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National Needs (II.).

" Son, I am wearied of that Madrissah (school) where they take the best years of a man to teach him what he can only learn upon the road."—*The Mahbub to Kim.*

" *Sciencia vinces*—whether it be on the field of battle, on the waves of the ocean, amid the din and smoke of the workshop or on the broad acres under the light of heaven ; assuredly, in the future, even more than in the past, not only the prosperity but even the existence of the Empire will be found to depend upon the ' improvement of Natural Knowledge '—that is upon the more complete application of scientific knowledge and methods to every department of industrial and national activity."—*Sir Wm. Huggins* (1905).

WHAT, precisely, are we to do ? Mr. Louis Anderson Fenn asks (Nature, Nov. 28, p. 909) in commenting upon my article on " National Needs ". He summarises my contentions in saying, that due appreciation of the *method of science* should be part of the cultural equipment of the citizen, adding : this can only be brought about through *a new kind of scientific education*, differing from the current type in having a definite social and political reference. I agree—but it is a little late to ask me to create and sustain such a movement. My article was a trumpet-call to this end ; my whole life, since 1870, has been consciously devoted to such purpose, I am obliged to confess, with little constructive success, except that I have learnt how all but insuperable are the difficulties to be overcome ; how every advance that we would make is subject to reduction by an overwhelming indeterminate factor—human nature.

The fundamental difficulty is to secure agreement as to the meaning of the label *scientific*. A science is a body of knowledge ; to be scientific is something very different from having knowledge : it means knowing how to make complete use of knowledge. The pioneer workers, in whatever field, are necessarily scientific ; yet among these, only a small minority are consciously scientific ; very few know how priceless a gift they have in their possession or seek to use it outside their specific work ; the majority act intuitively. I well know how long it was before I was clearly conscious of a guiding purpose behind my own efforts. The fact is, as I have often said, original inquiry is artistry pure and simple and the artist, we know, is rare. Artists are not noted for their common sense. Even in the narrow field of experimental inquiry, we have still to learn to exercise *proportionate judgement*, for which see Faraday's lecture on " Mental Education ", delivered before

Prince Albert in 1854. The doctrine Faraday professed should be our profession of faith: read frequently, as a lesson, in every church and in every school, in every laboratory before beginning work —if it be in us to rise so high and to have and hold a scientific faith. I agree with Mr. Fenn that our present-day 'science' is as ambiguous as the Christian faith. I would say not only politically but in all respects.

The Bishop of Birmingham said recently "that on this earth life would flicker out when the solar heat passed away but, in some other realms, he was forced to assume all that was of value in his personality would endure". Even mitred heads can asseverate, "I know it's true but I won't believe it". Why assume anything of an inconceivable situation? Our textbooks are full of similar proof of the prevalence of dogma. This is our difficulty—we do not hold to the truth even in teaching so-called science. In short, we have to cure ourselves before operating upon the public confidence. Few, probably, are educable to a scientific faith; most of us are inescapably credulous. Yet I believe much might be done with the multitude, if only a few of us could rise to the height of the opportunity before the teacher; could see how great is the peril in which we now stand and the call for the supreme effort calculated to raise our mental and moral standards; could combine in such crusade.

There must be a focus point. There is but one: the *Royal Society*. No collegiate body is likely to undertake the task—the literary mind being definitely incapable of understanding and using the experimental method. At the head of this article I have quoted words used full five and twenty years ago by the president of the Society, the late Sir William Huggins, a man to be ranked with Faraday as a lover of truth and a master of philosophical method. In justification of the claim he made, he added the statement:

> "It is obvious that it must be so, for it is only through an increased understanding of what are called the laws of Nature—the sequence and the interaction of natural phenomena—that we can hope to bring Nature into complete subjection and to make use of her illimitable forces to work out our own ends."

In the interval, the growth of 'natural knowledge' has been marvellous. Unfortunately, the control man has secured over Nature in no way extends to himself. We are faced with the fact that he is incapable of managing his ordinary affairs. Chaos now prevails throughout the world: we seem to be unable to do more than await events; we have no considered policy; no men competent to evolve one in any considered way. The astounding revelation has come upon us that the commercial community has no method of business—the banking fraternity, perhaps least of any, in view of the magnitude of its business and the trust imposed in it by the public. We have lived, it seems, upon the 'confidence trick': confidence being lost, the game cannot go on. The world is like Hans Andersen's 'King that had no clothes': at the mercy of pretending weavers. Money-making, as the aim and end of life, the American religion, is being made impossible by over-running the machinery which has made such doctrine possible. This is why I say that "a wise socialism is foreshadowed". Man is necessarily and by nature selfish but scientific advance will only be possible if he learn to subordinate his individual desires and be rational. This is our difficulty—to overcome our human nature.

To quote Sir William Huggins:

> "Clearly, it is only by such a widening of the general education common to all who go up to the Universities, before specialisation is allowed, that the present 'gap between scientific students of literary form, and classical students ignorant of scientific method' can be filled up, and the young men who will in the future take an active part in public affairs, as statesmen and leaders of thought, can be suitably prepared to introduce and encourage in the country that fuller knowledge and appreciation of science which are needed for the complete change of the national attitude on all science [scientific] questions, which is absolutely necessary if we are to maintain our high position and fulfil our destiny as a great nation."

The Society had memorialised the universities in the previous year (1904), begging them to take steps to ensure that *a knowledge of science* should be recognised in schools and elsewhere as an essential part of general education. The schools and universities may answer that this has been done. Those of us who are alive to facts, however, know that the object aimed at by Sir William Huggins has in no way been accomplished. Examinations have more and more prevailed to prevent the desired change; now even the teachers hug the chains that have been hung around them. Thereby hang coaching fees, examiners' fees, bold advertisement of schools and fond parents' worship of Tommy and Jane's successes. All very human—but bad business. A certain number of expert scientific workers has been brought into being under the system but the public mind, the business mind, the administrative mind, is untouched, in no way *disciplined* to grasp the complexities of our modern life.

Sir William Huggins—I knew him intimately—knew well what he wanted : a more complete application of *scientific knowledge and method* to every department of national and industrial activity. He had no desire that the stars should be understood : yet every desire that the method which had enabled him to understand them should be clear to all—the experimental method, the method of exercising sound scientific thought—thought replete with knowledge and action based upon such thought.

The Royal Society has done nothing, during the twenty-five years' interval, to carry out its former president's behest and support its own action. We are more and more developing bureaucratic habits and academic impotence, making natural science a close corporation ; worse still, an inordinate vanity is growing upon us, through excessive publication and prize-giving. No other class, let us confess, gets itself so much talked about and rewarded for so little real service. Courage of opinion is gone ; there is no evidence among us of any clear sense of responsibility, let alone of patriotism. Yet in our hands rests a terrific power, if we would but use it—as there must ever be in real knowledge. Present-day engineering achievement, patent to the public on every side, the outcome of considered thought and exact work, is sufficient evidence not merely of what is but of what might be, if we combined our forces to useful public ends. The engineer is not actuated solely by thought of gain ; a greater end, the glory of achievement, counts for much. The late Sir Charles Parsons's concern was to make the turbine a perfect machine ; whether it paid was a secondary consideration—far more his friends' consideration than his own.

Man is a far finer machine than any turbine or, indeed, any engineering achievement—yet we give no real thought to his improvement. We seek to administer remedies when he falls into ill-health but do little, if anything, to render him proof against disease. In seeking to gain mastery over Nature, we neglect our own souls. The schools for our young gentlemen are in the hands of most respectable governing bodies who unconcernedly continue to support the grand old fortifying, classical curriculum, with its religious accompaniments ; they rarely elect a ' head ' who is not its advocate. Not a single school stands out as engaged in the conscious and calculated practice of real scientific method. The condition of our schools is heart-rending to some of us who know—considering what they might be. It is true—Rome was not built in a day ; still, I have watched school building operations during sixty-five years and can record little progress. Lytton Strachey tells us that Dr. Arnold elected not to teach physical science at Rugby (1828) :

" Obviously only two alternatives were possible, it must either take the chief place in the curriculum or it must be left out altogether. Before such a choice, Dr. Arnold did not hesitate for a moment. ' Rather than have physical science the principal thing in my son's mind,' he exclaimed in a letter to a friend, ' I would gladly have him think that the sun went round the earth and that the stars were so many spangles set in the bright blue firmament. Surely the one thing needful for a Christian and an Englishman to study is Christian and moral and political philosophy.' "

Even to-day, men of my school make no demand for physical science. We ask only that the underlying method, which has made modern, post-Arnoldian progress possible, be taught with interest and full honesty of purpose ; as a philosophy but through practice and with reference to life. In my own case, interest was first awakened through the study of words—and the sight of butterflies—not through ' stinks ' ; but possession came only through engaging in experimental inquiry.

Organise our scientific forces we must. The Royal Society alone can take the lead. It should forthwith constitute its fellows a parliament of scientific opinion, sub-dividing it into sections, according to subjects, if desirable ; also co-opting a limited number of specially competent persons from outside the Society. Our first act would be to learn to take counsel together for the common good—a hitherto unknown art unpractised by scientific workers : this would be the prelude to the establishment of a limited scientific democracy, the beginning of my scientific socialism.

Constantly complaint is made that scientific workers are not used by Government or in the public services. Why should we be, when we do not set the example of using ourselves ? " Physician, heal thyself ", after all, is an expression of worldly wisdom ; " Charity begins at home " is another. It rests with the Society to show openly that there is an intellectual method behind all its activities and, by example, to encourage the development of the scientific temper of mind in the community. Need I say more by way of giving the lead that is asked of me ? Personally I pursue one hope :

" To the solid ground of Nature trusts the mind that builds for aye."

H. E. A.

Science and Philosophy of Life.

Life: Outlines of General Biology. By Sir J. Arthur Thomson and Prof. Patrick Geddes. Vol. 1. Pp. xix + 714. Vol. 2. Pp. xi + 715-1515. (London: Williams and Norgate, Ltd., 1931.) 63*s*. net.

WHEN two men of science, with the ripe experience of Sir J. Arthur Thomson and Prof. Patrick Geddes, combine to give the world their finished thoughts about life, the result is likely to be unusual and instructive. These volumes are both. They contain no ordinary exposition of general biology, for, instead of the formal treatment of themes which incline to become stereotyped, they embrace less ceremonious discussions of the facts generally classed as biological, and pass beyond these, aided and abetted by the authors' long intimacy with teaching and with civic endeavour. So that their net, wide-mouthed and fine-meshed, seems to catch almost everything that floats in the ocean of life.

The treatment of the themes in general cannot fail to remind one of the works of the older naturalists, where anecdotes formed the supporting skeleton upon which the body of generalities was built; only here the uncritical anecdotes of the early field naturalist are replaced by authenticated observations and by records of experiments drawn from a wide knowledge of recent biological investigation. The method has this great advantage for the general reader, that at almost any page he may dip into these two great volumes and find himself interested in an example or a theme, carefully labelled and complete in itself, but in reality an item in a massed argument for some particular generality. For the student or the teacher of biological subjects the advantage of the method lies in the wealth of facts which have been marshalled here for his conviction, to give body to the argument, and which secondarily form a gold-mine of information from which he may extract nuggets at his leisure.

Another impression made by the design of the work is that the authors are conscious, as every follower of the science must be, of the unwieldy masses of evidence which have accumulated, and that by a *tour de force* they have compelled the multifarious evidences, differing in quality and degree, to fall into line and play a part in support of their biological theses.

A fourfold purpose animates the book. Its first aim is to state and illustrate the outlines of biology as generally understood—the characteristics of organisms, their ways of acting in relation to their own organisation and in relation to their inanimate and animate environment, their development as living units, and their evolution as items in the complete tale of life's progress. Characteristic of this great section (of more than 900 pages) is the successful endeavour to import into the discussions a real flavour of livingness and of the wonder and drama of life. A second purpose is focused upon an examination of the science of biology, first as to its constituent branches, and second as to its place in the field of knowledge, its relation to the sciences and the arts; and here we are faced with subtle schemes of inter-relationships, as intricate as the web of life itself, which culminate in the mystical end papers of the volumes and their necessary but illuminating interpretation.

In the third place, throughout the whole work, which is marked by a philosophic synthesis of the factual groundwork, there runs the continuous thread of the neo-vitalistic outlook; but the treatment is cautious, and full weight is given to the discoveries of the biochemist and biophysicist, though insistence is made upon the need still for concepts characteristic of and peculiar to the life sciences.

Finally, the authors very properly bring together again for the consideration of their fellow-workers the special contributions to biological interpretations which their earlier writings have made familiar—the metabolic theory of sex, the inclined plane of animal behaviour, the concept of the cell-cycle with its morphological and physiological counterparts, the restatement of the concepts of reversion and parasitism, and so on.

No part of the "large and crowded volumes", however, so reveals the reactions of these skilled teachers to their long experience of education and of life as the final chapters and appendices. There, in discussing man and the wider aspects of biology, they let themselves go, and from a series of talks about many things they reach forward to a theory of life, "evolutionary throughout, from organisms at simplest to humanity at highest", in which due place is found "for each and all the contributory sciences, for the occupations and the arts, and for literatures and philosophies as well". Since the biological outlook lies at the foundation of this evolutionary integration, a strong plea is made for the further teaching in school and college of biology, "the general science of organisms—the study of the nature, persistence, continuance, development, and evolution of life". Of first-class zoology and first-class botany there is abundance, but "our frank reproach is that the Universities, within and beyond the British Empire, fall short of their just ambition as regards Biological Education". The cultural course for 'arts' students might well be oriented, on a sound basis of correlated structure and function, towards the old-fashioned natural history, which would stimulate dormant interest and fill the mind with concepts later to be applied subconsciously and automatically in any walk of life. As a basis for medical studies, what could be more telling than the driving home, by practical exercises and observations, of the great biological concepts of growth, development, correlation, variability, heredity, evolution, and so forth, with excursions, where need be, into issues of special significance to medicine? It is a strong plea for 'biology for life'.

In places this is a wayward work, occasionally discursive and diffuse, occasionally unnecessarily repetitive, mostly clear and easy in style, sometimes tantalisingly involved, but it has an atmosphere of its own, which, with its wealth of facts and its ideals, will well serve its purpose of furthering an interest in the science of life and in life itself.

James Ritchie.

Second Thoughts on Radiotelegraphy.

(1) *Modern Radio Communication: a Manual of Modern Theory and Practice, covering the Syllabus of the City and Guilds Examination and suitable for Candidates for the P.M.G. Certificate.* By J. H. Reyner. Third edition. Pp. xi + 259. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 5*s*. net.

(2) *The Cable and Wireless Communications of the World: a Survey of Present Day Means of International Communication by Cable and Wireless; containing Chapters on Cable and Wireless Finance.* By F. J. Brown. Second edition, revised. Pp. xi + 153. (London: Sir Isaac Pitman and Sons, Ltd., 1930.) 7*s*. 6*d*. net.

(3) *The Theory and Practice of Radio Frequency Measurements: a Handbook for the Laboratory and a Textbook for Advanced Students.* By E. B. Moullin. Second edition, entirely re-set and greatly enlarged. Pp. xii + 487. (London: Charles Griffin and Co., Ltd., 1931.) 34*s*. net.

THE new edition of a technical work presents acute problems to the author, the publisher, the librarian, the reader, the editor, and the reviewer. A rapidly advancing art and a widely distributed literature demand frequent revisions of these 'zusammenfassenden Berichte' on which the harassed worker must increasingly depend. But the author and his publisher must find it difficult to determine the appropriate moment at which to revise, and the conditions in which revision should be embodied in a new work rather than in a new edition. The librarian and the reader have to face the problems of expending money in purchasing and time in reading the revised or enlarged works; on the editor and reviewer devolves the special responsibility for guiding them on the degree of novelty or value embodied in the new edition, without dereliction of their primary duties towards entirely new works.

(1) Mr. Reyner's book, first published in 1923, is designed "to cover the City and Guilds examination in the subject". It is of the essence of a plan thus restricted that there should be some superficiality of treatment, and a judicious superficiality is not a defect. But there is evidence that the revision work of the 1925 and 1931 editions has not been sufficiently thorough, with the result that in places the allocation of space is disproportionate, in others the treatment is actually erroneous. If, indeed, a completely fresh work is not here called for, pruning of the sections on obsolescent apparatus like the arc transmitter, the high-frequency alternator, and the frequency changer, expansion of the apparently hasty additions dealing with screen-grid valves, and a complete re-writing of the sections on atmospherics and on the Heaviside layer, neither of which represents the position even of 1928, may be recommended.

(2) Mr. Brown's book was, in its original form, unique as a guide to the difficult economic technical and administrative problems of world communications by cable and by wireless. His rare combination of experience in State and private enterprise admirably fits him for his task, and the fresh information embodied in the present volume is characteristic of the appropriate treatment of new editions. The book may be unhesitatingly recommended to all who are interested in the vital problems of close linking of the Empire and the world by electrical communications.

(3) Mr. Moullin's "Handbook for the Laboratory and a Textbook for Advanced Students" attained a deservedly high reputation in its first edition of some 270 pages. That the preface to the first edition was written from the Engineering Laboratory, Cambridge, while that to the second edition comes from a corresponding address in Oxford, is perhaps not the least significant change in this story of radio frequency measurements, which now occupies nearly double the space to which it was formerly confined. Even though it

belongs to the first edition, a cautionary statement in the 'Cambridge' preface is of such importance to the worker from other fields on his entry into radio-frequency measurement that we quote it without apology:

"In high-frequency work we are again and again forced to remember that inductance, capacity and resistance are attributes possessed simultaneously by all apparatus, and we cannot say this is an inductance or that a capacity with the easy nonchalance of the power engineer. Therefore the chapter headings in this book are bound to be a little fictitious."

The greatest innovation in the new edition is the introduction of a new chapter (i.), "Developing the Electromagnetic Equations and Calculating the Field near Circuits and Aerials". "This chapter forms a focus for the book, but is not meant to be a full exposition of the equations of the electromagnetic field." So long as this limitation is fully recognised, the heroic effort of compression into forty pages may be commended, but the chapter is certainly not in itself a sufficient introduction to the equations; it should be used only for re-proportioning knowledge acquired from other sources.

For an account of the main plan of the work the reader must be referred to the review of the first edition (NATURE, Jan. 29, 1927, p. 155). The chapter which has attained the greatest expansion is that on the valve generator, now nearly three times its former length. The treatment is satisfactory within the limits adopted, but the crucial question of frequency stability is too lightly dismissed, and might well be given more weight in the next edition. The problem of the acoustic-frequency generator also merits fuller handling; in particular, the diagram for a beat-frequency generator might readily have been made very much more useful by the addition of a schedule of circuital element values, since it represents a generator which is only "very perfect" if certain stringent but sufficiently familiar conditions, not detailed in the text, are satisfied.

The chapters on measurement of potential difference and current, and on measurement of capacity, deal with fields in which the author has himself made especially valuable contributions, and contain discussions of the thermionic voltmeter, the dynamometer ammeter, and the tubular variable condenser, the two latter instruments having been devised by him since the publication of the first edition. There is now available a not inconsiderable literature of thermionic voltmeters, in which the departures from the author's original patterns are of great practical significance; fuller reference to these contributions would have been useful. The dynamometer ammeter and the Moullin condenser are instruments of great elegance and importance; it is very satisfactory to have an adequate discussion of them in the handbook.

The chapter on the intensity of radiated fields has been very little expanded, and it must be confessed that this is symptomatic of the not entirely healthy state of the subject. It may be hoped that the recent decision of the International Union for Scientific Radiotelegraphy to undertake a comparative study of the methods of field measurement will lead to the resolution of present doubts and difficulties.

One of the most surprising features of the book is that it contains no description or illustration of the normal equipment of the radio laboratory. The sub-standard wavemeter, the standard signal generator, the attenuation box, the Campbell capacitance bridge are in hourly use in the technical laboratory, but they would come almost as novelties to the reader of this work. The range and flexibility of the filter circuits of everyday practice are, too, much in excess of anything that might be inferred from the four pages which the author devotes to them. It may be added that a section on filter circuits which does not refer to Campbell, Zobel, Johnson, or Shea is an unexpected phenomenon. There are, perhaps, other evidences of insularity in the name index, but even this does not explain the absence of a reference to Bartlett on filters.

On the merely editorial side it may be suggested that the footnote which economises for the publisher by the use of "loc. cit." and "id.", where multiple references to many works of a few authors are in question, makes extravagant demands on the patience and perspicuity of the reader, who merits the greater consideration.

These notes are critical, and that they have been set down in detail must be taken as a token of the high regard in which the book as a whole is held. It is alone of its kind, it is extremely good, it should be in every high-frequency laboratory, and possession of the first edition does not excuse failure to acquire the second. But we venture to suggest that while the second edition is probably as good as any one author can make it, Mr. Moullin would increase the already heavy debt we owe him if, in proceeding to a third edition, or to an equivalent new work, he would take to himself one or more collaborators in the herculean task of preparing the ideal and monumental "Handbook of Radio Frequency Measurements".

Forest Travel in the Tropics.

Tropical Forests of the Caribbean. By Tom Gill. (Published by the Tropical Plant Research Foundation in co-operation with the Charles Lathrop Pack Forestry Trust.) Pp. xix + 318 + 81 plates. (Yonkers, N.Y.: Tropical Plant Research Foundation, 1931.)

THE Spaniard Cortez is known as a brave man, with an indomitable spirit and an almost inhuman quality of endurance. The American Tom Gill, more than four hundred years later, in adventuring the survey of the tropical forests of the Caribbean, required a very different kind of courage, and found a very different world, which was traversed in a very different manner. After reading Mr. Gill's book, the reader will reflect upon what the condition may be when another four hundred years have passed, but at present Mr. Gill, in association with the Charles Lathrop Pack Forestry Trust, has presented us with an interesting and informative up-to-date account of these forests.

Cortez, and those other bold adventurers who followed him in rapid succession, spoke of the marvellous forests of rare and unknown timbers. Mr. Gill says: "Cuba, seen through the eyes of Columbus, was a place of lovely verdure to be described only by the most glowing words in his vocabulary. It was a place of cool and fragrant woodlands, made up of trees of strange varieties, displaying leaves, flowers, and fruits of kinds he had never seen", and he refers to "the infinite number of fine, large, green trees", and "the verdure of the place, tempted me to fix there for ever". He also quotes Henry Hawks, writing in 1572, who said: "There are marvellous great woods, and as faire trees as may be seene of divers sorts, and especially firre trees that may mast any shippe that goeth upon the sea".

From the opening pages throughout to the end there is a mournful story of the way in which successive generations visiting the Caribbean have destroyed these forests. It seems as though the march of civilisation has proclaimed everywhere the destruction of trees over the wide surface of the globe.

The book is divided into sixteen chapters, among the titles of which are "Effects of Human Occupancy", "British Forestry in Tropical America", and "Tropical Forests and To-morrow", with others divided into the different countries—Porto Rico and Haiti; Central America and the West Indies; Mexico; Venezuela and Colombia—giving full information regarding each country; and it is enlivened by no less than eighty excellent pictures taken on the spot.

With the text supplemented by the pictures, the reader is enabled to visualise the existing conditions; the forester to gain necessary information; and all of us to learn a lesson to-day to plant beforehand, and so to lay up for those who follow us a rich heritage in the place of a vast deforested country.

No light feat of hardihood and endurance was required to accomplish this work, necessitating three winter visits—two by Mr. Gill and one by Mr. Barbour, Mr. Gill paying a special tribute to the value of aeroplane survey.

The writer combines the qualities of the scientific worker with the mature knowledge of a lumberman, so that the fortunate blending of both points of view increases the value of his catalogued information. It is consoling for us to read:

"one has to confess that British forestry has gone further in the American tropics than United States forestry", and for the American an alarming note when he says, "Nor does there seem to have been at any time, including *the present*, a real adequate effort on the part of Government and individuals to place the United States on a self-supporting timber basis. The American lumberman has cut his way across the Continent; and now is hacking out the *last great* stand of virgin timber within the Continental United States, the Douglas Fir region of the Pacific North-West."

There is an arresting thought expressed in the following words:

"Throughout the world there is a very fundamental relationship between man and trees, and in the tropics one sees it on every hand—a delicately balanced relationship, dangerous to destroy."

This pronouncement is illustrated and emphasised by the pictures of the deforested hill-top in Haiti in contrast to the year-old plantation in Trinidad and the mahogany forest in British Honduras, and other pictures. The author continually refers to, and stresses, the destructive effect on the climate and health of the people as the result of deforestation. He specially refers to the altered climate in the valley of Mexico. He says:

"Not more than twenty-five years ago it was extremely rare that high winds would raise even small clouds of dust over the City of Mexico. To-day from December to April the wind blows with great force, bearing large quantities of fine dust that hover like clouds over the city and settle there. . . . All these conditions conspired to convert regions once forest-covered into desert, and created a serious menace through soil erosion. More than one Mexican forester has pointed out that the effect of forest destruction on climate, soil, and water flow has brought about the abandonment of many flourishing towns.

"In old documents are still preserved requests for permission to cut trees necessary to be removed in grading for new cities and making highways in regions which to-day are desert and desolate of all trees. One finds, for example, permission granted many years ago to cut oak and pine about Saltillo, showing that in those days the region was at least partially covered with some kind of forest vegetation. To-day it is desolate." The author then pays a special tribute to Miguel A. de Quevedo, whom he calls the "Father of Mexican Forestry".

Appended to the book is a list of the better known broad-leaved species of the Caribbean region.

There is perhaps too much repetition and occasionally an absence of information which the expert in fine woods would have valued, but on the whole the book adds greatly to the world's knowledge of this wonderful tract of forest country, which includes a considerable area of yet unexplored forests, and provides a lesson to the whole world on the urgent importance of vigorous reafforestation based on scientific principles.

Short Reviews.

Maize in South Africa. By A. R. Saunders. (South African Agricultural Series, Vol. 7.) Pp. 284 + 72 plates. (Johannesburg: Central News Agency, Ltd., 1930.) 20*s*. net.

THIS book will naturally be of most interest to those vitally concerned with the cultivation and disposal of maize in South Africa, but students of the problems which arise when an economic crop undergoes rapid development in a new region will also find it of value.

Maize viewed as a world crop occupies first place in respect of tonnage. Of the 131 million tons produced, the Union of South Africa is responsible for about 2½ million, so that it is as yet one of the minor producing countries. None the less, 40 per cent of the cultivated land of the Union is occupied by maize, and nearly four-fifths of the crop is exported. Compared with other countries, the yield of maize in the Union is low, being less than one-half of that of the United States, and the future of the industry rests more on the possibility of increasing the yield per acre than in the extension of the existing area. In this, the position has some similarity to that of sugar beet cultivation in England.

The author discusses in detail the factors affecting the yield of maize in South Africa. Climate, soils, fertiliser treatment, and systems of cultivation are all dealt with in an interesting way. As in many relatively undeveloped countries, superphosphate plays a great part in crop production and is by far the most important fertiliser in the maize-growing areas, where it gives quite striking results. A further factor in improving yield is inter-cultivation with the object of checking weeds, and some interesting experimental data are given on this point. The most direct method of crop improvement is the choice of suitable varieties and a chapter is devoted to practical notes on the more important varieties in cultivation. The remainder of the book deals with the diseases of the crop, and this section, like the rest of the book, is excellently illustrated. The disposal of the crop and its position in commerce are also discussed. Many references to the literature are given and the book is well indexed. H. V. G.

(1) *Worsted Open Drawing: a Simply Written Explanation of the Process; for Managers, Foremen and Students in the Industry.* By S. Kershaw. Pp. vii+131. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 5*s*. net.
(2) *Leather Crafts Manual.* By Ivy Evelyn Norman and Paul I. Smith. (Lockwood's Manuals.) Pp. vii+88. (London: Crosby Lockwood and Son, 1930.) 2*s*. 6*d*. net.
(3) *Practical Dry Cleaner, Scourer and Garment Dyer.* Edited by William T. Brannt and J. B. Gray. Sixth corrected edition. Pp. xviii+378. (London: Crosby Lockwood and Son, 1930.) 12*s*. net.

IT is always matter of conjecture as to the kind of reader to whom technical works will hold an appeal. Class students will use the textbooks recommended by their teachers; the majority of craftsmen may well carry on without such books (Does not Mr. Kershaw write, in (1), p. 75, "Intelligent working is better than a guide book"?), whilst the general reader will mostly ignore technical works; (3) is an exception to test the rule, for it seems to interest the public and is now in a sixth edition. Truly, the essential merits of these three books are independent of general favour, however such limitation might be disapproved by the publishers. Once again, as so very often, are we confronted with the view ("Worsted Open Drawing", p. 85): "Even experts disagree". Mr. Kershaw's work is commendably practical and has many useful diagrams. "The Leather Crafts Manual" is brief and to the point; it may, however, be remarked, regarding the historical survey, that assumptions are not proofs. The text is full of interest and the illustrations are attractive, but the index is very poor. (3) is far too diffuse in treatment, and however accurate the text, yet the impression conveyed is as of a *catalogue raisonnée* of recipes, with not infrequent repetition of information. Sufficiently pruned, there would be enough left to satisfy requirements; but the treatment is due probably to the book being a compilation by various writers. P. L. M.

Index of Spectra. By the late Dr. W. Marshall Watts. Appendix Z: *Iron and Iron Oxide.* Pp. 116. (Westcliff-on-Sea: T. M. F. Tamblyn-Watts, 1931.) 18*s*.

WATTS'S "Index of Spectra" was a household name among the last generation of spectroscopists, and few books have in their day fulfilled more adequately an important purpose. Mr. F. Tamblyn-Watts, who was Dr. Watts's assistant for more than thirty years, and to whom have been left the papers which were to have formed the basis of a continuation of the "Index", has decided to publish these papers as they stand, as additional appendices. They contain material up to 1918 relating to some twenty elements and certain of their compounds, and the volume before us is one of the posthumous publications. Those familiar with Watts's "Index" —that is to say, all the older spectroscopists—will need no description of the character of the work.

We cannot but regret that Mr. Watts has ventured to continue the publication of this work. Invaluable as the "Index of Spectra" has been in the past, its work is done. Modern spectroscopy requires something different, and this is being adequately supplied in the seventh volume of Kayser's "Handbuch der Spektroscopie", which is now appearing part by part. The new appendix dealing with the iron spectrum is particularly inopportune, since iron provides the secondary and tertiary standards of wave-length and has accordingly received special attention during the last decade. At the time when the measurements here published were made the importance of 'pole effect' was unknown! Mr. Watts would be well advised to abandon his project, which must inevitably fail to achieve the purpose he has in view.

Handbuch der Spektroscopie. Von Prof. H. Kayser und Prof. H. Konen. Band 7, Lieferung 2. Pp. 499-750. (Leipzig: S. Hirzel, 1931.) 28 gold marks.

THE seventh volume of Kayser's standard "Handbuch der Spektroscopie" is devoted to bringing up to date the collection of data which vols. 5 and 6 provided for an earlier period. In this great task Prof. Kayser has the collaboration of Prof. Konen, and the first part of the new volume appeared in 1923. It contained data for the elements A to Fe (in alphabetical order of chemical symbols) complete up to 1922. The long interval which has elapsed before the publication of the second part of the volume is due to the magnitude of the task and pressure of other work. The second part now before us treats of the elements Ga to Ir, but includes only data up to 1928. In order so far as possible to preserve homogeneity of the whole volume with respect to the period covered, it is proposed in the third part, which is now nearly ready, to summarise subsequent work on the elements A to Hf up to the time of publication. The remaining parts will then appear as quickly as possible and will be complete to date of issue.

The new part, in which 250 pages are necessary to present the work on ten elements, has the well-known characteristics of this invaluable book, and no description will be necessary. The deep debt of gratitude which spectroscopists have for long owed to Prof. Kayser (and for the present volume to Prof. Konen also) will be increased by this new publication, and the forthcoming parts will be eagerly awaited.

A School Algebra: as far as the Advanced Course in the School Certificate Stage. By A. M. Bozman. Pp. viii + 427 + lxii. (London and Toronto: J. M. Dent and Sons, Ltd., 1931.) 4*s.* 6*d.*

THIS textbook is designed to cover a school course in algebra up to the stage of the advanced papers in school certificate examinations. It is divided into two parts, the first comprising twelve good chapters on the fundamentals, and the second an additional thirteen chapters on the progressions, surds, logarithms, theory of quadratics, graphical solutions, permutations, combinations, and the binomial theorem.

The general plan of the course is well laid out, though the chapter on generalised arithmetic might have come a little earlier. Very commendable features are the changing of the subject of a formula and the graphical treatment of equations. The former is too often inadequately dealt with in many existing textbooks in spite of the fact that a knowledge of the fundamental processes of algebra is demanded, whilst the latter is frequently vitiated by piecemeal treatment, which tends to obscure the real significance of graphical representation. In the present volume these defects have been skilfully remedied; the chapter on graphical solutions being particularly clear and thoroughly sound.

Each chapter contains a good assortment of interesting and well-graded examples, though a few seem rather difficult, for example, Nos. 11 and 13 on p. 251. There are also five sets of excellent revision exercises, the last of which, beginning on p. 413, should be announced in the list of contents on p. vi.

The volume may be favourably commended to all who need a good book on the subject.

Die Schlämmanalyse. Von Dr. Hermann Gessner. (Kolloidforschung in Einzeldarstellungen, herausgegeben von Herbert Freundlich, Band 10.) Pp. x + 244. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 18 gold marks.

MECHANICAL methods of analysis by elutriation, originally applied almost exclusively to soil analysis, are finding increasing value in the examination of many technical products. This book deals with particles ranging from 1 mm. to 0·001 mm. diameter, and is mainly concerned with sedimentation methods, although sieving and air separation are touched upon. The first third of the letterpress treats of the theory of the falling particle; the next third describes the apparatus used, and more than sixty types of sedimentation vessels are figured; the last third shows the practical applications of the methods. With such a host of different types of apparatus, all designed for the same purpose and differing only in detail, it is not easy to appreciate the various advantages and disadvantages. A greater measure of criticism might have been given, and comparison of results obtained with different types would have been instructive. The question of sieves receives rather scant treatment, and standard sieves other than German are not mentioned. Nevertheless, the book forms a worthy addition to the monographs on colloidal subjects of which it is the tenth volume. J. R. NICHOLLS.

The Passivity of Iron.

By U. R. EVANS.

IN 1790, James Keir [1] discovered that treatment of iron with nitric acid produces a peculiar condition in which the metal loses its power of precipitating silver from silver nitrate, although retaining its ' metallic splendour '. The behaviour of iron towards nitric acid was further examined by Schönbein [2] and Faraday; [3] Schönbein described the peculiar condition as ' passivity '. Later work has shown that many other oxidising agents render iron passive towards reagents which attack the metal in its ordinary or ' active ' condition; reducing agents tend to restore ' activity '. Similarly, anodic treatment may produce passivity, but cathodic treatment usually renders the metal active again. Low temperatures favour continuation of passivity, and high temperatures a return to activity; alkalis are favourable to passivity, and non-oxidising acids to activity. These facts cannot fail to suggest that passivity is due to a protective oxide film.

The objection has been raised that passivity can be produced under conditions where an oxide film would be dissolved. Recent work, however, has shown such statements to be untrue. Furthermore, the oxide films responsible for the principal types of passivity have now been stripped from the metal and studied; although invisible when in optical contact with the bright metal, the films are perfectly visible when lifted from it. Finally, optical methods have been worked out which enable the invisible film to be detected whilst still upon the metal; such methods depend on the manner in which a film affects the character of polarised light reflected at a metallic surface—a subject examined mathematically by Drude.[4] The cause of passivity is therefore no longer in doubt, and the time is appropriate to review the subject.

PASSIVITY DUE TO NITRIC ACID.

Dilute nitric acid consumes iron far more rapidly than dilute sulphuric acid; but the concentrated acid produces only a feeble reaction, and even this soon dies away, the iron becoming passive; the iron may then be brought into acid sufficiently dilute to attack active iron, and yet will remain unchanged. It has been alleged that this type of passivity cannot be due to a layer of oxide, which, it is argued, would be destroyed by the acid. In 1928, however, Hedges [5] studied the action of nitric acid on ferric oxide (free from hydroxide), and found that there was practically no dissolution at low temperatures; when the acid was heated, dissolution set in at about 75° C., and this is roughly the temperature at which the passivity of iron, placed in nitric acid, breaks down. Thus, Hedges not only removed the objections to the oxide film view, but also produced new evidence in its favour. I have found it possible to keep flaky ferric oxide in nitric acid for six days without destruction of the flakes.[6] The film formed on iron by concentrated nitric acid is invisible, but, in 1900, Michéli [7] obtained optical evidence of its existence. Moreover, Benedicks and Sederholm [8] have shown that iron placed in dilute nitric acid containing alcohol develops a film which displays a network of cracks on drying; in this special case, therefore, the film becomes visible even when it is still attached to the metal. There is no reason to doubt that the passivity produced by nitric acid is due to an obstructive film of ferric oxide.

PASSIVITY PRODUCED BY EXPOSURE TO AIR.

Pilling and Bedworth [9] have divided metals into two classes, according to the relation between the densities of the elements and their oxides. In the first class, the natural volume of the oxide is less than the volume of the metal needed to produce it; here any superficial oxidation will necessarily produce an oxide layer pierced by voids through which oxygen can pass unobstructed to attack the metal below. This class includes most of the lighter metals, such as magnesium and calcium, and it is not surprising to find that those metals ' burn ' readily in air. Iron and most other heavy metals belong to the second class. Here, the oxide, when unstressed, occupies a greater volume than the metal contained in it. Consequently, conversion of the surface into oxide will produce a layer free from voids, which is actually in a state of lateral compression.

At ordinary temperatures, such a film, even when very thin, should exclude oxygen from the metal below, and thus the film on iron exposed to dry cold air never attains ' visible thickness '. At slightly elevated temperatures, diffusion of oxygen through the solid film becomes possible, and the film may reach a thickness comparable to the wavelength of light, so that interference tints appear on the metal; at still higher temperatures, a thick greyish scale is produced, which often tends to crack and peel off.

This cracking and peeling is very characteristic of relatively thick films. It is partly attributable to differences in the coefficients of expansion of iron and its oxide; but probably even if produced and held at constant temperature, a thick film would tend to crack more than a thin film. All films formed on heavy metals must possess potential energy due to the state of compression, which energy will be released when the film becomes detached. Thus, the work needed to detach area a of an ideal film of thickness θ will not be less than $aW_A - a\theta P_C$, where W_A is the adhesional work per unit area and P_C the compressional energy per unit volume (work against cohesional forces is neglected, being small for a thin film). When, therefore, the thickness θ is less than W_A/P_C, energy must be expended in stripping the film; but if the thickness is greater than that value, spontaneous peeling is at least not impossible. In the case of scale produced at a red heat, this spontaneous detachment can often be observed microscopically, whilst the ultra-microscopic cracking of films of the interference colour range is inferred from the fact that these films have a far smaller protective action than 'invisible' films, which are too thin to give colours. Electrolytic iron, if freshly abraded, quickly precipitates copper when a drop of dilute copper nitrate solution is placed on the surface. If the iron is exposed to air at ordinary temperatures for some time before the copper nitrate is applied, the deposition of copper does not occur; the time needed for the formation of a film sufficiently continuous for protection is much greater after coarse abrasion than after fine abrasion, doubtless owing to the internal stresses and ultra-microscopic fissures left in the metal in the first case. If the iron is gently warmed in air and cooled again, the passivity towards copper nitrate is produced more quickly than at ordinary temperatures; but if the warming has been conducted at temperatures where interference tints appear, deposition of copper commences, starting at points representing cracks in the film. Thus, if a strip of freshly abraded iron is gently heated for a few seconds at one end (the other end being unheated), cooled and tested with copper nitrate, the iron will usually be found active at the unheated end, where the film is incomplete, and also at the heated end, where it is cracked; but there will generally be a passive region in the gently warmed part in the middle.

There is little doubt that the nitrate itself has some film-repairing action, since copper sulphate usually produces some deposition of copper under analogous conditions. Copper chloride invariably produces instantaneous growth of copper; chlorine ions can penetrate through imperfections which the larger ions cannot pass.[10] Even in copper nitrate the passivity of iron often tends to break down at jagged places. This failure is to be expected; geometrical considerations indicate that, at points of high convex curvature, the metallic atoms will, on oxidation, move outwards to a circle of greater radius, so that the lateral compression already referred to will be abnormally low at these points.

Steel or commercial iron does not attain reliable passivity on exposure to air alone; the junction between dissimilar phases constitutes a place where a protective film is liable to break down. But if steel is treated in a solution of chromic acid or potassium chromate the weak places are brought into repair, and a drop of copper nitrate afterwards produces no action.

In recent papers which I have published,[11] with J. Stockdale, L. C. Bannister, S. C. Britton, and other collaborators, methods are described for isolating oxide films from a metallic basis. All methods depend on an operation, such as immersion in iodine, or anodic treatment in a chloride or sulphate solution, which dissolves the metal just below the oxide film; this allows the oxide film to peel off or to be transferred to glass or cellophane. In the case of some metals, particularly nickel, the films responsible for heat-tints themselves show bright colours after removal. The protective films on iron made passive by exposure to air at low temperatures, being too thin to give colours, are invisible whilst on the bright metallic surface; but they are found to be plainly visible when removed from it. Being thinner than the films from heat-tinted iron, they are, as a whole, more transparent; but since there is more interlocking with the metal when the film is thin, the 'passivity films' show frequent opaque spots due to residual metal. A comparative study of films above and below the limiting thickness needed to produce colour (about 400 A.) has indicated that no sharp change of properties occurs at the limiting thickness, the position of which is merely fixed by the accident that the human eye is insensitive to waves below a certain wave-length.

The thinner (invisible) films have been detected optically whilst still on the metal by Freundlich, Patscheke, and Zocher,[12] whose conclusions agree with the results of the Cambridge experiments in indicating that combination of iron with oxygen occurs rapidly even at room temperature, although the films cease to grow before they reach visible thickness.* A pure iron mirror free from oxide was obtained by heating iron carbonyl vapour in a closed vessel. When air was admitted and quickly pumped out again, an oxide film was left on the metal which could be detected by the polarised light method; simultaneously the mirror became inert to nitric acid of specific gravity 1·4, although similar mirrors not exposed to air were attacked by the acid under identical conditions. The optical change corresponded to a mean film-thickness of about 10 A. The films produced on abraded surfaces at Cambridge are very much thicker, since the abrasion produces a zone of disorganised metal, and the oxygen can penetrate more deeply. These thicker films are actually less protective than the very thin ones; but to the experimenter the thickness is useful, since it allows the film to be removed from the metal.

PASSIVITY PRODUCED BY ANODIC TREATMENT.

The fact that an iron anode becomes passive in an alkaline solution is easily understood on the oxide film view. But anodic passivity can also be produced in a neutral salt solution, or even (if the current density is high enough) in dilute acid. When iron is made the anode in dilute sulphuric acid at a low current density, it passes smoothly into solution as ferrous sulphate. When the initial current density is high, dissolution also occurs normally at first; but later passivity sets in, the dissolution slows down, and the current sinks to a lower value The current, which continues to flow in the passive state (providing the e.m.f. is high enough), is mainly devoted to the production of oxygen gas; the dissolution of iron, although still measurable, becomes very slow.[13]

W. J. Müller [14] has shown that the time needed to produce passivity becomes shorter as the initial current density is increased; he has also demonstrated that passivity never sets in until the liquid layer next to the metal has become saturated with

* Some evidence of the very rapid oxidation of iron in air at low temperatures was provided by Faraday in his "Experimental Researches in Electricity", Series XVII. § 2049 (1840). I am indebted to Mr. A. Marshall for directing my attention to this work.

some iron compound; indeed, at this stage the polarising microscope has revealed some solid substance, apparently $FeSO_4,7H_2O$, upon the metallic surface.[15] It is unlikely, however, that a layer of ferrous sulphate is directly responsible for the passivity;[16] for all visible material present on the iron surface peels off or disappears when complete passivity sets in, a circumstance noticed by Hedges.[17] When once oxygen evolution has begun, the metal is clean and bright, and the passivity is certainly due to an invisible oxide film on the surface. This film has recently been detected and measured optically in an important research by Tronstad,[18] who has followed the increase of film thickness under anodic treatment, as well as the diminution under cathodic treatment, in acid, neutral, and alkaline solutions.

Probably authorities would still differ regarding the details of the anodic reactions. When the iron is active, the discharge of sulphate ions to give ferrous sulphate may conveniently be written thus:

$$SO_4'' + Fe = 2e + FeSO_4.$$

The ferrous sulphate will at first dissolve in the liquid, regenerating SO_4'' ions; but at high-current densities the liquid layer will soon become supersaturated, and solid matter will separate out, covering up most of the surface, and raising the true current density on the small part still uncovered. This may permit the local potential to rise high enough for the inception of alternative reactions, which absorb greater amounts of energy. For example, the discharge of hydroxyl ions, according to the equation

$$2OH' = 2e + H_2O + O$$

becomes quite possible at this stage, since the hydrogen ion concentration of the layer next the anode is now greatly decreased. The oxygen may convert the iron superficially into oxide, which will interfere with further conversion of iron to sulphate; but the major part of the oxygen will stream off as oxygen bubbles, which will dissipate the visible crust of ferrous sulphate or basic salt, and leave only the invisible oxide to protect the metallic surface.

I have investigated the objection that sulphuric acid would dissolve a ferric oxide film,[19] commencing by studying iron covered with a visible ferric oxide film. Iron heated in air to give an early interference tint (caused by a film of 500-800 A. thickness) was cooled and introduced into $M/10$ sulphuric acid; within a second, the film was dissolved away and the colour vanished. The experiment was repeated with iron heated to give thicker films (greater than 2000 A.); here there was some slight attack at first, but the films soon peeled off, and, as soon as the oxide was out of contact with the metal, the dissolution practically ceased; the film flakes could then be collected, washed, and photographed. This shows that sulphuric acid has practically no *direct* action on ferric oxide; the rapid destruction of the film in contact with metal is due to the cell

Iron | Sulphuric Acid | Ferric Oxide

set up at discontinuities; the ferric oxide is the cathode of this short-circuited cell, and becomes reduced to ferrous oxide, which at once dissolves in the acid; it seems that oxides of the type MO are usually much more quickly attacked by acid than those of the type M_2O_3. This explanation is supported by the fact that if chromic acid, a strong oxidising agent, which would prevent the reduction, is added to the dilute sulphuric acid, heat-tinted iron can be kept in the acid mixture for many hours without loss of colour.

Heat-tinted iron was then subjected to anodic treatment in $M/10$ sulphuric acid (the e.m.f. and resistance being such as to provide a current density of 6 amp./dm.^{2} when the iron was active, or 3 amp./dm.^{2} when it was passive). It was found that if the tinted iron was introduced into the acid before the circuit was completed, the colour film was destroyed, and when the current commenced to flow, the iron behaved as an active electrode, passing into solution as ferrous sulphate. But if the circuit was completed before the introduction of the anode, so that the current flowed from the instant of immersion, then the iron was passive from the first moment, and oxygen was evolved, the colour due to the film remaining undestroyed. It was then possible to interrupt the current for a few seconds without destruction of the film; during the interruption a few oxygen bubbles continued to rise from the metal, indicating a residual charge of excess oxygen, which doubtless prevented the local reduction to the quickly soluble ferrous compound. If the circuit was restored before this supercharge of oxygen was exhausted, the iron was still found to be passive, oxygen was again evolved freely, and the colour remained undestroyed. But if the interruption was continued after the bubbles representing the supercharge had ceased to appear, then the oxide film was destroyed by the mechanism already indicated, the colour vanished, and, on restoring the circuit, the iron was active, and dissolved freely without any appearance of oxygen. If the circuit was restored at the precise moment when the film had suffered destruction at some points but not at others, dissolution of the iron commenced at the film-free points, thence extending under the skin, which peeled off in curling flakes. When once these oxide flakes had passed out of contact with the metal, their dissolution ceased.

Experiments conducted on iron which had been exposed, after abrasion, to air at ordinary temperatures showed remarkable analogies with the results obtained on heat-tinted specimens; evidently, the thin invisible films behaved in much the same way as the thicker colour-films. When the current was turned on after the anode entered the acid, the iron was dissolved freely, whereas if the circuit was completed before the introduction of the anode, the iron was usually passive from the moment of immersion, oxygen being evolved from the surface. The current could then be interrupted for a few seconds without destroying the passivity, but if the interruption was prolonged beyond the short period during which the slow stream of oxygen bubbles (representing the supercharge) rose from the metal, then, on restoring the current, the iron behaved as an active anode, and iron passed freely into solution without evolution of oxygen. Special experiments,[20] in which the circuit was restored at a chosen moment when the film was destroyed at certain points but not at others, indicated that it was possible to undermine the invisible film formed during the previous passive period ; it peeled off in curling microscopic flakes, which, although mechanically flimsy, were chemically stable in the acid, when once out of contact with metallic iron. Thus the films responsible for anodic passivity, like those responsible for air-passivity, have been stripped from the reflecting basis and rendered visible.

Space does not permit the discussion of several other aspects of anodic passivity, particularly the periodic alternations between the active and passive states which often occur at a range of current densities intermediate between the activity and passivity ranges. For this matter, the reader is referred to the work of Hedges,[21] who has made the subject particularly his own.

CONCLUSIONS.

It is not suggested that all inert metals owe their lack of reactivity to oxide films ; metals like gold will react very slowly even when quite free from films. But the important types of passivity in iron are almost certainly due to films of ferric oxide. The facts as known to-day confirm in many respects the porous oxide film theory put forward twenty-five years ago by Haber and Goldschmidt.[22] All iron which has been exposed to air is covered with an oxide film ; the essential difference between active iron and passive iron is that on the former the film is in bad repair and on the latter it is in good repair ; the degree of initial repair needed to cause a sample of iron to display passivity will vary with the presence or absence of film repairers or penetrating ions in the solution into which it is to be introduced. A ferric oxide film will only resist the action of a non-oxidising acid, for example, dilute sulphuric acid, if a supercharge of oxygen is present to prevent local reduction to the rapidly dissolving lower oxide, or alternatively if an oxidising agent, for example, chromic acid, is also present ; where the main acid is itself an oxidising agent, for example, nitric acid, this reduction does not occur.

I am indebted to Dr. L. Tronstad for much information embodied in this article.

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The Voyage of the *Beagle*, 1831–1836.

ON Dec. 27, 1831, H.M.S. *Beagle*, a ten-gun brig, under the command of Capt. FitzRoy, R.N., sailed from Devonport. " The object of the expedition was to complete the survey of Patagonia and Tierra del Fuego, commenced under Capt. King in 1826 to 1830—to survey the shores of Chile, Peru, and of some islands in the Pacific—and to carry a chain of chronometrical measurements round the world." It is well known how FitzRoy proposed to the Hydrographer that " some well-educated and scientific person " should be invited to join the expedition, how Capt. Beaufort wrote to Prof. Peacock, that he in turn consulted Prof. Henslow, who, as FitzRoy writes, " named Mr. Charles Darwin, grandson of Dr. Darwin the poet, as a young man of promising ability, extremely fond of geology, and indeed of all branches of natural history ".

The voyage lasted about three months short of five years. The first land touched was St. Jago, one of the Cape de Verd Islands. In the three weeks spent there, Darwin's observations had two most useful results. They showed him " the superiority of Lyell's manner of treating geology " in the first volume of the " Principles ", in spite of Henslow's well-meant warning " on no account to accept the views therein advocated ". It was there, too, that it " first dawned on me that I might perhaps write a book on the geology of the various countries visited, and this made me thrill with delight. That was a memorable hour to me."

From St. Jago the *Beagle* crossed the Atlantic, by way of the St. Paul's Rocks and Fernando Noronha, to Bahia in Brazil. Nearly three and a half years, from March 1832 to July or August 1835, were spent at various ports on the South American coasts from Bahia southwards to the Falkland Islands and Tierra del Fuego, and then up the west coast to Valparaiso and Callao. From the latter port the *Beagle* sailed westwards, with long stops in the Galapagos Islands, Tahiti, New Zealand, and Australia, then by Keeling Island, with its coral reefs, Mauritius, Cape Town, St. Helena and Ascension, and once more to Bahia, returning to England in the autumn of 1836.

During the long pauses at the various South American ports, Darwin made many an excursion inland. From Bahia Blanca he crossed the Pampas and dug out the remains of " great fossil animals covered with armour like that on the existing armadillos ", a discovery that he notes as one of the beginnings of his views on the origin of species. At Valdivia he felt the great Concepcion earthquake of Feb. 20, 1835, and his accounts of the earthquake in his " Journal " and in his important memoir on the volcanic phenomena of South America read before the Geological Society are among our chief authorities on this great disturbance.* On the west coast of South America, from lat. 45½° to 12° S., he found traces of shelves uplifted at various times to a height, as near Valparaiso, of 1300 feet. It was here also that the whole theory of the origin of coral reefs was thought out before he had seen a single true reef. The intermittent elevation of the South American coast led him to reflect on the effects of subsidence, replacing " in imagination the continued deposition of sediment by the upward growth of corals ".

No part of the voyage had so much effect on his subsequent work, however, as the five weeks spent in the Galapagos archipelago. The chapter on these islands was almost rewritten in the later editions. But there are a few sentences in the first edition, omitted from the others, that are worth reprinting, if only for what was evidently in his mind, though then left unexpressed. " It would be impossible for any one accustomed to the birds of Chile and La Plata to be placed on these islands, and not to feel convinced that he was, as far as the organic world was concerned, on American ground. This similarity in type, between distant islands and continents, while the species are distinct, has scarcely been sufficiently noticed. The circumstance would be explained, according to the views of some authors, by saying that the creative power had acted according to the same law over a wide area " (p. 474). He afterwards reflected " with high satisfaction " on the discovery of these relations ; for it was evident, even in those early days, that such facts " could only be explained on the supposition that species gradually become modified ".

The *Beagle* reached Falmouth on Oct. 2, 1836, and, in the following December, Darwin was in Cambridge arranging his collections. At the same time he began writing his " Journal of Travels " ; not hard work, he notes, for his MS. journal had been written with care. His chief labour was to make an abstract of his more interesting scientific results. In March 1837 he moved to Great Marlborough Street in London, and the " Journal " seems to have been finished by July, for in August he was unable to leave London as he was busily engaged in correcting the proofs. Possibly it was to celebrate the completion of the MS. that, in July 1837, he opened his " first notebook for facts in relation to the Origin of Species ", a subject on which even then he " had long reflected ".

Even so late as December of the same year there was evidently some idea of mixing the journal up with FitzRoy's, for his future wife then wrote that his sister " wants it to be put altogether by itself in an Appendix " (" Emma Darwin ", vol. 1, p. 274). This was the plan afterwards followed, and it appeared as the third volume of FitzRoy's " Narrative " under the title " Journal and Results ".

The " Journal " was one of the longest of Darwin's books, and it was begun and finished within seven months. This meant that he must usually have written nearly three pages a day. Copies of the proofs were circulated among various friends, for Hooker read Lyell's set before he left on his southern voyage and slept with them underneath his pillow. On the other hand, Dr. Holland thought they were not worth publishing, though " I don't believe ", wrote Darwin's future wife, " he is any judge as to what is amusing or interesting ".

When it did appear there was little doubt as to its reception. The copy that Lyell gave to Hooker became " a well-thumbed copy ", for all the officers in the *Erebus* were borrowing it. The second master of the *Terror* wrote that Darwin had " accomplished what Old Johnson said of Goldsmith when he heard he was going to write a Natural History, ' he will make it as interesting as a Persian tale ' ". Even the historian Sismondi was " found in an ecstasy over the book ". " Notwithstanding his ignorance of natural history he found the greatest interest in it, that it was written with so much feeling, so good, so right a heart."

The " Journal and Results " is in one way unique among Darwin's works. It is the only book of his that was written before he became a permanent invalid. It has all the charm of the health and vigour of youth ; on nearly every page it reveals his delightful personality, his humour and never-ending courtesy. It is written in a style that is always fresh and interesting. It has inspired many similar works, and yet it remains, far and away beyond all others, the greatest of our books on scientific travel.

It owes this place no doubt to Darwin's habit of writing up his MS. journal day by day, taking pains to describe carefully and vividly all that he had seen. In after years Darwin often lamented his inability to write a simple sentence. There is no trace of this difficulty in the " Journal ", and page after page might be quoted as models of good clear English. There is one passage at least—the description of Brazilian forest scenery—that seems not altogether unworthy of a master of English prose. " I have said that the plants in a hothouse fail to communicate a just idea of the vegetation, yet I must recur to it. The land is one great wild, untidy, luxuriant hothouse, which nature made for her menagerie, but man has taken possession of it, and has studded it with gay houses and formal gardens. . . . In my last walk, I stopped again and again to gaze on these beauties, and endeavoured to fix for ever in my mind an impression, which at the time I knew, sooner or later must fail. The form of the orange-tree, the cocoa-nut, the palm, the mango, the tree-fern, the banana, will remain

* On next April 19 it will be fifty years since Darwin's death, and we are still wanting : (i) a volume reprinting his memoirs (such as that mentioned above) and his other papers not directly reproduced in his books, and (ii) an index to all his works, like that compiled by Cook and Wedderburn for Ruskin's complete works.

clear and separate; but the thousand beauties which unite these into one perfect scene must fade away; yet they will leave, like a tale heard in childhood, a picture full of indistinct, but most beautiful figures" (p. 390).

The "Journal and Remarks" long survived the two volumes with which it was once connected. In the first three years 1337 copies were sold. A second edition appeared by itself in 1845 as one of the "Home and Colonial Library". It was then called "Journal of Researches into the Natural History and Geology of the countries visited during the Voyage of H.M.S. 'Beagle', etc." The third edition, with the same title inside, but on the cover "Naturalist's Voyage round the World", was published by Murray in 1860.* They were thus prepared in the years following the writing of the "Sketch" of 1844 and the appearance of the "Origin", and they naturally contain more distinct references to his views on the modification of species. It is unnecessary to quote the changes made, for they are fully given in the "Life and Letters" (vol. 2, pp. 1-5). Of these two editions, many thousands of copies were sold—the imprint of 1879 is labelled "fourteenth thousand"—and translations have appeared in French, German, and other languages. In addition to the "Journal", "The Structure and Distribution of Coral Reefs", a book that he said "no human being will ever read", was published in 1842, and a second edition in 1874. "Geological Observations on the Volcanic Islands, etc.", appeared in 1844, and "Geological Observations on South America" in 1846, and a second edition of both in one volume in 1876.

If it were only for these four books—and it was for the work contained in them and the Cirripede volumes that the Copley medal of the Royal Society was awarded to Darwin in 1864—we should be justified in recalling the departure of the *Beagle* a hundred years ago. But a still stronger claim lies in the observations that Darwin made on the Pampas, in the Galapagos Islands, and elsewhere in South America, the discoveries that were the foundation of the long course of reflection and experiment that ended in the "Origin of Species".

* In 1901 a new edition was brought out with 15 plates and other illustrations.

Obituary.

PROF. CARVETH READ.

PROF. CARVETH READ, whose death occurred on Dec. 6 at Solihull, was born at Falmouth on March 16, 1848. He counted among the contemporary philosophers who have been most influenced by science and scientific ideas. His early logical studies, which found their expression in an essay "On the Theory of Logic" (1878), are marked by what has been considered the Cambridge spirit, which insists on sound method, and is not satisfied with mere divination, even if it turns out to be true. His later well-known treatise, "Logic, Deductive and Inductive" (1898), of which the fourth edition (1914) is definitive, brought to a term his studies on that side.

A more speculative work was "The Metaphysics of Nature" (1905), where Prof. Read anticipates the later phase of thought that brings science and metaphysics into close contact. This phase, as has been pointed out sometimes in our columns, has made the old jokes about the futility of the pursuits of metaphysicians obsolete. To give science itself a firm standing-ground, as Prof. Read showed by setting himself to the task, metaphysical as well as logical distinctions are necessary.

Still, Prof. Read felt the influence of the prejudice, and owned that, "amidst the contempt into which ontology has now fallen it is lonely, wearisome, and depressing to write about it". With an ironic humour for which he had a gift, he therefore turns in a self-deprecating manner on his own conclusions. These do, however, constitute a real construction, to which, as he has himself noted, Spinoza and Hume have in their different ways especially contributed.

In "Natural and Social Morals" (1909) Prof. Read went on to apply the conclusions arrived at, so far as they are applicable to human life. He had found that in a certain sense, with careful definitions, the world can be called a conscious being; though he also held that the interpretation of Nature, or of history, by final causes seems to lie beyond our power. But while we cannot say that consciousness, as it exists in the human mind, is the end of the universe, yet philosophy, or, to use a more generalised term, culture, is, in the old phrase of the schools, for man the Chief Good.

Evidently, however, theoretical knowledge as an end, whether in philosophy or in any other mode of activity, cannot be so predominant as to exclude all others. "To philosophise is not every man's ruling passion", though thinkers like Aristotle and Spinoza placed it at the summit. The idealistic conclusion that "consciousness appertains universally to the unconditioned and perdurable Being", Prof. Read regards as merely "orectic"; it is an effort to conceive rather than a definite conception. No use can be made of it in relation to the knowledge of phenomena. To those the thinker has to come back with only the guidance of scientific method.

Rather in the spirit of Hume, who, after all his subtle inquiries into ultimate questions, turned to something so tangible as history, Prof. Read took up finally as his special subject comparative psychology and the physical and mental evolution of man. The results are partly on record in "The Origin of Man and of his Superstitions" (1920; second edition in two separate volumes, 1925). With such positive scientific studies the years of Prof. Read's retirement from his successive chairs of philosophy and of comparative psychology in the University of London were occupied to the last.

News and Views.

ON Dec. 29 occurs the bicentenary of the death of Brook Taylor, who in his day was considered the most notable British mathematician after Newton, and who counted among his contemporaries Halley, Cotes, Saunderson, Colson and Maclaurin. Born on Aug. 18, 1685, at Edmonton, Middlesex, Taylor entered St. John's College, Cambridge, and in 1701, while there, began a correspondence with Keill of Oxford. He was elected a fellow of the Royal Society in 1712 and from that time onwards he contributed papers to the *Philosophical Transactions*, discussing the motion of projectiles, the centre of oscillation, and the forms taken by liquids when raised by capillarity. In 1715 he published his important work "Methodus Incrementorum Directa et Inversa", the first treatise dealing with the calculus of finite differences. It contained the famous 'Taylor's theorem', the importance of which was, however, not fully realised until pointed out by Lagrange. Taylor also published, in 1715 and 1719 respectively, two works on linear perspective which contained the earliest general enunciation of the principle of vanishing points. In 1714, he became one of the secretaries of the Royal Society, but resigned this post in 1718 and soon afterwards abandoned the study of mathematics. He long suffered from consumption, and he died at Somerset House on Dec. 29, 1731, at the age of forty-six years, two years after succeeding to his father's estate in Kent. He was twice married, his second wife dying in 1730, leaving him a daughter who married Sir William Young. Taylor was buried in the churchyard of St. Anne's, Soho.

AMONG the many vessels of the British Navy connected with the history of scientific exploration, H.M.S. *Beagle* will always be remembered on account of the work of her commanding officer, Capt. Robert FitzRoy, and of his famous guest, Charles Darwin, who, through Prof. Henslow, became FitzRoy's companion during five years. An account of the famous voyage which began on Dec. 27, 1831, appears elsewhere in this issue (p. 1065). FitzRoy had been appointed to the *Beagle* in 1828 at the age of twenty-three years, and already had made surveys of the coasts of Patagonia and Terra del Fuego. Though deeply interested in science himself, FitzRoy could not have foreseen what were to be the fruits of Darwin's studies. Darwin was invariably a sufferer from sea-sickness, the effects of which were felt all his life, yet he remained in the *Beagle* to the end of her voyage. From South America the ship crossed the Pacific, visited New Zealand, Australia, and the Cape, and arrived at Falmouth on Oct. 2, 1836. From the first there was a complete understanding between the commanding officer and his guest, and to FitzRoy is due the geographical names Mount Darwin, Darwin Sound, and Port Darwin. FitzRoy afterwards became governor of New Zealand, but he is also remembered for his work as chief of the Meteorological Office of the Board of Trade, and as a pioneer in the publication of weather forecasts. FitzRoy died in 1865, six years after Darwin's publication of his "Origin of Species", a work which was the direct outcome of Darwin's observations begun on the *Beagle*.

A TABLET has been placed on the house in Egerton Road, Bristol, where he lived for the last twenty-six years of his life, in memory of the late Mr. W. F. Denning, the veteran amateur astronomer and observer of meteors, who died on June 9. The tablet was unveiled on Dec. 18 by Dr. H. Knox-Shaw, president of the Royal Astronomical Society, in the presence of a number of Mr. Denning's relatives and friends. Prof. Lennard-Jones, who was present as the representative of the University of Bristol, referred to the fact that the University had conferred on Mr. Denning the honorary degree of M.Sc., and stated that he was a citizen of whom Bristol might well be proud. Dr. Knox-Shaw, in a short address, bore testimony to the high value set on Mr. Denning's work by his fellow-astronomers, and directed attention to the fact that the observation and study of meteors has of recent years come to be regarded as of much greater importance than in former days, partly owing to the information they afford as to the conditions at great heights in the earth's atmosphere.

DENNING's catalogue of meteor radiants, published in 1899 in the *Memoirs of the Royal Astronomical Society*, still remains unique of its kind. In the later years of his life he calculated a large number of true meteor paths from observations made by himself and other people, many of whom were induced to cooperate with him by his evident devotion to his subject. He has left in manuscript a book on meteors which it is hoped will soon be published. An indication of the high standard of Denning's work is afforded by a letter which he wrote in the early 'seventies to the Rev. Robert Main, Radcliffe Observer at that time, requesting that the observations of meteors then being carried out at Oxford might be made with greater accuracy. His activities were by no means confined to meteors—he also made a series of valuable observations of the surface markings of the planet Jupiter—but it is because of his work on meteors that Denning's name will live in the foremost rank of English amateur astronomers. Mr. Denning was of an extremely retiring nature, and although he frequently wrote articles for the scientific journals and corresponded with a number of astronomers, he was personally known to only a very few. The inscription on the tablet runs as follows: "William Frederick Denning, F.R.A.S., Hon. M.Sc., Bristol University, and gold medallist of the Royal Astronomical Society, lived here from 1905 till his death on June 9th, 1931, aged 83 years. He discovered five comets and, in 1920, the new star in Cygnus, and was specially distinguished for his lifelong devotion to the observation and study of meteors."

ON Dec. 16 the new ore-dressing laboratory of the Mining Department of the University of Birmingham was opened by Sir Robert Horne. The Department already has a coal-treatment laboratory and a mining-machine laboratory (in which demonstrations of the use of coal-cutting and other machinery used in mines are given to students). This new extension therefore brings the state of equipment of the mining department to a standard probably unequalled in the world. At a luncheon which followed the opening ceremony, Sir Robert Horne insisted that " research, research, and research is the only policy upon which a thriving business can be founded ". He believes that our coal industry is so far from being played out that in its future we shall find the renewal of prosperity of our country. There are great opportunities in low temperature carbonisation of coal on one hand and in hydrogenation on the other, and Sir Robert feels certain that scientific research to-day is on the edge of great discoveries. In both of these processes we have come very near to practicable results, and if the experiments which are being fruitfully made by an association of coalmasters in the Birmingham district are not misleading, " we may look forward with confidence to what the future of the coal industry is going to be ". Sir Robert also believes that while large liners will keep to the use of oil fuel, a large part of the mercantile fleet will in future be run on pulverised coal.

AT the degree congregation which followed the luncheon, the honorary degree of LL.D. was conferred on Sir Robert Horne and Mr. Evan Williams. In introducing the former, the vice-principal (Prof. E. de Selincourt) said: " A University which believes in knowledge not only as worthy to be pursued for its own sake, but also as the one sure foundation for successful achievement in all branches of human activity, delights to honour those men who, prominent in the larger world of practical affairs, pay willing tribute to the intrinsic value of higher education and the vital importance of scientific research ". In introducing Mr. Evan Williams, the vice-principal referred to the special effort which Mr. Williams has made to attract into the coal industry men of a high type : " We at this University hold him in special honour because he has always recognised that the success of the industry he controls depends ultimately on its power to draw into its ranks men of brains and character, who bring to their work no mere smattering of technical knowledge but a wide outlook and a scientifically trained intelligence ; and because he has given a timely and practical encouragement to those researches which can only be conducted in the laboratory of the expert investigator ".

SIR DANIEL HALL's thoughtful and moving article on " The Faith of a Man of Science " in the December number of the *Nineteenth Century* is a welcome sign of the times. Short as it is, it touches on a number of the deepest questions which are exercising all thinking men, and does it in a sincere and simple way which is the most effective for the purpose. It has often been remarked that the modern conferences of men of science have taken the place for us of the medieval conferences which discussed theology. But, with all their faults, the medieval conferences did go to the root of the matter ; they discussed the subjects which at that time men thought the most fundamental. With us the scientific conference tends to be more and more specialist and technical, and we have to look to the individual to tell us what he thinks about first principles. More of them are coming to do this, and we may now add Sir Daniel Hall to the list on which Sir Oliver Lodge, Sir Arthur Eddington, and Prof. Julian Huxley are conspicuous names.

SIR DANIEL is alone among those mentioned in deriving his religion from the study of Berkeley, but in this he agrees with a large number of philosophical thinkers who are returning to Berkeley with added interest and pleasure. He is the fountain of the belief in modern times that the one reality is mind, and it is well known that recent extensions of our view of the universe, so far from dwarfing the mind of the thinker, have given a fresh range to the Berkeleian conception. The side on which one would have wished Sir Daniel Hall to have developed his thought is that of the collective mind, especially as exhibited in the history of science. No individual thinker, least of all the man of science, can expect to evolve a religion, or a coherent view of the whole, from his single consciousness. He needs to keep widening it to embrace the whole thinking process, back to the beginning of thought, and infinite, as it seems to us, in both directions. But it is a process in time, of which, for our own small part, the events are becoming more and more distinctly known.

" ACADEMIC Research and National Dividends " was the very topical alternative title given by Sir Frank Smith, secretary of the Department of Scientific and Industrial Research, to his Gluckstein Memorial Lecture entitled " Chemistry and the Community ", delivered at the Institute of Chemistry on Dec. 18. Pure research, he said, has played a large part in the birth and development of most modern industries. Aluminium was exhibited in 1885 as a laboratory curiosity, but now a quarter of a million tons are produced yearly, chiefly by electrolysis, while the rare metals are the basis of many important engineering developments. Physical research on atomic structure and the nature of radiation, perhaps the most outstanding work of the present day, may seem far removed from practical affairs, but already it has given us the wireless valve, which has revolutionised communications, and the gas-filled tungsten lamp, with an efficiency four times that of the old carbon filament lamp. Sir Frank stated that such pure research in the past twenty-five years has led to a saving of not less than a thousand million pounds, and no one can foresee its further possibilities. As an indication of directions in which pure research can render further aid to industry, he mentioned lubrication, distillation of coal, alloys of iron and steel, and vulcanisation of rubber, all familiar subjects industrially but none of them fully understood. Tremendous advances would result from complete knowledge of the mechanism of these processes. The least depressed industries of the present time are those which maintain efficient research services. Work of this kind pays industry handsomely, and pays the community even better.

SOME important facts on the distribution of urban population in Great Britain were noted by Prof. C. B. Fawcett in a lecture to the Royal Geographical Society on Dec. 7. Using the term conurbation for the large urban areas, Prof. Fawcett showed that there are seven of these with a population of more than a million each, and that during the intercensal period 1921–31 the combined population of these areas has increased by 6·5 per cent, while that of the total population of Great Britain has increased by only 4·7 per cent. The population of the thirty next largest urban areas increased by 4·4 per cent, and that of the next thirty-eight towns by only 2·6 per cent. Thus the great conurbations have absorbed a considerable share of the total increase in population during the last decade. Of the total increase, greater London has absorbed about one half and greater Birmingham more than a sixth. Other interesting facts emerged from the county figures. These show that the gain in population is almost entirely confined to the English lowland. The 'highland areas' and the Isles of Man and Wight show actual decrease. The metropolitan area of London and its satellite towns has now a population of about twelve millions.

IN *Mechanical Engineering* for November is a biographical sketch by Mr. and Mrs. H. P. Vowles of Jacob Perkins, who was undoubtedly the pioneer in the use of very high pressure steam. His experiments extended over many years, and between 1820 and 1830 he constructed boilers and engines working at pressures of 800-1400 lb. per sq. in. One of his inventions was the precursor of what to-day is known as the uniflow engine. Perkins was born in Newburyport, Mass., on July 9, 1766, and was apprenticed to a goldsmith. He then turned his attention to the making of dies for copper coinage, machinery for nail making and for bank-note engraving. It was this last which brought him to England. The Bank of England would have nothing to do with Perkins' inventions, but he was successful in other directions and, in his later years, the firm he founded printed the first penny postage stamps. Ventilating and heating, steam-guns, paddle wheels, and other things all engaged Perkins' attention, and in 1826 he read a paper before the Royal Society describing his experiments on the compressibility of water, in which he used pressures up to 2000 atmospheres. As an American, he was regarded with a certain amount of jealousy, and by some was looked upon as a charlatan, but the present paper should remove any doubt as to the value of his work. He died in London on July 30, 1849, at the age of eighty-three years. His second son, Angier March Perkins (1799?–1881), and his grandson, Loftus Perkins (1834–1891), were both well known for their work with high pressure steam and hot water, and the latter was responsible for the machinery of the yacht *Anthracite* which in 1881 crossed the Atlantic fitted with a water-tube boiler with 500-lb. steam pressure. A great grandson, Ludlow Patton Perkins, who died in 1928, carried on the traditions of the family, while the firm of bank-note and stamp engravers, Messrs. Perkins, Bacon and Co., of Southwark Bridge Road, recalls the name of Jacob Perkins himself and of Joshua Bacon, a printer who married his daughter.

MANY engineers ten years ago deprecated the use of aluminium for overhead conductors on the grounds of its comparatively small tensile strength and that its weather-resisting qualities had not yet withstood the test of time. Since then the use of steel-cored aluminium has become almost universal. In this cable, the inner core generally consists of seven strands of galvanised steel wire twisted together, surrounded by a layer of aluminium wires twisted together, which forms a water-tight covering for the core. In this way a mechanically strong and electrically good conducting cable is obtained. The steel core provides the necessary tensile strength, and the aluminium carries most of the current. In the *Electrician* for Nov. 27, E. T. Painton points out the great demand there is for this kind of cable. The five chief factories in Great Britain are manufacturing it at the rate of 150,000 miles of cable per year. A large fraction of this cable is used for the national grid, but much of it is exported. In France the extensions of railway electrification and the development of water-power resources have led to great extensions of the overhead system, the bulk of which is carried out by steel-cored aluminium. In the United States, in Canada, and in Australia many new lines are being erected and the old lines duplicated by this kind of cable. Until its advent, span lengths of 1000 feet were only used in crossing rivers and ravines. It is now quite customary to use 1000-feet span lengths. The distance apart of the lattice towers in the Grampian Supply System varies from 900 ft. to 1300 ft. One of the greatest difficulties the engineer has to overcome is the obtaining of wayleaves, and the fewer towers required the easier it is to get them.

IN the annual report of the North-East Coast Institution of Engineers and Shipbuilders it is stated that the standard and volume of the discussion of papers have been well maintained, and the average attendance has been appreciably higher than for a number of sessions past. The membership roll now stands at 1201; but the Institution has to deplore the loss by death of twenty-four members, among whom are Sir Charles Parsons, Mr. Andrew Laing, Sir Hugh Bell, and Sir Archibald Ross. One interesting note in the report states that, as a result of the efforts of the Institution, the Newcastle-upon-Tyne City Council decided on May 20, 1931, to establish an engineering museum. The president of the Institution for 1931 is Mr. J. McGovern, now holding office for a second year, who delivered his presidential address on October 16. Dealing with the importance of technical knowledge and research, he asked the question whether a central research station controlled by the shipbuilding industries and free from direct government control would not be to the interests of the industries. He would include in the programme not only problems of resistance in air and water, propulsion, stability and rolling, but also investigations on vibration, stresses and deflections at sea, the impartial recording of trials and other problems, the solution of which demand resources not at the service of the majority of private firms. Regarding the best interests of the industry as a whole, " and further, as a general truth, we gain more by conference than by competition ". In referring to the use of heavy oil engines in ships, Mr. McGovern spoke of the pioneer work of Akroyd—this, of course, should read ' Akroyd Stuart ', ' Akroyd ' being Stuart's Christian name.

THE Empire Marketing Board has issued a report, compiled by Sir William Dampier, on " Dairy Research " (E.M.B. No. 44. London: H.M. Stationery Office. 1*s*. net). The subject is dealt with under three headings: (1) What is dairy research, and what is the dividing line between a dairy research institute and other research institutions in the sphere of animal nutrition and diseases, and low temperature research ? (2) What is being done in this field ? and (3) What extensions are desirable, and to what problems should research be directed ? A new system of payment for milk is advocated, on a basis of quality instead of volume. A further study of the detection of adulteration by freezing-point methods is recommended. As the consumption of milk per head of population in Great Britain is low, a publicity scheme for milk would, it is suggested, greatly benefit the industry. Attention is directed to some of the important practical results that have emerged from research work, such as Major Dunkin's test for the detection of Johne's disease; and further problems needing investigation are suggested—for example, the influence of pasteurisation on the vitamins in milk, the keeping and ripening of dairy products, the utilisation of by-products, inheritance of high milk yield, and many others.

Two developmental tendencies in connexion with the bird sanctuaries in the Royal Parks of England are noticeable in the Report for 1930, issued by H.M. Stationery Office. The first and most natural and proper tendency is towards the encouragement of native British birds, for nesting or for shelter and food. This has been brought about through the thinning of undergrowth, the planting of bushes suitable for cover and for their yield of berries, and by the suppression of vermin, amongst which the introduced grey squirrel is reckoned one of the greatest menaces. The most striking natural visitor of the year was a white stork which paid a spring-time call at Richmond Park. The second tendency is making the Royal Park sanctuaries something quite different from a bird sanctuary as generally understood. It is marked by the introduction of various sorts of foreign birds, with the intention that they should establish themslves and multiply. There have been added to the waters of the sanctuaries mandarin ducks, black-billed tree ducks, Baikal teal, Japanese spotbills, and Magellan geese, and in the shrubberies Indian doves, Amherst pheasants, and others—interesting birds all of them, and many beautiful, but a little suggestive of a zoological garden rather than a sanctuary for the encouragement of native birds and bird visitors.

THE sixteenth annual report (1931) of the Experimental and Research Station at Cheshunt, under the direction of Dr. W. F. Bewley, is a record of very varied activities, many of which have considerable general interest. Manurial trials and soil sterilisation trials are reported upon, steam sterilisation proving more successful than formaldehyde in practice, whilst P. H. Williams has continued the determination of the numbers of bacteria in the soil at weekly intervals. The presence of organic nitrogen seems to be the main factor determining the large and rapid fluctuations of bacterial content noted during the season. T. Small has continued the study of the tomato leaf mould, *Cladosporium fulvum*; the freeing from infection of empty greenhouses seems possible by fumigation under certain ideal conditions, but the incidence of the disease in practice obviously provides numerous puzzles, and considerable difficulties seem to stand in the way of its control by fungicide sprays or fumigants under commercial conditions. Interesting experimental results with several virus diseases are described. Attention may perhaps be directed to the frequent isolation of a bacterial organism from necrotic tissues by Bewley and Corbett, and to the simple and very effective methods of experimental inoculation of mosaic disease employed by B. D. Bolas. An ingenious experimental device for the study of soil ventilation described by the latter worker may also prove to have wide applicability, whilst the attempt to use electric light to rear hardy tomato seedlings during the winter months will be of special interest to northern readers.

NORTH country naturalist activity is shown in a very favourable light by the November issue of the *Vasculum* (vol. 17, No. 4). The news of societies reported in its pages shows local societies with an active membership, and with both field and indoor meetings able to supply reports of genuine interest, whilst some of the contributors' notes show how inquiries of very general interest are raised by such meetings. Thus the Darlington and Teesdale Naturalists' Field Club held its fungus foray this year at Dryderdale, and Mr. F. A. Mason, of Leeds, who undertook the task of identification, had as a result a list of 138 species and varieties. This autumn it has been a very general experience in the British Isles that the larger agarics are relatively scarce, but at Dryderdale they were found relatively in abundance. J. B. Nicholson contributes a suggestion based upon the abundance of toadstools in this locality compared with their poor appearance this season in the Darlington district. Usually their relative scarcity this autumn is put down to the poor growth of the mycelium during the inclement summer. Dryderdale is at a higher altitude than Darlington, and is not likely to be appreciably warmer. Mr. Nicholson suggests that a more important factor may have been the good drainage in this locality, and that a reason for the scarcity of such fungi may be, in some cases, the high water-table during the wet summer.

SIMILARLY, the editor of the *Vasculum*, the Rev. J. E. Hull, has a very interesting note, as the result of his collection of spiders during this wet summer, upon a possible association between melanism and humidity. The other articles, beside including valuable new records, as of the mosses, liverworts, and sphagna of South Northumberland, by E. M. Lobley, and upon a new genus and species of feather-mite (*Hirstia chelidonis*, J. E. Hull), also include two papers of considerable general interest. W. K. Richmond discusses the overland migration of wading birds in England, whilst J. E. Hull discusses a very interesting recent French paper by Jacques Denis, upon the spiders found in the coal mines of the north of France. The editor discusses, in charming but critical fashion, and with a recollection of earlier English records, the puzzles of distribution provided by the presence of some of these spiders living and breeding in the depths of the mine. Most of them have probably been introduced in the bark of the timber carried down the mine, but how does a species of *Theridion* arrive and flourish there when its normal habitat is the greenhouse, and it has never been taken in the open air in the north or centre of France ?

WE learn from Science Service, Washington, D.C., that attention is being given to the problem as to whether the yellow fever mosquito and other kinds of similar insects are likely to be carried to the United States through the agency of long-distance aeroplanes. Members of the United States Public Health Service have found that certain types of aeroplanes do carry mosquitoes. Stained examples of the insects were liberated into planes leaving Porto Rico and a certain number were recovered when the machines arrived at Miami, 1250 miles away. Heavy infestation of planes at airports is not considered likely, but even one infected mosquito, of the yellow fever kind, might be the means of starting an epidemic. Considering the small number of these insects that find their way into aircraft, and the facility with which the latter may be freed, it is concluded that while the danger does exist, aeroplanes can be efficiently treated so as to destroy mosquitoes. Air traffic development need not therefore be delayed on this account.

AN interesting institution, known as "La Clinique-Manufacture Internationale", at Leysin, Switzerland, is described by Dr. Rollier, the director of heliotherapy there, in *Bull. Soc. d'Encouragement pour l'Industrie Nat.*, Nos. 7, 8, 9; 1931. This Institute is devoted to sun treatment of cases of surgical tuberculosis, the patients while under treatment being engaged in regular and remunerative work. This is accomplished, for example, by the use of trolleys provided with electric motors and such tools as may be required, which are wheeled to the bed and adjusted to the needs of the particular person. We see depicted in the illustrations, patients in bed, but fully exposed to the sun's rays—basket-maker, sculptor, needle-woman, lace-maker, and mechanics—at work at their crafts ; spinal cases lying in the prone position. The Institute, a fine building looking out to the Dents du Midi, was opened in February last year and has 120 beds.

WE have received from the Ministry of Agriculture and Fisheries a copy of an illustrated Bulletin, No. 29, entitled "Insect Pests and Fungus Diseases of Basket Willows", 1931. Few plants are more subject to insect attacks than are willows and osiers, while fungus diseases are, on the whole, less numerous. This Bulletin describes the principal pests involved, whether they be insect or fungus, and the control measures that are appropriate in each case. It is a publication of definite practical utility, and growers should make use of the information that it brings together. The heaviness of insect infestation is often a serious drawback to osier cultivation, but with the present Bulletin in his hands, the grower should be able to surmount such difficulties. It is priced at 6*d.* net, and is obtainable from His Majesty's Stationery Office, or through any bookseller.

THE Lord President of the Council has appointed Dr. F. S. Sinnatt, M.B.E., to be director of fuel research under the Department of Scientific and Industrial Research.

THE triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1931 to the Institution of Electrical Engineers, has been made by the Council to Dr. M. G. Say, for his paper on "High-Voltage Underground Cables".

THE Council of the Institution of Electrical Engineers has appointed a special technical committee, representative of electrical engineers, medical men, and radiographers, to obtain papers on radiological and electromedical subjects, and to deal with such other matters as may be referred to it by the Council. The aim is to stimulate and foster interest in the electrical engineering aspect of radiology.

IN the autumn issue of the *Fight against Disease*, the quarterly journal of the Research Defence Society, tributes are paid to the late Lord Knutsford, who was chairman of the Society from 1908 until his death. There is also an excellent portrait. Comment is also made upon litigation concerning the Grove-Grady will, under which a sum of approximately £200,000 was to be devoted to the founding of a new anti-vivisection organisation ; the Court of Appeal held, however, that it was not a valid charitable gift.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A bacteriologist at the Royal Free Hospital and a lecturer in bacteriology at the School of Medicine for Women—The Warden and Secretary, School of Medicine for Women, 8 Hunter Street, W.C.1 (Jan. 8). A Massey scientific research fellow at University College, Nottingham, for research on cancer by physical and chemical methods—The Registrar, University College, Nottingham (Jan. 8). A principal of the Woolwich Polytechnic—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, S.E.18 (Jan. 23). A dean of the British Post-graduate Medical School—The Chairman of the Governing Body, British Post-graduate Medical School, New Public Offices, Whitehall, S.W.1 (Feb. 15). A professor of physics and a professor of botany at University College, Cork—The Secretary, University College, Cork. An assistant to the Editor and Secretary of the Society of Chemical Industry—The President, Society of Chemical Industry, 46 Finsbury Square, E.C.2.

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.*]

Constitution of the Keratin Molecule.

As a result of a study of the action of acids on wool, it has been possible to identify one of the most important linkages in the keratin molecule. The following is an outline of the argument.

Wool fibres are easier to stretch in acid solution than in water at the isoelectric point, but when they are washed free from acid in running water, they show an almost perfect recovery of the original elastic properties.[1] Nitrous acid is similar to other acids in causing a reduction in the resistance to extension, but its effect on the fibre is incapable of being reversed by prolonged washing in running water. This peculiarity is clearly due to the irreversible conversion of amino groups into hydroxyl groups,[2] and the otherwise similar action of nitrous and other acids on wool suggests that *all* acids react primarily with the free amino groups present.

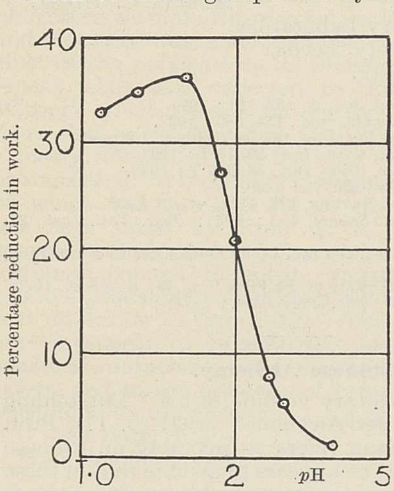


FIG. 1.

The preceding deduction may be substantiated as follows. The reduction in the work required to stretch fibres in hydrochloric acid solutions of varying *p*H has been determined in a manner precisely similar to that described in an earlier communication on sulphuric acid solutions.[3] It is clear from the results, which are reproduced in Fig. 1, that reaction between wool and hydrochloric acid is complete at about *p*H 1, just as in the case of sulphuric acid. Similarly, the removal of hydrochloric acid from solution by wool reaches completion at the same *p*H, as shown by the data of Fig. 2.* If, however, the action of acids on wool is concerned primarily with its free amino groups, then the acid adsorbed by wool at *p*H 1 should be chemically equivalent to its content of free amino nitrogen. From the curve of Fig. 2, it will be seen that 100 gm. of dry wool adsorb about 80 c.c. of *N* hydrochloric acid at *p*H 1, and the percentage of free amino nitrogen in wool must therefore be $14 \times 80/1000 = 1{\cdot}12$ per cent. Direct determination of the amount of free amino nitrogen in the Cotswold wool used in these experiments has already given values which range from 0·94 to 1·11 per cent.[4]

The removal of hydrochloric acid from solution by wool must therefore be due to simple chemical combination with free amino groups. If further support for this view should be necessary, it is afforded by the fact that a linear relationship holds between the reduction in the work required to stretch fibres in acid solution and the corresponding amount of acid adsorbed, as shown in Fig. 3. Each molecule of hydrochloric acid combined with wool contributes a definite quantum to the total reduction in the resistance to extension observed in strongly acid solutions. It must, however, be clearly understood that precise relations of this type are not to be expected in the case of acids weaker than hydrochloric, for reasons to be discussed elsewhere.

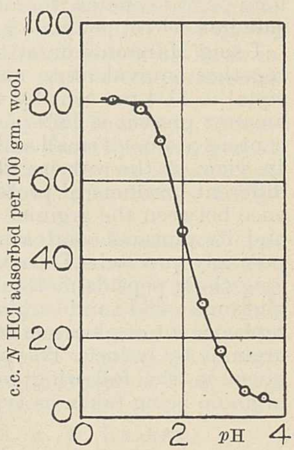
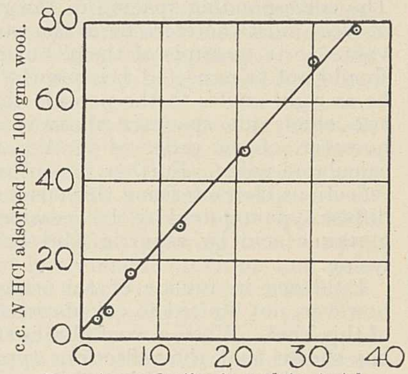


FIG. 2.

So far, it has been shown that acids react with amino groups in wool and, in so doing, make it easier to stretch. It is obvious that stretching could not be facilitated by acid were it not that the amino groups are already combined in some way to form a link which opposes extension. The most probable mode of combination is with a carboxylic acid giving a link of the type: R_1–COO–NH_3–R_2. When wool is immersed in acid solution, the carboxyl group is displaced by the external acid, the link is opened and extension of the fibre facilitated. Assuming such a link as the above to exist in wool, its position with regard to the fibre structure may be deduced as follows.

Studies of the structure of the wool fibre by the methods of physical chemistry [5, 1] and X-ray analysis [6, 7, 8] have shown conclusively that the fibre is constructed from long-chain protein molecules arranged parallel to its length. X-ray analysis indicates that these chains are simply peptide chains folded into a series of hexagons, but the precise nature of the side linkages between them has remained undetermined.[7] The suggested linkage of the type: R_1–COO–NH_3–R_2 must be one of these linkages, because wool fibres, on treatment with acid, show only a negligible change in length (which may be a contraction), whereas the increase in cross-sectional area is always considerable and may, with acids like formic acid, attain a value as high as 125 per cent.[1] Thus the linkage opened by acid must lie between the long-chain protein molecules from which the fibre is constructed.



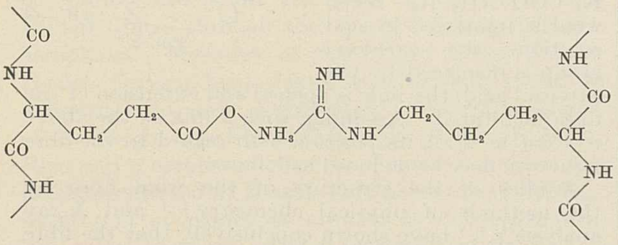
Percentage reduction in work to stretch.
FIG. 3.

Proof that the suggested linkage really occurs in wool, and more exact details of its nature, may be obtained as follows. Such a linkage can be formed only from diamino and dicarboxylic acids. The diamino acids available for the purpose are arginine and lysine, which, according to Marston,[9] are present in wool to the extent of 10·2 per cent and 2·8 per cent

* These figures are taken from a hitherto unpublished investigation carried out in conjunction with Mr. A. E. Battye in 1925. Recent research has provided an explanation of the anomalies then observed in the adsorption of different acids by wool.

respectively. If, as must be the case, one of the two amino groups of each acid forms an integral part of the long peptide chains, the arginine and lysine would together account for 1·09 per cent by weight of free amino nitrogen in wool. Thus the whole of the arginine and lysine present must be involved in the linkage under discussion. The dicarboxylic acids available for combination with arginine and lysine are glutamic and aspartic acids. In each case, one carboxyl group would form an integral part of the long peptide chains, the other being combined in the side link with the amino group of arginine or lysine.

Using Marston's data, the arginine and lysine are together equivalent to an amount of glutamic acid equal to 11·4 per cent by weight of the wool, and the amount present is 12·9 per cent.[10] The aspartic acid content of wool is small and of the order of 2·3 per cent. In view of the varying difficulty of estimating the different products of protein hydrolysis, the equivalence between the arginine and lysine content of wool and its glutamic and aspartic acid content is surprisingly precise. Thus the main link between the long-chain peptide molecules of wool will be a salt of glutamic acid and arginine, with the occasional replacement of glutamic acid by aspartic acid and of arginine by lysine. The precise nature of the link is given in the following formula, glutamic acid and arginine being taken as typical units :



According to this formula, the distance between the long peptide chains will be of the order of $14 \times 1{\cdot}25 = 17{\cdot}5$ A., whereas when aspartic acid and lysine form the link, the distance will be about $12 \times 1{\cdot}25 = 15{\cdot}0$ A. The corresponding spacing in the X-ray photograph of wool must therefore be of the same order as these values, or a multiple of them, but precise agreement should not be expected, because the side link may not be at right angles to the peptide chains. One of the two chief side spacings observed by Astbury[6] is, however, of the order of 27 A., almost double the calculated value. Further, according to Astbury, the reflections characterising this spacing are of the very diffuse type required by the occasional replacement of glutamic acid by aspartic acid and of arginine by lysine.

Evidence in favour of the suggested linkage is, however, not limited to calculations and coincidences of this kind. When a wool fibre is stretched, Astbury has shown that the reflections typical of the 27 A. spacing disappear, and from his model of the 'keratin complex' it is clear that the side link under discussion must rotate through an angle of at least 109° 28′.[8] Such rotation is clearly impossible unless the side linkage is opened at the $-COO-NH_3-$ group. In other words, when a wool fibre is stretched in water, work has to be done in opening the $-COO-NH_3-$ groups, the smaller resistance to extension in acid solution being due to the fact that these groups are already opened by acid before extension commences. Thus the difference between the work required to stretch fibres in, say, $N/10$ hydrochloric acid and in distilled water is a measure of the heat of formation of the $-COO-NH_3-$ linkage from free acid and base. The actual value for the reduction in the work required to stretch fibres 30 per cent of their length in $N/10$ hydrochloric acid, compared with that required in water at the isoelectric point, is $3{\cdot}86 \times 10^7$ ergs, or 0·923 calorie per gram of wool. But 100 gm. of wool combine with 80 c.c. of N hydrochloric acid at pH 1, so that the reduction in the work to stretch fibres, corresponding with the adsorption of one gram molecule of hydrochloric acid, is $92{\cdot}3 \times 1000/80 = 1{\cdot}15 \times 10^3$ calories. This value is in close agreement with that for the neutralisation of the weak acid hydrogen cyanide by the weak base ammonia, namely, $1{\cdot}3 \times 10^3$ calories per gram molecule of base.[11]

The cumulative evidence presented in this note is such as to leave no doubt that one of the linkages between the long peptide chains in the keratin molecule is a salt of glutamic acid and arginine, qualified by the fact that glutamic acid may occasionally be replaced by aspartic acid and arginine by lysine.

In conclusion, we wish to express our indebtedness to the Government Grant Committee of the Royal Society and to the Clothworkers' Company of London, for grants in aid of the present investigation.

J. B. Speakman.
Mercia C. Hirst.

Textile Chemistry Laboratory,
The University, Leeds,
Oct. 19.

[1] Speakman, *Proc. Roy. Soc.*, A, **132**, 167 ; 1931.
[2] Meunier and Rey, *Compt. rend.*, **184**, 285 ; 1927.
[3] Speakman and Hirst, Nature, **127**, 665, May 2, 1931.
[4] Speakman, *Jour. Soc. Chem. Ind.*, **50**, 17 T ; 1931.
[5] Speakman, *Jour. Soc. Chem. Ind.*, **49**, 209 T ; 1930.
[6] Astbury, *Phil. Trans.*, **230**, 75 ; 1930.
[7] Astbury and Woods, Nature, **126**, 913, Dec. 13, 1930.
[8] Astbury, *Jour. Text. Science*, **4**, 1 ; 1931 : *Jour. Text. Inst.*, **22**, 1931 ; in the press.
[9] Marston, Council of Sci. and Ind. Res., Commonwealth of Australia, *Bulletin* 38 ; 1928.
[10] Barker, "Wool : A Study of the Fibre", p. 36 : H.M.S.O., 1929.
[11] Berthelot, *Ann. der Chim. et der Phys.* ; 1878.

Chinese Alchemy.

In the supplementary volume of his "Entstehung und Ausbreitung der Alchemie" (1931, p. 17), Prof. E. O. von Lippmann refers to my note on Chinese alchemy,[1] and since he appears to assume that in these matters silence gives consent (see his work, p. 40), it seems necessary to make some reply to his statements. He had adopted in the first volume of his book (1919, 449 ff.) the thesis of Berthelot that alchemy in China was transmitted through the Arabs, and this view, which is not held, so far as I am aware, by any competent authority at present, he maintains in the new volume. The sources of his information in both volumes are considerably removed from the originals, and for this reason he has probably not noticed that they are almost entirely based on the important paper by Edkins, which he refers to as 'old'. He directs attention to a review by Laufer[2] of Johnson's "Study of Chinese Alchemy" (also largely based on Edkins's paper) as in some way representing 'modern' opinion on the matter. In this review Laufer makes no contribution to the subject, merely referring to Maspero's 'critical work' on China.[3] Maspero, however, does not mention alchemy beyond a vague remark that it probably reached China from India in the third century A.D., a thesis which is not at all in agreement with Prof. Lippmann's. An Arabic origin of Chinese alchemy seems to me improbable on several grounds. In addition to those already given, I may refer to the statement of Al Nadim in the "Fihrist",[4] which shows that, even in the early period (A.D. X cent.) of the study of Arabic alchemy, an Indian or Chinese origin was considered possible. Another fact which seems to speak against an Arabic origin of Chinese alchemy is that its study was almost entirely confined to Buddhist circles, both in India and China.

A further statement made by Prof. Lippmann, to the effect that Stapleton, Husain, and Azo support an Arabic origin of Chinese alchemy, is incorrect, as will be seen by referring to the publication of these authors, or to my summary of it.[5] A similar inversion of the views of these authors appears in Prof. Lippmann's account of Indian alchemy,[6] and many such examples of lack of care in quoting authorities could be given from both his volumes. That an unfamiliarity with a foreign language might be the cause does not seem to be a satisfactory explanation, since the same course is taken with publications in German (see, for example, the reference to Hammer-Jensen's work on p. 9, and the very serious error with respect to Roger Bacon on p. 53, ref. 2).

The difficulty about quoting 'authorities' in the way adopted by Prof. Lippmann is that almost any view may be supported by a suitable choice of authority. An example in my own experience may serve to illustrate this, since an eminent authority on China referred me to a recent paper on Chinese alchemy in which it was asserted that alchemy began in China in 1100 B.C., that the Chinese had a theory of phlogiston several centuries before Becher and Stahl, and that glass was made in China in prehistoric times. Most of the publications on Chinese alchemy merely repeat what was collected by Edkins; although Wieger's great treatise on Taoism[7] gives a list of more than a hundred and fifty Chinese treatises on alchemy, not one of these has been critically examined or translated. A beginning in this study, the necessity of which was pointed out in my original notes,[1] has been made by Prof. T. L. Davis with the assistance of a native scholar, and since he has been fortunate enough to enlist sympathy in a region where I personally found none, we may expect some real additions to knowledge. The purpose of this note is mainly to indicate the doubtful value of a source of information which may be quoted as authoritative, and to the necessity of preserving a perfectly open mind on the question.

J. R. PARTINGTON.
81 Barn Hill,
Wembley, Middlesex.

[1] NATURE, 119, 11; 1927: see also *ibid.*, 120, 158, 878; 1928—which are not mentioned by Lippmann.
[2] *Isis*, 12, 330; 1929.
[3] "La Chine antique", Paris, 1927.
[4] Berthelot, "Chimie au moyen âge", vol. 3, p. 40.
[5] NATURE, 120, 158, 242; 1927.
[6] *Alchemie*, 2, 23.
[7] Vol. 1, 1911.

New Yields from the Oldoway Bone Beds, Tanganyika Territory.

IN NATURE for Oct. 24, 1931, a letter from us was published giving the first results of our work at Oldoway in Tanganyika Territory; we should be grateful if the following additional results could be recorded:

(1) Bed No. 1, the lowest bed in the Oldoway series, has now yielded an extensive fauna which includes *Deinotherium* sp., *Hipparion* sp., and also *Elephas* (*antiqus recki* ?). The *Deinotherium* cannot be regarded as a derived fossil, since five complete teeth were found amongst a partially articulated skeleton. In Bed 1, at two different sites, we have found artefacts of a Pre-Chellean type actually with *Deinotherium.*

(2) Bed No. 2, at its base, contains tools of an early Chellean type of large size, and in its upper part, at the same horizon as the human skeleton found by Reck in 1913, tools of a more advanced Chellean type. Thus *Homo sapiens* is shown to be the contemporary, and presumably the maker, of an advanced Chellean type of culture. The fauna includes *Hipparion* and *Elephas antiqus recki.*

(3) Bed No. 3 has yielded a series of tools which may be regarded as transitional from the Chellean to the Acheulean stage of culture development.

(4) Bed No. 4, in its lower part, has yielded a big series of tools of an early Acheulean type, whilst in its higher levels we have found an old open station site which has yielded more than 500 perfect advanced Acheulean type tools. Even Bed No. 4 includes in its fauna *Elephas antiqus recki, Hipparion, Pelorovis, Hippopotamus gorgops,* and *Equus* sp., and we know, from the results of the material obtained by Reck in 1913, that more than fifty per cent of the species are extinct.

(5) Bed No. 5 overlies the other four beds unconformably and is separated from them by a long period of earth movement and erosion. At two sites in bed No. 5 we have found tools of an upper Kenya Aurignacian type.

(6) In view of the evidence of the fauna, and also in view of the fact that we have in beds Nos. 1 to 4 the gradual evolution from a Pre-Chellean type of culture to a developed Acheulean, we incline to the view that this part of the Oldoway series represents the lower and middle Pleistocene, a period which Leakey and Solomon have shown to be represented in Kenya by Gregory's Kamasian series.

L. S. B. LEAKEY.
ARTHUR T. HOPWOOD.
HANS RECK.
East African Archæological Expedition,
Nov. 30, 1931.

Latency of Seedlings in some Grasses.

EXPERIMENTS at this Station have shown that when seeds of *Lolium italicum* are sown in the field together with those of certain other grasses (notably *Festuca pratensis, Phleum pratense,* and *Poa trivialis*), the early establishment of the latter may be considerably diminished as compared with that occurring in the absence of the rye-grass. Some months after sowing, an increase in the establishment of the same grasses is often shown. In seeking an explanation of this behaviour, a peculiar property of grass seedlings has been revealed.

Under certain conditions, when seeds of *F. pratensis, P. pratense,* and *P. trivialis* are sown between plants of *L. italicum*, the seedlings which result develop with extreme slowness, and after several months are no larger in size than is normally the case two weeks after germination. Such seedlings, growing in the open under conditions of low mineral nutrition and poor illumination, have been found to be remarkably persistent. The mortality in seedlings of *F. pratensis* has been after 10 months 29 per cent; in seedlings of *P. pratense*, 3 per cent after 4 months; and in those of *P. trivialis*, 4 per cent after 3 months; a high proportion of the seedlings of each species has remained alive for much longer periods.

In each case, the seedlings proved capable of normal development when transferred to a favourable environment.

There is no reason to suppose that this behaviour is peculiar to these species only of grasses, and its importance to agricultural practice is obvious. It would also seem probable that the ability of seedlings to persist for long periods in an environment unfavourable to growth and to develop normally afterwards must be an important factor in competition under feral conditions. In the colonisation of denuded areas, for example, its effect would be to increase the chances of establishment of species the seeds of which germinate slowly, and in the invasion by alien species of areas already occupied by other plants (especially when this is a consequence of the grazing, and other activities, of animals) the value to any species of this behaviour in the seedling stage would also seem clear. In this connexion it would be extremely interesting to know if a similar phenomenon is shown by the seedlings of any dicotyledonous plants.

H. G. CHIPPINDALE.

Welsh Plant Breeding Station,
Aberystwyth, Dec. 7.

Zeeman Effect of a Forbidden Line.

THE Zeeman effect is one of the most powerful methods of finding the causes of the occurrence of forbidden lines. The selection rules which govern it are quite different for ordinary lines, for quadripole lines, and for lines the appearance of which is due to external electric fields.

Quite recently the Zeeman effect of quadripole lines has been experimentally investigated. We have now been able to obtain the Zeeman effect of a line which shows the characteristic features of a line due to the random electric fields of the discharge, for example, the components with $\Delta m = 0$ are observable in the transverse direction as σ- and π-components.

The mercury line $6\ ^3P_2 - 7\ ^3P_2$ $\lambda = 3680$ A., which is forbidden by the selection rule for the azimuthal quantum number, was investigated in a magnetic field of about 12,000 gauss. As light source an arc in vacuum was used.

If this line was due to quadripole radiation, its Zeeman pattern would have been of the type $\frac{(3)\ 6}{2}$, with all the components of equal intensity as shown in Fig. 1.

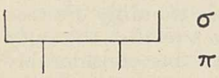


FIG. 1.

Assuming an electric field distributed at random, the type can be calculated by means of the Schrödinger perturbation theory (we are indebted to Dr. E. Majorana for this calculation), and one obtains the pattern of Fig. 2 of the type $\frac{(0)\ (3)\ 0\ 3\ 6}{2}$. (The numbers in the figure denote the calculated intensities of the components.) Moreover, we should expect that the line would be rather diffuse owing to the rapid variability of the electric fields, due to the ions which are present in the discharge and to the Stark effect shift.

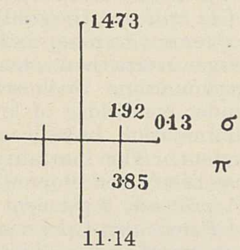


FIG. 2.

What we actually observed without field was a rather diffuse line. In the magnetic field the line showed little alteration, but became a little broader, especially in π-polarisation.

The diffusion was real because the Zeeman pattern of other lines on the same plate, for example, $\lambda = 3662{\cdot}88$ $6\ ^3P_2 - 6\ ^3D_1$ of mercury, Zeeman pattern $\frac{(0)\ (2)\ 1\ 3\ 5}{2}$, were resolved. Anyhow, from our photographs we conclude that the Zeeman pattern was a centred one both in π- and σ-polarisation. If the Zeeman type had been as in Fig. 1, corresponding to quadripole radiation, we should undoubtedly have seen a non-centred type and probably should have resolved components separated by 3 and 6 normal units, even with a line originally so diffuse, if they had occurred.

Moreover, the broadening of the π-components is a confirmation of our interpretation, because, as shown in Fig. 2, the lateral components in π-polarisation are in the same position as, but double the intensity of, those in σ-polarisation.

We hope to repeat the experiment with a stronger magnetic field.

We are indebted to Prof. P. Zeeman for his interest and advice in connexion with this investigation.

E. SEGRÈ.
C. J. BAKKER.

Laboratory "Physica" of the
University, Amsterdam.

Neon-Helium Bands.

IN the course of some experiments on the spectrum of the negative glow, some bands near 4000 A. were observed in the negative glow of neon-helium mixtures. The definite experiments were carried out in the following way.

Two glow lamps (nickel plate cathode, ring anode) were joined by a glass tube; in the tube was a small glass bulb which separated the gases from another, and the bulb could be shattered by a small iron ball. One glow lamp was filled (after degassing) with neon and the other with helium, both at a pressure of 6 mm. of mercury. Spectrograms were taken of the two negative glows with a small glass spectrograph, Fig. 1.

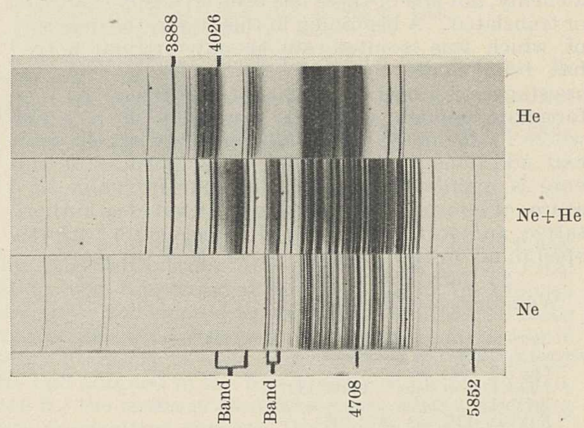


FIG. 1.

In the neon glow the neon arc- and spark-lines were observed, in the helium glow the helium lines and the He_2-bands were present. Then the small glass bulb was shattered, so that the gases were mixed and a new spectrogram was taken. The He_2-bands had now disappeared, but besides the neon and helium lines two bands were observed, the stronger one between the helium lines 4026 and 4121, the other one between 4219 and 4276. Although the bands could not be resolved, it seems very improbable that they would coincide with He_2-bands. The most probable explanation seems that the bands are to be attributed to a compound of neon and helium, such as Ne-He.

Prof. Coster in Groningen was so kind as to take some spectrograms of these bands with a grating; on some plates the bands were partly resolved, but the intensity was too low to photograph the lines with greater dispersion. To obtain a greater intensity I looked for these bands in a direct current positive column in a neon-helium mixture, but I did not obtain the bands.[1] Maybe this can be attributed to the fact that in the negative glow a great velocity range of electrons is present, while in the positive column studied the electronic velocity was too low. In the negative glow the bands disappeared when 10 per cent argon was added to the neon-helium mixture. The bands did not change when the lamp was cooled with liquid air.

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[1] W. Weizel, *Zeit. für Phys.*, **51**, 328 ; 1929.

The Study of Specific Combination in Immunity Reactions.

IT can scarcely be denied that up to the present the study of immunity reactions has been especially difficult owing to current theories being most vague and conflicting. As a result much of the work done has shown a lack of method and definite line of attack. It seemed to us that if a reaction, in which at any rate one of the reacting substances was a definite chemical compound, could be studied, this would form a sound basis for further investigation. This we have attempted to do.

The work of Landsteiner and others [1] affords strong evidence that in certain precipitin reactions the first stage of the reaction is the combination of antibody with definite chemical groups in the antigen. This work has shown (1) that the sera of rabbits immunised with a protein to which one of various chemical groups has been attached will give a precipitate with any protein to which this group has been attached, and (2) the simple substances (haptenes) containing the active chemical group, although they do not give a precipitate with the serum, when added in excess inhibit the formation of a precipitate by serum and protein containing the active group. Presumably there are two stages in such a precipitin reaction : first a specific combination of chemical groups with antibody, and second a molecular rearrangement, leading to precipitation, which does not take place unless these groups are attached to protein. This suggests a method of simplifying the study of immunity reactions by confining the investigation to the first stage and using as one of the reacting substances a haptene, that is, a chemical compound of known composition.

Since the haptenes will pass through a collodion membrane and the antibodies will not, it is possible to measure the concentration of free haptene in a mixture of haptene and antibody by dialysis. Non-static methods such as the ultracentrifuge and ultrafilter would not be sound, as the amount of haptene bound by antibody may vary with the antibody concentration, and water probably passes through a membrane faster than the haptenes. Using a small dialysing apparatus so designed that the concentration of haptene in the antibody-free fluid could be measured photometrically without its removal, we have been able to demonstrate the specific combination of antibody with haptene. We used *p*-aminobenzene arsinic acid (atoxyl) as the active group ; this was diazotised and coupled with horse serum-pseudoglobulin to form the antigen, and with tyrosin to form the haptene.

Using a solution of haptene approximately $M/25,000$, the ratio of haptene bound by globulin prepared from immune sera to that remaining free was approximately 2/1. We used, as control, globulin from normal rabbit serum and globulin from immune serum from which the antibody had been removed by precipitation with excess of antigen ; with these the ratio of bound to free haptene was approximately 1/6. We were not dealing simply with an increased power of adsorbing azo-dyes, since *o*-carboxybenzene-azo-dimethylaniline (methyl red) was not adsorbed any more by immune serum globulins than by normal globulin. On the other hand, atoxyl diazotised and coupled with *p*-cresol behaved in the same way as the tyrosin compound. This direct method therefore confirmed Landsteiner's supposition that haptenes combine specifically with antibodies.

We hope so to improve this method as to obtain accurate measurements of the amount combined under varying conditions. Such specific combinations may be involved in many biological processes and certainly are essential to enzyme action. Hitherto the methods of their study have been limited. In the case of enzymes direct methods have not been suitable for quantitative work and kinetic methods involve considerable assumptions.

Evidence has accumulated of recent years that antibodies are modified serum globulins. It may be hoped that, with increasing knowledge of the nature of the combination between haptenes and antibodies, it will be possible to correlate this process and the further stages of immunity reactions with theories of protein structure such as have been outlined in recent letters to NATURE.[2]

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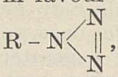
E.1.

[1] K. Landsteiner and H. Lampl, *Biochem. Z.*, **86**, 343 ; 1918. K. Landsteiner, *Biochem. Z.*, **104**, 280 ; 1920.
[2] C. Rimington, NATURE, **127**, 440 ; 1931. W. T. Astbury and H. J. Woods, NATURE, **127**, 665 ; 1931.

Structure of the Azides.

WE have just seen Dr. Sutton's communication on the "Structure of the Azides, from their Electric Dipole Moments".[1] We also have measured the dipole moments of phenylazide, *p*-chlorphenylazide, and *p*-bromphenylazide and found the values 1·55, 0·47, and $0·64 \times 10^{-18}$ e.s.u., respectively, in good agreement with Dr. Sutton's data. We believe that the moments for the two halogeno-compounds are really zero or very small, because we must neglect their atomic polarisation. The moment of the molecule is, therefore, the vectorial sum of the moments of the substituents.

Dr. Sutton considers his measurements as evidence in favour of the cyclic structure of the azide-group



, because in that formula the moment-vector coincides with the R – N linking, and, indeed, the parachor measurements of Lindemann and Thiele [2] are in harmony with his conclusion. But we cannot agree with this. A short time ago, L. Pauling [3] determined exactly the crystal structure of potassium azide. The data given by him show that the three nitrogen atoms lie on a straight line.

It seems, therefore, possible that any 'open-chained' formula for the azide-group may hold true. We can accept that the argument of Dr. Sutton in terms of the octet theory for ruling out the classical formula R – N = N ≡ N—the central nitrogen atom would have a shared decet—is not decisive, because the octet rule of valency electrons seems not to be a comprehensive law (compare the existence of sulphur hexafluoride, etc.). Probably also the formula R – N = N ⟶ N is valid because the angles between the links in an azide molecule are very uncertain. The dipole measurements by no means contradict the assumption that the three nitrogen atoms lie on a straight line; the data given by Pauling seem to prove it.

With regard to the very interesting work of Lindemann and Thiele, it seems that the parachor measurements do not give a definitive structural proof,[4] because in the series of the aliphatic diazo-compounds very closely related to the azides there is a discrepancy between the parachor measurements and the chemical evidence. The former evidence [5] is in favour of the cyclic structure, but such a structure is unable to account for the existence of optically active diazo-compounds.[6] Also, the assumption of an equilibrium between the cyclic and the open-chained molecules is not in harmony with the observed optical properties of the compounds cited.[7]

ERNST BERGMANN.
W. SCHÜTZ.

Chemical Institute of the University,
Berlin, Nov. 15.

[1] NATURE, 128, 639, Oct. 10, 1931.
[2] *Ber.*, 61, 1529; 1928.
[3] *Zeit. physik. Chem.* (B) 8, 326; 1930. *Jour. Am. Chem. Soc.*, 47, 2904; 1925.
[4] E. Bergmann, L. Engel, and Stefan Sándor, *Zeit. physik. Chem.* (B) 10, 403; 1930.
[5] Lindemann, Wolter, and Groger, *Ber.*, 63, 702; 1930. Lindemann, *Ber.*, 63, 1246; 1930. Compare Sidgwick, *Jour. Chem. Soc.*, 1108; 1929.
[6] Levene and Mikeska, *Jour. Biol. Chem.*, 45, 592; 1920: 52, 485; 1922: 55, 795; 1923. Noyes and co-workers, *Jour. Am. Chem. Soc.*, 44, 1798; 1922: 48, 2404; 1926.
[7] Compare K.v. Auwers, *Ber.*, 63, 1242; 1930.

A Two-Dimensional Space Lattice?

AFTER reading the letter from Dr. R. C. Menzies in NATURE of Nov. 28, I wrote to him stating what I believe to be the cause of the orientation of the growing crystals at the liquid surface, and it is at his suggestion (letter dated Nov. 30) that I submit this note for publication.

The explanation probably lies in the convection currents set up by the growing crystals. When a crystal is floating by surface tension forces at the surface of the solution, some of the molecules of solute in the neighbourhood will be deposited on the crystal and this will decrease the density of the solution in the immediate vicinity. The crystals are thus centres of local rising currents and will therefore mutually repel each other, since the currents must spread out sideways on reaching the liquid surface. Crystals of the same size will exert the same lateral forces and must take up the close-packed hexagonal arrangement shown in the photograph. Larger crystals may be expected to exert greater forces than smaller ones, so that a swarm of large crystals will have a greater spacing than a swarm of smaller crystals when both swarms are floating in the same liquid surface; this is very apparent in a second photograph sent to me by Dr. Menzies. The effect may break up owing to (*a*) the sinking of the crystals, (*b*) the crystals growing sufficiently large to touch and unite, or (*c*) as Dr. Menzies has pointed out to me, the reaching of equilibrium between crystals and solution, when the surface currents must cease.

I have noticed the same structure in the crystallisation of a number of organic compounds, though in a much less perfect form. Substances which readily separate from hot solution in compact crystals usually give the lattice effect to a greater or lesser degree, though failing spontaneous crystallisation it is necessary to drop a little of the finely powdered substance on the surface. The phenomenon is shown somewhat feebly by 4-nitropyrogallol 1:2-dimethyl ether crystallising from alcohol, and by 4-iodopyrogallol trimethyl ether separating from light petroleum.

Undoubtedly the spontaneous crystallisation and great density of the thallium derivative are responsible for the unique perfection of the case described by Dr. Menzies.

W. BAKER.

The Dyson Perrins Laboratory,
Oxford, Dec. 4.

The Tertiary Wall of Wood Fibres.

IN addition to the primary and secondary walls of the fibres of the secondary xylem of angiosperms, a third inner wall is not infrequently present. This layer is commonly known as the tertiary wall, and so far little is known of its exact nature or function. The distribution of the tertiary fibre walls in trees suggests, however, that their formation is influenced by environmental conditions, and may therefore admit of a certain amount of control.

A recent study of the occurrence of tertiary fibre walls in the wood of elm [1] led to the conclusion that these layers add to the specific gravity of wood without contributing a proportional increase to its mechanical strength. A study of the moisture relations of wood the fibres of which contain tertiary walls was undertaken to examine the commonly quoted statement that these structures influence the hygroscopicity of wood and "prevent undue shrinking and swelling".[2] Fifteen carefully matched pairs of wood specimens from several trees of *Robinia Pseudacacia* L. and of *Ulmus campestris* L. were selected, so that tertiary fibre walls were present in one member of each pair and absent from the other. Comparison of these samples revealed no difference in behaviour that could be attributed to the presence of tertiary fibre walls, either in the total shrinkage of the wood from the green to the oven-dry condition or within any shorter intermediate range of moisture content. It is true that the shrinkage of the wood of *Robinia Pseudacacia* is somewhat less than might be expected from its structure, but the reason must be sought in other features than the presence of tertiary fibre walls.

S. H. CLARKE.

Forest Products Research Laboratory,
Princes Risborough, Bucks,
Nov. 19.

[1] "Home-grown Timbers, their Anatomical Structure and its Relation to Physical Properties: Elm." (Forest Products Research Bulletin No. 7. 1930.)
[2] E. C. Jeffrey, "The Anatomy of Woody Plants". (University of Chicago Press, 1917, p. 34.)

Turbulence in a River.

IN the river Cam, in its normal state, the conditions correspond to an eddy viscosity of the order of 1000 $cm.^2$/sec. It therefore seemed remarkable that in my work on the formation of surface waves by wind [1] the conditions for formation were the same in the river as on a pond.

It occurred to me that the uppermost layer in the river might actually be non-turbulent; and when this possibility was tested by dropping ink into the river it was verified. The drops spread out merely as in still water until they reached a depth of 10 cm. or so and were then torn apart by eddies.

It appears, therefore, that the stabilising influence of gravity prevents eddy motion from reaching the free surface. The formation of waves produced by a light wind, with lengths of 8-10 cm., is therefore controlled by ordinary viscosity and not by turbulence.

HAROLD JEFFREYS.

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[1] *Proc. Roy. Soc.*, A, 107, 189-206; 1925.

Research Items.

Ancient Egyptian Sealings.—During the seasons 1928–29 and 1929–30 the Harvard-Boston Expedition excavated the ancient Egyptian fortress on Uronarti (Geziret-ib-Melek). In addition, the ground south of the fort was examined, resulting in the discovery of a few graves and a large unfortified palace or dwelling-house. The fort was built in the twelfth dynasty, but abandoned as a military post before the end of the thirteenth dynasty. In the eighteenth dynasty the cult of Sesostris, the founder, was re-established and two temples built or reconstructed, the fort being occupied by the priests. An account of the results by Dr. G. A. Reisner is given in *Sudan Notes and Records*, vol. 14, pt. 1. The objects found were of no great importance, except for a large collection of sealings in mud or clay, numbering nearly five thousand. Of these, the official and the private sealings were about equal in number. Not only do these provide a large variety of designs, but they also add very considerably to our knowledge of the methods of using the seal. The sealings are of various forms. The letter seal is of firm black clay, and bears the papyrus imprint on its reverse. The funnel and double funnel sealings have a hole or holes arising from the base, and show prints of string passing two or more times around the hole. They were evidently used for sealing bags of rations and other supplies for the garrison. The parcel seal is of ordinary mud and circular in form, bearing the mark of tied string on the under side. The box seal and door seal are chiefly in slot form. The key-hole seal was forced into a hole like a key-hole. The sample seal is a single impression on a pat of mud, and has not been attached to anything. It was probably kept for comparison with the sealing of official dispatches. The sealings are usually covered with impressions of the same seal; but in a large number of cases the official seal has been over-stamped with a private seal, probably that of the officer using the official seal. It seems possible that there was a system of registration of seals, similar to that now employed in modern Egypt, to prevent fraud.

Skulls of the Pueblo and related Indian Races.—The Pueblo Indians, once inhabiting America from Texas to Arizona and from Colorado to northern Mexico, form one of the largest and most interesting of the aboriginal American groups. They are a sedentary, mainly agricultural, and peaceful people, but they have the obnoxious habit of so compressing and deforming the bones of the forehead that the craniologist stands helpless before them. However, by selecting skulls where the deformations were of minor grade, Dr. Aleš Hrdlička has been able to publish an informative report and analysis of 645 crania (*Proc. U.S. Nat. Mus.*, vol. 78, art. 2, 1931). He reaches the conclusion that the Pueblos are not a homogeneous group, but contain two distinct strains, one substantially dolichoid, the other fairly strongly brachycranic. Brain capacity and hence size of brain are relatively small, and though this may partly be attributed to the moderate stature of the people, it indicates a somewhat weakened group. As to affinities, unexpected light is shed by the skulls. The Pueblos differ substantially from their neighbours to the north-west and west, but they approach very significantly on one hand the Algonkins, and on the other hand the Gulf types of farther east. The low-vaulted Apache and related Indians now settled in the Pueblo region stand apart from the high-vaulted brachyoid Pueblos.

Distribution of Herring and Plankton.—It is of obvious value if a correlation can be shown between the abundance of herring in any area and that of their food. In *Fishery Investigations*, Ser. 2, vol. 12, No. 38; 1931 (London: H.M. Stationery Office), Mr. R. E. Savage reports on the relation between the feeding of the herring off the east coast of England and the plankton of the surrounding waters. Much information on the biology of the herring is contained in this report, which covers the Lowestoft spring fishery, the Shields summer fishery, the Yorkshire coast fishery, and the Lowestoft autumn fishery. The appetites of the herring show a diminution from May onwards through the summer, and by the autumn fishery they have practically ceased feeding. The most important feeding ground is in the Shields area, and here we have evidence of a correlation between the amount of available food and the size of the catches for the years 1922–23 and 1926. An interesting calculation is made that in order to provide all the herring landed at the English east coast seaports during 1926 with one 'average' meal, it would require three hundred tons of plankton. Useful observations are also given on the vertical distribution of various species of plankton animals. Comparison of plankton catches and stomach contents of the fish showed that the herring fed on the most abundant species in the plankton at the time, and the author is of the opinion that larger animals such as schizopods and post-larval sand-eels are definitely selected and captured, while there is a discriminate mass selection of the smaller species.

Evolution of Dominance.—Dr. R. A. Fisher has brought together in a convenient form, in *Biological Reviews*, vol. 6, No. 4, October 1931, the several groups of facts of observation upon which his theory of the evolutionary modification of dominance is based. The theory itself is the outcome of the view that the effects of Mendelian factors are largely susceptible of modification through interaction with other factors in the germinal complex. The heterozygote, in particular, since it contains both of two alternative genes, may be expected to be particularly susceptible of modification. It is shown that, from this point of view, the deleterious modifications occurring commonly in Nature and the fancy novelties favoured by man in domesticated animals and plants may both be expected to be recessive, whilst variant forms of polymorphic species should generally be dominant. The anomalous case of the domestic fowl is examined, in which a number of characters behave as dominant in crosses with the presumed ancestor, *Gallus gallus*, and the conclusion is reached that the situation here can be explained by the early history of domestication of these species. This theory asks for a reconsideration of the effect of selective action upon characteristics of very minor importance in the organism, upon, in fact, the type of difference between species which has made some students of evolution regard natural selection as a quite inadequate instrument in species production. Dr. Fisher's theory, in numerous directions, suggests further genetical experiments, often involving extensive breeding experiments with native wild populations of the organism.

Humidity Control and Entomological Problems.—In the *Bulletin of Entomological Research*, vol. 22, September 1931, Dr. P. A. Buxton contributes a short practical article on the above subject. Most of the published work bearing upon the influence of humidity on phases of insect life is in terms of relative humidity at different temperatures. We require fuller investigation as to the scale which is most appropriate for such lines of inquiry. The adoption of a constant saturation deficiency as the index may perhaps prove to be a better criterion, but the whole subject is one which has been largely neglected. Dr. Buxton discusses the several scales by means of which water vapour in the atmosphere may be measured—for example, absolute humidity, relative humidity, and saturation deficiency —and then proceeds to describe various methods for the direct measurement of humidity. These include wet and dry bulb thermometer, the use of hygroscopic substances, dew-point determination, and the working of chemical hygrometers. In dealing with methods of controlling humidity, the use of supersaturated salt solutions, sulphuric acid, and aqueous solutions of potassium hydroxide are dealt with critically, their advantages or disadvantages, as the case may be, being referred to briefly. Appropriate apparatus wherein controlled experiments can be carried out also comes in for some mention. The use of desiccators is favoured by Dr. Buxton, who, it may be added, further takes into account the needs when a current of humidified air is desirable. The paper is one likely to be useful to those biological workers who are not familiar with experiments requiring control of humidity (see also NATURE, Nov. 14, p. 837).

Liming and Fertility.—Although liming or chalking is one of the oldest operations in British agriculture, it is now realised that much land in England is less productive than it might be owing to the neglect of this practice during the past fifty years. Increase in costs and the introduction of artificial manures have probably largely contributed to this falling off in the use of lime, but owing to the heavy dressings originally applied, considerable time has elapsed before the soil has shown signs of losing its fertility. In view of the many failures of crops which can be attributed to a lack of lime, the Ministry of Agriculture has issued an illustrated bulletin (No. 35), entitled "The Use of Lime in Agriculture" (London: H.M. Stationery Office; 6*d.*), which should prove of real practical help to the farmer. The subject is introduced by a survey of the chief functions of lime. An account of the causes and rate of loss of lime from the soil follows, and definite symptoms of both grass and arable land deficient in lime are described. Remedial measures are considered in detail, the comparative values of the various forms of lime and chalk on the market, such as free and slaked lime, carbonate of lime, waste lime products, and lime rich in magnesia being fully discussed. Definite information as to the best quantity to apply is less simple to provide since conditions are so diverse, but advice on general lines is given, and if in any doubt the farmer is recommended to communicate with his county agricultural organiser.

Cross-Pollination in Cotton.—A study of the frequency of natural crossing between adjacent varieties of cotton, for which de Vries coined the useful term 'vicinism', has been made by Dr. M. A. Fikry (*Tech. Bull.* No. 18, Roy. Agric. Soc. Egypt). He planted strips of Red Leaf Acala cotton, which is homozygous for a dominant red leaf factor, in a field of Maarad cotton having green leaves. The plants are visited by insects, especially the honey bee and another bee of the genus *Nomia*, but wind is negligible as a factor in crossing. By making two pickings of Maarad seeds from successive ridges at increasing distances from the Acala and determining the percentage of red seedlings in each case, the conclusion was reached that 4 per cent of the seed from each plant in a cotton-field is crossed, that is, there is 96 per cent of self-fertilisation. A gradient of pollination, beginning with the source of pollen, gradually falls to zero at about forty metres, which is the maximum range to which pollen was transmitted. The amount of vicinism will no doubt vary, depending especially on the frequency of insects and the distance between the plants, but the figures obtained are a measure of the precautions necessary to maintain purity in a cotton crop.

Seeds and Seedlings of Sâl.—Some investigations are being carried out by Mr. H. G. Champion and Mr. B. D. Pant on the seed and seedlings of the Sâl (*Shorea robusta*), one of the timbers of chief commercial importance in more than one province of India (*Ind. For. Rec.* (Silv. Series), vol. 16, pt. 5; 1931). One of the conclusions reached with reference to the seed is that no relation has yet been demonstrated between the average size of the seed from a given tree and the vitality and vigour of the resultant seed crop. This is contrary to an opinion expressed in 1928. The authors consider, however, that "since the bigger the seed the better it is, one would expect the average for trees with relatively big seed to give higher average values for plant per cent and seedling height". There is a remarkably wide range in size of the seed from 0·308 in. to 0·561 in. The root system of seedlings is described in relation to soil factors, etc., and seedling types in line sowings are differentiated and their relative development studied. The interesting fact is recorded that "seedlings with several equal shoots develop nearly as well as those with a single or dominant shoot, and the presence of small shoots increases the growth of a dominant shoot". Burning back seedlings three seasons old makes no significant difference to the shoot height reached the following season. Experiences with the growth of cover or shelter crops between the lines of young sâl seedlings, notably with the crop *Tephrosia candida*, with which remarkable results have been attained in some parts of India, are described.

Tertiary Foraminifera.—A memoir by Dr. W. A. Macfadyen on "Miocene Foraminifera from the Clysmic Area of Egypt and Sinai" (*Egypt. Geol. Survey*, Cairo, 1931; pp. 149, pls. 4, map) deals mainly with the Foraminifera from the marls of the Clysmic (or Greater Gulf of Suez) area of Egypt and Sinai, but is preceded by an account of the stratigraphy and correlation of the deposits. Descriptions are given of nine carefully measured sections taken at different parts of the region, and the beds are regarded as of Burdigalian, Schlier, and Helvetian ages, with perhaps some representative of the Tortonian. The succession is compared with the Miocene series of Vienna, Transylvania, Malta, and Cyprus. The greater development of the foraminiferal marls in the central part of the area is taken to indicate that the faulted Clysmic trough was already in existence in Schlier times. The Clysmic area formed an arm of the Mediterranean in Miocene times and was not connected with the Indian Ocean until the Pliocene period; consequently the majority of the 185 species and varieties of Foraminifera recorded by Dr. Macfadyen are known to occur in the Tertiary or recent faunas of the Mediterranean region. Dr. J. A. Cushman and J. D. Barksdale (*Contrib. Depart. Geol. Stanford Univ.*, 1, 2, 1930; pp. 55-73, pls. 11, 12) describe the Foraminifera of the Martinez Eocene of California, and conclude that that formation is of the age of the Claiborne beds of the Gulf Coastal plain of the United States and Mexico.

Illumination in Factories.—The question of the best direction and intensity of the illumination of the work in factories in order to improve the efficiency of human labour and effect economy in the cost of production has led to the formation in Germany of a

Board to carry out experiments on the subject. A report on the work done in connexion with weaving, by Drs. N. Goldstern and F. Putnoky, has been translated into English and appears in the November issue of the *Journal of the Franklin Institute*. The woollen cloth being woven was illuminated directly by lamps in enamel reflectors, indirectly by lamps sending their light to the ceiling, and by a side light introduced to give shadows of the fibres, and the intensity of the illumination of each type could be changed. Each increase of illumination produced an increased output which was greater for dark than for light material. With the costs of electric light and labour in Germany, the most economical illumination is 60-70 foot candles, which secures a net gain of 6 per cent for dark and 4 per cent for light materials. With the American costs of light and labour the net gain would probably be greater.

Formation of a Spark.—The second October number of the *Physical Review* contains an account by F. G. Dunnington of an investigation of the initial stages in the formation of a spark. The method used was that of the so-called electro-optical shutter, in which the electric impulse of the spark is applied at a variable time of less than a microsecond later to the electrodes of a Kerr cell full of nitrobenzene. This becomes almost instantaneously doubly refracting, and allows the stage of growth of the spark to be seen or photographed through a polarising system. The way in which the spark-gap collapses varies. The bright conducting filaments, which follow the initial dark discharge, may appear either at the cathode or both at the cathode and in the gas. Effects such as the latter indicate that space-charges are present, and with this criterion it is found that they become more important as the number of molecules between the sparking electrodes is increased. Other interesting observations were made, such as the occasional development of a single bright filament into a bundle, and an attempt is now being made to follow the growth of the spark spectroscopically.

Flame Temperatures.—Measurements of the flame temperatures of binary mixtures of gases in admixture with air are described by Jones, Lewis, and Seaman in the November *Journal of the American Chemical Society*. The addition of oxygen to methane raises the maximum flame temperature with air by about five per cent with 20 oxygen to 80 methane. Addition of hydrogen to methane raises the flame temperature only slightly up to about eighty per cent of hydrogen, after which it increases rather rapidly. The maximum flame temperatures of mixtures of methane and acetylene indicate that the addition of small amounts of acetylene to pure methane causes a considerable increase in flame temperature. The temperatures from pure methane to 20 methane + 80 acetylene lie practically on a straight line when plotted against composition. It was not possible to determine the flame temperature of pure acetylene mixed with air, but a slight extrapolation gave the maximum of 2325° C. The highest temperature was in all cases reached with mixtures slightly on the rich side, that is, having an insufficient amount of oxygen present to consume all the combustible substances. This is in agreement with results with single hydrocarbon gases and air. Calculations of the flame temperatures gave satisfactory results.

Astronomical Topics.

Sigma Scorpii.—*Popular Astronomy* for November contains a note by Mr. B. H. Dawson on an occultation of this star that he observed at La Plata on July 25. The disappearance was in two sharp steps, at intervals of less than half a second. More than half the light was cut off at the first step. Señor Dartayet made identical notes, using another telescope 50 metres distant. The note recalls similar observations made during occultations of the same star on March 12, 1860 (Cape), and April 10, 1917 (Washington). Mr. Dawson points out that a separation of the pair by about a tenth of a second of arc is indicated. This is too large for the spectroscopic system, which has a period of 33 days. M. Henroteau had already suggested the presence of another component, with a period of about twelve years; the phenomena noted during occultations support this suggestion.

The Variable Star AK Herculis.—Reprint No. 11 of the publications of Warsaw Observatory contains a careful study of this interesting variable by J. Wasiutynski. The variability was discovered in 1917 by J. H. Metcalf, the period being at first given as 0·210760^d; but it was found later that the star is of the β Lyræ type, and that the complete period is twice as long. The extreme range of light is half a magnitude, from 8·2 to 8·7; the two maxima are nearly equal, but at the secondary minimum the magnitude is 8·6. There is continual variation of light, so it is concluded that it does not arise wholly from eclipses; the stars are assumed to be elliptical in outline; the value 0·12 is, somewhat doubtfully, assigned to the ellipticity. The relative orbit also appears to be elliptical, but the article concludes that it is difficult to explain all the features of the light curve without assuming that a portion of the light-variation is physical.

Report of the Paris Observatory for 1930.—This report records a large amount of useful work in many departments of astronomy. Perhaps the most epoch-making is M. Lyot's observation of the corona without an eclipse, from the station on the Pic du Midi, with the aid of a polarimeter; the streamers could be traced to a height of 6′ above the limb. The two brightest lines in the coronal spectrum, at 5303 and 6374, were also seen and photographed. A new catalogue of 10,656 stars in the zone from +16° to +24° was published; the observations had been made between 1899 and 1912.

The sheets of the "Carte du Ciel" are being published at the rate of five per month; it is hoped that they will be completed within a year. Proper motions are being deduced by comparison with the plates taken by the brothers Henry in the last century. The last volume of the astrographic catalogue has gone to press. A catalogue is also being prepared of all the stars on the plates down to magnitude 10, giving right ascensions and declinations.

Measures were made of the positions of faint stars near Pluto suitable for use as comparison stars. Studies of the orbit of Pluto were made by MM. Mineur and Barbier. M. Baldet observed it visually with the Meudon equatorial, concluding that its diameter did not exceed 0·2″; he observed the nucleus of the comet 1930 *d* (Schwassmann-Wachmann) with the same instrument when it was within five million miles of the earth, and deduced that its diameter was of the order of 400 metres.

Daily observations of the sun are made with the spectroheliograph; the results are sent to the national meteorological office and transmitted by wireless throughout France. There is also a record of much optical and chemical research in the astrophysical laboratory.

Constitution of the Alloys of Silver and Mercury.

THE physical characteristics of silver and mercury place formidable experimental difficulties in the way of any attempt to apply to this system of alloys the ordinary methods of physical metallurgy. At the melting point of silver the vapour pressure of mercury is about 250 atmospheres, and in overcoming the difficulties involved great credit is due to Dr. A. J. Murphy, who, in a paper read before the Institute of Metals on Sept. 15, has investigated this thermal equilibrium diagram.

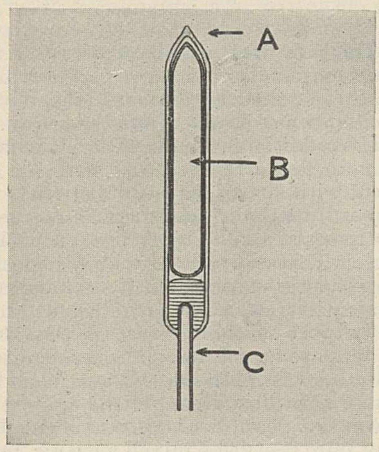

FIG. 1.

In order to obtain the necessary heating and cooling curves, the metals, in a high state of purity, and, so far as the silver was concerned, in a very fine state of division, were placed in the fused silica vessel *A* (Fig. 1), which at this stage was open. Into the tube *C* the thermo-couple wires of chromel and alumel were introduced. It was not possible to seal off the tube *A* at a distance less than 3 in. from the amalgam if undue heating were to be avoided, and to reduce the dead space that this entailed the closed silica tube *B* was introduced. The outer silica tube was finally filled with hydrogen and sealed.

With most of the alloys it was necessary to apply a high pressure to the outer walls of *A* to prevent explosion. For this purpose it was enclosed in a seamless steel bomb, fitted at both ends with massive caps which screwed down on to copper-asbestos washers. The upper cap was provided with an inlet through which gas was passed at a pressure of 120 atmospheres. An internal electric furnace circuit was then closed and heating proceeded. No variation of the gas pressure was made during the observations owing to its liability to give rise to troublesome thermal effects.

The diagram deduced is shown in Fig. 2. The α phase consists of a solid solution of the two metals. On heating to 276° C., the β phase dissociates into α and liquid, whilst the γ phase similarly dissociates into β and liquid at 127° C. Although the exact nature of the α and β phases has not been determined, formulæ of the type Ag_4Hg_3 or Ag_5Hg_4 would satisfy the observations relating to the composition of the β phase, and Ag_3Hg_4 or Ag_4Hg_5 for the γ phase.

Although in general the vapour phase is neglected in dealing with most metallic systems, this can no longer be done in that under investigation without further consideration, since both the nature and the composition of the phases might be affected by the considerable pressure under which they were formed. It is of general interest, therefore, that the author shows that the actual phases present are independent of the pressure, and that, from an application of the Clapeyron equation, the temperatures at which transformations occur are not appreciably affected.

Figs. 1 and 2 are from Dr. Murphy's paper, by courtesy of the Institute of Metals. F. C. T.

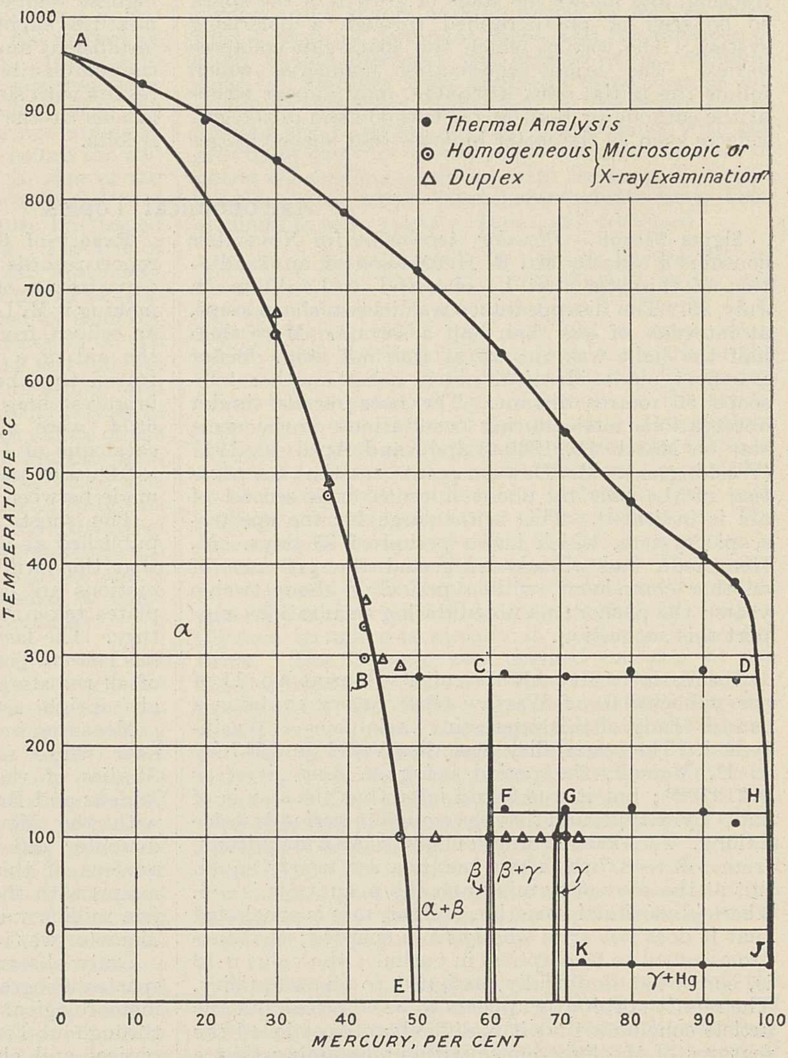

FIG. 2.—Equilibrium diagram of silver and mercury.

International Standards of Lighting.

A BRIEF summary of the chief conclusions arrived at during the session of the International Commission on Illumination (held in Cambridge on Sept. 13–19) was included in an article on the International Illumination Congress which appeared in Nature of Oct. 10, p. 642. A detailed account of the resolutions has now been issued. The series is a formidable one. There are more than seventy separate resolutions or recommendations. Of fundamental importance is the announcement that in future the Comité International des Poids et Mesures will include photometric standards within its scope. A select committee is accordingly to be formed by the International Commission on Illumination to handle this matter and co-operate with the Comité International. Other resolutions fall under the following heads: definitions; automobile headlights; factory and school lighting; street lighting; coloured signal glasses; traffic control signs; diffusing materials; test plates; photometric precision; daylight illumination; glare; colorimetry; aviation lighting; lighting education; vocabulary; heterochromatic photometry; light flux distribution, and applied lighting practice.

Under "Definition" the use of the symbol *n* for refractive index is approved, and likewise the use of c.g.s. units in official publications of the International Commission on Illumination. Authors are requested to express values (in brackets) in c.g.s units as well as in their national units. In connexion with factory and school lighting no change in the minima included in the International Commission of Illumination Code (Geneva) is made. Recommendations relate mainly to educational effort. In order to facilitate international comparisons of street lighting installations it is suggested that (*a*) a complete description of the luminaire, with its consumption of gas or electricity, (*b*) the spacing of luminaires, their height and transverse position, and (*c*) the average illumination and minimum illumination, should be given. The nominal range of a beam of an automobile headlight is specified as the distance at which an illumination of 1 lux is produced in a vertical plane. Cars driven at speeds exceeding 30 km. an hour should be furnished with (i) a driving beam (for use on the open road) and (ii) a passing beam (for use when meeting other vehicles). The intensity and lateral spread of driving beams are defined. 'Transmittance' is approved in place of 'transmission' of coloured signal glasses and lenses. The use of red at left or top, amber in centre, and green at right or bottom for traffic control signs is approved, and it is recommended that the lens diameter shall not be less than 8 in., and the lamp wattage not less than 60. Information is to be collected on the influence of traffic signs in diminishing accidents and facilitating traffic.

There were numerous conclusions in regard to diffusing materials, test plates, and photometric precision, of special interest being the statement that visual measurements are most accurate with illuminations on the photometer screen between 5 and 20 lux. Under these conditions and with no colour difference a mean error of 0·25 per cent is practicable. In commercial work an error of 3 per cent is considered usual. In connexion with daylight illumination the use of 'contour lines of constant daylight factor' is recommended. At all parts of interiors where the daylight factor at table height is less than 0·2 per cent, the daylight is regarded as definitely inadequate for work involving visual discrimination over reasonable periods of time and comparable with ordinary writing. It is proposed to set up a technical committee to study 'artificial daylight' and if possible prepare agreed forms of specifications for lighting units intended to imitate daylight. Further investigations on the sensation of discomfort associated with the presence of bright sources in the field and on the time variations of glare effects are proposed. There were a series of six resolutions bearing on standard procedure in colorimetry.

In connexion with aviation lighting there were no fewer than fourteen definitions or recommendations. The nature and position of obstruction lights, boundary lights, and airport and airway beacons were indicated. The figure of 0·2 candle at 1 km. was adopted as the requisite minimum for visibility under laboratory conditions, and experiments on the corresponding value appropriate to flying conditions are contemplated. Other recommendations dealt with the details of navigation lights, standard voltages and sockets, etc., and supplementary researches on lighting equipment, colour, etc.

There were also numerous resolutions bearing upon lighting education; for example, that the subject of illumination should receive greater consideration in post-primary schools and in all architectural colleges, that in each country there should be at least one full course of illuminating engineering available, and that all public utilities should include on their staffs technically trained representatives able to give advice on lighting matters to the public.

Research in Wood Preservation.

THE problems of wood preservation are of world-wide interest, perhaps never more so than at the present time of economic stress, when the world is threatened with a shortage of its timber supplies. The discussion on this subject, held under the chairmanship of Sir Alexander Rodger, in the Department of Forestry, Section K (Botany), at the meeting of the British Association on Sept. 24, was therefore opportune, and served a valuable purpose in directing attention to research in progress in Great Britain upon a subject of wide economic importance. The proceedings took the form of a series of short papers [1] by members of the staff of the Forest Products Research Laboratory, Princes Risborough. Mr. R. S. Pearson, director of the Laboratory, gave a brief review of the whole field of investigation, in which he stressed the view that co-operation in research between the different groups of workers is essential to the successful progress of this work. Development of new methods in wood preservation is no longer limited to devising ways and means of introducing powerful antiseptics into timber and demonstrating their efficiency by durability and service tests. Viewed at a much wider angle, the work involves biological studies of the organisms causing decay, and investigations into the effect of these organisms upon the chemical constitution of wood. The scope of the work, therefore, calls for the co-operation of mycologist, entomologist, chemist, engineer, and workers in other branches of the study of timber, particularly in relation to its structural and physical properties.

Mr. K. St. G. Cartwright dealt with some of the methods used for the testing in the laboratory of the relative value of different preservatives against wood-destroying fungi. The comparative value of tests on artificial media and on wood blocks was discussed, but it was pointed out that, up to the present time, no standard method of testing wood preservatives has been adopted throughout the world, so that the results obtained by different workers in this field are not strictly comparable. In June 1930 a conference was held on this subject in Berlin, when investigators from different countries reviewed the position and inquired into ways and means of establishing recognised standard international tests for use in determining the value of wood preservatives (NATURE, **126**, 921; Dec. 13, 1930). The difficulties of standardising tests are considerable, and these were summarised by Mr. Cartwright. Although laboratory tests may give useful information for comparing the relative value of preservatives and also furnish an idea of the concentrations required for commercial use, it is necessary to supplement these by large-scale field tests. Such tests are in progress on different sites of varying soil and climatic conditions and supplement the investigations carried on in the laboratory.

The problems of wood preservation in relation to damage by insects to structural and manufactured timber in Great Britain were described by Dr. R. C. Fisher. The two groups of insects primarily concerned are the Powder-post beetles (Lyctidæ) and the Furniture beetles (Anobiidæ), to which the Death-watch beetle *Xestobium rufovillosum* belongs. The *Lyctus* beetles cause serious damage to the sapwood of partly and recently seasoned hardwoods, and the most satisfactory methods of preserving wood against damage caused by them consists in periodic inspection of stores of susceptible timbers, elimination of sapwood, and the maintenance of clean and tidy premises in timber yards and factories. The use of preservatives or insecticides has a limited value for the treatment of timber in buildings. The Death-watch beetle presents a much more difficult problem, for, although a number of palliative measures are available against this insect, knowledge of the details of its life-history are lacking. It is believed that the acquisition of a fuller knowledge of the biology and physiology of the Death-watch beetle is the most helpful contribution which can be made towards the solution of this problem, and will not only form a sound basis for the application of improved control measures, but will also shed further light on the mode of nutrition of wood-boring insects, a subject upon which existing knowledge is particularly meagre.

Mr. W. G. Campbell then discussed the problems of wood preservation from the point of view of the wood chemist. Current work on the chemistry of decay of wood by fungi and insects was summarised and the suggestion made that, if decay could be considered in terms of its ultimate chemical effect on wood substance, the future objective of preservative treatment might be the inhibition of certain definite chemical reactions instead of the poisoning of all organisms which might attack timber. Briefly, the lines along which such work is being developed can be considered under two headings: (1) the characterisation of the chemical reactions which take place during decay, and (2) the study of ways and means of treating wood so that the key reactions are inhibited. Existing knowledge of the chemical reactions caused by fungi on timber far exceeds that available on the effect of wood-boring insects, partly due to the lack of information upon the details of their life-history and development.

Whilst investigations into these problems are of paramount importance in the development of new methods of preservation, it is imperative that the best use should be made of preservatives at present available. The value of such substances depends to a large extent upon the degree of penetration achieved in their application. This aspect of the study of wood preservation was described by Mr. J. Bryan, who stressed the necessity of deep impregnation of antiseptics for the preservation of exposed timber and discussed different ways of obtaining this. A brief account was given of the various methods of impregnation by pressure difference and of methods depending on the diffusion of water-soluble preservatives. Special attention was directed to the value of incising as an aid to the satisfactory treatment of refractory timbers, a process now being used commercially in connexion with the impregnation of Douglas fir railway sleepers.

Sir Alexander Rodger referred briefly to the work on wood preservation in progress at the Forest Research Institute, Dehra Dun, and again emphasised the value of co-operative work when each subject concerned has its own contribution to add to the progress of the investigation as a whole. A short general discussion followed, to which members of industries interested in wood preservation contributed.

[1] To be published in forthcoming numbers of *Forestry*, the journal of the Society of Foresters of Great Britain.

University and Educational Intelligence.

EDINBURGH.—Dr. C. B. Williams, lecturer in agricultural and forest entomology, has requested permission to resign as from March 31, on his appointment as head of the Department of Entomology at Rothamsted Experimental Station.

The degree of D.Sc. has been conferred on R. M. Craig for a thesis on "Geology of the Outer Hebrides—North Harris and Uig, Morsgail and Aline in Lewis".

A THERESA SEESSEL research fellowship, for the promotion of original research in biological studies, of the value of 1500 dollars is being offered by Yale University. Preference will be given to candidates who have already obtained their doctorate, and have demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications should be made to the Dean of the Graduate School, New Haven, Connecticut, U.S.A., before March next.

THE twentieth annual Conference of Educational Associations has been arranged for Jan. 4–11, at University College, London, under the presidency of Sir William Rothenstein. All members of affiliated associations may attend any of the meetings, except those which are definitely set aside for members only. Non-members also may purchase tickets for all open meetings from the secretary, at five shillings each. The presidential address will be given on Jan. 4. On the same day, Dr. Emmanuel Miller will deliver a lecture on "The Difficult Child: Sociological *versus* Individual Interpretation". Other lectures include Mr. J. Howard Whitehouse on public schools and public life, and Mrs. C. B. S. Hodson on the desirability of including biology in the school syllabus. On Jan. 6, a popular lecture on comets and shooting stars will be given by Sir Richard Gregory. A discussion has also been arranged on the film in education. The chairman of committee of the Conference is Mr. W. W. Vaughan, the honorary treasurer, Miss H. Busk, and the secretary, Miss M. A. Challen, 29 Gordon Square, W.C.1.

Birthdays and Research Centres.

Dec. 27, 1887.—Prof. E. N. DA C. ANDRADE, Quain professor of physics in the University of London.

I am at present engaged on three main lines of research: the accurate determination of the velocity of sound in gases by new methods, which involves a more exact knowledge of the behaviour of a column of vibrating gas in a tube; the laws governing the flow of crystalline solids, both in the poly-crystalline and in the single crystal state, in connexion with which the electrical properties of metal single crystals are under investigation; and the theoretical and experimental aspects of the viscosity of liquids. In respect of flow, the liquid state seems to be in many respects more analogous to the solid than to the gaseous state. In this connexion it is to be noted that there are very few reliable data on the viscosity of elementary substances in the liquid state. Such measurements are badly needed, and I am about to undertake an experimental investigation to remedy this deficiency.

Dec. 28, 1853.—Dr. ALEXANDER SCOTT, F.R.S., director of scientific research in the British Museum and formerly superintendent of the Davy Faraday Research Laboratory of the Royal Institution.

In the past my work has been mainly on problems relating to atomic weights, on which I have still much unpublished.

Since the War my occupation has been to discover methods for preserving and restoring museum objects of every kind. This presents a never-ending series of scientific problems of the most fascinating nature. Through one's hands are continually passing marvellous specimens in gold, in carnelian and bronze, concerning which one must ask: What has caused this specimen to deteriorate in this way? or, How has the craftsmanship disappeared which thousands of years ago was able to fashion such an article?

The endeavour to find answers to such questions leaves but little time for more purely theoretical investigations.

Dec. 28, 1882.—Sir ARTHUR EDDINGTON, F.R.S., Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

My main work this year has been in the borderland between relativity theory and quantum theory. For some years, the position was that not much further progress in relativity theory could be expected until the quantum theory advanced to meet it; but now the two theories are in contact, and Dirac's linear wave equation seems to provide a bridge between them. This gives a strong hint as to the direction in which relativity theory should be extended in order to cope with atomic phenomena. Following the hint, I have been working on the relativity side of the bridge, using as additional clues the values of the absolute constants of Nature. Attention was at first confined to the fine-structure constant 137; but lately further insight has been obtained from the cosmical constant and the mass-ratio of the proton and electron. The work is, I hope, progressing towards the direct formulation of a 'geometry' from which these constants will emerge naturally.

Dec. 29, 1873.—Prof. H. STANLEY ALLEN, F.R.S., professor of natural philosophy and director of the Physics Research Laboratory in the United College of the University of St. Andrews.

Since my induction in 1923 to the St. Andrews chair —described on its foundation as a chair of natural and experimental philosophy—my work has been concerned mainly with quantum theory and with spectroscopy. My interest in the historical and philosophical aspects of natural philosophy has increased of late years, and a small volume dealing with recent developments in atomic physics is now passing through the press.

The new laboratory opened by Sir William Bragg in 1925 has provided opportunity for experimental research by zealous helpers on the subject of band spectra, the secondary spectrum of hydrogen in particular. The request from the Editor of NATURE for a statement as to the chief investigations now in progress reached me two days after the disastrous fire in the chemical and physical laboratories. Apparatus for physical investigation and for advanced students has been to a large extent destroyed, and for the moment experimental research is at a standstill.

My hopes for the future may be expressed in a sentence familiar throughout Scotland—*nec tamen consumebatur*.

Dec. 29, 1878.—Dr. W. D. LANG, F.R.S., Keeper of the Department of Geology in the British Museum (Natural History).

While the neontologist sees the organic world as a single cross-section, the palæontologist views it as a series of superposed cross-sections, and seeks morphological series collected from consecutive strata, series which, when he has applied certain safeguards, he may have reason to suppose approximate to true lineages. He is thus able, with suitable material, to test the evidence afforded by individual growth-stages and their bearing on recapitulation. Further, in so far as his series represent true filiations, their terms show by what changing characters evolution can be traced. They also call in question the selection-value of characters. Lineages, again, show trends, in following which characters of parallel lineages are seen to run similar courses, and those of one lineage often to run their course regardless of the stage reached by other characters of the same lineage—facts which, again, bear upon the theory of evolution by means of natural selection.

Palæontological investigation, therefore, should, I think, be carried out along the lines of bed-by-bed collecting; of tracing lineages; of noting growth-stages; and of observing trends and the evolutionary history of individual characters; and, whether investigating Palæozoic corals, Cretaceous Polyzoa, or the faunal succession of the Dorset Lias, I have followed, and continue to be guided by, these methods of research.

Dec. 30, 1850.—Dr. WILLIAM GARNETT, formerly educational adviser to the London County Council.

While at Newcastle I was almost wholly occupied with the development of the College of Science into a complete university college. I also gave considerable attention to electrical engineering, and as honorary electrical engineer to the Royal Jubilee Exhibition of 1887, I arranged the first public display of the Parsons turboelectric generators, lighting therewith by means of high-power incandescent lamps a floor area of three acres. At the same Exhibition I exhibited for the first time a colliery engine plane with full-sized tubs electrically driven on a main and tail rope.

After entering the service of the L.C.C. in 1893, my time was so completely occupied in educational administration that it was impossible for me to carry out original work. My main object was to secure that the polytechnics should not be congeries of independent science and art classes, but organised educational institutions with competent principals, and teachers paid by fixed salaries and not on the examination results of their own classes.

Societies and Academies.

LONDON.

Society of Public Analysts, Dec. 2.—H. W. Buston: A micro-method for the determination of uronic anhydride groups in pectic substances. The method involves distillation with dilute hydrochloric acid and measurement of the resulting carbon dioxide. The process is complete in 60-70 min., and the results are as accurate as those given by the macro process.—N. E. Cocchinaras: The composition of linseed oil. From the results of bromination experiments it is concluded that the linolenic acid of linseed oil is present in only one isomeric form, namely, that yielding the crystalline hexabromide. Less than two per cent of oleic acid was found, and the solid fatty acids were proved by fractional distillation to consist only of palmitic and stearic acid.—T. Hedley Barry: Oil from Malayan *Aleurites Montana* and the properties of Hong Kong oil. Oil from the seeds of *Aleurites Montana* from the Malay States had an abnormal refractive index, which was lower than any recorded for the oil of *A. Fordii*. It also gave abnormal results in the polymerisation test.—S. G. Clarke and W. N. Bradshaw: The calcium fluoride method for the determination of fluoride, with special reference to the analysis of nickel-plating solutions. In the presence of an excess of calcium chloride to reduce the solubility of the precipitate, calcium can be quantitatively precipitated as calcium fluoride without simultaneous precipitation of calcium carbonate. Iron does not interfere if it is first reduced to the ferrous condition by means of hydrazine, and the adsorption of calcium sulphate is largely prevented by the presence of ammonium chloride, which increases the solubility of the calcium sulphate.

DUBLIN.

Royal Irish Academy, Nov. 30.—C. H. Rowe: A characteristic property of systems of paths. Unless a system of curves in a space of N dimensions ($N>2$) consists of the paths of a linear connexion, the subspace generated by the curves that issue from a point in the directions of a linear vector-space will in general have a singularity at this point, the second partial derivatives of the functions involved in its parametric representation being discontinuous there.

PARIS.

Academy of Sciences, Nov. 16.—Jules Drach: The determination of the linear elements for which there exists a triangular network of geodesics. Generalisations.—J. Costantin, P. Lebard, and J. Magrou: The influence of a period in the mountains on the productivity of the potato. Tubers of potato from healthy plants previously cultivated at a height of 1650 metres have given better developed and higher yields than similar tubers of the same origin but from plants cultivated at a low level in the preceding year.—A. Lumière and A. Seyewetz: The preparation of fine grain negative images by development. Normally, the size of grain of the negative developed in the usual way is a function of the initial size of the particles of silver bromide forming the sensitive emulsion. Paraphenylenediamine, in presence of caustic alkalis or carbonates, behaves like other developers from this point of view, but under certain conditions (feeble alkalinity) may give images with much finer grain than those of the initial emulsion. A formula of a suitable developer is given, together with reproductions of the same plate (×500) with two developers showing difference in grain size.—E. Mathias: Ascending flashes of lightning.—Al. Pantazi: Certain projective properties of families of surfaces.—P. J. Myrberg: Systems of functions which admit of a theorem of algebraical addition.—M. Ghermanesco: The successive means of an n-metaharmonic function.—L. Goldstein: The quantic mechanics of various simple photo-chemical processes.—G. Déchène: Peculiarities of lead chloride semi-conducting cells.—Garrigue: The electrical conductivity of acetone with a continuous current.—J. Jaffray: Some properties of thermocouples in a vacuum. Two types of thermocouples designed for the measurements of weak alternating currents were studied. The relation between the intensity of the heating current (I) and the deviation of the galvanometer receiving the thermocurrent produced (D) was found to be $D = KI^n$, where n was approximately 2.—R. Freymann: The infra-red absorption spectra of mixtures of organic liquids; the hypothesis of an electrolytic dissociation for these mixtures.—C. Haenny: The magnetic double refraction of paramagnetic salts in aqueous solutions. Utilising the large Bellevue electromagnet, the results of Elias on the magnetic double refraction of solutions of erbium nitrate were confirmed. Solutions of cerous nitrate give very high magnetic double refraction of negative sign.—R. Toussaint: The measurement of fluorescence with a photoelectric cell.—M. Bourguel: The influence of substitutions on the frequency of the ethylene line.—A. Perret and R. Perrot: The hydrolysis of nitrosyl chloride and of nitrogen peroxide by caustic potash. These reactions are shown to depend on the concentration of the solution of caustic potash. Nitrosyl chloride gives not only nitrite and chloride but also nitric oxide, the latter in proportions varying from 9 per cent to 42 per cent of the total nitrogen. Nitrogen peroxide also gives some nitric oxide when absorbed in potash solution.—Raymond Quelet: Paramethoxymethyl-benzoic aldehyde.—L. Palfray, S. Sabetay, and Mlle. Denise Sontag: The dehydration of phenylglycol by potash.—A. Demay: The Hercynian tectonic of the southern Cevennes and of the Rouergue district.—A. Dauvillier: The synthesis of the polar aurora.—J. Imbrecq: Globular lightning with multiple explosions.—M. Bridel and Mlle. C. Bourdouil: The evolution of the glucides in the course of the formation of the seed of two varieties of pea.—A. Guilliermond: The frequent existence of specialised vacuoles in the anthocyanine cells.—Ch. Rousseau: The presence of zooxanthellæ in Æolidia.—Emile F. Terroine, A. Giaja, and L. Bayle: The formation of creatine and purin bodies of urine at the expense of proteid materials.—J. Errera, H. Vogels, and L. Hauss: Animal and plant proteids. Electrometric analysis.—Octave Bailly and Roger Netter: The isolation of carotene from the suprarenal glands. From 30 kilograms of suprarenal capsules (ox) 0·3 grams of pure carotene was isolated, or 100 mgm. per kilogram of fresh glands. Its identity with plant carotene was established.—Ugo Lumbroso: Inoculation of the monkey with strains of bacteria isolated from Tunisian cases of trachoma.

GENEVA.

Society of Physics and Natural History, Oct. 22.—A. Brun: (1) The apparent dispersion of the optical axes in peridote and the measurement of $2V$. The author has measured the angle of the axes and the dispersion, eliminating the causes of error arising from the index of the liquid medium and the radiation employed. The examination of the dispersion curves peculiar to the peridote and to the bromonaphthaline show that the radiation 4870 A. to 4880 A. gives the most exact value of the angle $2V$. The author finds $2V_\rho > 2V_v$ and for the line H_β (4861A.), $2V = 87° 40'$.—(2) The separation of the *ng* and *np* ultra-violet spectra refracted by a doubly refracting prism. The author separates the *ng* and *np* spectra of a prism by passing them through a calcite prism, the edge of which is normal to that of the prism studied (zircon, beryl, peridote). He has proved that colourless zircon is as transparent for the ultra-violet as quartz.—A. Jayet and G. Amoudruz: The discovery of Magdalenian deposits near Frangy (Haute Savoie). At Douattes, near Frangy, the remains recently discovered occur in two levels. The lower, of Magdalenian age, has furnished flints and bones of mammals. In the upper level, probably of neolithic age, pottery appears. This deposit appears to connect the Magdalenian deposits of Ain with those of Veyrier.

Diary of Societies.

TUESDAY, DECEMBER 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: The Universe of Light (Christmas Lectures) (1): The Nature of Light.

WEDNESDAY, DECEMBER 30.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College), at 5.

THURSDAY, DECEMBER 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: The Universe of Light (Christmas Lectures) (2): Light and the Eye.

FRIDAY, JANUARY 1.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.

SATURDAY, JANUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir William Bragg: The Universe of Light (Christmas Lectures) (3): Light and Colour (1).

Public Lectures.

MONDAY, JANUARY 4.

ROYAL GEOGRAPHICAL SOCIETY, at 3.30.—The President: South and East (Christmas Lecture for Young People).

WEDNESDAY, JANUARY 6.

UNIVERSITY COLLEGE, at 3.—Sir Richard Gregory, Bt.: Comets and Shooting Stars.

BELFAST MUSEUM AND ART GALLERY, at 8.—Mrs. H. Richardson: Costume and History.

Annual Meeting.

JANUARY 4 AND 5.

MATHEMATICAL ASSOCIATION (at London Day Training College).

Monday, Jan. 4, at 3.30.—Sir Arthur Eddington: The Decline of Determinism (Presidential Address).

At 5.—Prof. S. Brodetsky: Modern Dynamics in Astronomy, Relativity, and Quantum Theory.

Tuesday, Jan. 5, at 10 A.M.—Discussion on The Report of the Association of University Teachers on Entrance Tests and Initial Degrees.

At 11.15 A.M.—Dr. S. Verblunsky: The Foundations of Mathematics.

At 12.15.—Prof. A. Lodge: Interpolation by Central Differences.

At 2.30.—G. Frecheville: The Application of Mathematical Methods to Research Work in Agricultural Economics.

At 3.30.—Discussion on Calculus and Co-ordinate Geometry at the School Certificate Stage, with special reference to the Additional Mathematics Syllabus of the Joint Matriculation Board of the Northern Universities.

Conferences.

DECEMBER 29 TO JANUARY 1.

SCIENCE MASTERS' ASSOCIATION.

Tuesday, Dec. 29 (at King's College for Women), at 8.15.—Dr. C. Norwood: Presidential Address.

Wednesday, Dec. 30 (at Imperial College of Science and Technology), at 10.15 A.M.—Prof. J. Thorpe: The Schools and Research (Lecture).

At 11.45 A.M.—Discussion on The Correlation of Mathematics and Science.

At 5.30.—E. G. Savage: Demonstration of Experiments on Colour.

At 6.15.—F. A. Meier: Lecture-Demonstration.

(At King's College for Women), at 8.15.—Dr. G. C. Simpson: Modern Weather Forecasting (Lecture).

Thursday, Dec. 31 (at Imperial College of Science and Technology), at 10 A.M.—Discussion on The Size of Classes for Practical Work in Science.

At 11.30 A.M.—Lecture-Demonstration by the Television Society.

At 5.30.—F. A. Meier: Lecture-Demonstration.

At 6.15.—E. G. Savage: Demonstration of Experiments on Colour.

(At King's College for Women), at 8.15.—Prof. E. W. MacBride: The Inheritance of Acquired Characters (Lecture).

JANUARY 4 TO 11.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College).

Monday, Jan. 4, at 3.—Sir William Rothenstein: Presidential Address.

At 5.—Dr. E. Miller: The Difficult Child: Sociological *v.* Individual Interpretations (Lecture) (British Psychological Society—Education Section).

Tuesday, Jan. 5, at 2.30.—Discussion on The Film as an Instrument of Humane Education (University of London Animal Welfare Society).

At 3.—J. H. Whitehouse: Public Schools and the Public Life (Lecture) (Society for Experiment and Research in Education).

Wednesday, Jan. 6, at 3.—Sir Richard Gregory, Bt.: Comets and Shooting Stars (Lecture) (School Nature Study Union).

At 5.30.—Prof. D. Laurie: Biology in Schools (Lecture) (Association of Assistant Mistresses).

Thursday, Jan. 7, at 2.30.—Mrs. C. B. S. Hodson: Desirability of including Simple Biology and Heredity Teaching in the School Curricula (Lecture) (Eugenics Society).

Friday, Jan. 8, at 2.—Discussion on Physical Education in Schools (Medical Officers of Schools Association).

JANUARY 6 TO 11.

GEOGRAPHICAL ASSOCIATION (at London School of Economics).

Wednesday, Jan. 6, at 9.30 A.M.—Opening of Publishers' Exhibition and Address by Miss E. H. McLean.

At 11 A.M.—Discussion between the Historical Association and the Geographical Association: What is Historical Geography?

At 2.—Sir Leslie Mackenzie: A Health Administrator's Attitude to Geography (Presidential Address).

At 5.30.—S. A. S. Hozayen: The Expansion of the Arabs and their Contribution to Geography (Lecture).

Thursday, Jan. 7, at 11 A.M.—Mrs. H. Ormsby: The Part played by the Limestones in the Human Geography of France (Lecture).

At 12.—J. Fairgrieve: Demonstration Lesson with Films.

At 2.—Demonstration of Amateur Films.

At 3.—J. Fairgrieve: The Use of Films in Teaching.

At 5.—Prof. P. F. Kendall: How Britain became an Island (Lantern Lecture).

Friday, Jan. 8, at 10.30 A.M.—Brigadier H. S. L. Winterbotham: New Developments of the 1″ Map (Lantern Lecture).

At 11.30 A.M.—Prof. Gerhard Schott: The Humboldt Current in Relation to Land and Sea Conditions on the Peruvian Coast (Lantern Lecture).

At 2.45.—Discussion on The Difficulties of using the Lantern in Primary Schools.

Discussion on The Scope and Content of the Geography of the 'rest of the world' in the First School Certificate Examination.

Exhibition.

JANUARY 5 TO 7.

EXHIBITION OF SCIENTIFIC INSTRUMENTS AND APPARATUS (at Imperial College of Science and Technology), 3 to 6 and 7 to 10.

Tuesday, Jan. 5, at 8.—C. C. Paterson: Photocells: The Valves which operate by Light (Lecture).

Wednesday, Jan. 6, at 8.—T. Smith: Photographic Shutters and their Properties (Lecture).

Thursday, Jan. 7, at 8.—Sir Oliver Lodge: Reminiscences (Lecture).

Official Publications Received.

BRITISH.

Leeds University: Department of Pathology and Bacteriology. Annual Report by Prof. Matthew J. Stewart and Prof. J. W. McLeod; with Abstract Report on Experimental Pathology and Cancer Research, by Prof. R. D. Passey. Pp. 15. (Leeds.)

Annual Report for the Year 1930 of the South African Institute for Medical Research, Johannesburg. Pp. 81+3 plates. (Johannesburg.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1410 (Ae. 531—T. 3095): Experiments on the Flow Past a Rotating Cylinder. By A. Thom. Pp. 13+13 plates. 1s. net. No. 1404 (Ae. 525—Spin 62): Free-Flight Spinning Experiments with Several Models. By A. V. Stephens. Pp. 12+10 plates. 1s. net. No. 1405 (Ae. 526—T. 3108): The R.A.E. Automatic Observer Mark IA. By D. A. Jones. Pp. 6+6 plates. 1s. net. No. 1407 (Ae. 528—T. 3045a): Note on Change of Wind with Height. By L. W. Bryant. Pp. 8+2 plates. 6d. net. No. 140 (Ae. 530—T. 3135): The Drag of Small Streamline Bodies. By E. Ower and C. T. Hutton. Pp. 7+3 plates. 6d. net. (London: H.M. Stationery Office.)

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Forestry Society. Vol. 45, Part 2, October. Pp. xvi + 121-248+27-34. (Edinburgh: Douglas and Foulis.) 7s. 6d.

The South-Eastern Naturalist and Antiquary: being the Thirty-sixth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirty-sixth Annual Congress, held at Winchester 1931. Edited by A. F. Ravenshear. Pp. lxii+117. (London.) 5s. net.

Ministry of Agriculture and Fisheries. Report on the Work of the Research and Education Division for the Year 1929-30. Pp. 76. (London: H.M. Stationery Office.) 1s. 3d. net.

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Thirty-fifth Session adopted at the Annual Meeting of Governors held on the 20th October 1931. Pp. 76. (Glasgow.)

Second Annual Report of the National Smoke Abatement Society. Pp. 24. (Manchester.)

Royal Agricultural Society of England. Agricultural Research in 1930. Pp. vii+201. (London: John Murray.) 1s.

The Scientific Proceedings of the Royal Dublin Society. Vol. 20 (N.S.), No. 13: On Alginic Acid; its Mode of Occurrence and its Constitution. By Dr. Thomas Gillon and Annie McGuinness. Pp. 129-133. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.). 6d.

Proceedings of the University of Durham Philosophical Society. Vol. 8, Part 4, July. Pp. iv+281-358+viii. (Durham.) 5s.

The Quarterly Journal of the Geological Society of London. Vol. 87, Part 4, No. 348, November 16th. Pp. 551-686+xv. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

Nutrition Abstracts and Reviews. Issued under the direction of the Imperial Agricultural Bureaux Council, the Medical Research Council, and the Reid Library. Vol. 1, Nos. 1 and 2, October. Pp. 351+xi. (Aberdeen: Imperial Bureau of Animal Nutrition.) 13s. net.

Transactions of the Royal Society of Edinburgh, Session 1930-1931. Vol. 51, Part 2, No. 20: Note on Cayley's Elimination-problem involving Superfluous Data. By Sir Thomas Muir. Pp. 162-168. 9d. Vol. 51, Part 2, No. 21; Studies in the Scottish Marine Fauna—The Crustacea of the Sandy and Muddy Areas of the Tidal Zone. By R. Elmhirst. Pp. 169-176. 9d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Transactions of the Institute of Marine Engineers, Incorporated, Session 1931. Vol. 43, No. 10, November. Pp. 449-504+xlii. (London.)

Proceedings of the Eighteenth Indian Science Congress, Nagpur, 1931 (Third Circuit). Pp. xli+543. (Calcutta: Asiatic Society of Bengal.)

Journal of the Indian Institute of Science. Vol. 14A, Part 7: The Origin and Nature of the Peaty Soils of Travancore. By T. R. Narayana Pillai and V. Subrahmanyan. Pp. 99-117. 1 rupee. Vol. 14A, Part 8: The Relation between Seeds and Micro-organisms. By T. R. Sathe and V. Subrahmanyan. Pp. 119-139. 1.4 rupees. (Bangalore.)

What is "Probable Error"? By Dr. J. F. Tocher. Pp. 63. (London: Institute of Chemistry.)

Journal of the Chemical Society. November. Pp. iv+2829-3088+viii. (London.)

Nigeria. Annual Report of the Geological Survey for the Year 1930. Pp. 43. (Lagos: C.M.S. Bookshop; London: The Crown Agents for the Colonies.) 4s.

University of Cambridge: Solar Physics Observatory. Nineteenth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1930 August 1-1931 July 31. Pp. 5. (Cambridge.)

Report of the Ninth Conference of the International Federation of Eugenic Organisations, Farnham, Dorset, September 11th to 15th, 1930. Pp. 100. (London.)

Physics in Industry. Lecture No. 16: Physics in Relation to the Development of the Internal Combustion Engine, given before the Institute of Physics on May 19, 1931. By Alan E. L. Chorlton. Pp. 32. (London.)

Journal of the Royal Society of Western Australia. Vol. 16, 1929-1930. Pp. xx+85+xxi-xxxv. (Perth.) 15s.

The North of Scotland College of Agriculture. Report on the Work of the North of Scotland College for the Year 1930-31. Pp. 30. (Aberdeen.)

India: Meteorological Department. Scientific Notes, Vol. 3, No. 29: The Bengal Cyclone of September 1919. By V. Doraiswamy Iyer. Pp. 119-129+8 plates. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2s.

Livingstone College. Annual Report and Statement of Accounts for the Year 1930-31. Pp. 24. (London: Leyton, E.10.)

Transactions and Proceedings of the New Zealand Institute. Vol. 62, Part 2, September. Pp. iii+67-178+plates 9-25. (Dunedin.)

FOREIGN.

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 14, No. 5, September. Pp. 195-250. (Tokyo and Kyoto: Maruzen Co., Ltd.) 1.30 yen.

Japanese Journal of Astronomy and Geophysics. Transactions and Abstracts, Vol. 9, No. 1. Pp. 75+5. (Tokyo: National Research Council of Japan.)

Proceedings of the United States National Museum. Vol. 79, Art. 22: The Stegocephalid and Ampeliscid Amphipod Crustaceans of Newfoundland, Nova Scotia and New Brunswick in the United States National Museum. By Clarence R. Shoemaker. (No. 2888.) Pp. 18. Vol. 79, Art. 34: Flies of the Genus Pseudotephritis Johnson (Diptera: Ortalidae). By John R. Malloch. (No. 2900.) Pp. 6. (Washington, D.C.: Government Printing Office.)

Field Museum of Natural History. Anthropology Memoirs, Vol. 1, No. 3: Report on Excavations at Jemdet Nasr, Iraq. By Ernest Mackay. (Field Museum-Oxford University Joint Expedition.) Pp. 217-303+plates 63-80. (Chicago.)

Memoirs of the San Diego Society of Natural History. Vol. 1: Catalogue of the Marine Pliocene and Pleistocene Mollusca of California and adjacent Regions, with Notes on their Morphology, Classification and Nomenclature, and a Special Treatment of the *Pectinidae* and the *Turridae* (including a few Miocene and Recent Species); together with a Summary of the Stratigraphic Relations of the Formations Involved. By U. S. Grant, IV., and Hoyt Rodney Gale. Pp. 1036 (32 plates). (San Diego, Calif.) 8 dollars.

Smithsonian Miscellaneous Collections. Vol. 85, No. 6: Morphology of the Insect Abdomen. Part 1: General Structure of the Abdomen and its Appendages. By R. E. Snodgrass. (Publication 3124.) Pp. 128. Vol. 85, No. 8: Modern Square Grounds of the Creek Indians. By John R. Swanton. (Publication 3126.) Pp. 46+5 plates. (Washington, D.C.: Smithsonian Institution.)

Sudan Notes and Records. Vol. 14, Part 2. Pp. iv+105-197+15 plates. (Khartoum: Sudan Notes and Records; London: Sudan Government Office.) 30 P.T.; 6s.

Journal of the Faculty of Science, Imperial University of Tokyo. Section 4: Zoology. Vol. 2, Part 4. Pp. 225-447. 3.30 yen. Vol. 3, Part 1. Pp. 90. 1.60 yen. (Tokyo: Maruzen Co., Ltd.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 73: Über die Herstellung und die mechanischen Eigenschaften der Al-Cu-Si Legierungen. Von Masaharu Goto, Sin-ichi Fukuta, Sadao Horiguchi und Tenji Nagai. Pp. 141-217. 0.56 yen. No. 74: Action of Antioxygens in the Oxidation of Unsaturated Fatty Oils. 3: The Relation between the Induction Period in Oxidation and the Catalytic Effect of Driers. By Bunnosuke Ramaguchi. Pp. 219-235. 0.16 yen. No. 75: Action of Antioxygens in the Oxidation of Unsaturated Fatty Oils. 4: Oxidation of Triolein. By Bunnosuke Yamaguchi. Pp. 237-250. 0.14 yen. (Tôkyô: Koseikai Publishing House.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 83. The Miocene and Recent Mollusca of Panama Bay. By H. A. Pilsbry. Pp. 427-440. A Small Collection of Fishes from Singapore. By Henry W. Fowler. Pp. 443-448. (Philadelphia.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry), Vol. 20, No. 4. Pp. 489-648. (Tokyo and Sendai: Maruzen Co., Ltd.)

Publications de l'Observatoire Astronomique de l'Université de Belgrade. Tome 4: Annuaire pour l'an 1932. Rédigé par V. V. Michkovitch. Pp. 91. (Beograd.)

U.S. Department of Agriculture. Circular No. 189: Control of the Satin Moth by Spraying in Alternate Years. By C. W. Collins and Clifford E. Hood. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents.

Japanese Journal of Geology and Geography. Transactions and Abstracts, Vol. 9, Nos. 1 and 2, September. Pp. ii+142+8+11 plates. (Tokyo: National Research Council of Japan.)

U.S. Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 131: Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1931. Pp. ii+50. 15 cents. Research Paper No. 354: The Passage of Gas through the Walls of Pyrometer Protection Tubes at High Temperatures. By Wm. F. Roeser. Pp. 485-494. 5 cents. (Washington, D.C.: Government Printing Office.)

Bulletin of the American Museum of Natural History. Vol. 63, Article 1: The Upper Zonal Bird-Life of Mts. Roraima and Duida. By Frank M. Chapman. Pp. 135. (New York City.)

Smithsonian Institution: United States National Museum. Bulletin 100: Contributions to the Biology of the Philippine Archipelago and adjacent Regions. Four New Species of Polychaetous Annelids collected by the United States Fisheries Steamer *Albatross* during the Philippine Expedition of 1907-1910. By Aaron L. Treadwell. Pp. 313-321. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 80, Art. 1: Observations on the Growth Rate of the Foot in the Mound Birds of the Genus Megapodius. By Herbert Friedmann. (No. 2901.) Pp. 4. (Washington, D.C.: Government Printing Office.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 20, No. 2: The Flora of the Revillagigedo Islands. By Ivan M. Johnston. Pp. 9-104. (San Francisco.) 1.25 dollars.

Collection des travaux chimiques de Tchéchoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 3, No. 11, Novembre. Pp. 517-562. (Prague: Regia Societas Scientiarum Bohemica.)