago he seriously considered accepting such a position.

Having completed his medical studies and occupied the position of house physician and house surgeon at the hospital and graduated M.D., Starling was confronted with the problem, how he was to live if he were to follow his desire and devote his life to physiology. With his brilliant career at the hospital, the profession of a physician was open to him and success undoubted. He was keenly interested in medicine and pathology, and the temptation to follow the line of less resistance and greater promise of reward was considerable. However, in 1889 he determined to try the rougher path, and became demonstrator in physiology. The rewards of this office were minute, and Starling told me that he owed the possibility of giving his allegiance to science to a British Medical Association Scholarship for medical research. The Scholarship was worth £150 a year, and this addition to his slender salary kept him going. Next year, owing to the death of Wooldridge, a vacancy as joint lecturer on physiology occurred and Starling was appointed. On the termination of the British Medical Association Scholarship he was appointed to the research scholarship of the Grocers' Company of the value of £250 per annum. It was not then so easy to embark on a scientific career without financial resources as it is now, and it is terrible to think how one of Starling's glorious attainments was nearly deterred.

He was confronted, not only with the problem of how he was to continue to subsist on one-third of a salary which was never intended to command the whole services of a physiologist, but also how he was to secure a physiological laboratory to work and teach in. The Grocers' scholarship temporarily solved the first problem, and he determined that adequate accommodation and equipment for teaching and research in physiology should ere long, by some means, be obtained. Meanwhile, being but one of three joint lecturers, he was able to arrange to go and work abroad occasionally. In 1893 he went to Breslau to work with Heidenhain, and later for a few months to the Pasteur Institute, as he was greatly impressed by Metchnikoff's discoveries about phagocytosis. In order that this work might be more available to English students, he and his wife translated Metchnikoff's lectures on comparative inflammation.

Until his hopes for a physiological laboratory should materialise, Starling did his best to secure some improvement of the arrangements for practical teaching and demonstration with the funds available; meanwhile he repaired to Schafer's laboratory at University College to carry on his researches. Bayliss was also working in the laboratory, and here began a scientific partnership which lasted on and off for thirty years. The two complemented one another in many respects. Whilst both possessed scientific imagination of the highest order, Starling was more ardent and forceful, eager to translate ideas into action, but rather bored with details of technical method. He had never been interested in doing things with his hands, except climbing, although later he became a most beautiful and dexterous operator. Bayliss was the philosophical student, calm, with better critical judgment. He read widely and had a wonderful knowledge of scientific literature, was an excellent mechanic, and found enjoyment in the development of the technical methods of research. How fruitful this partnership was will be seen from the account below of Starling's scientific work.

The equipment at Guy's Hospital steadily improved, and Starling and Bayliss did their work on the innervation of the heart there. By 1895 Starling had planned a really good physiological institute for Guy's Hospital, and secured the assent of the authorities to its erection. These laboratories were completed in 1897 and were, at that time, the best laboratories for physiology in London. The amount of time and effort involved in this accomplishment was considerable. Unwilling authorities had to be persuaded to provide territory and funds and colleagues to make sacrifices of their own legitimate aims, and although it was becoming recognised that Starling was going to be a great man and was an ornament to the staff, this was no easy matter.

Not long after the opening of the new physiological laboratories at Guy's Hospital, the Jodrell

chair of physiology at University College fell vacant owing to Schafer's acceptance of the professorship at Edinburgh. In 1899 Starling was appointed. It was a wrench to leave his fine new laboratories, to the construction of which he had devoted so much time, but the emoluments of the Jodrell chair were greater, and the conditions at University College he deemed more favourable to the realisation of his ideals. Moreover, he was determined that it should not be many years before he would have a new Institute of Physiology at University College, for the planning of which the Guy's laboratories would have served as useful exercise.

This determination came to fruition in 1909, when the present fine Institute of Physiology was opened. Starling's plan was not merely for a new physiological school, in which he was naturally more particularly interested, but he wanted all the medical sciences at University College to have the advantages of more commodious and nobler buildings. His original scheme was for an Institute of the Medical Sciences, including anatomy and pharmacology as well as physiology, with a central library, pathology being well housed in the new Clinical School. At first only the physiological section was built, but a few years ago the erection of the whole institute, as originally contemplated, was rendered possible by a generous gift from the Rockefeller Foundation, the directors of which were desirous of devoting funds in the interest of medical science in London. That they chose this particular means of fulfilling their aims was largely, if not entirely, due to Starling, and the noble Institute of Medical Sciences with which University College is now endowed is a fine material monument to the memory of one who not only helped to build up a great school of physiology in London and obtained an appropriate habitation for it, but also was as unsparing in his efforts to secure similar advantages for the other medical sciences.

In 1923 Starling retired from the Jodrell chair and was appointed to a Foulerton research professorship of the Royal Society. He still continued to work at University College, but was relieved of all administrative duties and all teaching except that of a small band of research pupils. His laboratories continued to be a centre of great activity, and a limited number of distinguished young physiologists from Great Britain and abroad still enjoyed the advantage of working in close communion with one of the greatest masters of experimental physiology. It was a happy family.

STARLING'S PHYSIOLOGICAL RESEARCHES.

"Only by following out the injunction of our great predecessor [Harvey], to search out and study the secrets of Nature by way of experiment, can we hope to attain to a comprehension of 'the wisdom of the body and the understanding of the heart,' and thereby to the mastery of disease and pain, which will enable us to relieve the burden of mankind." (Starling, Harveian Oration, Royal College of Physicians, 1923.)

Starling's interest in physiology was general, but the subjects for investigation which particularly attracted him were those physiological processes which seemed capable of interpretation in terms of chemistry and physics. Whilst realising that adaptation was the essence of organism and had no counterpart in inanimate nature, he had not much sympathy with the neo-vitalists. In his view, if the contraction of muscle was not understood, it was because we did not know enough about physics and chemistry or about muscle.

He was always, from his student days, fascinated with the problem of the heart and the adjustment of its action to varying conditions of the body, and his first paper, written with Bayliss in 1891, was on the electromotive phenomenon of the mammalian heart. Waller had recently studied the electrical variation of the excised heart and also of the heart *in situ* by leading off from the neighbourhood of the apex and base respectively. It was evident to Starling that by photographing the movements of the capillary electrometer, connected with electrodes placed in different positions on the naked heart in the anæsthetised living animal, much might be learnt of the nature of the cardiac contraction; in fact, that a new method of observation was at the disposal of the investigator. At that time, any sort of muscular continuity between the auricles and ventricles was denied, and the view that conductivity was due to some nervous network supplying the fibres was in favour. In this research he enjoyed the co-operation of Bayliss. They set out to ascertain the course and time relations of the wave of contraction in the ventricle, the nature of the transmission from auricle to ventricle and throughout the ventricle, and to examine critically Frédéricq's reasons for regarding the nature of the ventricular contraction to be tetanic.

They succeeded in showing (1) that the ventricular contraction is a single wave starting from the base; (2) that there is a natural block at the auriculo-ventricular groove; (3) that the rate of transmission of the contraction wave is about 5 metres per second. This sounds commonplace at this time, when the electrocardiograph is in general use for clinical diagnosis, but their observations not only formed an important step in the development of our knowledge of cardiac contraction and in the interpretation of disease of the heart, but also, by showing what valuable information could be obtained by the electrical method, stimulated its employment and accelerated the development of the electrocardiograph.

They next explored the separate action of the vagi and accelerator nerves on the auricles, on the ventricles, and on the conducting power of the auriculo-ventricular junction in the mammal. The effects of these nerves on the hearts of frogs and tortoise had been previously studied by Gaskell and Heidenhain, and that of the vagi upon the auricle of mammals. Bayliss and Starling completed the story, showing that there was no essential difference between the hearts of mammals and cold-blooded animals, and that the vagus depresses conduction in auricle, auriculo-ventricular junction and ventricle, and that the accelerator nerves had the opposite effects on all three structures.

Two other important papers dealing with the mechanism of the circulation were published by Bayliss and Starling at this time. One was an exhaustive study of the simultaneous changes in the arterial and venous pressures of various regions of the body under a great variety of experimental conditions. The results showed the universal applicability of the principle of the circulation worked out by Ludwig. They said, in their paper, that the effects produced were such as might have been predicted by any one with a knowledge of the elementary principles of the circulation. However, nobody had predicted them.

The last contribution of this first series of papers on the circulation was an analysis of simultaneous pressures in the aorta and ventricles of the heart *in situ*, by an ingenious method which was a vast improvement on any hitherto devised. They used a continuous photographic record of the changes in volume of a small air-space at the end of a capillary glass tube connected with the aorta and ventricle respectively. This method was free from inertia and aperiodic, and they succeeded in obtaining a true record of the rapid variations occurring in the ventricle and aorta and the precise relation of these to one another. Their measurements have been the tandard of reference ever since.

Transudation from the Vessels and Lymph-flow.

In 1892, Starling, for a while, relinquished the study of the blood circulation and turned his attention to the mechanism of lymph flow. The conditions determining the equilibrium between the liquids in the blood-vessels and tissue spaces required exploration. Was lymph a transudation or an excretion? Heidenhain had recently published a stimulating paper on lymph formation, in which he concluded that normally filtration played no part in the formation of lymph, so in 1892 Starling went to work in the Breslau laboratory.

Heidenhain had distinguished two kinds of lymphagogues, and under his inspiration Starling set to work to make a more detailed analysis of the effects of one of them, peptone. In summarising his results he adopted the interpretation of Heidenhain that the experimental facts concerning lymph formation could not be explained by filtration and that it was necessary to suppose a selective activity on the vessel wall. However, on returning to England he continued to work energetically at the problem of lymph formation and repeated all of Heidenhain's experiments. He was able to confirm his facts but came to doubt the correctness of his interpretation. He searched for evidence of lymph-secretory nerves, but found that the nervous system could only influence lymph flow by altering vascular conditions. After years of experimenting he came to the conclusion that it was unnecessary to suppose a secretory activity of the endothelium, and that there was no experimental fact inconsistent with the view that lymph formation was a function of two factors, permeability of the vessel wall and intracapillary pressure. Nevertheless, there were a number of observations equally unintelligible on either hypothesis, and further work with Leathes and Tubby on the absorption of various solutions from the pleural cavities only emphasised that there was yet another factor concerned in determining whether fluid passed in or out of the capillaries.

In 1896 Starling discovered that the missing factor required to afford a complete interpretation of the phenomena was the osmotic pressure of the colloids, to which the walls of the capillaries are relatively impermeable. It had hitherto been supposed that the osmotic pressures of proteins, being so insignificant compared to those of salts, must be of no account in physiological processes. The reverse is indeed the case, because it is only to the proteins that the membrane is impermeable. He therefore set to work to measure the osmotic pressures of the proteins in serum and found them to be, though small, of the order of magnitude of the capillary pressure. The problem was solved. The hydrostatic pressure and the osmotic pressure supplied the balance of forces necessary to explain the experimental observations. These, together with altered permeability of the endothelium, are capable of supplying a reasonable interpretation of ædema and pleural effusion, and formed the subject of his Arris and Gale lectures to the Royal College of Surgeons in 1926.

Starling's work on lymph formation occupied five years, and is of the best he did. After long-continued and difficult experimentation, combined with observation of the highest order of accuracy, this hitherto obscure but fundamentally important region of physiology was finally illuminated by his dexterous experimentation and triumphant imagination.

The Movements and Innervation of the Intestines.

When Bayliss and Starling undertook this study, the nerve supply to the small and large gut had been carefully determined by Langley and Anderson, but of the working of the neuromuscular mechanism there were many discrepancies as to fact and opinion. After eighteen months' careful experimenting, with appropriate recording methods devised for the purpose, they were able to reduce the previous chaos to order and to summarise the main facts concerning intestinal movements in a few simple statements. (1) That peristaltic contractions are true co-ordinate reflexes carried out by the local nervous mechanism and independent of the connexion with the central nervous system. (2) Local stimulation of the gut produces excitation above, inhibition below. (3) Besides the local mechanism, every part of the gut is subject to the control of the central nervous system through the splanchnics and vagi, the former being inhibitory and the latter containing both augmenting and inhibitory fibres. This was as far as understanding of the matter progressed until Cannon introduced the method of observation by means of X-rays in an animal fed upon a bismuth meal.

Pancreatic Secretion.

The discoveries of Pawlow had determined the order of events in gastric secretion and their co-ordination through the agency of the nervous system, but although he had found that no secretion from the pancreas occurred until the acid chyme reached the duodenum, just how pancreatic secretion was called forth in an appropriate manner had baffled this great experimenter and his pupils. Popielski had determined that the introduction of acid into the upper part of the small intestine caused secretion from the pancreas, notwithstanding previous section of the vagi and sympathetic or even complete extirpation of the solar plexus. He concluded, therefore, that secretion must be brought about reflexly, by means of some local nervous apparatus.

Bayliss and Starling started their investigations with the idea of deciding where this peripheral nervous mechanism was. They verified all the facts stated by the Russian physiologists but were unsuccessful in proving the existence of any nervous mechanism controlling pancreatic secretion. Nor could they discover how secretion was brought about until they made the crucial experiment which led to the discovery of secretin.

I happened to be present at their discovery. In an anæsthetised dog, a loop of jejunum was tied at both ends and the nerves supplying it dissected out and divided so that it was connected with the rest of the body only by its blood-vessels. On the introduction of some weak hydrochloric acid into the duodenum, secretion from the pancreas occurred and continued for some minutes. After this had subsided, a few cubic centimetres of acid were introduced into the enervated loop of jejunum. To our surprise, a similarly marked secretion was produced. I remember Starling saying, "Then it must be a chemical reflex."

Rapidly cutting off a further piece of jejunum, he rubbed its mucous membrane with sand in weak hydrochloric acid, filtered and injected it into the jugular vein of the animal. After a few moments, the pancreas responded by a much greater secretion than had occurred before. It was a great afternoon.

Bayliss and Starling followed up their discovery in many important directions which space forbids me to mention. A method of obtaining natural pancreatic juice was now available, and they made full use of their opportunities to study trypsinogen and its conversion into trypsin by enterokinase. Their observations were afterwards summarised and their significance illustrated in their Croonian lecture to the Royal Society in 1904.

Starling was also moved by them to much constructive thought and further research on the chemical integration of the bodily functions generally. He proposed the name 'hormones' or chemical messengers for all such active principles formed in one part of the body and distributed by the circulation to excite the normal functioning or stimulation of growth of other parts. This fascinating story, embellished with a wealth of illustration, formed the subject of his Croonian lectures to the Royal College of Physicians in 1905, entitled "The Chemical Correlation of the Functions of the Body."

Researches upon the Isolated Heart.

The behaviour of the heart had interested Starling from the time he was a house physician. His earliest work was upon the heart, and though he diverged into other fields of investigation, the questions which intrigued him at that time always retained their fascination. In 1909 he returned again to their investigation. He had been attempting to dissociate the effects of asphyxia on the circulation into those due to diminished oxygen and increased carbonic acid tension respectively. He used the 'spinal animal,' that is, one in which the brain above the pons has been destroyed. He obtained some interesting information, but the observations were difficult to interpret until he should be able to separate the effects of alteration in the gaseous composition of the blood upon the heart itself.

To arrive at this, it was necessary to be able to record the influence of variations of carbon dioxide and oxygen upon the mammalian heart isolated from the nervous system and not subjected to any simultaneous modification in its nutritive state, in the inflow of blood, or in the amount of work it was called upon to do. To satisfy these requirements the heart must be isolated from the rest of the body and at the same time fed with a constant supply of perfectly oxygenated blood; it must be working under mechanical conditions completely under the control of the experimenter. This was accomplished by a device, now famous, known as Starling's heart-lung preparation, in which the lesser circulation is intact, but the only paths from the left ventricle to the right auricle are (1) through the coronary arteries, (2) through an artificial connexion in which the resistance can be regulated. By appropriate means the pressure and flow in different parts of the circulation can be recorded and also the volume of the blood circulation per unit time and the work done by the heart. If required, the gaseous metabolism of the heart contracting under various conditions can be studied. The limited amount of blood in circulation permits analysis of its contents from time to time. Further, the method is admirably adapted to the observation of the direct effect of drugs, etc., upon the mammalian heart, working under every conceivable condition. Nor does this exhaust the possibilities of Starling's heart-lung preparation as an engine of research into cardiological problems. The flow through the coronary circulation can, if necessary, be diverted and measured so that change in the blood-supply to the cardiac muscle can be determined.

After the perfection of this technique, a series of discoveries were made by Starling and his pupils, which, in conjunction with those of Lewis, have made the laboratories of University College as famous a focus of research upon the circulation as was the laboratory of Carl Ludwig sixty years ago.

The years immediately succeeding the development of this method of studying cardiology were the most productive, from the point of view of scientific output, in Starling's career. He was surrounded by enthusiastic and devoted pupils drawn from all over the world. He had plenty of problems for them to attack, with every prospect of a reasonable reward for their efforts. Starling was unsparing in helping them towards their solution, often performing the more difficult parts of the experiments himself and afterwards writing their papers for them.

It is only possible to indicate the principal researches undertaken and the more fundamental facts established by this happy band of discoverers until it was scattered by the outbreak of war in 1914. Detailed accounts will be found in the publications from his laboratory between the years 1910 and 1915. They are in no case merely qualitative observations but quantitative determinations. They occupy hundreds of pages of the *Journal of Physiology* and other periodicals during this period. They show the marvellous power of the heart, apart from the nervous system, to adapt its work in accordance with the needs of the body as a whole, and also the exquisite mechanisms to enable it to do this within wide limits, without embarrassment or permanent injury.

In the first case the effects of variations in the tensions of oxygen and carbon dioxide in the blood upon the diastolic volume and output of the heart, on its capacity for work, and on the flow through the coronary arteries, were determined. The heart was found to have an astounding power of utilising the oxygen in the blood. When an isolated heart was fed with blood from an asphyxiated animal, the heart removed all but traces of oxygen. The conditions controlling the rate of the heart-beat were studied, and the only influences found to modify the rate of the isolated heart were temperature, the volume of the inflow, and adrenalin. The maximum output of the heart was measured and found to be three litres a minute for a dog's heart weighing 50 gm. Important observations were also made upon the energetics of the heart by determining the oxygen used per unit of work done. The respiratory quotients of the normal and diabetic heart were determined, and from these two sets of observations the efficiency of the heart as a machine working under various loads was determined. The ventricular output was discovered to be independent of the arterial pressure, but, on the other hand, it was found to be dependent upon inflow. From this it appeared that as the heart dilated and its fibres were stretched, it worked with greater efficiency. This was afterwards shown to be the case by his distinguished pupil Lovat Evans.

The experiments upon the flow of blood through the coronary arteries showed that this flow was primarily dependent upon the arterial pressure, but that dilatation of the coronary system occurred when the carbon dioxide tension in the blood increased, when adrenalin was added, and most markedly when some metabolites, the product of the heart's own activity, were added to the blood circulating. In the latter circumstances the increased flow through the

coronary arteries was out of all proportion to the pressure in the aorta, a further indication of automatic adjustment to a condition of stress.

Starling having supplied us with a new method of inquiry, many competent physiologists could have ascertained much of the information outlined above, but there was one discovery which is peculiarly the product of his genius, namely, that cardiac muscle, like voluntary, contracts more forcibly as it is stretched even up to the point when the texture is fractured. Therefore to work at greatest efficiency a heart must first dilate, which it inevitably does, as the pressure in front of it increases. This is what Starling calls the "Law of the Heart." As he said in the fine Harveian oration he delivered before the Royal College of Physicians in 1923, when he expounded in simple and beautiful language the results of his researches into the movements of the heart, "The heart has thus the power of automatically increasing the energy evolved at each contraction in proportion to the mechanical demands made upon it, behaving in this way almost like a sentient, intelligent creature."

Starling's Services during the War.

After-War broke out Starling became very unsettled. He wanted to go and fight. Persuaded, if not convinced, that this was not the most suitable manner in which to satisfy his strong tribal instincts, he joined the R.A.M.C. as a Captain and was for some time a medical officer at the Herbert Hospital. Later, as the scientific resources of the country were mobilised, he was made Director of Research at Milbank and was busy experimenting with defensive methods against poison gases. In this he rendered invaluable service to his country, and no one could be better to control a research laboratory. However, at the end of 1916 he was exalted to the rank of Lieut.-Colonel and sent as Chemical Adviser to Salonika, where he had nothing to do. Maybe his impatience of official methods had embarrassed the authorities. In 1917 he resigned his commission, deeming that he could be of greater service as a civilian.

At that time food-shortage seemed most likely to decide the issue, and Starling became chairman of the Royal Society Food Committee and was largely responsible for the value of the advice given by it to the Government. Afterwards he was scientific adviser to the Ministry of Food, and British scientific delegate on the Inter-Allied Food Commission.

In all these capacities Starling rendered yeoman service. He soon had a mastery of the necessary facts, and he was by nature and training able to marshal them comprehensively and arrive at definite conclusions. He was never 'havering,' and he impressed all those statesmen and officials with whom he had to deal. It is doubtful whether any other of our physiologists could have served us so well.

Later Researches on the Circulation.

For a while, after the War, Starling's work was seriously curtailed owing to ill health, which finally necessitated a serious surgical operation. However, in 1920 he was back again at work, with Anrep, on the central and reflex regulation of the circulation by an ingenious cross-circulation method built up on his heart-lung preparation. In this method the circulation through the brain of an animal is entirely under the control of the experimenter, while the animal's own heart supplies the rest of its body.

A notable discovery was that, whereas rise of aortic pressure leads to dilatation of the blood-vessels so long as the depressor nerves are intact, change in the blood-pressure in the supply to the brain produces the reverse change in the pressure of the rest of the body. These fundamental laws of vasomotor regulation were suspected but never before established.

The Secretion of Urine by the Isolated Kidney.

The heart-lung preparation affords a means by which any isolated organ may be fed with arterial blood of known composition at any desired pressure, rate of flow, and temperature. It is thus possible to study the functions of an organ apart from nervous influences and from the chemical influences which may arise in consequence of modifications in the blood caused by other organs of the body. After numerous attempts, Starling and Verney succeeded in maintaining the isolated kidney in such a condition that it would secrete abundant urine.

By this method, which demands extraordinary experimental skill, Starling has opened a new chapter on the physiology of renal secretion. Already, many new facts, and others which were previously only matters of surmise, have been discovered and established. His observations with Verney and in collaboration with Eichholtz have shown that the glomeruli filter from the blood plasma its non-protein constituents, and that by using hydrocyanic acid to suspend tubular activity, a pure glomerular filtrate is obtained from the ureter. Also that, whilst urea and sulphate are secreted by the tubule cells, water, chloride, bicarbonate and glucose are re-absorbed by the tubule cells from the glomerular filtrate. Pituitrin increases the amount of chloride and decreases the amount of water eliminated.

The influence of the pituitary gland upon the secretion of the kidney was particularly studied by Starling's pupils, Eichholtz and Bruhl. Their experiments suggest that the inability of the isolated kidney to secrete inorganic phosphate is due to the absence of the pituitary hormone. If this be so, it is another discovery of a chemical correlation of the body for which Starling is largely responsible.

These researches on the isolated kidney were in full swing in April when Starling left for the holiday which was long overdue. They were affording most important results, and doubtless, had he been spared to continue them, he would, with his unrivalled experimental skill, ultimately have succeeded in clarifying our knowledge of urinary secretion as he had laid bare the principles involved in the self-adjustments of the heart to physiological requirements.

Starling as a Teacher.

Starling was a fine teacher. He had not a natural gift of oratory, but by practice he early became a good, coherent and agreeable speaker. He had a happy way of finding telling phrases to emphasise the main points of his discourse, and sometimes, when feeling deeply, he was eloquent. His enthusiasm was infectious, and his pupils enjoyed his lectures. His influence as a teacher was, however, not confined to those who had the privilege of sitting at his feet. His "Principles of Human Physiology" is the best text-book on the subject in the English language, and is widely used by students on both sides of the Atlantic. It has also been translated into Spanish. As a teacher to research students he was ideal. He loved the companionship of young men. To every one, provided only that he were a serious inquirer after truth, he was ready to extend help, encouragement and friendship.

An account of Starling's scientific career would

be incomplete without allusion to the part played in it by his wife. In 1891 he married Florence Wooldridge, the daughter of Sir Edward Sieveking. They were inseparable companions. With unselfish devotion she helped him more than will ever be known. They discussed all his projects together, and for many years she performed for him all the functions of an efficient secretary. Further, in addition to the responsibilities of bringing up their four children, she bore on her shoulders the burden of the humdrum duties of his life, thus releasing the more energy for his work.

Starling was the recipient of many academic honours. Honorary degrees were conferred upon him by the Universities of Dublin, Sheffield, Cambridge, Breslau and Heidelberg. He received the Baly Medal in 1907 and the Royal Medal of the Royal Society in 1913. What place amongst the great discoverers in medical science should be allotted to Starling must be left to the judgment of posterity, but it will be generally conceded by his contemporaries that he was one of the foremost physiologists of our time, and that no one since Harvey has so greatly advanced our knowledge of the action of the heart.

Although no man gave more devoted service to science, Starling's interests were many-sided. He loved music, he loved beauty, he loved a fight; in fact, he loved life. The great charm of his companionship was, in part, due to his extraordinary mental alertness and boyish enthusiasm; like Peter Pan, he refused to grow old. His death means a sad loss to all of us and will be felt not least by the generations of pupils who have been his companions during his lifelong search for new knowledge by experiment. C. J. MARTIN.

News and Views.

IN a supplement to NATURE for July 3, 1926, Dr. G. E. Hale described his recently completed spectrohelioscope—a visual instrument for observing solar phenomena in monochromatic light—and indicated its large scope in exploring the higher parts of the sun's atmosphere. On p. 708 of our issue this week, Dr. Hale gives us some of his results obtained during the last few months from observations of the hydrogen gases involved in the upper part of the vortex of a sunspot and its attendant region of disturbance. The particular problem to which he has applied his instrument is to determine whether the characteristic appearance of whirl-formation of the hydrogen flocculi surrounding sunspots is hydrodynamical or electromagnetic in origin. These hydrogen whirls, depicted on photographs taken in monochromatic light of $H\alpha$ by the spectroheliograph, had previously been closely studied by Dr. Hale, who found the evidence inconclusive for an explanation of their exact nature, for they appeared to be unrelated to what is presumably a periodic reversal every $11\frac{1}{2}$ years of the direction of whirl of a deeper-seated vortex which gives rise to the magnetic field of a sunspot. He is now able to show in the present article that his recent observations afford a more critical test, which proves to be against the electromagnetic explanation. He states, however, that there still exist several difficulties in the way of explaining the structure of the flocculi along purely hydrodynamical lines.

ONE great advantage of the spectrohelioscope is that it permits the observer to watch continuously the movements of the solar gases, and by means of a 'line-shifter'—a neatly devised accessory—the radial velocity of separate portions of a flocculus can readily be estimated. Although photographs of hydrogen flocculi strongly suggest movements of inflow or outflow, the reality of such motions has, as a general rule, been difficult to establish even from a long series of daily spectroheliograms or from others taken at shorter intervals. With his spectrohelioscope, Dr. Hale has now seen a number of these flocculi being drawn into spots with accelerated velocities, in one instance increasing from 22 to 50 km./sec. at corresponding distances of 56,000 km. and 20,000 km. from the centre of the spot. These and other observations of moving masses of gas in the near vicinity of spots have an important bearing on the motions of related prominences which have been recorded from time to time. The possibilities of this instrument and the remarkable observations which have already been made with it are of the greatest interest.

THE commemoration of Huxley's birthday by an annual lecture delivered at the College with which most of his teaching life was associated, is a new institution, which the Imperial College of Science owes to its Rector, Sir Thomas Holland, who himself was an old pupil of Huxley's. The first lecture in the series was delivered by Prof. E. B. Poulton in 1925 and was of a charming and intimate biographical character. The second lecture, by Dr. P. Chalmers Mitchell, should have been delivered last year, but had to be postponed owing to the general strike. It was delivered on May 4 of this year. Dr. Mitchell took as his title, "Logic and Law in Biology," and, as was to be expected, he delivered an admirably lucid and incisive address. Dr. Mitchell's thesis was that it is a weakness of the human mind to invent imaginary entities to account for the flux of things, and that of these entities the idea of 'law' is the most universal. He pointed out that Huxley had said that every law is a construct of the human intellect, and no more exists outside us than does colour. Dr. Mitchell then went to scourge the concepts of 'vitalism,' 'orthogenesis,' and 'emergent evolution.' If we get rid of all these conceptions, what remains? According to Dr. Mitchell, an increase of 'plain materialistic explanation.' But many will ask: Is not 'materialistic explanation' itself an imaginary concept? There was, in fact, an aura of nineteenth-century materialism and scarcely veiled 'episcopophagy' about Dr. Mitchell's address which was admirably in keeping with one phase of Huxley's character. But the same Huxley who on one occasion said that it was as absurd to talk of the

'vitalism' of an animal as of the 'horology' of a clock, on another occasion declared that he was not a materialist because he could not conceive of matter apart from mind to picture it in.

DR. CHALMERS MITCHELL referred to biogenesis—the chief stumbling-block in the way of the thorough-going materialist. He pointed out that Huxley fully admitted that all life comes only from pre-existing life, but that he claimed the right to 'imagine' a condition in the past when life had arisen from dead matter. If science is the determination and measurement of the processes going on now and their imaginary prolongation into the past and the future, and if this procedure leads to the inference that a discontinuity occurred, then the scientific attitude is to recognise frankly that this is so. To say that it could not have been so, is to introduce an *a priori* conception such as Dr. Mitchell justly deprecates. Indeed, many biologists will maintain that Lord Kelvin's famous assertion that there are in the history of the universe at least two discontinuities which the theory of development cannot get over, namely, the primary concentration of energy and the beginning of life, remains as justified to-day as when he made it. Dr. Mitchell referred to numerous investigations which he claimed are reducing the gap between the living and the non-living. To the opposite school of thought the trend of the recent investigation is not in this direction. A few years ago it was thought that Amœba could be successfully imitated by a drop of rancid oil, and that all its motions were due to surface tension; now, a recent investigator tells us that if Amœba were the size of a dog, no one would refuse to call its actions intelligent.

BIOLOGISTS will be surprised to learn that Prof. Julian S. Huxley is resigning the chair of zoology in King's College, London, to which he was appointed less than two years ago. We understand that Prof. Huxley will still continue to be attached to King's College in an honorary capacity, but he intends to devote himself entirely to writing and research. Thus a new situation is created with regard to the purveyors of knowledge and their relation to academic institutions, a situation which all who are concerned with the spread of knowledge will do well to examine thoroughly. With the spread of popular education and the use of applied science there has come into existence not only a large body of the general public which desires further knowledge, but also, in the shape of cheap printing, broadcasting, instructional films, and the systematisation of popular lectures, the means for gratifying this desire without recourse to formal lectures at a college or university. The use of broadcasting and the cinematograph is now being officially encouraged for instruction in schools. The successful 'libraries' issued by various publishers, such as the Home University Library, Benn's new Sixpenny Library, and other similar ventures, show what can be done with educational series; works like Wells's "Outline of History," what can be done with the single book; the University Extension Lectures and the classes arranged by the Workers' Educational Association—which some members of the Royal Commission on Oxford and Cambridge thought the most important innovation in university practice which had ever occurred—the Chautauqua, the organised lecture-tours of the United States, what can be done with lecturing partly or wholly detached from academic institutions.

THESE gateways to knowledge are of great importance to the learner; but their importance to the teacher seem not yet to have been fully realised. They imply that an increasing number of those who are interested in teaching or in the pursuit of knowledge for its own sake will be able to make a livelihood without lecturing to students in a college or university. On the other hand, it will obviously be of advantage to such workers to be connected in some way with academic institutions, with their facilities for research and study and their atmosphere of learning; it will equally be of advantage for the academic institutions to be associated with any new means of spreading knowledge, and with any one, whatever his method of obtaining a livelihood, who desires to devote his energy to pure research. It will be interesting to see how educational organisation will adapt itself to the new situation which is thus arising, and in particular to follow the success of this new and courageous venture of Prof. Huxley.

IN the past twenty-five years, the Appointments Board of the University of Cambridge has effected quietly a noteworthy revolution in the attitude of tutors and undergraduates towards the business world and of the business world towards the universities. Where formerly men looked to an academic life, to the Civil Service, or to one of the professions as a natural sequel to a successful university career, now in growing numbers they are looking to the world outside, and the outside world is more and more seeking for men of proved ability with a university training. The immediate result is at present most apparent in the Far East, where, for example, Sir John Jordan has described the Cambridge graduates as having "changed the face of business in China," and where the great oil groups are relying with confidence to their staffs, mainly university men, to enable them to maintain their lead throughout the world. Firms and industrial organisations in Great Britain are also more and more inclined to turn to the universities for their administrative appointments, and along with this is a growing demand in industry for trained scientific workers for chemical, physical, geological, engineering, forestry, or agricultural work. The Appointments Board at Cambridge has, through its secretary, Mr. H. A. Roberts, gained the confidence of the business world and of Government departments, and serves now as the natural channel for meeting their demands. In meeting these demands satisfactorily it has also stimulated a wider demand. It will be of interest to watch in the coming years the reaction of this larger demand on the conditions of the alternative careers which are losing ground at present in the order of choice of the young graduate.

A PRELIMINARY programme has now been issued of the Leeds meeting of the British Association, to be held on Aug. 31-Sept. 7, under the presidency of Sir Arthur Keith. The president's address will be delivered in the Majestic Cinema, City Square, on Wednesday evening, Aug. 31, on the subject, "Darwin's Theory of Man's Descent as it stands To-day." Evening discourses will be given to members of the Association in the Albert Hall, Leeds, on Sept. 2 by Prof. R. A. Millikan on "Cosmic Rays," and on Sept. 5 by Dr. F. A. E. Crew on "The Germ-plasm and its Architecture." Public lectures are being arranged for Leeds and the neighbouring towns. Several excursions to local places of interest and to works and factories in or near Leeds are being organised, a civic reception will be held in the Art Gallery on Sept. 1, and the University will hold a reception on Sept. 6. The reception room during the meeting will be at the Town Hall; the local honorary secretaries for the meeting are Mr. James Graham and Prof. A. Gilligan, Education Department, Calverley Street, Leeds.

IN the issues of the *Morning Post* for May 4 and succeeding days, Dr. T. W. Gann publishes a further report on his investigations of Maya ruins in Yucatan in the present season. Writing from Belize, he says that his last expedition has proved somewhat eventful, his larger motor boat having been wrecked and the smaller left behind badly damaged, while the greater part of his equipment has been lost. At Ambergris Cay, off the north coast of British Honduras, he found evidence that this island had once been inhabited by a branch of the Maya who had developed along lines of their own. They worshipped a god, a short, round-faced, masked individual like nothing known on the mainland. Dr. Gann's objective was Tuluum, where he proposed to visit the jealously guarded country of the Santa Cruz Indians, the only pure-blooded descendants of the ancient Maya. Before reaching Tuluum, however, he landed at a place called Majanal, just south of Espiritu Santo Bay, on a report from his pilot that there were ruins in the neighbourhood. A search revealed a city literally buried in sand, which lay in terraces. On the highest of these, huge square stones were still exposed. The preservative qualities of sand should make this a profitable site for future excavation.

ON reaching Tuluum he found the ruins cleared of vegetation, and learnt later from the chief of the Santa Cruz Indians, by whom he was most hospitably received, that although they had a chapel in their nearby native *pueblo*, the temple was held in veneration and used by them. Dr. Gann took part in an elaborate religious ceremony in the old Maya temple before a cross draped with a native woman's skirt, and before which *jabin* branches were placed, this being the herb held peculiarly sacred to their gods by the ancient Maya. The celebrant at the service was a woman, the widow of the priest who had recently died leaving a son too young to learn the prayers. She conducted the service in Spanish, although she knew no word of the language, but the responses were given in Maya. The service opened with a fumigation of every one and the temple with aromatic resins to drive away the devils, and concluded with the drinking of a bowl of a mixture of ground corn and honey. Dr. Gann was able to collect much interesting information about the beliefs and customs of these survivors of the ancient Maya race, and obtained a unique photograph of the idol which they dread as an embodiment of evil.

AN interesting series of copies of frescoes from Theban tombs has been placed on exhibit in the British Museum on permanent loan. They have been executed by Mrs. N. de Garis Davies and belong to Dr. Alan Gardiner, but will ultimately become the property of the Museum. With the exception of copies made for the Metropolitan Museum of New York, this is the only representative collection of reproductions of this class of Egyptian art. The examples which have been chosen for exhibition go back in date to so early as 2150 B.C. They have been selected especially with the view of covering as wide a field as possible in illustration of the social life and history of the early Egyptians. The earliest example shows women baking cakes. A representation of women at a feast of 1420 B.C. is interesting as illustrating the custom of placing solid unguents on the head at a feast, which melted and ran down over the hair, face and even garments. The motives of conventionalised spirals and lotus flowers used as the decoration of the ceilings of tombs are illustrated in frescoes of about 1300 B.C. A cat seated beneath the chair of its mistress and another eating fish, from the tombs of the astronomer Nakht and the Harbour Master are successful examples of Egyptian realism, more happy, indeed, than the leashed hound from the tomb of Rekhmire. Paintings showing relations with Crete are well represented. A drawing from the tomb of Tut-ankh-amen's governor of Syria will no doubt prove attractive on the ground of its associations. Among other features represented are negroes carrying tribute, and Ethiopians with cattle having fetishes on their horns, golden rings and a giraffe. There are also shown cattle, mourning women in a boat, and Kenre and his wife Mutemnia drinking from a pool in the fields of the dead. As an exhibit the collection is one of the most attractive and, possibly, instructive now in the gallery.

IT is announced that a decision taken at the concluding meeting of the International Congress of Orientalists at Athens in 1912 that the next meeting of the Congress should be held at Oxford is to be given effect. With the consent of the Vice-Chancellor of the University, the seventeenth International Congress will be held there during the week beginning Aug. 27, 1928. The approval of the Royal Asiatic Society has been obtained, and the leading oriental societies of France, Italy, Germany, Holland, and America have signified their intention to take part. The arrangements for the meeting are in the hands of the members of the Oriental Faculty of the University. It is to be hoped that the Congress will be strongly supported, for circumstances combine to give it a special importance. During the interval which has

elapsed since the last meeting the international bonds of common study have been strained and broken, while for Great Britain as an Empire with vital interests in the Middle and Farther East, the course of events since the War has given a peculiar significance to the subject-matter with which the Congress deals as one, and not the least important of the avenues by which we may arrive at an understanding of the mind of the various Eastern races. In the circumstances, no more appropriate meeting-place for the Congress than Oxford could be found. We trust, therefore, that the Oriental Faculty of the University may receive wide public support.

THE new laboratories of the Metropolitan Asylums Board at the Park Hospital, Hither Green, London, S.E., were opened on May 9 by Mr. Neville Chamberlain, Minister of Health. The buildings, which have cost about £13,500, have been equipped for research on the primary causation of infectious diseases and particularly acute fevers. Mr. Chamberlain, in his address, said that about 5 per cent. of the children born in London die from infectious disease before reaching twenty years of age. Apart from the suffering, this constitutes a great waste of human material, and Mr. Chamberlain expressed surprise that local authorities throughout Great Britain, which have to meet expenditure for isolation hospitals and treatment of infectious disease, have not done more in the past to discover the causes and means of prevention of such diseases. The results already achieved by the investigation of scarlet fever and diphtheria have been most encouraging and have shown that money spent on research in this field is a good investment.

ON Tuesday, April 26, a numerous party of members of the Illuminating Engineering Society and friends paid a visit to the National Physical Laboratory, Teddington, and were afforded an opportunity of inspecting the Photometric Section under the supervision of Mr. J. W. T. Walsh. Some of the most interesting features of the work were summarised by Mr. H. Buckley, who pointed out how it has become interlinked with that of other bodies, such as the Illuminating Engineering Society, and directed attention to the variety of researches being conducted for Government departments. In addition to the important work dealing with the unit of light, such problems as the design of picture galleries, the requirements for ships' navigating lights, the effects of glare, the relation between illumination and the carrying out of fine work, and reflection of artificial light from road surfaces have been studied. The visitors were afforded an opportunity of seeing the apparatus for such tests in operation, and much interest was taken in the equipment, notably the new 10-ft. diameter integrating sphere now installed. It was recalled in the discussion that the problem of devising a primary standard of light was raised in a comprehensive paper on photometry read by Prof. J. A. Fleming nearly twenty-five years ago. Research on this difficult problem is still proceeding at the National Physical Laboratory and elsewhere.

THE annual cider-tasting day took place at the University of Bristol Research Station, Long Ashton, on Thursday, May 5. The gathering was a record one, about 1000 visitors—mainly fruit growers, cider makers, and agriculturists—being present on the occasion. In addition to the usual display of single variety ciders made during the past season from the 1926 crop, there were exhibited ciders made from apples submitted by farmers of the surrounding counties in connexion with the Institute's scheme of cider-apple competitions. These competitions are designed to demonstrate to farmers the cider-making values of the various varieties grown in the different localities and to stimulate interest in the growing of high-grade cider fruit to meet the greatly increased requirements of the cider industry. The competitions are extremely popular with the farmer, and have proved of definite value to the Station for research purposes. During the day, parties of visitors were conducted around the laboratories and field plots by members of the Station staff, who demonstrated the practical results of the Institute's research work on problems of fruit culture. Special parties of fruit growers were organised for demonstrations of the results of research work on strawberries and for practical demonstrations in the making of spray fluids. Demonstrations of the use of various new models of motor-driven cultivators suitable for use in fruit plantations and of the latest types of spraying machines for applying spray fluids and 'dusts' were given by commercial firms throughout the day.

DR. L. PRANDTL, professor of applied mechanics in the University of Göttingen, has been awarded the Gold Medal of the Royal Aeronautical Society, in recognition of his work on aerodynamics. The medal will be presented on May 16, when Dr. Prandtl will deliver the fifteenth Wilbur Wright memorial lecture.

IT will be remembered that a fund was subscribed by friends and old students of Dr. J. A. Fleming for a portrait to be presented to University College, London, in commemoration of his forty-two years' tenure of the chair of electrical engineering in the College. The portrait, which was painted by Sir William Orpen, is considered to be an excellent likeness, and is being exhibited in Room XI. at the Royal Academy.

MR. T. H. SAVORY, Biological Laboratory, Malvern College, Worcs., informs us that he is at present engaged in the compilation, for the Welsh National Museum, of a list of the spiders of Wales, to accompany a type collection which has recently been presented to the Museum. Records are not numerous, and it is desirable to be complete, if possible. Mr. Savory would therefore be glad to know of any work on Welsh spiders which has not been published or is not generally accessible.

INFORMATION has been received of further discoveries bearing upon the early peoples of East Africa by Mr. L. S. Leakey of the East Africa Stone Age Expedition. Portions of thirty-six skeletons have now been unearthed, of which twenty-six were found

in the Elmenteita district. According to a dispatch in the *Times* of May 4, Mr. Leakey considers the Elmenteita type to be even more primitive than that discovered at Nakuru in December last. In particular the nose is narrower, some individuals having a nasal index of 44. As a race they were tall, and differ markedly from the existing peoples of Kenya.

THE council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1926–27 : Telford Gold Medals to Mr. I. J. Jones (London) and Mr. T. B. Hunter (London) ; a Watt Gold Medal to Mr. Gerald Curry (London) ; and a George Stephenson Gold Medal to Mr. A. L. Bell (Malta) ; Telford Premiums to Mr. A. W. Stonebridge (Bombay), Mr. P. R. Roberts (Barrow-in-Furness), Mr. A. C. Anderson (London), and Mr. George Ellson (London) ; a Manby Premium to Prof. Douglas Hay (Sheffield) ; and a Trevithick Premium to Mr. Powys Davies (India).

THE Paris correspondent of the *Times* announces that Baron Edmond de Rothschild, who has already done great service to scientific research in France by creating the Rothschild Foundation, has made another gift of 30,000,000 francs to the foundation for the purpose of endowing an institute for physical and chemical research as applied to biology. The work of the institute is to be conducted by a committee consisting of Profs. Jean Perrin, Job, and André of Paris, and M. Pierre Girard.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A junior assistant hydrographic surveyor under the Port of London Authority—The Staff Manager, Port of London Authority, Trinity Square, E.C.3 (May 18). A lecturer in pharmacology and therapeutics at St. Bartholomew's Medical College—The Dean of the College, St. Bartholomew's Hospital, E.C.1 (May 20). A junior scientific assistant for Admiralty Research —The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (May 21). A full-time lecturer in chemistry at the Polytechnic, Regent Street—The Director of Education, The Polytechnic, 309 Regent Street, W.1 (May 23) A full-time teacher of geography at the City of London College—The Secretary, City of London College, White Street, E.C.2 (May 27). An assistant lecturer in physiology in the University of Birmingham—The Secretary of the University (June 1). A professor of zoology at King's College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (June 2). A part-time research organiser under the Research Fund Committee of the Institute of Brewing—The Secretary, The Institute of Brewing, Brewers' Hall, Addle Street, E.C.2 (June 3). A full-time lecturer in electrical engineering at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. An assistant master for electrical engineering at the Rugby Technical School—P. I. Kitchen, 61 Clifton Road, Rugby. A graduate to teach botany at the Erith Technical College—The Principal, Technical College, Erith Road, Belvedere. A full-time mistress for mathematics and science at the Girls' Trade School of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. A part-time mistress for hygiene, physiology, health, and science subjects at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1.

ERRATA.—In NATURE of April 30, p. 629, col. 1, line 29, for "Haustein" read "Hanstein," and line 47, for "Sonèges" read "Souèges."

Our Astronomical Column.

GLOBULAR CLUSTERS AND SPIRAL NEBULÆ.—An article by Mr. A. R. Hinks in the *Nineteenth Century* for May gives a vivid account of the great enlargement of our conception of the size of the visible cosmos that has resulted from the work of Hale, Shapley, and Hubble at the great American observatories. The various stages in the deduction of the absolute magnitudes of the Cepheids are lucidly described ; but one point in the proof, the practically perfect transparency of the celestial spaces, seems to need fuller treatment than is given in the article. The shortest proof appears to be the simultaneity of phase in light of different colours, whereas their speeds would be different in an absorbing medium.

Mr. Hinks was the first to detect the asymmetrical arrangement of the globular clusters : they lie in one hemisphere of the sky, with its pole in the galaxy. Further, their number is limited to about ninety, and no increase in optical power seems to add to it, so that they belong to a rather special class of objects, the curious grouping of which is still unexplained and merits further study.

Brief allusion is made in the article to Prof. Hubble's recent paper in the *Astrophysical Journal*, in which he assigns a distance of 140,000,000 light years to the smallest visible spiral nebulæ. Representing the distance of α Centauri as one inch, these objects would be 550 miles away. Some verses by G. M. Minchin appeared in NATURE, April 14, 1898, p. 564. One verse ran :

> "For, the rays that reach me here
> May have left your photosphere
> Ere the fight of Waterloo—
> Ere the pterodactyl flew !"

The last line was probably intended as a bold exaggeration, but Hubble's result would make it literally true.

ASTROPHYSICS IN RUSSIA.—The State Astrophysical Institute of Russia is publishing *Trudy* (Memoirs), the first volume of which appeared in 1922, the second in 1923, and two parts of the current third volume in 1925 and 1926, respectively. The contents of the published volumes are very varied, both theoretical papers and those elucidating various practical points of astrophysics being well represented. To the former category belong papers by V. A. Kostizyn on masses of stars and on equilibrium of radiation in stars ; those by V. G. Fesenkov on the evolution of the solar system, on cosmic refraction, on the structure of the atmosphere from photometric observations, and others. Some of the practical papers deal with the technique of stellar photography in particular cases ; B. V. Numerov describes a new method of determination of orbits and of calculation of ephemerids ; E. K. Epik writes on photometric properties of air and of clouds (with an explanation of variations in the brightness of Venus). The latest volume contains a catalogue of equatorial components of velocities of 1470 stars.

Research Items.

PRE-COLUMBIAN HUASTEC MOUNDS IN THE TAMPICO REGION, MEXICO.—Municipal and other work carried out at various times in the Tampico district of Mexico, which has necessitated the demolition of a number of the many mounds in the area belonging to the Huastec civilisation, has at the same time made it possible to form an accurate idea of their composition and structure. A number of observations of a series of mounds on one of the haciendas and on a series on the Colonia Flores on the north-western environs of Tampico are recorded in a paper contributed to the *Journal of the Royal Anthropological Institute*, vol. 56, pt. 2, by Mr. John M. Muir, who has been assisted in the mapping of the mounds by Mr. Cecil Drake. The mounds were used as the foundations for buildings, and were clearly raised or reconstructed from time to time, a cement floor being laid on each occasion. Sometimes as many as five floors were found in one mound. Steps were built for easy ascent to the floor of occupation, which in all likelihood was covered by a wooden structure. Any material conveniently available was used—shells, stone slabs, and even asphalt. Where no other material was available, soil was used. Oyster shells from pleistocene deposits were abundant on the Colonia Flores site, and were also used to form the cement floors. In one of the mounds a painted design was found which had been executed in a reddish colour and then apparently coated over in black. The drawing is 270 cm. long and 135 cm. wide and is approximately rectangular, resembling a ground plan in appearance. On the cement floor underlying this was found another painted design similar in character but more elaborate and complete. No purpose can at present be suggested for these designs.

EYE-STRAIN IN THE HOSIERY INDUSTRY.—No. 40 of the Reports of the Industrial Fatigue Research Board, by H. C. Weston and S. Adams (London: H.M. Stationery Office, 1927. 1*s.* net), deals with the effect of eye-strain on the output of linkers in the hosiery industry. The output of three operatives was recorded for a period of four weeks in order to determine the normal rate of working under existing conditions. The operatives were then examined and fitted with glasses suitable for the nature of the work, which involved a high degree of accommodation and convergence of the eyes. The output was then measured as before. The data show that the use of the glasses had important results. In the first place, the general rate of output was increased; and secondly, the usual fall of the output at the end of the day was considerably reduced. The subjects themselves experienced great relief as a result of wearing the glasses; their eyes did not feel so tired either during the working day or when they returned home at night. The writers suggest that it might be an advantage in other operations which make heavy demands on the eyes to wear suitable glasses. They point out, though, that it will always be necessary to examine and prescribe for each subject individually.

FISHING INDUSTRIES OF THE THAMES ESTUARY.—Reference was made last year (NATURE, June 19, 1926, p. 870) to a printed portion of Part 2 of the late Dr. Murie's "Report on the Sea Fisheries and Fishing Industries of the Thames Estuary," Part 1 of which was published in 1903. We are now advised by Mr. W. Pollitt, Borough Librarian and Curator of the Public Libraries and Museum, Southend-on-Sea, that a large portion of the remainder of Part 2 has been recovered. This consists chiefly of working proofs and 'galley' proofs, but what remained of Section 6, dealing with "Special Estuarine Fishes," which was in manuscript and rescued from a damp outhouse, has been so far as possible transcribed. Part 2 as it now exists is a folio volume of 256 pages, and in addition there is a number of drawings intended to illustrate it. The work is exceedingly valuable, embracing notes by an experienced authority on a large range of problems relating to the fisheries industries, much of which is new, and the whole brought together in a useful form. The part in question includes sections on whales, crustacea, shellfish, fishing grounds, nets, etc., plaice, spratting, whitebaiting, smelting, eel-spearing and trawling, spruling, shrimp trawling and shrimping, crab and lobster fishing, prawning, oyster industry, clam digging, scallop dredging, whelk trotting and potting, starfish, white weed gathering, and dredging. There are also sections on the Leigh fishermen, the fishing craft, apparatus for capture, cooking, transport, etc., fish products and economics of the fisheries. It would be a great pity if this work were lost, and it is apparently a question of funds as to whether it should be published. It is at present available for reference at the Library of the County Borough of Southend-on-Sea, and students interested in the subjects are invited to consult it.

CHROMOSOMES OF DIŒCIOUS PLANTS.—From a study of root-tips in *Vallisneria spiralis* and *V. gigantea*, Mr. C. A. Jorgensen (*Jour. Genetics*, vol. 18, No. 1) finds 20 chromosomes in the former (3 long pairs, 2 intermediate pairs, and 5 short pairs), while the latter species is tetraploid, having twice as many of each type of chromosome. Moreover, in these diœcious species the chromosome number and morphology appear to be the same in male as in female plants. These studies are confirmed by examination of the nuclear division in the pollen grains, in which the corresponding haploid numbers are found. Loss of chromosomes and probable non-disjunction is also found in the pollen meiosis, which accounts for the numbers observed by Winge, who mistook these conditions as indicating the presence of an XO set of sex chromosomes. Winge confirms this in the same issue of the *Journal of Genetics*, a lagging chromosome which he mistook for the X-chromosome being occasionally left behind and two chromosomes sometimes becoming attached to each other. Similarly in *Najas marina*, another diœcious plant, he finds no sex chromosomes, but in somatic cells sometimes 12, sometimes 14 chromosomes, owing to the smallest two pairs being more or less united. In the reduction division, six gemini are accordingly found, but Guignard occasionally found seven.

THE SERPENTINE BELT OF BURMA.—The *Journal of the Burma Research Society*, 16, p. 176, 1927, contains an interesting account of the serpentines of Burma by H. L. Chhibber. The intrusions described occur in the Henzada and Bassein districts, and consist of wholly or partly altered saxonites, lherzolites, and dunites. Hornblende-eclogite is also described. As usual, chromite occurs in segregated patches, but communications are still too bad to encourage the commercial exploitation of this mineral. The intrusions form part of a long interrupted belt of similar rocks that extend from the Andamans through the Arakan Yomas and the Chin Hills to the northern frontier of Burma. In Burma the belt is roughly parallel to the Irrawaddy-Chindwin valley and to the central volcanic line of the country. The author considers the age of the intrusions to range from late Cretaceous to early Eocene. Nummulitic

sandstones referred to the Laki stage contain derived fragments of serpentine, and are themselves invaded by later ultrabasic rocks.

THE GLACIAL ORIGIN OF DRUMLINS.—In the *Geological Magazine* for April, Prof. J. K. Charlesworth marshals a convincing array of evidence against Prof. J. W. Gregory's recent advocacy of the view that drumlins have been carved out of boulder-clay by the post-glacial action of wind and rain. Drumlins are commonly elongated parallel to the *last* direction of ice-flow, though they may lie oblique to the striæ directions scored in a pavement rock during earlier stages. One end is usually narrow and tapering, the other broader and steeper, and the blunt end faces the direction of ice advance. This feature suggests moulding by a moving ice-sheet. Drumlins are sometimes found beneath the moraines and eskers accumulated during the last recessional phase; they may be scarped by late-glacial lakes and by the 25-ft., 50-ft., and 100-ft. seas demonstrated by the raised beaches of Scotland; and in the lake deposits occasionally found in the hollows between drumlins, remains of the Irish elk have been discovered. There is thus incontrovertible proof that the period of drumlin formation preceded the close of the Quaternary ice age. Moreover, on the post-glacial theory, drumlins should not be restricted in distribution to boulder-clay regions. Prof. Charlesworth points out, however, that although the post-glacial hypothesis is manifestly inadequate, the glacial-moulding hypothesis has not yet been convincingly developed from the physical point of view. The physics of ice flow is still too little understood for a final solution of the problem.

DEFLEXION OF ATOMIC RAYS.—Magnetic deflexion of atomic rays is a relatively new line of research, and Prof. O. Stern's critical discussion of the method in No. 8 of the last volume of the *Zeitschrift für Physik* comes very opportunely. Since it is necessary to measure a deflexion of the pencil of rays through a distance not very much greater than the width of the limiting slits, the intensity distribution in the final trace is evidently of importance, and Prof. Stern has shown that in one instance neglect of this has introduced an unrecognised error of not less than 20 per cent. The greatest uncertainty at present, however, is in the measurement of the intense inhomogeneous magnetic fields which have to be employed, where the accuracy has been limited by knowledge of the susceptibility of bismuth. If, as appears probable, the method now in use could be bettered, Prof. Stern believes that experiments with molecular rays would give at least as precise a value for e/m as those based on observation of the Zeeman effect. The paper is accompanied by an account of work done in Prof. Stern's laboratory on the magnetic moments of the atoms of thallium, potassium, and sodium, by Dr. Leu, and the moment of hydrogen, by Dr. Wrede; both authors have made refinements in the technique. To within a few per cent., potassium, sodium, and hydrogen all have a moment of one Bohr magneton, and thallium one-third of a magneton.

DENSITY OF BORON TRICHLORIDE.—The accurate determination of densities of liquids by means of glass floats has recently been applied by Robinson and Smith to the problem of the constancy of the atomic weight of silicon from different sources. In the February issue of the *Journal of the Chemical Society*, Briscoe, Robinson, and Smith have published the results of a similar investigation on the densities of different samples of boron trichloride. The approximate density of the trichloride (D. 1·350/11°) was determined by means of a glass hydrometer, and suitable floats were constructed and calibrated in n-propyl bromide (D. 1·364/18°). The densities of boron trichloride, prepared from boron obtained from California, Tuscany, and Asia Minor, were measured, and the relative atomic weights of the samples calculated. The results confirm the discrepancies between the atomic weights of boron from the three sources, which were first noticed in the ratios $BCl_3 : 3Ag$, and in the densities of the fused boron trioxide.

CELLULOSE PAINTS.—We have received from the Institution of Automobile Engineers a copy of a paper by W. F. Starkey on nitro-cellulose enamels. In view of the increasing importance of this type of varnishing medium, especially in the motor-car industry, the information which the paper contains is of great interest. A typical nitro-cellulose paint contains nitro-cellulose of suitable solubility and viscosity, solid or liquid plasticisers to impart flow to the material, and a gum resin which will give gloss to the finished product without detracting from the surface hardness, dissolved in a solvent with as high a degree of volatility as is commensurate with the avoidance of chilling and with ease of application. The enamel is applied by the use of a spray pistol, after the surface to be treated has been thoroughly cleaned. It dries in half an hour, is harder than ordinary enamel, resists acids, alkalies, petrol, and heat, and although it has less gloss than ordinary enamel, this improves with cleaning and rubbing. The plasticisers and softeners used in the preparation of cellulose lacquers and paints are discussed by T. H. Durrans in the *Chemical Trade Journal* for Mar. 11. Plasticisers are required to impart a degree of elasticity to the film, as a rapidly drying paint is very brittle. The properties of sixteen organic substances of high boiling-point which are used as softeners and plasticisers are discussed in this article. The best cellulose enamels contain medium boiling-point solvents and high boiling-point plasticisers.

WALLIS'S AXIOM OF PARALLELS.—It is well known that Euclid's axiom of parallels is independent of the other assumptions made by him, and that several axioms have been suggested in place of that given by Euclid. Among these is Wallis's axiom that "to every figure there exists a similar figure of arbitrary magnitude." Prof. M. J. M. Hill, in his presidential address to the Mathematical Association (*Math. Gazette*, March 1927), has simplified Wallis's axiom to the following: Given any triangle, then a triangle with angles congruent to the corresponding angles of the given triangle can be constructed on any given base, and on a given side of the base. Assuming then some axioms on the congruence of angles, but without assuming anything on the congruence of intervals or of triangles, and without making any appeal to continuity, he shows that his axiom leads to the Euclidean parallel axiom both in the form given by Euclid and in Playfair's form, and that the further axiom that all right angles are congruent can also be shown from the same basis. This part of geometric theory thus involves the congruence of angles only and can be treated independently of the rest of geometry. Of the other substitutes for Euclid's axiom, besides Playfair's form, the best known is that which asserts that the sum of the angles of a triangle equals two right angles. But to deduce the Euclidean axiom from this, the full theory of the congruence of triangles is needed, and furthermore, as Dehn has proved, the axiom of Archimedes has to be assumed. The Wallis-Hill axiom thus supplies a much simpler basis for this part of geometry.

The Himalayan Silver Fir and Aeroplane Construction.

AN important communication (*Indian Forest Research Institute Bulletin*, No. 69 Economy Series, 1926) has been recently issued from the Research Institute at Dehra Dun, India, dealing with "The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir." The work of the various branches of the Research Institute is laid down on a triennial basis, lines of investigation to be undertaken being entitled "Projects." The present bulletin refers to timber-testing work under Projects Nos. I. and II. on *Picea Morinda* and *Abies Pindrow*.

These two species have been but sparsely utilised by the markets up to date owing to costs of extraction and a lack of knowledge as to the properties of the timbers. They exist in large quantities in northern India. Spruce is found in the Himalayan tracts from Afghanistan to Kumaon, from 7000 ft. to 11,000 ft. elevation, and commonly mixed with fir, deodar, and *Pinus excelsa*. The silver fir extends from Afghanistan to Nepal, from 7500 ft. to 11,000 ft., sometimes as pure crops but commonly mixed with spruce, deodar, and *Pinus excelsa*, and at times associated with broad-leaved species. It is estimated that existing mixed spruce and silver fir forest could supply a sustained annual yield of more than two million cubic feet, the best localities being enumerated. Both species grow to a large size. Himalyan spruce are reported up to 215 ft. in height and as much as 23 ft. in girth, whilst the Himalayan silver fir has reached a size of 202 ft. in height and 26 ft. in girth.

The investigations carried out in the timber-testing branch of the Institute were undertaken in order to ascertain the strengths of the two timbers for constructional, aeroplane, and other purposes. Incidentally, the question as to whether the spruce red wood was inferior to spruce white wood was decided. The impression that such is the case is commonly held. The investigations showed, however, that the red wood, which is simply the darker, denser material near the centre of the lower portion of the tree-trunk, is in no way inferior to spruce white wood when taken from healthy living trees. The tests have demonstrated that the timber of silver fir has proved to be stronger than the spruce, which is also the case, in some parts, with the European species of these genera. Apart from its scientific aspects, the bulletin has both a commercial and Empire value owing to the deductions derivable from the tests.

The two principal causes which have led to complaints, both from the match manufacturer and others, and to the restricted use of these two conifers in India, are the prevalence of knots and the lack of durability of these timbers. The comparison has usually been made with some of India's most valuable timbers, such as deodar, teak, *Xylia dolabriformis*, and so forth. A similar comparison in Europe would be to contrast silver fir and spruce with oak. The tests have shown that the Himalayan spruce and silver fir are at least as durable as and stronger than the corresponding species of Europe and America. The investigations carried out were made on similar lines and are strictly comparable with the results obtained in the Forest Products Laboratories both in Canada and the United States. The Himalayan silver fir has been proved to be stronger than Sitka spruce (*Picea sitchensis*), the accepted conifer for use in aeroplane construction. It is held that the Himalayan species are not more knotty than the spruces and firs of other parts of the world, with the exception of the Sitka spruce. The tests have shown that the silver fir is less knotty than the spruce in the Himalaya, and a case appears to have been made out for a careful survey of the denser older forests of the former species with the view of the possibility of their being able to furnish aeroplane material.

It is a common British failing to suppose that the foreigner has a better article than can be obtained in the Empire, so this careful piece of research work deserves to be widely known. For the time is assuredly approaching when the silver fir and spruce belt of the western Himalaya will furnish its quota to assist the rapidly dwindling soft-wood supplies of the globe.

The Influence of Impurities on Copper.

THE work that Prof. D. Hanson and his co-workers have been carrying out on the effect of various impurities on copper of the highest degree of purity is extended in two papers read recently before the Institute of Metals. The first of these, in collaboration with Miss G. W. Ford, deals with the influence of bismuth, the solubility of which in solid copper is less than 0·002 per cent. Small amounts of this element adversely affect the rolling properties of copper, particularly during hot-rolling, and the limiting percentage for this process appears to be less than 0·01 per cent. In cold-rolling, the material fractured when more than about 0·05 per cent. of bismuth was present. Even with smaller amounts the effect is bad, especially where the degree of cold-work is great. The effects of this impurity on the electrical conductivity and tensile strength are small.

The second paper, carried out in collaboration with C. B. Marryat, deals with the influence of arsenic, alone and together with oxygen. Copper containing up to 1 per cent. of arsenic alone is very difficult to produce as completely sound castings, but the presence of a little oxygen greatly improves the casting properties. The copper-arsenic alloys are, however, exceedingly ductile and can be worked, both hot and cold, to almost any desired extent. Arsenic alone has but a small hardening effect on pure copper, the Brinell hardness of which, in the annealed state, is almost constant, nor is the ductility greatly affected. In the case of cold-worked metal the arsenic does definitely increase the hardness. The ratio of the fatigue range to the tensile strength of arsenical copper is relatively high, about 0·9; higher, that is, than in copper containing oxygen or iron. The effect of the element on the electrical conductivity is profound, being much greater than that of either of the two latter metals. It reduces the size of the crystals in the castings, but has no appreciable effect on the structure of worked and annealed copper. The solubility of arsenic in solid copper is about 7·25 per cent., a figure which alters little with temperature.

The simultaneous presence of arsenic and oxygen leads to the following effects. The presence of arsenic reduces the deleterious effects of oxygen on the cold-working properties of copper. As the ratio of arsenic to oxygen is raised the cast bars become more ductile, but, unless this ratio is high, the metal is in an over-rolled condition and for severe cold-work the arsenic must exceed ten times the content of oxygen, and a much higher ratio than this is still quite satisfactory. The necessary ratio of these two impurities depends on the amount of cold-work to be done; the greater the amount of cold-working, the greater is the amount of arsenic required. Hot rolling of the copper con-

taining both elements can be done without difficulty.

The mechanical tests differ little from those given by arsenic without oxygen, and the same applies to the electrical resistivity. The oxygen, which occurs in pure copper as cuprous oxide, combines, when more than 1 per cent. of arsenic is present, to form a slaty-grey compound which is a reaction product of cuprous oxide and arsenic. The softening temperature of copper is raised by arsenic whether oxygen is present or not. Arsenic is without effect on the tendency of copper to become brittle through heating in hydrogen. F. C. T.

University and Educational Intelligence.

BRISTOL.—Four scholarships are offered by the Society of Merchant Venturers to matriculated candidates of not less than 17 years of age. The scholarships provide free tuition; one is open to pupils in any secondary school; three are restricted to pupils of secondary schools situated in the counties of Gloucestershire, Somerset, and Wiltshire. A War Memorial scholarship is also offered, with a preference to a candidate needing pecuniary help who is the son of a former student who lost his life while serving with H.M. Forces during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College.

CAMBRIDGE.—Mr. H. E. Tunnicliffe, Gonville and Caius College, has been appointed University demonstrator in physiology.

OXFORD.—The Halley Lecture for 1927 will be delivered on Friday, May 20, at 5 P.M., in the University Museum, by Lieut.-Colonel F. J. M. Stratton, of Gonville and Caius College, Cambridge, on the subject of "Modern Eclipse Problems."

DR. WILLIAM THOMAS, lecturer in chemistry in the University of Aberdeen, has been appointed principal of the Denbighshire Technical Institute, Wrexham, North Wales.

PROF. H. H. TURNER, Savilian professor of astronomy in the University of Oxford, will deliver a lecture at Birkbeck College, London, on May 25, on "The Total Eclipse of the Sun." The lecture is one of the special lectures arranged for teachers by the London County Council.

COURSES of free public lectures have been arranged by the Armourers and Brasiers' Company as follow: "Special Steels and their application in Engineering," by Dr. W. H. Hatfield (at the Sir John Cass Technical Institute, on May 17 and 31 and June 14, at 6.30), and "Oxidation, Corrosion, and Passivity of Metals," by Mr. U. R. Evans (at the Royal School of Mines, on May 18 and 25 and June 1, at 5.30). No tickets will be necessary. The Armourers and Brasiers' Company has founded senior industrial bursaries of £170 per annum and junior industrial bursaries of £50 per annum, the former to assist young men who have obtained honours at the final examination at the University of London for the degree of B.Sc. (Eng.), (mining) or (metallurgy), to enable them to prosecute further studies, and the latter to enable youths who have shown promise in their preliminary studies in subjects relating to engineering or metallurgy to continue those studies.

Calendar of Discovery and Invention.

May 16, 1888.—Whereas in the phonograph Edison made his sound records by causing the engraving tool to rise and fall, Emile Berliner in his gramophone employed a tool moving from side to side in a spiral groove cut in a disc. Berliner's original gramophone was first publicly exhibited in the Franklin Institute, on May 16, 1888, and it is now in the National Museum, Washington, D.C.

May 17, 1823.—Jacob Perkins was one of the pioneers of the use of high-pressure steam in engines, and he was also the first to put into practice heating by steam, the British patent for which is dated May 17, 1823.

May 18, 1825.—In the minutes of the Royal Society of Arts for May 18, 1825, is a report on Sturgeon's apparatus for exhibiting the principles of electro-magnetism. It was then resolved to award Sturgeon the Silver Medal and thirty guineas on condition of his leaving a complete apparatus and description thereof with the Society for the use of the public and relinquishing all pretensions to a patent. Included in this apparatus was the first electro-magnet, a horse shoe of soft iron made from a round bar about ½ in. in diameter wound over with about eighteen turns of copper wire. Though this historic gift has been lost, the transactions of the Society contain an illustration of it, and by means of this Prof. Fleming had a replica made which he presented to the Science Museum, South Kensington.

May 19, 1766.—When Euler left Berlin for St. Petersburg, D'Alembert suggested to Frederick the Great that his place in the Academy of Sciences should be filled by Lagrange. To this Frederick agreed, and on May 19, 1766, D'Alembert wrote to the King, "Je me tiens trop heureux d'avoir pu réussir dans cette négociation, et procurer à Votre Majesté et à son Académie, un si excellent sujet. Cet événement répand dans mon âme une satisfaction dont je n'ai pas joui depuis longtemps, et je suis sûr que mon estomac s'en ressentira."

May 19, 1919.—The first to attempt the direct flight from America to Europe for the £10,000 prize offered by Lord Northcliffe were Hawker and Grieve, who on May 19, 1919, set out from St. Johns, Newfoundland, in a Sopwith biplane driven by a Rolls-Royce engine. They had flown about 1100 miles in 14½ hours when the cooling water arrangements of the engine failed. It being impossible to complete the journey, search was made for a ship and the aeroplane brought down in the water close to her, both pilots being rescued and brought to England.

May 20, 1859.—Through information regarding the work of James Young on the distillation of oil, efforts were made to bore for oil in the United States. The first, however, to sink such a well, and thus become the founder of the great petroleum industry of America, was Colonel Drake, who on May 20, 1859, with four companions, began drilling in the woods of Pennsylvania, and after three months' strenuous work obtained oil from the rock on Aug. 27, 1859, for the first time.

May 21, 1797.—"Wherever the steam-mill resounds with the hum of industry, whether grinding flour on his native Schuylkill or cutting logs in Oregon, there do you find a monument to the memory of Oliver Evans." This tribute recalls the inventor who worked out the modern system of flour milling and was one of the first to use high-pressure steam. Among his patents was that of May 21, 1797, for a steam-driven carriage. He afterwards made a crude steam-driven vehicle and also a steam dredger.

E. C. S.

Societies and Academies.

LONDON.

Royal Statistical Society, April 26.—Miss E. M. **Newbold**: The practical application of the statistics of repeated events with special reference to the personal factor in industrial accidents. The Industrial Fatigue Research Board has in progress an inquiry into individual liability to accident, and the possibility of sorting out persons who ought not to be placed in particularly dangerous occupations. Records of minor accidents among various groups of factory workers, dockyard apprentices, and Royal Air Force apprentices have been compared with the results obtained with selected psychological tests. The statistical side of this investigation, and the effect of chance variation on figures of this kind, were discussed. As regards these minor accidents, the average rate is considerably affected by a comparatively small proportion of people with repeated accidents, whose liability shows measurable stability when they are observed over successive periods and also in different circumstances. These same people also report sick for various minor ailments more frequently than their fellow-workers.

PARIS.

Academy of Sciences, April 4.—Marcel **Brillouin**: Oceans and continents. Oceanic tides and soil tides. Normalised formulæ for their theoretical calculation. —C. **Matignon** and M. **Piettre**: The preparation of beryllium chloride. Beryllia, heated to between 700° and 800° C. in a pyrex glass tube and submitted to a current of chlorine carrying the vapour of sulphur chloride, is readily converted into beryllium chloride, which volatilises. Sulphur chloride may be replaced by the vapour of carbon tetrachloride or by phosphorus trichloride, but in the latter case the product is contaminated with a little phosphorus trichloride.—**de Sparre**: Remarks on the note by M. Sugot, of Feb. 28, 1927, on the integration of the differential equations of the gyroscopic motion of a projectile.—Jean Baptiste **Senderens**: The catalytic decomposition of formic acid. Study of the rate of production of carbon monoxide by the action of sulphuric acid of various strengths and of other catalysts (anhydrous aluminium sulphate, potassium bisulphate, orthophosphoric acid) on formic acid.—Charles **Nicolle**, H. **Sparrow**, and E. **Conseil**: The preventive vaccination of man against exanthematous typhus by the use of small repeated virulent doses (brain of the guinea-pig).—E. **Cartan**: The geodesics of spaces of simple groups.—A. **Gheorghiu**: The growth of the denominator $D(\lambda)$ of Fredholm.—D. V. **Jonesco**: A problem relating to the theory of partial differential equations of the second order with real characteristics. —Albert **Portevin** and André **Sourdillon**: The influence of the tempering temperature on the deformations of steel cylinders.—**Barbillion**: The distribution of the Foucault currents in a metallic disc submitted to the action of an inductor pole of circular section, but eccentric with respect to the disc.—Iser **Solomon**: A direct reading and continuous radio-qualitometer. An instrument for measuring the quality of the X-rays when used therapeutically.—C. **Mihul**: The third order spectrum of oxygen.—R. **Descamps**: The rotatory dispersion in the ultra-violet of aqueous solutions of tartaric acid containing boric acid.—Georges **Fournier**: A relation between the atomic weights of isotopic radio-elements and the velocity of the α-rays which they emit. The velocity of the rays, v, is given by $v_0 - kA$, where v_0 is a term which varies from one group of isotopes to another, A is the atomic weight of the emitting radio-element, and k is a constant. Polonium forms an exception.—René **Audubert**: The determination of the energies of reaction by a knowledge of the active light.—B. **Bogitch**: The reduction of the oxide minerals.—André **Kling** and Daniel **Florentin**: The transformation of the phenols into hydrocarbons in the presence of catalysts and hydrogen under pressure. All aromatic and cyclohexane hydroxyl derivatives heated in the presence of hydrogen under pressure (70 kgm. to 80 kgm. per sq. cm.) with a dehydrating catalyst such as alumina, clay, thoria, silica, give good yields of the saturated hydrocarbons. Thus ordinary phenol with 5 per cent. of alumina heated with hydrogen under pressure to 480° C. gives benzene with some fatty hydrocarbons. Ordinary commercial cresol under the same conditions gives 35 per cent. of light hydrocarbons.—Raymond **Quelet**: Parabromobenzyl chloride and the Grignard reaction. The reaction between $BrC_6H_4CH_2Cl$ and magnesium gives parabromtoluene and *p.p.'*-dibromodiphenylethane.—Maurice **Nicloux**: The microestimation of carbon. Applications. The method is limited to those compounds which can be completely burnt by heating with sulphuric acid, potassium bichromate, and silver bichromate in solution. Test analyses of various organic substances are given, the quantities taken for analysis being 4 mgm.-16 mgm.—Paul **Corbin** and Nicolas **Oulianoff**: The *besimaudites* of Prarion (Haute-Savoie).—Mlle. **Rémy**: Experimental mutations and the mechanisms of spontaneous mutations.—G. **Nadson**: The perforating algæ of the Black Sea. The perforating algæ are very widely distributed in the Black Sea and play an important part in the destruction of the limestone coast, oyster beds, and generally all calcareous substances.— G. **Guittonneau** and J. **Keilling**: Rendering elementary sulphur soluble and the formation of hyposulphites in a soil rich in organic nitrogen.—Emile **André**: Relations between the development of the liver and that of the sexual glands in some cartilaginous fishes.—A. **Gurwitsch** and G. **Franck**: The mitogenetic rays and their identity with ultra-violet rays.—Joseph **Magrou** and Mme. Madeleine **Magrou**: Mitogenetic radiations and the genesis of tumours.—Georges **Lakhovsky**: The influence of the astral radiations on the oscillation of living cells.—Henri **Mémery**: The influence of the astral radiations on wines.—**Swigel** and Théodore **Posternak**: The preparation of polypeptides containing the phosphorus and ferric nuclei of ovovitelline.—A. C. **Marie** and S. **Mutermilch**: Attempts at antirabic vaccination of the rabbit in the meningeal cavity.

WASHINGTON, D.C.

National Academy of Science (*Proc.*, Vol. 13, No. 2, February).—Norbert **Wiener**: On the closure of certain assemblages of trigonometrical functions.—G. Y. **Rainich**: On a type of Lorentz transformations. —Gordon T. **Whyburn**: Cyclicly connected continuous curves.—L. P. **Eisenhart** and M. S. **Knebelman**: Displacements in a geometry of paths which carry paths into paths.—Edwin H. **Hall**: Photo-electric emission, thermionic emission, and Peltier effect (from the point of view of dual electric conduction). These effects can be accounted for on the assumption that the greater part of the current within a metal is carried by electrons travelling from atom to atom without sharing the heat energy and a much smaller portion by 'free' electrons.—P. W. **Bridgman**: The transverse thermo-electric effect in metal crystals. With single crystal bars of bismuth about 10 cm. long and 6 mm. in diameter, basal plane inclined at 20° to the length, a temperature difference of 0·4° C. between two sides of the bar was observed when currents of 1 amp. were passed along it. Similar

but much smaller effects were obtained with zinc, tin, and cadmium. Kelvin's theoretical prediction of the effect is thus verified, but his reasoning seems inadequate. Regarding the current as an electron stream, the effect seems to be due to the reversible absorption or evolution of heat which occurs on the change of net direction of the electron stream with respect to a crystal axis inclined to the surface, after reflection from the surface.—Worth H. **Rodebush**: The effect of velocity distribution on the deflexion of atoms in an inhomogeneous magnetic field.—Carl **Barus**: Pinhole probe record of the closed organ pipe.—A. H. **Warner**: A comparison of the thermionic and photoelectric work functions for clean tungsten. The work functions in Richardson's thermionic equation and also in Einstein's photoelectric equation, which measure the work necessary to carry an electron from the interior of the metal to a position outside and beyond the influence of the image force, should, if conduction electrons are concerned in each process, be identical when measured at the same temperature. This has been verified within the limits of experimental error for clean tungsten illuminated by a quartz mercury arc and a monochromatic illuminator.—Enos E. **Witmer**: The quantisation of the rotational motion of the polyatomic molecule by the new wave mechanics. The polyatomic molecule is regarded as a rigid body with three principal moments of inertia.—Stanley **Smith**: A note on the spectrum of doubly ionised scandium.—Robert E. **Burk**: The thermal decomposition of ammonia upon the surface of a molybdenum wire. The effect of the initial pressure of ammonia upon the time of half life at 1228° Abs. suggests an apparent order of the reaction of zero. Hydrogen as an impurity was almost without effect; nitrogen caused marked retardation (catalyst poison), which persisted after pumping off to a vacuum. The results can be explained equally well by assuming that the reaction continues on parts of the surface not poisoned or that it can take place, at a reduced rate, on the poisoning film of nitrogen. Working at 1097°-1228° Abs., measurements of the temperature coefficient indicate a true heat of activation of 53,200 cal.—A. V. **Kidder**: Eskimos and plants. Fernald supposes that the highly specialised plants found in the Arctic Archipelago, the Torngat Mountains of Labrador, and similar localities in Northern America, are remnants of a general preglacial flora surviving in districts not covered by continental ice during the Pleistocene. It is suggested that the Eskimos are comparable in many ways with Fernald's plants.—C. Stuart **Gager** and A. F. **Blakeslee**: Chromosome and gene mutations in Datura following exposure to radium rays. Sealed glass tubes containing radium emanation were inserted into flower buds of *Datura Stramonium*. The results claimed include an increased percentage of chromosomal mutants, a new compound chromosomal type, Nubbin, and two new gene mutants.—A. F. **Blakeslee**: The chromosomal constitution of Nubbin, a compound $(2n+1)$ type in Datura.

Official Publications Received.

BRITISH.

Department of the Interior, Canada: Natural Resources Intelligence Service. Canada as a National Property. Pp. 75+9 maps. (Ottawa: F. A. Acland.)

Society of Chemical Industry: Chemical Engineering Group. Proceedings. Vols. 6B and 7, 1924-1925. Pp. viii+199. (London.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1924. Pp. v+127. (London: H.M. Stationery Office.) 4*s.* 6*d.* net.

Annals of Eugenics: a Journal for the Scientific Study of Racial Problems. Edited by Karl Pearson, assisted by Ethel M. Elderton. Vol. 2, Parts 1 and 2, April. Pp. 244. (London: Francis Galton Laboratory for National Eugenics, University College.) 35*s.* net.

Report of the Oversea Settlement Committee for the Year ended 31st December 1926. (Cmd. 2847.) Pp. 30. (London: H.M. Stationery Office.) 6*d.* net.

Mysore Geological Department. Records, Vol. 24, 1925. Part 2. Pp. v+29-160. (Bangalore: Government Press.) 2 rupees.

Bureau of Education, India. Occasional Reports, No. 14: Some Experiments in Indian Education. Pp. iv+84. (Calcutta: Government of India Central Publication Branch.) 1.8 rupees: 2*s.* 6*d.*

British Guiana: Combined Court, Annual Session 1926. Interim Report and Statement of Policy of Geological Survey. By the Economic Geologist and Mineralogist. Pp. 8. (Georgetown, Demerara.)

Publications of the South African Institute for Medical Research. No. 19: Contributions to the Study of Miners' Phthisis. By A. Mavrogordato. Pp. 83+13 plates+13 graphs. (Johannesburg.) 5*s.*

Deep Level Mining and High Temperatures: an Enquiry into certain Cases of Sudden Death presumably due to Heat Stroke, with a Report on the Associated Conditions. By A. Mavrogordato and H. Pirow. (Reprinted from the *Journal of the South African Institution of Engineers*, Vol. 25.) Pp. 23. (Johannesburg: South African Institute for Medical Research.)

Cocoa: the Story of its Cultivation. Pp. 48. (Bournville: Cadbury Bros., Ltd.)

Seale-Hayne Agricultural College, Newton Abbot, Devon: Department of Plant Pathology. Third Annual Report for the Year ending September 30th, 1926. (Pamphlet No. 21.) Pp. 25. (Newton Abbot.)

The National Physical Laboratory. Watch and Chronometer Trials, 1926. Pp. 6. (London: H.M. Stationery Office.) 6*d.* net.

Journal of the Chemical Society: containing Papers communicated to the Society. April. Pp. vi+iv+697-960. (London: Gurney and Jackson.)

The Quarterly Journal of the Geological Society. Vol. 83, Part 1, No. 329, April 23rd. Pp. xlviii+194+12 plates. (London: Longmans, Green and Co., Ltd.) 7*s.* 6*d.*

FOREIGN.

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1926. Pp. 41+4 plates. (New York City.)

Smithsonian Miscellaneous Collections. Vol. 75, No. 4: Cambrian Geology and Paleontology, V. No. 4: Pre-Devonian Sedimentation in Southern Canadian Rocky Mountains. By Charles D. Walcott. (Publication 2870.) Pp. 147-173. (Washington, D.C.: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 24: An Outline of Methods of Research, with Suggestions for High School Principals and Teachers. Pp. vi+31. (Washington, D.C.: Government Printing Office.) 10 cents.

Travaux et Mémoires du Bureau International des Poids et Mesures. Publiés sous les auspices du Comité International par le Directeur du Bureau. Tome 17. Pp. vi+240+142+95+4. (Paris: Gauthier-Villars et Cie.)

Ministry of Finance: Control of Printing. Almanac for the Year 1927. Pp. ix+358. (Cairo: Government Publications Office.) 7 P.T.

Travaux de la Section de Géodésie de l'Union Géodésique et Géophysique Internationale. Tome 3: Rapports nationaux sur les travaux exécutés dans les différents pays présentés à la deuxième assemblée générale, Madrid, 24 septembre—8 octobre 1924. 19 rapports. (Paris.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 16, Part 5: Beiträge zur Entwicklungsgeschichte der Reptilien. i: Die frühesten Entwicklungsvorgänge bei der Waldeidechse (*Lacerta vivipara* Jacq.). Von Tetsuo Inukai. Pp. 125-201+14 Tafeln. Vol. 16, Part 6: Studies on the Sauropsid Chromosomes. i: The Sexual Difference of Chromosomes in the Pigeon. By Kan Oguma. Pp. 203-227+plates 15-16. (Sapporo.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 335: Thermal Expansion of Graphite. By Peter Hidnert and W. T. Sweeney. Pp. 223-230. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES.

The West Indies: being a Catalogue of Books, Maps and Engravings, relating to British and Foreign Possessions in the West India Islands. (No. 495.) Pp. 42. (London: Francis Edwards.)

Akehurst's Sub-Stage Condenser Changer. Pp. 6. Shop Soiled Apparatus at Reduced Prices: Microscopes, Objectives, Binocular Dissecting Microscopes, Photomicrographic and Projection Apparatus, Cameras, etc., also Second-hand Apparatus. Pp. 28. Fodis Photographic Distance Meter. Pp. 1. Microscope Objectives. Pp. 1. Leitz Binocular Microscope. Pp. 2. Ogilvy Elementary Microscope. Pp. 2. Brinnell-Ogilvy Microscope. Pp. 2. Leitz 'Leica' Roll Film Camera. Pp. 4+4. (London: Ogilvy and Co.)

Diary of Societies.

SATURDAY, MAY 14.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District Meeting) (at Town Hall, Cleckheaton), at 2.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, Cambridge), at 2.30.—Demonstrations: Crystals of Hæmoglobin in Intracorpuscular Environment, N. Henderson and G. N. Spencer; Bodies related to Hæmoglobin in Vegetable Food Stuffs, D. Keilin; The Preparation of Hæmoglobin and its Analogues from their Constituents, R. Hill; Auto-oxidation of Plasma in Anæmia, Dr. Litarczeck and Dr. Stromberger; The Extra Cutaneous Spleen, Prof. J. Barcroft; The Dissociation Curve of CO Hæmoglobin, W. H. Forbes; Apparatus for Measurement of Difference in Potential on two Sides of a Membrane, G. S. Adair; Vital Staining in Living Blood Cells, L. J. Witts and R. A. Webb; The Influence of Relative Proportions of Antigen and Antibody on the Formation of a Precipitate, Prof. H. R. Dean and R. A. Webb; A New Method for Subjecting Developing Organisms to

Temperature Gradients, with some Results on the Development of the Frog, M. Shaw, J. Dean, and M. Tazelaar; Dowlings Electric Micro-manometer Adapted to Physiological Purposes, H. J. J. Braddick and B. G. King; A Simple Capillary Electrometer and Recording Camera, Dr. E. D. Adrian; The Discharge of Impulses in the Optic Nerve with Moving and Stationary Visual Fields, Rachel Matthews and E. D. Adrian; The Process of Ovulation in the Rabbit, J. Hammond and A. Walton; (*a*) Some new Ice-action Velocity Apparatus, (*b*) The Thermal Measurement of the Rate of Buffering of Acids by Proteins, Prof. H. Hartridge and F. J. W. Roughton.—Communications:—A. N. Richards and J. B. Barnwell: Experiments concerning the Elimination of Phenolsulpho Phthalein by the Kidney.—Sir E. Sharpey-Schafer: On Recovery of Sensation after Severance of Cutaneous Nerves in Man.—J. G. Dusser de Barenne and G. C. E. Burger: A Comparison of the Respiratory Exchange in Man during Static and Phasic Work.—Dr. J. O. Wakelin Barratt: The Action of Hirudin upon Thrombin.—I. de Burgh Daly: A Method of Measuring Small Changes in Electrical Capacity and its Application to the Measurement of Blood Velocity in Closed Tubes.—T. R. and W. Parsons: (*a*) Oxidation of Serum Constituents; (*b*) Lipoid-Protein Complexes.—T. Lewis and H. M. Marvin: A Postganglionic Axon Reflex in Human Skin.—L. E. Bayliss, E. A. Müller, and Prof. E. H. Starling: New Determinations of the Respiratory Quotient of the Heart-Lung System.—P. De and W. E. Dixon: Quinine Anæsthesia.—W. E. Dixon and J. H. Wadia: The Action of Thallium on the Skin.—W. A. H. Rushton: The Dependence of the Threshold for Nervous Excitation upon the Position of the Electrodes.—A. R. Fee and A. Hemingway: The Oxygen Usage of the Kidney.—J. Needham: Insulin in Embryogenesis.—B. G. King: Relation of Coronary Outflow to the Length of the Cardiac Cycle.—R. S. Stacey: Relation of Coronary Outflow to Heart Volume.—E. Peserico: Effect of Anoxæmia upon Systematic Blood Vessels.—Prof. H. Hartridge and F. J. W. Roughton: The Rate of Buffering of Acids and of Alkalies.—H. Dryerre: The Effect of Successive Injections of Adrenaline upon the Perfusion Rate.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

SUNDAY, MAY 15.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

MONDAY, MAY 16.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in the Botany School, Cambridge), at 4.30.—Dr. J. Needham: The Carbohydrate Metabolism of the Developing Frog Embryo.—O. M. B. Bulman: Some Structural Characters of the Genus Dictyonema, Hall, and the Technique Employed in their Determination.—J. S. Yeates: Some Problems in the Comparison of Chromosomes.—*Papers to be communicated by title only:*—M. Abeloos: Les théories de la polarité dans les phénomènes de régénération.—Dr. F. H. A. Marshall: The Conditions Governing Parturition.—G. R. de Beer: The Mechanics of Vertebrate Development.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Lieut.-Col. F. Molony: A Restatement of the Argument for Theism from Design.

RAILWAY CLUB (at 25 Tothill Street, S.W.), at 7.30.—C. N. Anderson: Some Railway Byways.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Modern Hospital Planning:—H. Percy Adams: English Hospitals.—L. G. Pearson: American Hospitals.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—E. H. de Bunsen: Formosa.

TUESDAY, MAY 17.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—E. T. Elbourne: Trade Association Statistics.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.2), at 6.30.—C. B. Smith: Notes on Swiss Butterflies.—R. M. Wattson: Pre-Reformational Baptismal Fonts.

ROYAL PHOTOGRAPHIC SOCIETY (Colour Group), at 7.—Major A. B. Klein: Colour Photography from the Standpoint of the Painter.

RÖNTGEN SOCIETY (Annual General Meeting) (at British Institute of Radiology), at 8.15.—Dr. R. G. Canti: An Investigation of the Effects of Beta and Gamma Radiation on Normal and Malignant Tissue Cells Growing in Vitro by Means of the Cinematograph with Demonstrations.—Prof. J. A. Crowther: An Analysis of some Observations on the Action of X-Rays on Drosophila Eggs.

WEDNESDAY, MAY 18.

SOCIETY OF GLASS TECHNOLOGY (London Meeting) (at University College), at 2.40.—Dr. G. W. Morey and Dr. N. L. Bowen: The Decomposition of Glass by Water at High Temperatures and Pressures.—Prof. G. Gehlhoff: The Brittleness of Glass.—F. Redfern: The New British 15-arm Automatic Suction Bottle Machine.—Standard Durability Tests for Bottles.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section) (Annual General Meeting), at 5.—J. Leveen: Shabbethai Donnolo.—Dr. R. W. Innes Smith: An Unpublished Letter of John Fothergill.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. H. Jeffreys: Cyclones and the General Circulation.—G. M. Meyer: Early Water-mills in Relation to Changes in the Rainfall of East Kent.—S. Morris Bower: Report on Winter Thunderstorms in the British Isles from January 1st to March 31st, 1926.

CHEMICAL SOCIETY (at Royal Institution), at 5.30.—Prof. R. Willstätter: Problems and Methods in Enzyme Research (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—P. K. Turner: A Wireless Works Laboratory.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 7.45.—S. Wernick: The Protective Effect of Metal Deposits on Iron.

ROYAL SOCIETY OF ARTS, at 8.—R. R. Hyde: Industrial Welfare in Great Britain and the United States.

FOLK-LORE SOCIETY (at University College), at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—F. P. Carrel: A New Development of the Ultra-Microscope.—Prof. R. Ruggles Gates and Dr. J. Latter: Observations on the Pollen Development of Two Species of Lathræa.—J. Lomax: The Preparation and Examination of Coal Sections.

THURSDAY, MAY 19.

SOCIETY OF GLASS TECHNOLOGY (London Meeting) (at University College), at 2.30.—General Discussion on Furnace Efficiency, in particular on the paper presented by Prof. W. E. S. Turner to the April meeting, namely, A Brief Review of Furnace Developments.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: Studies of the Mercury Band-Spectrum of Long Duration.—Prof. A. Fowler and L. J. Freeman: The Spectrum of Ionised Nitrogen (N II).—Prof. O. W. Richardson: Note on a Connexion between the Visible and Ultra-violet Bands of Hydrogen.—D. Jack: The Band Spectrum of Water Vapour.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Mrs. H. Earl, Mrs. T. Edmunds, and A. W. Goodman: What converted me to Birth Control and What I should like to see done for the Movement.

CHEMICAL SOCIETY, at 8.—Dr. H. M. Dawson: New Developments in the Study of Acid Catalysis. The Catalytic Catenary.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, Cavendish Square), at 8.15.—Debate on The Organisation of Medical Research in the Tropics, Prof. Warrington Yorke, Dr. A. T. Stanton.

FRIDAY, MAY 20.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Mrs. Ursula Roberts (Susan Miles): The Functions of the Critic.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (Annual General Meeting), at 7.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—Pictorial Group Meeting.—R. H. Lawton: Individuality.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. L. Bragg: The Structure of the Silicates.

PUBLIC LECTURES.

SUNDAY, MAY 15.

GUILDHOUSE (Eccleston Square, S.W.), at 3.30.—Dr. D. G. Hogarth: The Hittite People and their Civilisation.

MONDAY, MAY 16.

MIDDLESEX HOSPITAL MEDICAL SCHOOL, at 5.—Prof. J. Fraser: Some Surgical Problems. (Succeeding Lectures on May 17 and 18.)

LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN, at 5.30.—Prof. H. Beckwith Whitehouse: The Menstrual Function, its Physiology and Pathology. (Succeeding Lectures on May 23 and 30.)

TUESDAY, MAY 17.

GRESHAM COLLEGE, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on May 18, 19, and 20.)

SIR JOHN CASS TECHNICAL INSTITUTE, at 6.30.—Dr. W. H. Hatfield: Special Steels and their Application in Engineering. (Succeeding Lectures on May 31 and June 14.)

WEDNESDAY, MAY 18.

LONDON SCHOOL OF ECONOMICS, at 5.—C. S. Orwin: The Economics of Agriculture. (Succeeding Lectures on May 25 and June 1.)

ROYAL SCHOOL OF MINES, at 5.30.—U. R. Evans: Oxidation, Corrosion, and Passivity of Metals. (Succeeding Lectures on May 25 and June 1.)

THURSDAY, MAY 19.

BRITISH MEDICAL ASSOCIATION (Tavistock Square, W.C.), at 3.30.—Dr. E. Goodall: Some of the Work done to elucidate the Pathology of Disease falling to be considered under the rubric 'Insanity' (Maudsley Lecture).

LONDON HOSPITAL MEDICAL COLLEGE, at 4.15.—Prof. K. Faber: Gastritis, its relation to Achylia and Ulcer (Schorstein Memorial Lecture).

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Lt.-Col. S. P. James: Some Methods and Problems of Malaria Research.

FRIDAY, MAY 20.

GUY'S HOSPITAL MEDICAL SCHOOL, at 5.30.—Prof. E. H. Kettle: Inflammation and Infection. (Succeeding Lectures on May 27, 31, and June 3.)

CONGRESSES.

MAY 25 and 26.

FRENCH SOCIETY OF OTO-NEURO-OPHTHALMOLOGY (at Strasbourg).

JUNE 6 TO 9.

CONVENTION OF CANADIAN CHEMISTS (at Quebec).